Managing Natural Resources for Development in Africa

A Resource Book

Edited by:

Washington Ochola

Pascal Sanginga

Isaac Bekalo

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Foreword

Natural Resource Management is faced worldwide with an accelerating transformation. In Africa, advances in science and technology, shifting consumption patterns, continuing population growth, trade globalization, frictions in subsidy regimes, and the impacts of local and global environmental change are leading to new and serious risks to sustainable management of water systems, land, forests, rangelands and other natural resources. The complex and dynamic context of natural resource use in Eastern, Central and Southern Africa, necessitates integrated and community based approaches which must be part of the training of future researchers, policy makers, academicians and natural resource scientists.

In our times, environmental and natural resource problems have increasingly come to the fore globally and the science of sustainable natural resource management as well as prudent policy making are vital for development of countries that are largely natural resource-based. Whether in discerning development options for national and regional level targets, the list of NRM issues has expanded beyond traditional concerns of biophysical processes in air, land and water to new frontiers of integrated natural resource management and mainstreaming of global climate change. Today's concerns have begun to clash with the traditional extraction-oriented management regimes; hence; the need for highly skilled professionals that facilitate use of our natural resources and environment in more innovative ways. The paradigm of resource management that guided our approach to these matters throughout the twentieth century is clearly unsuitable for addressing environmental problems that have become global in nature. Consequently, the treatment of natural resource issues from a cross-disciplinary and comparative perspective is integral to finding acceptable solutions for the fundamental and often contentious environmental and natural resource management problems that bedevil Africa’s development.

Africans’ livelihoods are closely linked to their access to and responsible utilization of natural resources. Majority of the region’s population live in the rural areas and are among the most vulnerable and insecure in terms of poverty, health, food security, economic losses, and conflicts resulting from competitive access to natural resources, among other factors. Integrated and community based approaches are pivotal to scientifically addressing the emerging challenges to natural resources management including increased frequency of resource-use conflicts and extreme climatic events. A crisp presentation of factual basis to influence community action and policy decisions is needed. Scientists and professionals have a role to play in this effort while graduate training through relevant natural resource management research and critical thinking is both paramount and very urgent.

With this in mind, the intent and organization of this resource book on *Managing Africa's Natural Resources for Development* is to provide an understanding of the various levels at which natural resource management issues occur and are being addressed scientifically, socially and politically. A central focus of the book, therefore, is its discussion of how Natural Resources Management (NRM) occurs through sound scientific basis, cases of good practices, and a series of student centered learning activities. In this way, the book provides a regional and integrated versus a solely state-centered and sectoral perspective. In addition, the authors have provided a detailed list of relevant reading material and companion web sources so that readers can remain appraised of current events and issues in natural resource management in Africa.

The production of the book has been made possible by the critical assistance of the International Development and Research Centre (IDRC) while the process has been facilitated by the International Institute of Rural Reconstruction (IIRR), Africa Office. The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) has been a close partner in the book writing processes and most of the authors in the various chapters are from RUFORUM member Universities). With the support of IDRC, IIRR coordinated a multi-stakeholder process to piece together concepts, theories, principles and cases from the region on natural resource management. The varied perspectives of the scientists and experienced authors were captured through a facilitated and participatory *writeshop* process. The *writeshop* was conducted as an open, transparent, representative and legitimate process.

The book is the outcome of a series of face-to-face and virtual collaborative writing and in-depth discussions including peer review and joint editing. It presents the state-of-the-art perspectives in natural resource management of local relevance and also includes information regarding NRM in a holistic context. The book systematically navigates the tricky landscape of integrated natural resource management with special reference to Eastern and Southern Africa especially in the backdrop of prevailing challenges of global and local environmental changes. The wide experience of the authors and the rich references made to emerging challenges and opportunities, the presentation of different tools, principles, approaches, case studies and the results and syntheses of process discussions, add value to the book's noble intent.

Managing Africa's Natural Resources for Development aims at presenting a holistic and advanced content on NRM consistent with demand for integrated approaches to resource custodianship and scientific rigor. The resource book and the process of its production has paid special attention to the current situation, issues and potential opportunities to redirect the current NRM system to realize adaptive research and policy support. It addresses, in a holistic manner, issues critical to integrating community participation, project management, gender, climate change adaptation and policy formulation. The theories, principles, conceptual frameworks and case studies presented in the book have been carefully chosen and contextualized to guide the reader through the art and science of NRM.

I believe that the book's presentations and treatment of NRM will be of interest to postgraduate students, policymakers, development practitioners, donors, academics and civil society, and will enrich our understanding of the various dimensions of natural resource management sustainability in our reading. I wish all readers a fruitful application of the concepts, principles, theories, frameworks and NRM science that have been ably presented by this ensemble of Africa's scientists.

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Preface

The challenges and prospects for "*Managing Natural Resources for Development in Africa*" are embedded in the mission and work of the International Development Research Centre (IDRC). Since its establishment in 1970s, IDRC has a long-standing reputation for supporting applied research on environment and natural resource management (NRM) in Africa and other developing countries. This is illustrated by the significant roles that IDRC played in the preparations of the 1987 World Commission on Environment and Development and the 1992 United Nation Convention for Environment and Development (the Earth Summit) that developed Agenda 21. IDRC was also instrumental in the establishment of international research organizations such as the World Agroforestry Centre (ICRAF) in Nairobi and provided consistent support to regional African networks such as the Africa Highlands Initiative, the Center for Environmental Economics and Policy in Africa, the International Union for Conservation of Nature, and many more, to develop innovative ways for the implementation of sustainable development agenda.

A key thrust of IDRC investments in the past four decades has been the emphasis of interdisciplinary, multi-stakeholder gender responsive participatory research approaches to natural resource management that recognize the competing demands on their use and conservation for social, economic and environmental benefits. In Africa and in other parts of the developing world, IDRC has supported applied research in the strategic areas of community-based natural resources management; rural development, land and water management; biodiversity, food systems, health and the environment, environmental economics and climate change adaptation. And we are pursuing our efforts.

Over the next five years, IDRC will continue to support research done by African scientists and their partners to confront the biggest challenges of the 21st century: food insecurity, climate change, water and energy scarcity, emerging infectious diseases and globalisation. Many of these challenges and opportunities require innovative integrated and multidisciplinary approaches. This book reflects these emerging challenges and demonstrates that African universities are prepared to contribute to meeting sustainable development goals of managing natural resources more effectively.

This book takes the field of NRM and its mainstreaming in African universities a major step forward. Its focus on contextualizing and adapting the theories, principles, frameworks, approaches and practices of NRM to African realities will contribute to enhancing the quality and relevance of university teaching and research standards; building stronger linkages between universities and training a new generation of African scholars, planners, policy- makers and development practitioners. I hope that many other universities and research programmes will be encouraged by this initiative, and inspired to become champions of transforming and innovating teaching, learning and research in African universities.

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This book is a co-publication of the International Development and Research Centre (IDRC), the International Institute of Rural Reconstruction (IIRR), the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), and the University of Nairobi Press. The editors would sincerely like to thank the following organizations and individuals for their invaluable contributions in the completion of this volume. While most of the names are mentioned in the list of contributors and *writeshop* participants, we owe special gratitude to:

- IDRC for providing the funding, which covered the costs for planning, conducting the *writeshop*, editing and printing of the book among others. It would not have been possible to produce a book of this volume without their generous support.
- The planning team, who conceptualized the content of the book, identified the organizations with relevant content, cases and authors and co-authors with relevant experience in the various topics. The quality of the initial planning had set the stage for the subsequent steps that proved successful.
- The steering committee members, who further helped shape the content of each chapter, identified new authors and reviewers. The steering committee guided the process and content systematically, and ensured quality. We are grateful for their guidance in the entire process.
- Authors and co-authors who tirelessly generated initial texts for each chapter and revised several times until the manuscripts were technically sound and had clear learning objectives and outcomes with practical cases relevant to eastern and southern Africa context. Writing together is difficult, but this group disproved this and we are proud that African professionals can unite to write.
- The peer reviewers who provided critical feedback at various stages of the manuscript have helped to polish the various chapters of the book. The initial draft was peer reviewed by selected university lecturers and PhD students who were assigned different chapters. We also thank the independent peer reviewer from the University of Nairobi Press who reviewed the entire manuscript and provided insightful comments to finalize the book. Having been reviewed by different professionals in the various subjects, and by students who represent the user community, the book has undergone through a sophisticated scrutiny of academic rigor. We thank each of the reviewers for their professional contribution.
- IDRC colleagues from the Rural Poverty and Environment programme (now Agriculture and Food Security) for their encouragement and enthusiasm in the initial discussions about disseminating research outputs.

Our gratitude also go to the several research partners whose project results and practical field experience have enriched the case studies, conceptual frameworks, study boxes and other learning materials throughout this book.

- IIRR staff who served as a secretariat and managed the entire process from inception to the completion of the project. This, among other, included organizing logistics, gathering relevant documents, validating needs for NRM resources book, conducting background research, setting agenda for various meetings, contracting different services, facilitating the planning workshops and *writeshop*. Coordination of such a complex project that involves several players is an enormous task. We thank each of the staff for their contribution towards the success of the project.
- The RUFORUM Secretariat for providing some cases for inclusion in selected chapters and allowing staff members to participate variously in the *writeshop*, review and editing processes of the book. As a network, RUFORUM offered a perfect platform from which authors and reviewers including students on regional programs were drawn and will be instrumental in the distribution and collation of feedback as the book gets used by postgraduate students and other NRM practitioners in the region.
- The various institutions that cooperated by sharing information, materials or allowed faculty to take part in the various activities. We would like to mention a few who we have made specially contributions. These include: the University of Nairobi, Egerton University, Kenyatta University, the University of Zimbabwe, the University of Malawi, Makerere University and the University of Dar es Salam, the World Agroforestry Center (ICRAF) and Africa Forest Forum.
- The *writeshop* participants who tirelessly worked day and night for 9 days writing, rewriting, editing and revising the various manuscripts and providing critical review across chapters and cases. It was during the *writeshop* that fundamental agreements were reached about the book. We are thankful for each of the participants that comprised of authors and coauthors, facilitators, graduate students, editors and logistic staff for their dedication and commitment during the long *writeshop* period.
- The two artists who redesigned most of the illustrations, diagrams, tables and charts in the book and the design of the cover page
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Finally, we thank our respective families for their understanding and support throughout the process of producing this book.

The Editors

Acronyms and Abbreviations

ADB	Asian Development Bank
ADMP	Adaptive Decision-Making Process
ADR	Alternative Dispute Resolution
AEZ	Agro Ecological Zones
AFOLU	Agriculture, Forestry and Land Use
AM	Adaptive Management
AO	Arctic Oscillation
ARIPO	Africa Regional Intellectual Property Organization
CAMPFIRE	Common Areas Management Programme for Indigenous Resources
CASS	Centre for Applied Social Sciences
CBA	Cost Benefit Analysis
CBD	Conservation on Biological Diversity
CBE	Community Based Enterprises
CBNRM	Community Based Natural Resource Management
CBO	Community Based Organization
CBR	Cost Benefit Ratio
CEDAW	Convention on the Elimination of all forms of Discrimination Against Women
CFC11 and CFC12	Chlorofluorocarbon 11 and 12
CGIAR	Consultative Group on International Agricultural Research
CIFOR	Centre for International Forestry Research
CIMMYT	International Maize and Wheat Improvement Centre
CM	Co-Management
CPM	Critical Path Method
CPR	Common Property Resource (Regime)
CRES	Compensation and Rewards for Environmental Services
DANIDA	Danish International Development Agency
DEAP	District Environmental Action Planning
DFID	Department for International Development
DPU	Development Planning Unit
EBRD	European Bank for Reconstruction and Development
EIED-SA	Economic Impact of Environmental Degradation in Southern Africa
EIA	Environmental Impact Assessment
EIB	European Investment Bank

ESA	Eastern and Southern Africa
FAO	Food and Agriculture Organization
FPR	Farmer Participatory Research
FSR	Farming Systems Research
GAD	Gender and Development
GAM	Gender Analysis Matrix
GDP	Gross National Product
GEC	Global Environmental Change
GED	Gender, Environment and Development
GEF	Global Environment Facility
GHGs	Greenhouse Gases
GID	Gender In Development
GIS	Geographic Information Systems
GISP	Global Invasive Species Programme
GLTFCA	Great Limpopo Trans-frontier Conservation Area
GPS	Global Positioning System
HASHI	Hifadhi Ardhi Shinyanga
IARC	International Agricultural Research Centre
ICDPs	Integrated Conservation and Development Projects
ICRISAT	International Crops Research Institute for the Semiarid and Arid Tropics
ICSU	International Commission for Science
IDF	Institutional Development Fund
IDRC	International Development Research Centre
IEA	International Energy Agency
IIED	International Institute for Environment and Development
IIRR	International Institute of Rural Construction
IISD	International Institute for Sustainable Development
IITA	International Institute of Tropical Agriculture
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
ILRI	International Livestock Research Institute
INRM	Integrated Natural Resource Management
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IPR	Intellectual Property Rights
IRR	Internal Rate of Return
ISFM	Integrated Soil Fertility Management
ITK	Indigenous Technical Knowledge
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
KFS	Kenya Forest Service

KM	Knowledge Management
LFA	Logical Framework Approach
LKMS	Local Knowledge and Management Systems
LTK	Local Technical Knowledge
LUMPs	Land Use Management Plans
M&E	Monitoring and Evaluation
MEA	Millennium Ecosystem Assessment
MDBs	Multilateral Development Banks
MDG	Millennium Development Goals
MERI	Monitoring, Evaluation, Reporting and Improvement
MLAF	Multilevel Analytical Framework
NAM	Northern Annular Mode
NAO	North Atlantic Oscillation
NARS	National Agricultural Research Systems
NACSO	Namibian Association of Community Based Natural Resources Management Support Organization
NEPAD	New Partnership for Africa's Development
NERICA	New Rice for Africa
NGO	Non-Governmental Organization
NIE	New Institutional Economic Theory
NPV	Net Present Value
NRM	Natural Resource Management
ODI	Overseas Development Institute
OECD	Organization for Economic Cooperation and Development
OM	Outcome Mapping
PA	Protected Area
PBM	Process-Based Management
PDO	Pacific Decadal Oscillation
PEAP	Poverty Eradication Action Plan
PERT	Project Evaluation and Review Technique
PES	Payment for Ecosystem Services
PFM	Participatory Forest Management
PGN	Practical Gender Needs
PLAR	Participatory Learning and Action Research
PM	Performance Management
PM&E	Participatory Monitoring and Evaluation
PNAP	Pacific North American Pattern
POP	People Oriented Planning
PPP	Polluter Pays Principle
PRA	Participatory Rural Appraisal
PVO	Private Voluntary Organizations
R&D	Research and Development

RAISE	Rural and Agricultural Incomes with a Sustainable Environment
RBM	Result Based Management
RDC	Rural District Council
REDD	Reduced Emissions from Deforestation and Forest Degradation
SAM	Southern Annular Mode
SES	Socio-Ecological Systems
SGN	Strategic Gender Needs
SIA	Social Impact Assessment
SL	Sustainable Livelihood
SRES	Special Report on Environmental Scenarios
SSA	Sub-Saharan Africa
SWC	Soil and Water Conservation
TA	Traditional Authority
TAC	Technical Advisory Committee
TK	Traditional Knowledge
TPLF	Tigrayan People's Liberation Front
UNCCD	United Nations Convention to Combat Desertification
UNCST	Uganda National Council for Science and Technology
UNDP	United Nations Development Programme
UNECA	United Nations Economic Community for Africa
UNEP	United Nations Environmental Programme
UNESCO	United Nations Education Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention for Climate Change
UNCED	United Nations Conference on Environment and Development
UNICEF	United Nations International Children Fund
UNU	United Nations University
USAID	United States Agency for International Development
VH	Village Headperson
WAD	Women And Development
WED	Women, Environment and Development
WID	Women In Development
WMA	Wildlife Management Areas
WMO	World Meteorological Organization
WRI	World Resources Institute

Introduction

P. C. Sanginga, I. Bekalo and W. O. Ochola

Why this Book on Managing Natural Resources for Development in Africa?

The complex and dynamic interlinkages between Natural Resources Management (NRM) and development have long been recognized by national and international research and development organizations and have generated a voluminous literature. However, despite this abundance of publications, research and development projects and policies in NRM in Africa, much of what is available in the form of university textbooks, practical learning manuals and reference materials in NRM, is still based on experiences from outside Africa. Thus, it is quite common to find learning materials that emphasize exotic animals or crops management systems that are inappropriate or have limited relevance to the African context and are unable to draw examples or case studies from the local environment. In addition, the curricula and learning materials in NRM are generally disciplinary and sectoral, far removed from the context, and inadequate for effective management of natural resources. It is not surprising therefore, that there is a huge gap between what is being taught in NRM and the generally observed practices especially by small-scale resource users, practitioners and policy makers. There is also clear disconnect between research, practice and policy on matters of natural resource management.

Many governments in Africa have expressed the urgent need to revitalize their university and tertiary education in agriculture and NRM as the number of African universities teaching agricultural and NRM sciences have grown tremendously over the last two decades. An increasing number of these universities now have dedicated postgraduate programmes on NRM, and all offer courses or course units on NRM. There are, however, apparent weakness in these programmes with regard to curricula, curricula delivery, research agenda setting, and staff capacity for teaching NRM. One of the critical areas of concern is the improvement of learning resources at graduate and postgraduate levels by incorporating materials and resources generated from interdisciplinary research, projects and local knowledge. It is evident that improving the learning systems in terms of content relevance and quality of delivery will influence many other areas of natural resource management research, practice and policy. New generations of African university graduates need better capacity to absorb, adapt and develop scientific and technical knowledge, to ensure research meets the needs and problems of the African continent.

In recognizing the weaknesses of past and current education systems, the Millennium Ecosystems Assessment (MEA), the African Environment Outlook (AEO) and the International Assessment of Agricultural Science and Technology for Development (IAASTD) argue that narrow disciplinary treatment of natural resources is sub-optimal in dealing with immense need for science-based and integrated, yet community-based technology development, dissemination, utilization and policy support.

This book originated from the awareness and concerns that the training of future researchers, academicians, policy makers, development workers and other professionals with direct and indirect influence on the natural resource users, has hitherto remained highly technical and insensitive to the complex and dynamic nature of natural resource management. The field of NRM and environmental sciences has expanded beyond the initial focus on conservation biology and ecology to embrace a multi-disciplinary orientation, systems thinking and sustainable development and livelihood approaches. This requires training of a new generation of NRM graduates who are able to deal with the complexity of natural resource systems. Previous graduates have generally lacked ability to influence community-based management regimes, projects and policy formulation processes in favour of sustainable NRM. This becomes particularly evident in the wake of crosscutting issues such as gender, governance, globalisation and emerging global challenges including climate change.

Grounded in research and teaching carried out by a variety of African scholars, academicians and experts working on different aspects of NRM in Africa, this book seeks to make some contribution to the teaching and learning about NRM and development in African universities. The book encourages a new way of thinking, teaching and learning that can ultimately improve current knowledge and practice of NRM in the quest of more sustainable and resilient socio-ecological systems. Instead of the common paradigm of despair about the degradation of natural resources, environmental crisis and poverty, the book seeks to demonstrate that more holistic and integrated approaches have the potential to integrate environmental concerns with improved livelihoods.

Managing Natural Resources for Development in Africa represents a collective endeavour to reframe, filter and contextualize some of the main concepts, theories and practices of NRM in the context of Eastern and Southern Africa. It aims to synthesize current knowledge, discuss approaches and perspectives to equip African graduates with the needed knowledge, skills and attitudes to respond to and shape changes in social-ecological systems in order to sustain the supply and availability of ecosystem services by society. The book links recent advances in the theories, concepts and principles of NRM with practical and topical exposition of community-based NRM, gender, climate change, project and programme management, policy and governance, and trans-disciplinary research in NRM.

Users and Uses of the Book

This book is written primarily as a resource book for graduate and postgraduate students and their lecturers, academics and researchers specialising in NRM. It can be used by undergraduate students for their advanced courses in NRM. Government planners, extension and local government staff, development professionals, facilitators and practitioners in development agencies and civil society organizations concerned with NRM and development will find many aspects of this book valuable resource in developing policies, designing and implementing NRM projects and programmes.

The chapters follow a sequence designed to help the reader, teacher and learner achieve a progressive mastery of the different concepts, theories and issues in the field of NRM. Care has, however, been taken to ensure that the book can be used flexibly and can easily adapt to the needs of particular courses, course units, modules, users and uses. Chapters can be selected and studied in any order, without much loss. Each chapter has been written as a fairly autonomous unit, with cross referencing to other chapters at relevant points. Each chapter has been structured to make the reading and learning as interesting and stimulating, yet systematic and academic, as possible.

The book is not about natural resources *per se* but about their management. It takes a holistic approach rather than a sectoral focus on specific natural resources – water, land, forest, wildlife, biodiversity, atmosphere, minerals. It takes a development perspective for natural resource management – a perspective based on a more holistic and integrated view of natural resources management for ecological integrity and human well-being in a continent that is experiencing rapid change and uncertainty. There is no abstract treatment of concepts and theories. Rather, they are debated and illustrated by means of concrete examples and case studies from NRM projects and experiences in the Eastern and Southern Africa (ESA) region. Learning activities and references for further reading are meant to stimulate discussion and make the teaching and learning as interactive and lively as possible, and to make this book particularly suitable for use in all courses of environment and natural resource management. Authors have tried to keep the writing style simple and direct, while adhering to the rigour of academic and scientific writing. All contributions have been peer reviewed and fully edited.

How this Book was Produced: The *Writeshop* Process

This book was initiated by a nucleus of African university lecturers and professionals in NRM, motivated by the desire to refocus and improve the quality, relevance and holistic aspects of learning and teaching materials in NRM based on

African knowledge and experiences. The book was produced by a multi-disciplinary team composed of university lecturers from the University of Nairobi, Egerton University, Kenyatta University, University of Zimbabwe, University of Malawi, Makerere University and University of Dar es Salam. In addition, selected NRM experts from regional and international research organizations including the World Agroforestry Centre (ICRAF), Africa Forest Forum, the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), the International Institute of Rural Reconstruction (IIRR) and the International Development Research Centre (IDRC) actively contributed in the development and production of the book.

The Writeshop Process

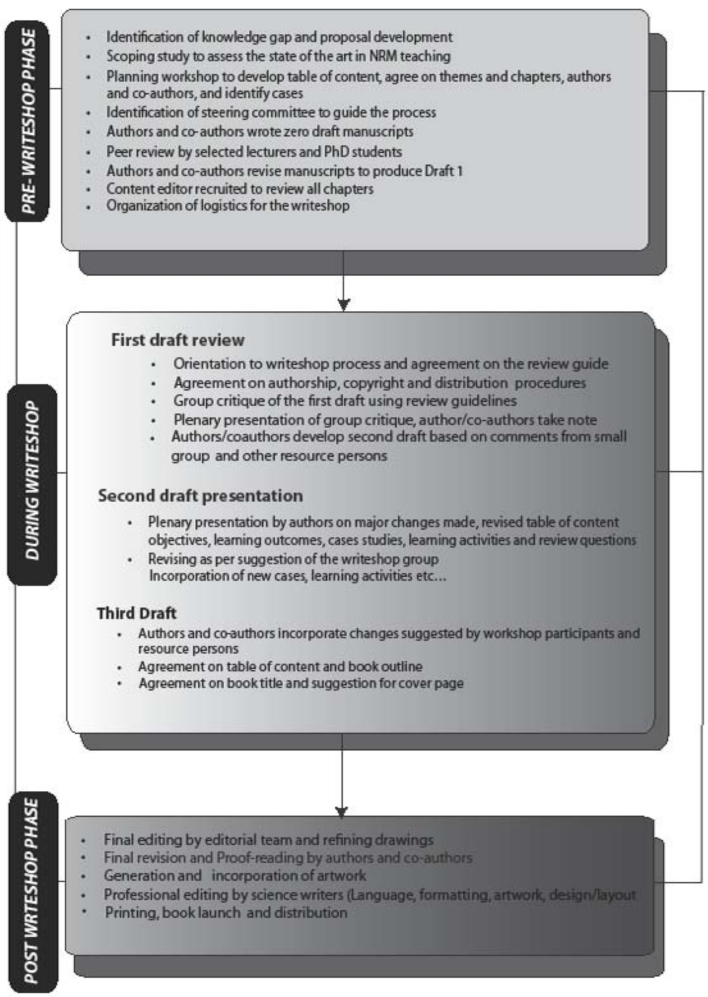
The book was produced through a *writeshop*. A *writeshop* is an intensive participatory workshop to write and learn to produce information materials and documentation about a particular topic. The *writeshop* process was pioneered by the IIRR to produce manuals, field guides, toolkits, training modules, and to simplify scientific and technical materials for development professionals and extension workers, although the manuals can also be used for teaching.

The *writeshop* process offers numerous advantages: A major advantage derives from the participation and contribution of a diverse range of experts and combining the skills of professional facilitators, editors, writers, illustrators and support staff in one forum. Moreover, when the process of content generation, drafting, editing, illustration, revision and feedback is conducted under the same roof, it provides a great opportunity for team work and mutual learning. The repeated presentations, critiquing and revision of drafts allow for papers to be reviewed and revised substantially and new topics to be developed during the *writeshop*; also topics to be combined, dropped or split into parts.

This critical and iterative feedback encourages interdisciplinary approaches and multiple perspectives on NRM. It is more useful than the external review process as it allows for in depth interactive and iterative peer review, peer learning and mentoring that enhances the quality and relevance of the product and creates a sense of collective ownership of the product. The *writeshop* also allows for vibrant exchange of ideas and focused development of themes – both during the *writeshop* and in the preparatory phase. Finally, by bringing together such a rich diversity of personalities, skills, views and experiences, the *writeshop* has proven to be ideal in forming enduring professional and personal relationships and building social and human capital necessary for networking.

The development of the book was a unique collective action process that adapted IIRR's *writeshop* model to the specific needs of producing a resource book for graduate students and university lecturers. This involved an intensive and rigorous process of planning, independent peer reviews, collective peer reviews, revisions and writings. Partnership with the RUFORUM, a consortium of 25 universities in

Eastern, Southern and Central Africa, was an important step forward to promote collaboration, networking, capacity building in the production of academic publications with local content to facilitate regional postgraduate training in Eastern, Central and Southern Africa. Another important partner in this process was IDRC whose "Grant Plus" approach goes beyond making financial contributions to support the process. IDRC placed a great emphasis at creating opportunities, connecting and engaging with researchers and university lecturers from complementary disciplines, and making intellectual contributions in a spirit of peer learning to confront the challenges of learning and teaching NRM in 21st century African universities. The following flow chart summarizes the adaptation process that was introduced to produce this resource guide for postgraduate students.



1. The first step was a needs assessment exercise to establish the demand and relevance for a graduate resource book in NRM. Scoping study was undertaken with lecturers and graduate students of selected universities offering NRM postgraduate programmes. Interviews were conducted with heads of departments, university lecturers, researchers and postgraduate students. A content analysis of the different programmes, modules and course units on NRM was also done. The results were presented to a steering committee and to a group of university lecturers and NRM researchers and practitioners who attended the planning workshop. The results of the needs assessment and scoping study clearly established a significant gap in NRM teaching and learning, and revealed a considerable interest and commitment to develop appropriate teaching and learning materials.
2. The second step involved a two-day planning workshop and several steering committee meetings and iterations with the authors and contributors and reviewers. During the planning workshop, participants were introduced to the *writeshop* process and were challenged to work as a team to jointly develop an outline and a detailed table of content for the text books relevant to African universities. A preliminary list of potential authors and contributors was also identified for the different chapters and case studies. A steering committee was selected to guide the process and ensure quality of the work.
3. In the third step, the contributing authors virtually developed their manuscripts which were peer reviewed by selected independent university lecturers, researchers and graduate students with relevant expertise in NRM. Each chapter was reviewed by two independent NRM experts from the biophysical and social sciences. Their comments were incorporated by the authors to revise their drafts prior to the workshop.
4. The fourth step was an intensive 8 day participatory *writeshop* process (April 22-29, 2010) in Nairobi, Kenya involving 25 authors, resource persons, facilitators, editors, university students and logistics staff. During the *writeshop*, the content editor presented general guideline for reviewing each chapter. Workshop participants worked in small, focused groups of four people from different disciplines, strengths and interests to review, critique each chapter and provide feedback to the lead author and co-authors. Reviewers' feedback for each chapter was presented in plenary to allow all participants to provide additional comments and link the different chapters in a logical flow. The lead authors and co-authors worked together, incorporated comments, and consulted other participants for additional materials and case studies in order to produce a second draft. The second draft was presented in plenary focusing further constructive feedback on the content, outline, illustrations, focus, expected outcomes, learning activities and summary. The authors used this collective feedback and critiquing to produce a third draft. At the end of the *writeshop*, the authors produced a

manuscript for each chapter that has benefited from independent peer review, revisions, collective review and contributions, and further revisions by the authors,

5. The fifth step was a collective editing of the different chapters and the entire book by the editorial team assisted by graphic artists. The team of four reviewed each chapter, cross referenced materials and produced the 4th edition. This edition was sent to original authors and contributors of each chapter where necessary, who had an opportunity to respond to queries by the editorial team and provide final inputs to their chapters before the book was sent for copy editing by professional language editors, and finally, for printing.
6. The sixth and last step concerned the publication, printing and distribution process of the book. The book was jointly co-published by IDRC, IIRR and RUFORUM and is available for free download on IDRC website, on CD ROMs and on hard copies. The book was further launched at the African Ministerial Meeting on High Education in Agriculture and Natural Resources Management and distributed to major universities with NRM programmes.

Content of the Book

The nine chapters contained in this book provide a comprehensive coverage of the major areas and issues of NRM for development.

Chapter One: Natural Resource Management and Development Nexus in Africa sets the stage for a holistic treatment of NRM and presents the book's underlying objective of managing natural resources for development. It introduces the concepts of sustainable development, sustainable livelihoods and natural resource management. It then presents an overview of the complexity of NRM and development linkages, highlighting the current state, challenges, opportunities and future outlook of NRM and development in Africa.

Chapter Two: Concepts, Theories and Principles of NRM introduces the key concepts, theories and principles for understanding the science about the fundamental interactions and processes in social-ecological systems-systems in which people interact with their physical and biological environment. The chapter introduces the concept of ecosystems and discusses functions, structures and dynamics of ecosystems as they relate to the management of natural resources. It introduces practical concepts such as resilience, the Millennium Ecosystem Assessment Framework, Compensation and Rewards for Ecosystem Services, and provides the conceptual basis for subsequent chapters.

Chapter Three: Integrated Natural Resources Management, presents holistic perspectives in Integrated Natural Resources Management (INRM) systems and explores the trends, drivers and tools for natural resources management particularly in sub-Saharan Africa. It provides an operational framework and tools for operationalizing INRM. Integrating multiple perspectives, multiple scales of analysis, inter-action and response, and multiple disciplines and involving multiple stakeholders with often contrasting objectives and activities.

Chapter Four: Community-Based Natural Resource Management, presents the theoretical basis, the conceptual frameworks and the underlying principles of Community-Based Natural Resource Management (CBNRM). The principles of the new institutional economics, common pool resources and collective action theories, and their applications in collaborative, adaptive management, are discussed. The chapter addresses some practical issues in designing and implementing CBNRM projects. These include strategies and mechanisms for conflict management and use of indigenous technical knowledge.

Chapter Five: Gender and Natural Resources Management, underlines the need for a gender-sensitive approach to NRM. It explores the relationships between gender and NRM in different sectors (land, water, biodiversity, forests, fisheries). The chapter discusses how gender can be mainstreamed in CBNRM, climate change, project management, policies and NRM research. It then gives an overview of the different frameworks for gender analysis in NRM. The chapter takes a gender, environment and development approach that is not only concerned with empowering women, but with the social constructions of gender and the roles, responsibilities, rights and expectations of both women and men in NRM and development.

Chapter Six: NRM in the Context of Climate Change synthesizes the science and state of knowledge on climate change, giving historical accounts of climate change and exploring future projects and climate change scenarios, and their impacts on the management of natural resources in Africa. The chapter discusses different options for community adaptation to climate change vulnerabilities. It explores NRM-based mitigation options with focus to mechanisms such as Reduced Emission from Deforestation and Degradation (REDD), carbon trade, biofuel production, biodiversity and Payment of Ecosystem Services (PES). It discusses climate change governance and the need for re-orientation of national level institutions to effectively bridge local and global level mechanisms for adaptation and mitigation of climate change.

Chapter Seven: NRM Project Planning and Management, reviews the concepts, principles and application of project planning and management in natural resources development. The chapter presents different frameworks and approaches for project design, implementation, monitoring and evaluation of NRM programmes and projects. It provides tools to guide the formulation of projects proposals and for managing NRM projects, including risk management and stakeholder engagement. The chapter reinforces the notion that designing, managing and evaluating NRM projects requires a continuous reflective adaptive learning and adaptive management approach. Innovative approaches and tools for stakeholder engagement in monitoring and evaluation such as result-based management frameworks, outcome mapping, participatory monitoring and evaluation are introduced in the chapter.

Chapter Eight: Policy and Governance in NRM, helps to understand the complexity of policy processes in NRM. It further describes the different policy instruments and governance institutions for formulating and implementing NRM policies at different levels. The chapter delves into the processes and tools of participatory policy development and decentralized governance of natural resources, and the processes and frameworks for formulation of local policies. It concludes with a section on linking NRM research to policy and presents some guiding principles for influencing policy change in NRM.

Chapter Nine: Research in NRM, takes an interdisciplinary perspective for designing and conducting applied research for NRM. The chapter reviews the historical perspectives and the different research approaches in NRM. It takes the reader through the entire process of research planning and management. The role of community participation in research and the approaches for eliciting and enhancing active stakeholder participation in the research process are further discussed. The chapter discusses approaches to data and knowledge management and for designing and implementing effective communication strategies to influence policy and practice.

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Natural Resource Management and Development Nexus in Africa

P.C. Sanginga, W. O. Ochola and I. Bekalo

Introduction

Poverty eradication, sustainable economic growth and environmental sustainability are the key pillars of development plans in most African countries. There is consensus that natural resources, especially those of land, soil, water, forest, plant and animal diversity, vegetation, renewable energy sources, climate change and ecosystems services are fundamental for improving livelihoods and achieving sustainable development in Africa. This is especially so if emerging market opportunities for adding value to natural resource goods and services can be accessible to the poor. However, how best to manage Africa's natural resources to improve livelihoods, reduce poverty and advance economic growth while maintaining and enhancing the sustainability and resilience of the natural resource base remains an elusive goal and daunting challenge for research, teaching, development practice, community actions and policy. Understanding and tackling this complex challenge demands creative, integrative and holistic approaches by multiple stakeholders, to bring multiple and complementary perspectives, knowledge and skills to facilitate a socially equitable, economically efficient and environmentally sound development.

This chapter aims to set the stage for a holistic treatment of NRM. It presents the book's conceptual roadmap. In the book, the terms *natural resources* and *environment* are used interchangeably. The term *environment* generally refers to a natural resource base that provides sources and performs sink functions (Bucknall, 2000). The chapter starts with an overview of the different perspectives on the linkages between NRM, poverty and development. The chapter introduces the concepts of sustainable development and sustainable livelihoods as a way of thinking about the objectives, scope and priorities for NRM to serve development purposes. The second part examines the state of NRM and development in Eastern and Southern Africa (ESA). Drawing from insights embedded in the book's nine chapters, the concluding part summarises some options for managing natural resources for development. The learning activities at the end of the chapter are meant to engage readers and students and encourage them to further explore critical issues and contextualize them in the challenges and opportunities of their specific countries.

Specifically, this first chapter aims to:

- Introduce the concept of *sustainable development* and *sustainable livelihoods* and its relationship to NRM, and different approaches and paradigms on the linkages between NRM and development.
- Examine the state of natural resources, their challenges, opportunities and prospects for sustainable development in Africa.
- Demonstrate how the management of natural resources contribute to livelihoods of people, communities and nations.
- Present some options for action to enhance the management of natural resources for the triple goals of livelihood improvement, economic growth and environmental sustainability.

After reading this chapter, readers should be able to understand and improve their knowledge in order to address the complex linkages between NRM and development, and address the goals of sustainable development. Readers will be aware of the multiple challenges and opportunities and prospects for managing natural resources for livelihood improvement and poverty reduction in Africa.

NRM, Poverty and Development Linkages

Natural resource management is defined here as a scientific and technical principle that forms a basis for *sustainable* management (conservation and use) and governance of natural resources such as land, *water*, *soil*, *plants* and *animals*, with a particular focus on how management affects the *quality of life* for both present and future generations. It is widely recognized that natural resources contribute significantly to development in different ways: as an economic activity and source of growth; as a livelihood, by providing jobs for people; and as a provider of environmental services that can have both good and bad outcomes (NEPAD, 2003; Comim *et al.*, 2009; Khan, 2008; IAASTD, 2009; Chowdhury and Ahmed, 2010). Chapter two discusses the linkages between ecosystem services and human well-being: the bundle of positive benefits that people obtain from natural resources.

NRM and the Millennium Development Goals

In 2000, the United Nations (UN) adopted the eight (8) Millennium Development Goals (MDGs), as the broad comprehensive and specific development goals the UN set for the world to achieve by 2015 (Box 1.1). They provide a framework for the entire international community to work together towards a common end – making sure that human development reaches everyone, everywhere. The MDGs are both global and local, customised by each country to suit their specific development needs. There is a specific MDG focusing on environmental sustainability (MDG7) that advocates for the integration of the principles of sustainable development into country policies and programmes to reverse the loss of environmental resources. MDG 7 has direct links and is critical for the attainment of all other MDGs. Sustainable management of natural resources contributes to poverty alleviation, helps reduce diseases and child mortality, improves maternal health, and can contribute to gender equality and universal education. Non-sustainable use of natural resources, including land, water, forests and fisheries, can threaten individual livelihoods as well as local, national and international economies. The environment can play a significant role in contributing to development and human well-being. It can also increase human vulnerability, causing human migration, insecurity and other health effects. Environmental scarcity can foster cooperation, but can also contribute to tensions or conflicts (UNEP, 2007).

Box 1.1: Millennium Development Goals

Goal 1: Eradicate extreme poverty and hunger

- Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day.
- Halve, between 1990 and 2015, the proportion of people who suffer from hunger.

Goal 2: Achieve universal primary education

- Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling.

Goal 3: Promote gender equality and empower women

- Eliminate gender disparity in primary and secondary education preferably by 2005 and at all levels of education no later than 2015.

Goal 4: Reduce child mortality

- Reduce by two thirds, between 1990 and 2015, the under-five mortality rate.

Goal 5: Improve maternal health

- Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio.

Goal 6: Combat HIV/AIDS, malaria, and other diseases

- Have halted by 2015, and begun to reverse, the spread of HIV/AIDS.
- Have halted by 2015, and begun to reverse, the incidence of malaria and other major diseases.

Goal 7: Ensure environmental sustainability

- Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources

- Reduce by half the proportion of people without sustainable access to safe drinking water
- Achieve significant improvement in the lives of at least 100 million slum dwellers by 2020.

Goal 8: Develop a global partnership for development

- Develop further an open, rule-based, predictable, non-discriminatory trading and financial system
- Address the least developed countries' special needs
- Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term.
- In cooperation with developing countries, develop and implement strategies for decent and productive work for youth.
- In cooperation with the private sector, make available the benefits of new technologies, especially information and communications technologies.

Source: UNEP, 2006

There is evidence that NRM influences health, maternal health, child mortality, malaria, HIV/AIDS and other diseases. It is estimated that at least 30% of the 18 million people who die annually, most of them women and children, are due to poverty-related causes (IDRC, 2010). In sub-Saharan Africa, about 35% of the total burden of disease is caused by natural resource degradation. Degradation of natural resources fosters conditions for disease outbreak and transmission. Deterioration of fresh water resources decreases water quality. This leads to increase in water-borne diseases, a significant cause of child mortality. Land degradation, soil erosion, droughts and floods directly contribute to food shortage and malnutrition, and all the direct and indirect effects on child mortality, maternal health, and other diseases such as malaria, decrease of immunity that exposes people to a host of infectious diseases.

A number of studies conducted in Eastern and Southern Africa, have unveiled the complex, multifactoral and bidirectional pathways and negative feedback loops between HIV/AIDS and NRM (for a review see Bolton and Talman 2010). Bolton and Talman having reviewed studies conducted in 10 African countries including Uganda, have reported that the fisher folk are both highly dependent on natural resources (fisheries) for their livelihoods and are highly vulnerable to HIV/AIDS, with rates ranging from 4 to 14 times more than the general population. In Kenya and Uganda, fisher folk had 5 times higher rates of HIV/AIDS than truck drivers and sex workers, two high-risk groups. While degradation of natural resources enhance vulnerability to HIV/AIDS, HIV/AIDS in turn increase reliance on natural resources to meet increasing household needs that arise from having to cope with the effects of HIV/AIDS, as HIV/AIDS leads to loss of human capital, depleted financial and physical capital, increased vulnerability of community-based NRM institutions, and affects funding of NRM initiatives to HIV/AIDS related costs.

One of the challenges in Africa's development is related to the rapid rate of degradation of natural resources due to a complex combination of factors. Such degradation reduces the natural resources both quantitatively and qualitatively thereby compromising development activities based on these resources. The MA (2005), for instance, highlighted the linkages between climate change and biodiversity loss as depicted in Figure 1.1.

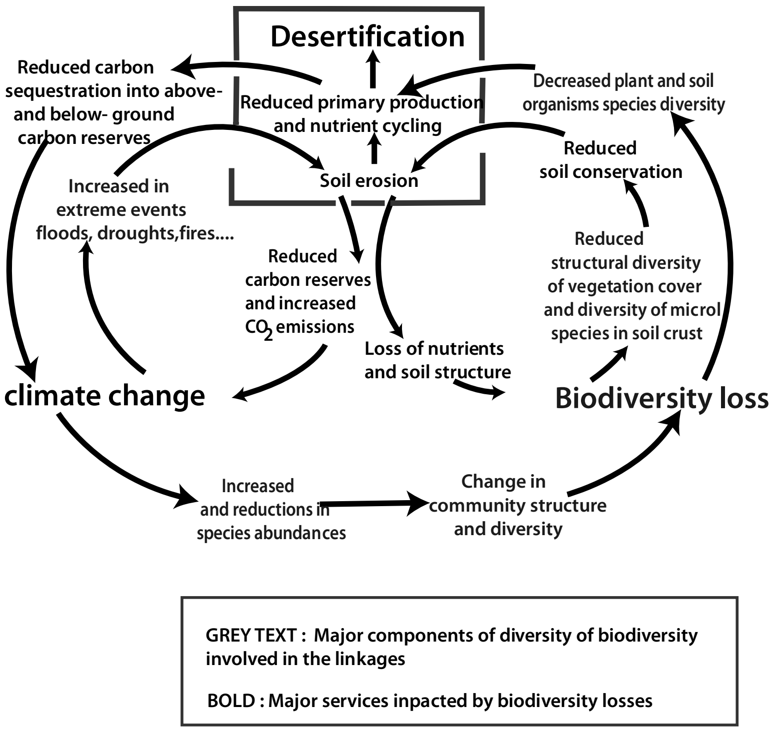

Figure 1.1: The Linkages Between Climate Change and Biodiversity Loss

Source: MA (2005) (Prudent NRM must address the relationships if Africa's biodiversity is to be conserved)

For example, declining biodiversity may have an impact on the functioning and resilience of ecosystems. Loss of biodiversity will decrease the species diversity of the plant and soil organisms, reduce structural diversity of vegetation, which in turn will cause loss of nutrients and affect soil structure. This could lead to reduced nutrient cycling, cause land degradation and soil erosion. Land degradation and soil erosion are some of the key factors that contribute to productivity decline and food insecurity. Soil erosion also reduces carbon sequestration above and below ground and increase CO_2 emissions, therefore accelerating climate change. Climate change could lead to increased costs caused by flood damage, mudslides, drought, fire and pests. In addition, loss of services such as water provision, nutrient cycling and pollination may impact on human welfare. Loss of ecosystem function and resilience is of particular concern in the light of predicted global warming and the anticipated, but largely unknown, impact this will have on climate, local weather conditions, sea level and human health.

Biological diversity can be thought of as an insurance cover. Given the possibly significant impact environmental degradation has on human welfare and the economy, it would be rational to exercise caution when development decisions are made which may have an impact on biodiversity. The impacts of climate change are now inevitable and are expected to affect people in African countries the most. Climate change will particularly affect ecosystems, food and fibre supply, coastal settlements, health, and water supply. Table 1.1 shows the numbers of people affected by various types of natural disaster in the Eastern, Central and Southern Africa (ESA) region in the past ten years. Each year, an average of more than 26.8 million people are affected by natural disaster in the region, and some 10.8 million people are directly affected by political instability and conflict. Drought has by far the greatest impact, followed by flood.

To fight poverty, promote security and preserve the ecosystems that poor people rely on for their livelihoods, governments must place pro-poor economic growth and environmental sustainability at the heart of our economic policies, planning systems and institutions (UNEP, 2009). Drawing upon recent analytical work prepared inside and outside it, the World Bank (2007) identifies key lessons concerning linkages between poverty and the environment. With a focus on the contribution of environmental resources to household welfare, the analysis demonstrates how specific reforms and interventions can impact on the health and livelihoods of the poor people.

There is no shortage of recommendations and strategies for improving the management of natural resources in Africa. Agenda 21 *(http://www.unep.org/documents.multilingual/default.asp?documentid=52)* offers a blueprint for action to ensure environmentally conservative and sustainable development throughout the twenty-first century. Africa is experiencing multiple crises (namely: food crises, energy crisis, financial crisis and climate change crises which combine with deepening poverty, rapid population growth and weak governance) that unduly create unprecedented pressures on natural resources and people’s livelihoods. Many of the solutions to the crises of NRM in Africa lie outside the NRM realm and are beyond communities, countries or regions and require global commitment and collective action.

Table 1.1: Numbers of People Affected by Natural Disasters in Eastern and Southern Africa, 1998-2007

Year	Drought	Earth-quake	Epidemic	Flood	Slide	Volcano	Wind Storm	Total
1998	4,911,000		121,192	2,252,600	0			7,284,792
1999	30,697,545	2,300	1,000,606	395,096			13,000	32,139,357
2000	33,977,835	750	791,477	5,372,276	0		1,106,558	41,245,896
2001	35,020,000	0	130,260	2,054,419	0		1,000	37,205,679
2002	37,799,435	1535	580,589	710,300			629,850	39,721,709
2003	26,334,500		63,982	1,082,088			137,641	27,618,211
2004	34,849,000		31,907	685,845			773,000	36,449,312
2005	17,739,000	5000	54,524	531,691		293,000	890	18,624,105
2006	16,514,000		28,722	1,916,360	2000		87,647	18,570,993
2007	5,067,750		154,612	3,069,616	0	2,000	373,195	8,667,173

Source: The International Disaster Database (EM-DAT): www.cred.be

The Poverty Environment Initiative (PEI) spearheaded by the United Nations Environment Programme (UNEP) and United Nations Development Programme (UNDP) typifies the need to mainstream environmental management in poverty reductions strategies (Box 1.2).

Box 1.2: Mainstreaming Poverty-Environment Initiative in Policy and Projects

The United Nations Environment Programme (UNEP) defines poverty-environment mainstreaming as the stepwise process of integrating poverty-environment linkages into development planning for poverty reduction and pro-poor growth at national, sector and local levels. To tackle this challenge, the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) have joined hands and launched the Poverty-Environment Initiative (PEI). Established in 2007, the PEI is a global UN programme that helps countries to integrate poverty-environment linkages into national and sub-national development planning, from policymaking to budgeting, implementation and monitoring.

PEI involves establishing the links between environment and poverty and identifying policies and programmes to bring about better pro-poor environmental management. It is a multi-year, multi-stakeholder effort targeted at influencing policymaking, budgeting, and implementation. It is based on the need to integrate the valuable contribution of environmental management to improved livelihoods, increased economic security and income opportunities for the poor - which is still largely overlooked in development planning and in the wider debate about development priorities. This framework has three phases with typically a cluster of tasks needed for each phase — for which a range of analytic tools can be used.

1. Preparatory Phase: Finding the Entry Points and Making the Case

The preparatory phase sets the stage for mainstreaming, focusing on activities designed to help countries identify entry points into the development planning process and to make a strong case for the importance of poverty-environment mainstreaming. Activities include conducting assessments of the country's governmental, institutional, and political context as well as assessments that increase understanding of the nature of poverty-environment links. Raising awareness, building partnerships, assessing the institutional and capacity needs and setting up working mechanisms are also essential activities of the preparatory phase.

2. Phase 1: Mainstreaming Poverty-Environment Linkages into Policy Processes

The next phase of the programmatic approach is concerned with integrating poverty-environment linkages into policy processes and the resulting policy measures. This step targets a specific policy process—such as a national development plan or sector strategy — identified as an entry point as part of the preparatory phase described above.

The elements of Phase 1 include developing new and targeted analytical studies to provide country-specific evidence about the nature of poverty-environment linkages in the country. Armed with such evidence, practitioners are better able to identify priorities and craft the arguments necessary to have an impact on the targeted policy process (such as a Poverty Reduction Strategy Paper (PRSP), Millennium Development Goal (MDG) strategy, or sector plan) and its associated documents. Once poverty-environment links have been integrated in the policy document, mainstreaming efforts continue with the development and initial costing of policy measures. These measures might be systemic interventions (such as fiscal measures) or they might be more narrowly focused, such as sector interventions (focusing for example on agricultural legislation, promotion of renewable energy, or the conservation of protected areas). Activities to strengthen institutions and capacities also occur throughout this phase.

3. Phase 2: Meeting the Implementation Challenge

The final, most sustained phase focuses on making poverty-environment mainstreaming operational through engagement in budgeting, implementation, and monitoring processes. These activities are aimed at ensuring that poverty-environment mainstreaming becomes established as normal procedure within the country. Meeting the implementation challenge calls for the integration of poverty-environment links in the national monitoring system. Phase 2 also requires engaging in budgeting processes to ensure that these processes incorporate the economic value of environment's contribution to the national economy. Collaborating with sector and sub-national bodies to build their capacities to mainstream poverty-environment links within their work and effectively implement policy measures at various levels is also essential. In order to strengthen institutions and capacities in the long term, it is critical to establish poverty-environment mainstreaming as normal practice in government and administrative procedures, systems, and tools at all levels.

4. Indicators of Successful Environmental Mainstreaming:

- Inclusion of poverty-environment linkages in national development and poverty reduction strategies.
- Strengthened capacity within finance/planning ministries as well as environmental agencies to integrate environment into budget decision-making, sector strategies and implementation programmes.
- Inclusion of poverty-environment linkages in sector planning and implementation strategies.
- Strengthened capacity in key sector ministries to include environmental sustainability into their strategies.
- Widened involvement of stakeholders in making the case for the importance of environment to growth and poverty reduction.
- Improved domestic resource mobilization for poverty-environment investments.
- Increased donor contributions to country-level environmentally sustainable investment.
- Improved livelihoods and access to environmental and natural resources for the poor.

Source: http://www.unpei.org/about/pe-mainstreaming.asp

A specific case of utilization of natural resources for sustainable poverty alleviation is in the promotion of access to emerging markets for goods and services presented by Africa's natural assets as described in the Case 1.1 of ecosystems services in Eastern Africa.

Approaches to NRM and Development Linkages

The linkages between environmental change and the wellbeing of populations who depend on natural resources have given rise to some major schools of thought in the literature. These include:

- The “Downward Spiral’ approach
- The entitlements approach
- The sustainable development approach
- The sustainable livelihoods approach
- The resilience approach

Case study 1.1: Emerging Markets for Ecosystems Services in East Africa

New markets are now emerging globally that promise to incorporate environmental values directly. First, these include eco-friendly product and service markets that privilege sources verified to have been produced sustainably, such as organic and biodiversity-friendly food, fair trade products, certified timber, and eco-tourism. Second are new markets and payment systems for ecosystem services, including an accelerating carbon market, biodiversity protection and payments for watershed services.

Certified organic food production is growing rapidly in East Africa and provides an opportunity for added value as a key market chain innovation to increase market competitiveness for African small-holder farmers. Uganda policies to promote organic agriculture have generated 200,000 certified farmers and exports growing from close to $4 million in 2003 to nearly $23 million now (UNEP, 2010). Market under-supply and high forecasted growth give Africa‘s organic small and medium producers a real chance of developing partnerships with domestic, US and European supermarket chains. Out grower agricultural schemes helping small-farmers supply agro-industry could be designed to help them meet standards for environmental management, as well as product quality.

Tourism already accounts for significant portions of GDP in Kenya and Tanzania, and the overall number of visitors for nature tourism in the region is projected to double by 2020. Opportunities for biodiversity conservation can come from environmentally-friendly tourism, in terms of financing protection of particularly charismatic species, and design of facilities and infrastructure.

Carbon markets, buying and selling the right to emit greenhouse gases, have been booming since 2006. Analysts believe that the global market reached 4.2 billion tons of carbon transacted in 2008, up 56% from 2007. These trades are projected to be worth USD 92 billion. Although the opportunities in carbon markets are vast globally, East Africa has been largely left out. In fact, only 2.6% of projects currently implemented under the Clean Development Mechanism (CDM), one of the primary options offered under the Kyoto Protocol for developing countries to benefit from carbon markets, are in Africa. Although new CDM-eligible projects are in the pipeline, East Africa has been largely left out of this and other regulated markets. Those markets having marginalized terrestrial offset opportunities, which East Africa is well suited for, in favour of energy projects for which East Africa is not well positioned. However, some excitement has been brewing over the opportunities that may be offered by a post-2012 trading regime (after the Kyoto Protocol expires), in which payments for Reduced Emissions from Deforestation and Degradation (REDD) and perhaps even soil carbon offsets may be included. Pilot REDD schemes are already being tested in East Africa, particularly in Tanzania. Despite the challenges for East Africa in the regulated markets, dozens of land-based projects are in the pipeline in the voluntary carbon markets. While they represent a major opportunity and offer great potential, these markets also present a threat if the funds are not informed by – and are not required to secure – the many other environmental, social and economic benefits provided by land associated with carbon stores. The challenge will be to design these projects in ways that bring positive impacts for biodiversity, watershed protection and local livelihoods.

Traditional payments for biodiversity conservation, made by conservation groups and tourists, continue in the region alongside emerging opportunities from voluntary and regulatory mechanisms such as 'biodiversity offsets'. These are payments made by investors in oil, gas, infrastructure and other activities, where even very good designs will result in biodiversity losses, to conserve or restore those same types of ecological resources within the broader habitat. Such payments could bring significant resources to support public and community conservation initiatives. Markets for watershed services, in which downstream users compensate parties upstream for stewardship of water quality and quantity, are also rapidly developing in East Africa. For example, in the Uluguru Mountains in the Morogoro Region of Tanzania, four villages are receiving payments from a public water utility in Dar es Salaam to improve land use practices within the city's watershed. These eco-market pilot activities are also having the effect of raising awareness among the private sector, governments and communities of the potential economic benefits from ecosystem stewardship.

Source: Bass et al., 2009; UNEP 2010

The Orthodox View or "Downward Spiral" of NRM and Poverty

The conventional literature on NRM-development linkages often presents a rather deterministic view of the relationship between poverty and natural resources. This view dominated the UNCED that stated that poverty is a major cause and effect of global environmental problems. This dominant view posits that there is a vicious downwards spiral: poor people are forced to overuse environmental resources to survive from day to day, and the degradation of natural resources further impoverishes them, making their survival ever more difficult and uncertain. The rapid degradation of natural resources pushes the poor further down in the spiral, making them more vulnerable and in abject poverty. This conventional wisdom promotes the view that natural resources are being rapidly degraded in Africa because of poverty, and that the poor are responsible for the degradation of natural resources. In the absence of any other options, the poor are bound to exploit the natural resources for their livelihood needs. This is illustrated in the poverty-environment vicious cycle in Figure 1.2.

In most African countries, some of the key environmental issues are: declining soil productivity, soil erosion, rangeland degradation, bush encroachment, salinization, desertification, agrochemical pollution of water, siltation, water supply and shortages, loss of habitats and biodiversity and overexploited forests (UNECA, 2002). These issues are agriculturally related and thus can be linked to challenges in the attainment of the MDG 1 of eradicating extreme poverty and hunger. Environmental degradation also threatens all aspects of human wellbeing including health. In most African countries, persistent poverty means that growing populations depend on mostly, inadequate local natural resources for survival. In their studies of land management in Uganda, Nkonya *et al.*, (2004) found strong linkages between poverty and land management as investments in land management was associated with household income levels and productivity.

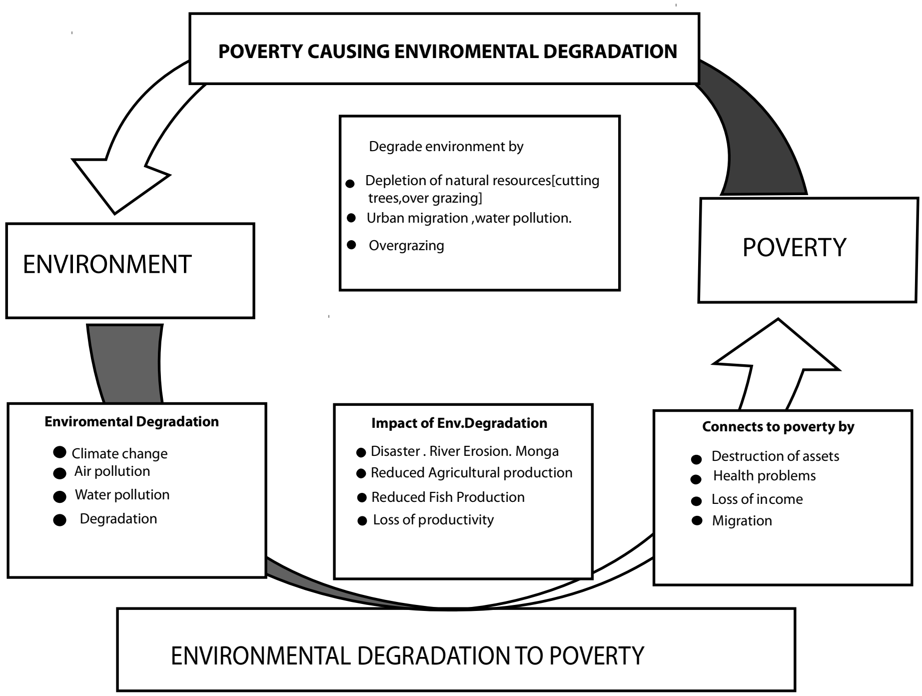

Figure 1.2: The Poverty-Environment Vicious Cycle

Source: Chowdhury and Ahmed, 2010

However, other studies have shown that the assumption of systematic degradation of natural resources by the poor does not always hold (Scherr, 2000; Cavendish, 2000; Comim, 2009; Bucknall *et al.,* 2000; Forsyth *et al.,* 1998; Broad, 2002). In an empirical study in Zimbabwe, Cavendish (2000) found that rich households, were more responsible for environmental degradation. Similarly, studies elsewhere (Chowdhury *et al.,* 2010; Khan, 2008) have concluded that poverty is not the primary cause of deforestation and poor people are not the primary agent for such degradation. In their book "*More People, Less Erosion*" Tiffen *et al.,* (2000) demonstrate an example of environmental recovery in Kenya where population growth and agricultural intensification have been accompanied by improved rather than deteriorating soil and water resources. Other examples that support this environmental recovery have been documented in Sahelian countries of Senegal, Nigeria, Burkina Faso and Niger (Mortimore, 2010). In addition, there has been a rising trend in the social sciences and economic literature which disputes the conventional theory and argues that simple generalizations of this multi-dimensional problem are erroneous and that a more complex set of variables are in play (Comim, 2009; Leach and Mearns, 1995). Therefore, the widespread view that poverty leads to environmental degradation is not clearly supported by evidence.

What is more strongly supported by evidence is the fact that environmental degradation hurts the poor more.

More understanding on how poor people depend on, interact with and use their environment in rural and urban areas is needed. These studies point to demographic, cultural, and institutional factors as important variables in the poverty-environmental degradation nexus. Most studies agree that the links point to the dynamic complexity, context-specificity and resource specificity of the linkages between NRM and poverty. Understanding these links is a rather complex task and requires an integrated, interdisciplinary, multi-sectorial and multi-institutional and multi-stakeholder perspective.

The "Environmental Entitlements" Approach

From her seminal work (Ostrom, 1990) and her subsequent work (Ostrom, 2005, Agrawal *et al.*, 2001; Dietz *et al.*, 2003;) that was awarded the 2009 Noble Prize in Economic Sciences, Elinor Ostrom challenged this conventional wisdom and orthodox view of NRM-Poverty linkages. Her work and others challenged Hardin's "Tragedy of the Commons" and demonstrated how humans interact with ecosystems to maintain long-term sustainable resource yields (Figure 1.3). This body of work has considered how societies have developed diverse institutional arrangements for managing natural resources and avoiding ecosystem collapse. It emphasizes the multifaceted nature of human–ecosystem interaction. Several chapters of this book explore different mechanisms that communities, programmes and policies have put in place to regulate access and use of NRM for sustainable development.

There is now widespread consensus within NRM literature that 'sustainable development' should be based on local-level solutions derived from community initiatives. This new paradigm, also called 'environmental entitlements' (Bucknall *et al.*, 2000; Forsyth *et al.*, 1998) emphasize the capacity of natural resources accessible to the poor to produce streams of products and environmental services essential for livelihood. It builds a conceptual framework highlighting the central role of institutions – regularized patterns of behaviour between individuals and groups in society – in mediating environment-society relationships. The notion of 'environmental entitlements' encapsulates this shift in perspective, and provides analytical tools to specify the benefits that people gain from their environment which contribute to their well-being. The processes by which people gain environmental endowments and entitlements are, in turn, shaped by diverse institutions, both formal and informal. This framework is grounded in an extended form of entitlements analysis used to explore the ways differently positioned social actors command environmental goods and services that are instrumental to their wellbeing (Leach *et al.*, 2009).

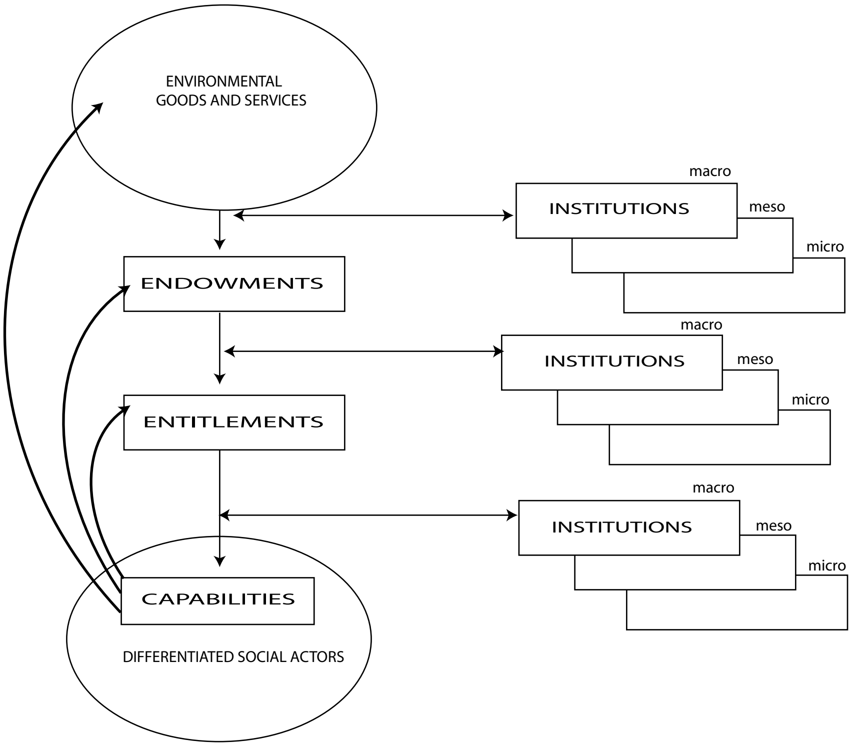

Figure 1.3: The Environmental Entitlements Framework

Source: Forsyth et al., 1998

Several chapters in this book argue that management of natural resources should include the full participation of local residents and cooperation with government to ensure socio-environmentally sustainable resource management.

The concept of environmental entitlements refers to the alternative sets of benefits derived from environmental goods and services over which people have legitimate effective command and which are instrumental in achieving well- being. These benefits may include direct uses in the form of commodities, such as food, water or fuel; the market value of such resources or of rights to them; and the benefits derived from environmental services. Chapter 2 of this book describes the environmental services, goods and products and their contributions to human wellbeing. It also provides a framework for compensation and rewards for environmental services as incentives to communities and resource users to improve resource management and livelihoods.

Forsyth and Leach (1998), Bucknall *et al.*, (2000), Cavendish (2000), and Comin *et al.*, (2009) reviewed literature and empirical studies conducted in several NRM contexts in Africa that demonstrate that many poor people are able to adopt protective mechanisms through collective action which reduce the impacts of demographic, economic and environmental change. Several other empirical studies conducted in Africa have revealed that although the rural poor may have limited resources, they still have considerable capacity to adapt to environmental degradation and to rehabilitate degraded resources, as presented below.

Box 1.3: Southern Ghana and the Leaves of Marantaceae Plants

In Southern Ghana, the leaves of *Marantaceae* plants are commonly collected by women for use and sale widely for wrapping food, kola nuts and other products. The leaves are associated with particular sites and times within dynamic, variable forest and forest-savanna ecology. Such conditions include disturbed forest sites, moderately burnt forest, swamps, and abandoned cocoa farms and fallows, especially during the rainy season. The leaves become endowments – people gain rights over them – in different ways depending on whether they lie inside or outside government-reserved forest. Off reserve, the leaves are usually the common property of a village, with each individual's ownership determined by village membership. Where they occur on farmland, collection rights are acquired through membership of, or negotiation with, the appropriate landholding family or farm household. On reserve, the distribution of endowments depends on the permits offered by the Forest Department. Without permits, leaf gathering is illegitimate from the state's perspective, although it may be sanctioned by customary tenure arrangements grounded in different definitions of reserved land as ancestral farmland.

The set of entitlements derived from *Marantaceae* leaves may include direct use of the leaves or their sale for cash income. In practice, most women involved in gathering leaves prefer to sell them as an important source of personal income. Both Labour and marketing issues are important in defining the distribution of entitlements. The utilities derived from the cash sale of *Marantaceae* leave contribute to a woman's capability to ensure that she and her children are well-fed and to satisfy other cash-dependent needs. But whether a woman can

keep control of the income, and how it is used, depends on intrahousehold bargaining arrangements, such as negotiations with husbands and co-wives over expenditure priorities and responsibilities for making food. Asking which combination of institutions make the most difference to resource access and control for a set of social actors, or for the dynamics of resource use and management surrounding the leaves, represents an environmental entitlements approach.

Box 1.4: Game Management in the Mkambati Reserve, South Africa

Hunting in South Africa is now largely carried out by two groups: urban people who conduct it as a pastime, and the rural poor, who use it to diversify their livelihoods. The endowments are the rights over animals such as wildebeest and blesbok. The institutional factors influencing these are the national legal framework – including conservation laws – and micro-level institutions such as traditional authorities established by chiefs and headmen. The entitlements are the venison, hides, and horns resulting from hunting, which may be influenced by gun legislation, or the local networks of borrowing, hunting and mutual aid that enable small rural groups to hunt game. The final capabilities resulting from the hunting include contributions to livelihoods, which may themselves be affected by micro-scale intrahousehold arrangements.

Box 1.5: The Coastal Farm Forest Association

Threats to Kenya's 80,000 wood carvers, including the overexploitation of forests, led to the formation of the Coastal Farm Forest Association. This group is a large cooperative of carvers who are linked to a dedicated marketing and sales company, Kenya Coast Tree Products. Forest Stewardship Council (FSC) certification of the Association's products has boosted both sustainability and profitability for tree growers (Macqueen 2007). This initiative is part of a wider East Africa Coastal Ecoregion conservation plan to connect the biodiversity-rich, but highly fragmented forest habitat in the area. It illustrates the conservation and development potential of well-designed natural resource-based businesses.

Source: Macqueen, 2007

Box 1.6: Landcare in Uganda

Landcare is a good example of a mechanism that support and facilitates networking, mutual learning and collective strengthening among local initiatives. It is a farmer-led movement of organizations with backing from local government, the private sector, and technical experts that focuses on landscape management to improve agricultural productivity by sustaining natural resources. It originated in Australia, but has been adapted to a range of contexts in 17 countries. NGOs, Community-Based Organizations (CBOs and local and national governments in a given country collaborate to train Landcare group facilitators who work with communities to develop collective action and investment plans to address farm and landscape-level land management problems and opportunities.

In Eastern Uganda, the Kapchorwa District Landcare Chapter (KADLACC), working in the Mt. Elgon area, which contains a national park of high biodiversity importance as well as vulnerable farming communities surrounding it, is a platform for institutions including local farmers groups, community development associations, soil and water conservation and agro-forestry associations, research organizations, and district and local government representatives. KADLACC works with the poor and vulnerable communities in the degraded, densely populated watersheds and landscapes in and around Mt. Elgon to address issues of low agricultural productivity. Priority areas for KADLACC members include collaborative watershed management; documentation of on-farm innovations; demonstration site development; facilitated peer-to-peer learning processes to enhance knowledge exchange; partnership and network building; and marketing and enterprise development activities. Demonstrated on-farm productivity improvements for staple crops, including maize and bananas, have been complemented by soil and water health improvements on-farm and within the surrounding landscape, as well as enhanced income generation options for collective enterprise development activities, including livestock rearing and fruit production.

Source: Catacutan, Ed. 2008; Kapchorwa District Landcare Team, 2006

The environmental entitlements framework stresses the need for differentiating the social actors in terms of their capabilities, endowments and entitlements. In many regions of Africa, poverty and NRM also have important gender dimensions, affecting women and men differently (both as actors, managers and users of ecosystems). Access to natural resources is frequently unequal. Households living in extreme poverty and depending directly on the use of natural resources tend to be female headed. Even when households have a male and female head, intra-household access to, and management of natural resources, often favour men and boys. Gender informs the suitability of all options developed and, thus, all research requires a sound gender perspective from the start. Gender is arguably one of the critical factors that affect the use and management of natural resources, and greatly influences the direction and magnitude of success of projects and programmes in NRM. Chapter 5 discusses in details the gender implications of NRM and strategies for mainstreaming gender in NRM programmes, projects and policies.

The "Sustainable Development" Approach

The emphasis on sustainability in NRM can be traced back to the natural resource conservation movement of the 19th century. This movement evolved in the 20th century and took on a more holistic and global recognition and development of a set of principles for sustainable development at the international level (Box 1.7).

Box 1.7: Sustainable Development History

The concept of "Sustainable Development" has emerged as one of the development paradigms that have given rise to a particularly rich literature, policies and programmes by a wide range of international and national governmental and non-governmental organizations. In his book *"Sustainable Development at Risk*", Hulse (2007) reviews the history and outcomes of different international conferences and agreements on environment and development.

- The first United Nations Conference on Environment and Development (UNCED) held in Stockholm in 1972 (known as the Brundtland Report), introduced the notion of "eco-development" and led to the establishment of the United Nations Environment Programme (UNEP) with the mission "to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations" (for details visit www.unep.org).
- The second UNCED held in Nairobi, Kenya in 1987 introduced the idea of "sustainable development".
- The third conference held in Rio de Janeiro in 1992 (known as the Earth Summit), further developed "Agenda 21" that highlighted the connection between poverty and underdevelopment on the one hand, and the connection between environmental protection and natural resource management on the other. Agenda 21 states in its Principle 1 that "human beings, the centre of concern for sustainable development, are entitled to a healthy and productive life in harmony with nature" (Hulse, 2007:84). Agenda 21 initiated the most important international conventions and agreements on climate change, biological diversity, and combating desertification.
- The fourth conference known as the "World Summit on Sustainable Development" was held in Johannesburg, South Africa in 2002. This summit placed much more emphasis on the social and economic aspects of sustainable development.

While many and confusing definitions of sustainable development abound, Pezzey (1989) states that "a development path is sustainable if total welfare does not decline along the path". Critical to this definition is a realization that sufficient welfare functions through consumption, environmental quality, social equity, and other factors contributing to the quality of life (Adams, 2006; UN, 1987). This definition is broad enough to capture the essence of a pattern of resource use that aims to meet human needs while preserving the natural resources. This is necessary so that these needs can be met not only in the present, but also for generations to come – intergenerational equity so to speak. The Bruntland Commission (Bruntland, 1987) first referred to sustainable development as one that "*meets the needs of the present without compromising the ability of future generations to meet their own needs.* For the sustainable management of Africa's natural resources, this definition permits broad and rigorous characterization of resource exploitation (Hasna, 2007).

Sustainable development is, therefore, a pattern of resource use that aims to meet human needs while preserving the *environment* so that these needs can be met not only in the present, but also for future generations. *Sustainability* requires that human activity only use nature's resources at a rate at which they can be replenished naturally.

It is clear that this definition is rooted in a systems thinking as it stresses the three interdependent and mutually reinforcing pillars of sustainable development: economic development, social development, and environmental sustainability. Sustainable development, therefore, aims to bring the three together in a balanced way, as three interconnected or nested rings (Figure 1.4).

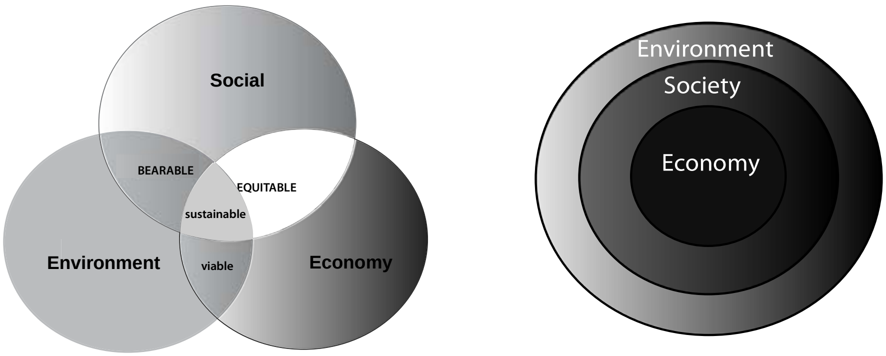

Figure 1.4: The Three-Ring Interconnected and Nested Views of Sustainable Development Depicting the Mutually Enforcing and Interdependent Pillars of Sustainable Development

Source: Adapted from Adams (2006)

The three essential dimensions of sustainable development are:

a. *Economic*: an economically sustainable system must be able to produce goods and services on a continuing basis, to maintain manageable levels of government and external debt, and avoid extreme sectoral imbalances that damage agricultural and/or industrial production.
b. *Environmental*: an environmentally sustainable system must maintain a stable resource base and avoid overexploitation of non-renewable resource systems, including maintenance of biodiversity, atmospheric stability and ecosystems services not always looked upon as economic resources.
c. *Social*: a socially sustainable system must achieve fairness in distribution and opportunity among all persons with adequate provision of such social services as health, education and gender equity. The social dimension focuses on reconciliation of environment and development, and governance related to provision of social services.

The nested rings approach insists that the economy is dependent on society and the environment. Human and economic activities take place within the environment and the society, depend on and have an impact on the environment. A key issue for sustainable development is therefore the integration of different dimensions of sustainability, taking a holistic view and overcoming barriers between disciplines, ideologies and sectors.

Chapter 2 of this book introduces the concepts and principles of ecosystem as social and ecological systems providing ecosystems services, goods and products for human wellbeing. Chapters 3 and 4, as well as several other chapters, take a holistic and integrated approach that appreciates the complexity and interactions of social, economic and ecological systems, and stresses the need for a more integrated, interdisciplinary and community-based approach in research, policy and practice regarding the management of natural resources.

The "Sustainable Livelihoods" Approach

This recognition of the complexity in NRM-poverty interactions has led to a focus on 'sustainable rural livelihoods'. According to Chambers and Conway (1992): *"A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base."*

The 'sustainable livelihoods' (SL) framework is increasingly important in the NRM-development debate. The framework shows how, in different contexts, sustainable livelihoods are achieved through access to a range of livelihood resources (natural, economic, human and social capitals) which are combined in the pursuit of different livelihood strategies.

The SL framework (Figure 1.5) places people, particularly rural poor people, at the centre of a web of inter-related influences that affect how these people create a livelihood for themselves and their households. People and communities are recognized as users, producers, managers and custodians of natural resources. Their participation in management decisions, policies, projects and research has always been recognized as central for NRM. Recently, it has become necessary to re-examine the role of communities and to recognise their contributions to NRM. NRM requires dynamic communities and local practices and supportive community-based mechanisms and institutions that regulate the management of natural resources, particularly common pool resources that make the best use of natural resources. Adaptation to climate change will, to a very large degree, depend on the capacities of communities to adapt to change and recover from shocks.

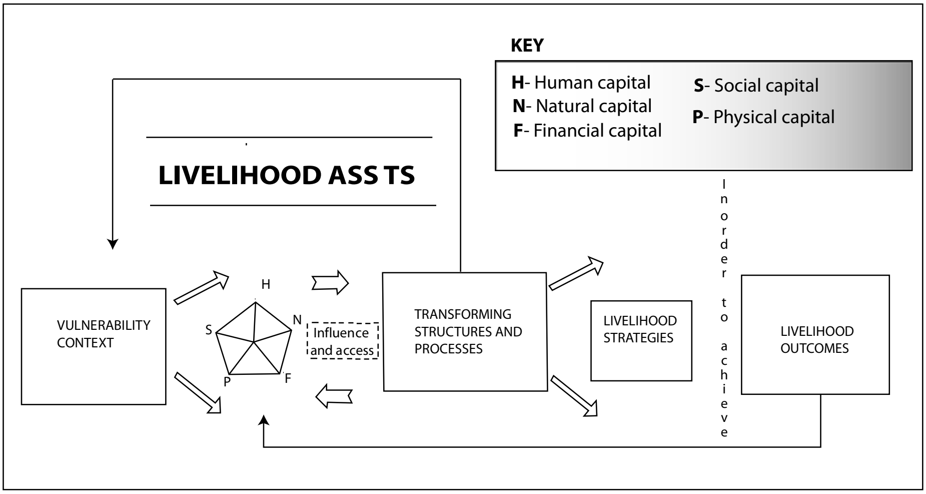

Figure 1.5: The Sustainable Livelihoods Framework

Source: Scoones (1998)

Closest to the people at the centre of the framework are the resources and livelihood assets that they have access to and use. The livelihood assets also known as the asset pentagon comprise of:

i). *Natural capital:* the natural resource stocks (forest, soil, water, air, genetic resources etc.) and environmental services (hydrological cycle, pollution, sinks, etc) from which resource flows and services useful for livelihoods are derived.

ii). *Financial capital:* the capital base (cash, credit/debt, savings, and other economic assets, including basic infrastructure and production equipment and technologies) which are essential for the pursuit of any livelihood strategy.

iii). *Human capital:* the skills, knowledge, ability to labour and good health and physical capability important for the successful pursuit of different livelihood strategies.

iv). *Social capital*: the social resources (networks, social claims, social relations, affiliations, associations) upon which people draw when pursuing different livelihood strategies requiring coordinated actions.

v). *Physical capital*: productive assets, such as housing, tools, infrastructure, water supplies, schools, social amenities whose ownership can contribute to improving livelihoods or income.

The extent of people's access to these assets is strongly influenced by their vulnerability context, which takes account of trends (for example, economic, political, technological, etc.), shocks (for example, epidemics, natural disasters, civil strife) and seasonality (for example, rains, droughts, employment opportunities). Access is also influenced by the prevailing social, institutional and political environment, which affects the ways in which people combine and use their assets to achieve their goals. In sustainable livelihood projects, the goal of NRM development projects is to enhance wellbeing and livelihoods of a variety of stakeholders with a responsibility to sustain the natural resource base so that future generations can meet their needs. Chapin (2009) suggests that the simplest approach is to sustain the inclusive wealth of the natural system, i.e., the total capital (natural, physical, human, and social) that constitutes the productive base available to society. Since natural and social capitals are the most difficult components of capital to renew, once they are degraded, these are the most critical components of inclusive wealth to sustain. Future generations depend most critically on those components of natural capital that cannot be regenerated or created over time scales of years to decades. These include: soil resources that govern the productive potential of the land; biodiversity that constitutes the biological reservoir of future options; regulation of the climate system that governs future environment; and cultural identity and inspirational services that provide a connection between people and the land or sea (Chapin, 2009).

The Resilience Approach

The SL Framework emphasizes the sustainability dimension, by looking at the resilience of livelihoods and the natural resource base on which, in part, they depend. Livelihoods are sustainable when they are resilient in the face of external shocks and stresses; maintain the long-term productivity of natural resources; and do not undermine the livelihoods of, or compromise the livelihood options open to others. Natural resource base sustainability refers to the ability of a system to maintain productivity when subject to disturbing forces, stresses and shocks.

A key challenge of sustainable development is the inherent complexity of NRM systems and the delicate balance of managing natural resources for present and future generations in the face of uncertainty and vulnerability at complex temporal and spatial scales. Chapin (2009) advocates broadening the concept of sustainable development to a resilience-based approach to respond to and shape change in social–ecological systems in order to sustain the supply and opportunities for use of ecosystem services by society. The resilience approach builds on sustainable development and sustainable livelihoods by emphasizing the strategies employed by communities to manage their natural resources and their livelihoods under conditions of uncertainty and in the face of rapid change. The resilience approach advances the principles of adaptive management and integrative approaches to NRM change and sustainability. It posits that the challenges of NRM can be confronted with a renewed optimism towards the empowerment of local communities to manage their natural resources more sustainably and to adapt to changes and live with uncertainty. Chapter 2 discusses the concept of socio-ecological resilience and the ability of socio-ecologic systems to recover from shocks and stresses. Chapter 6 further discusses opportunities and experience for communities to adapt to climate change.

The State of Natural Resources Management and Development in Eastern and Southern Africa

Africa entered the 21st century with paradoxes. Africa is arguably the continent most endowed with natural resources, and more than any other continent, the livelihoods of African rural populations are heavily dependent on natural resources. The livelihoods also affect the status of the natural resources in many ways. Yet, Africa remains one of the most vulnerable continents with deepening poverty levels and worrying trends of degradation of natural resources. This "paradox of plenty" (Campbell, 2009; Basedau and Wolfram, 2006) or "resource curse" (Collier, 2007) arises from a combination of multiple factors that have been the subject of an impressive scientific, academic and development literature. The sections that follow highlight some opportunities, challenges and prospects for managing natural resources for the triple objectives of economic, social and environmental sustainability.

A Continent Endowed With Abundant Natural Resources

Sub-Saharan Africa is a region that has rich and varied biological resources forming the continent's natural wealth on which its social and economic systems are based. Africa's natural wealth is also of global importance for the world's climate and for the development of agriculture, industrial activities, pharmaceutical production, construction and tourism (UNEP, 2010). The 2006 Africa Environment Outlook (UNEP, 2006) reports that biodiversity, with some exceptions, is currently in a better condition than in many parts of the world. East and Southern Africa comprises several centres and hot spots of global biodiversity, some of which are in the over 2 million km^2 of protected areas that Africa has. For example, the Mau complex, the largest forest of Kenya, covers some 400,000 hectares. It is one of the five main catchment areas – known as the "water towers" of Kenya.

In terms of water resources, Africa is endowed with hundreds of lakes and rivers. There are 677 lakes in Africa, of which 88 are principal lakes. Africa has also some 80 transboundary rivers and lake basins, and the catchment areas of the 17 largest exceed 100,000 km^2. Lake Victoria covering Uganda, Tanzania and Kenya is the largest freshwater lake in Africa and the second largest in the world. Lake Victoria Basin is rich in both natural (terrestrial and aquatic) and agricultural biodiversity, although natural habitats are under threat from rapidly increasing human caused pollution. Furthermore, the region is home to numerous wetlands of international significance, a number of which are listed in the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention). Wetlands in Africa are an important source of water and nutrients necessary for agricultural production, food security and habitat for a number of species.

The region is also a home to a number of large transboundary ecosystems, which are important for safeguarding the remarkable animal populations and their habitats. The importance of transboundary protected areas is especially obvious for migratory species. Some of these transboundary protected areas are the Mara-Serengeti national parks in Kenya and Tanzania, Great Limpopo Transfrontier Park (Mozambique, South Africa, and Zimbabwe), the Virunga Parks in Rwanda, DRC and Uganda, the Nyungwe forest (Rwanda)/Kibira National Park (Burundi).

Table 1.2 summarizes the status of some natural resources in selected African countries. Compared with the total land area, the proportion of arable land can be visualized in terms of the challenges and opportunities for managing the resources in each country in order to address livelihood challenges of the projected population and rationalize use of the vast natural resources such as water, especially through agricultural withdrawals.

A Continent with Multiple Crises

Despite this abundance of natural resources, deforestation, desertification, land degradation, water shortage and contamination, threat to biodiversity, and climate change are some of the many environmental problems that Africa experiences today. The combined effects of these multiple crises have serious consequences on the management of natural resources. This section summarizes some key highlights of these crises.

Deepening Poverty

Poverty and inequalities are deepening in many African countries. Africa has a large share of the proportions of the more than 1 billion poor people. The severity of poverty in sub-Saharan Africa and the limited progress in reducing it indicate that the poorest in sub-Saharan Africa may be trapped in poverty. This has led to the revision of poverty line thresholds distinguishing three types of poverty: the medial poor (those living on less than $1 a day, the threshold defined by the international community as constituting extreme poverty), the subjacent poor ($0.75)

Table 1.2: Characteristics of Selected Eastern and Southern African (ESA) Countries

Country	Total population (millions) (2009)	Projected population (millions) (2050)	Number of people undernourished 2003–05 (Proportion undernourished people)	Total Land Area ('0000 Sq km)	Arable land (% of land area) 2007	Forest land (% of land area) 2007	Average annual deforestation (%) 1995-2005	Renewable internal freshwater resources per capita cum 2005	Annual freshwater withdrawals for agriculture % total
Burundi	8.3	14.8	4.8 (63)	29	38.6	5.9	3.2	1,338	77
DR Congo	66.0	147.5	43.0 (76)	2,345	3.0	58.9	0.3	15,639	31
Eritrea	5.1	10.8	3.0 (68)	94	5.6	15.4	0.3	636	97
Ethiopia	82.8	173.8	35.2 (46)	1,101	11.1	13.0	0.9	1,712	94
Kenya	39.8	85.4	11.0 (32)	583	8.2	6.2	0.3	604	64
Madagascar	19.6	42.7	6.6 (37)	587	5.1	22.1	0.4	18,113	96
Rwanda	10.0	22.1	3.6 (40)	25	48.6	19.5	-3.4	1,051	68
Sudan	42.3	75.9	7.4 (21)	2,506	7.2	28.4	0.8	828	97
Tanzania	43.7	109.5	13.0 (35)	945	4.5	39.9	1.0	2,183	89
Uganda	32.7	91.3	4.1 (15)	200	26.4	18.4	1.8	1,353	40
Zimbabwe	12.5	22.2	5.2 (40)	391	8.3	45.3	1.4	945	79
Malawi	15.3	36.6	3.8 (29)	119	26.0	36.2	0.8	1,250	80
Mozambique	22.9	44.1	7.5 (38)	802	5.5	24.6	0.2	5,068	87
Zambia	12.9	29.0	5.1 (45)	752	7.1	57.1	0.9	6,873	76
South Africa	50.1	56.8		1,220	12.1	7.6	-2.2	2,562	68

Sources: FAO, 2008 and 2009; World Bank, 2009 and ultra poor ($0.50). Millions of the ultra poor- those living *on less than 50 cents a day*- are overwhelmingly concentrated in sub-Saharan Africa (Ahmed *et al.*, 2007). With this poverty trap, poverty begets poverty, and in the absence of other options, the poor people are heavily dependent on the use of natural resources for a significant part of their daily livelihoods.

Demographic Crisis

The rate of population growth in Africa is the most rapid: over 70% faster than in Asia (annual growth of 2.4% versus 1.4% in Asia, compared to the global average of 1.3% and only 0.3% in many industrialized countries). Africa's population is projected to increase from about 770 million to nearly 1.7 billion by 2050. For example, the East Africa community (Kenya, Uganda, Rwanda, Tanzania and Burundi) together have a population of over 181 million, which is expected to grow by 66% over the next 25 years. Although this population will remain largely rural, demographic trends and environmental degradation are pushing a large number of people to migrate to rapidly growing urban slums that lack infrastructure and services for waste management, energy, water and sanitation. There is no doubt that this rapid population growth is exerting pressure on natural resources and increasing the number of poor and hungry people.

Food Crisis

The Food and Agriculture Organization of the United Nations (FAO) estimated that in 2010, more than 1 billion people in the developing world are experiencing some form of shortage in food supply (Nelleman *et al.*, 2009). FAO's estimates show that the number of undernourished has risen in about 25 countries in Africa since 1990–92, presenting the continent with a major challenge in achieving the MDG targets of reducing hunger and extreme poverty by 2015. The Global Hunger Index further show that there is a higher concentration of hungry people in conflict and post conflict countries such as the DRC, Burundi, Eritrea, Somalia and Ethiopia, and in countries where natural resources are at great risk.

It is clear that the degradation of natural resources and global challenges such as climate change are some of the significant factors causing chronic food crises in Africa. Nelleman *et al.,* (2009) discuss the environmental causes of this food crisis, including climate change.

Financial Crisis

The 2008-2009 financial crisis and economic depression have rendered millions of people less able to meet their food, health care, and education needs. The poor must now draw on depleted assets even more deeply, potentially creating poverty traps and negatively affecting longer-term environmental sustainability, food security and well-being (FAO, 2009). Although Africa was less seriously affected by the financial crisis, its negative impacts on the environment are considerable. African

Governments' investments and policies are focusing on economic recovery, and less on environment and other social sectors. In many countries, important programmes have been suspended indefinitely as donor funding and government budgets are reduced or in deficit. The programmes targeting NRM have been lowered in government and international funding priority. Many international development agencies have been forced to reduce their NRM programmes.

The financial crisis impacted on the momentum in the global environmental movement. It affected climate change negotiations on reducing carbon emissions in developed countries, and generated resistance from emerging economies (China, India, Brazil, South Africa) to accept suggestions to slow their economic growth. For example, China‘s overall trade with Africa in 2006 at USD 55 billion was 10 times the level of 1995 with imports into China dominated by natural resource commodities including oil, natural gas, minerals and timber. It is reported that many exports to China are illegal – resulting from illegal felling and trade from Tanzania and Mozambique (Bass *et al.*, 2009).

Energy Crisis

Increased oil prices in 2007-2008 had far reaching consequences on the economy and the environment. This crisis led the world to focus attention on bio-fuels and other renewable energy sources.

Biofuels have grown quickly in demand and production, fuelled by high oil prices and the initial perception of their role in reducing CO_2 emissions. The recent investment boom in biofuels is a notable trend that continues to raise some debate and controversies. Biofuels are seen by some as a strategic investment and an engine of economic growth, poverty reduction, access to clean energy, and environmental rehabilitation. Many view it as neo-colonial "land grab" that will benefit only international investors and local elites while displacing and dispossessing local communities of their lands and resources, destroying ecosystems and exacerbating water, food and/or ecological problems. Some Governments (like Uganda) have sought to de-gazette natural forests for biofuel plantations. Others, like in Mozambique and Tanzania, are fast-tracking conversion of vast areas endowed with natural resources for biofuels production as a solution to energy shortages. In Ethiopia, 1.15 million hectares are either granted to foreign companies or are under negotiation for biofuels production.

Governance Crisis

Natural resources can, and often do, provoke conflicts within societies as different groups; factions fight for the control and exploitation of resources and their revenues. In his book, *The Bottom Billion*, Collier (2007) demonstrates that many African countries are trapped in a "natural resource curse and conflict traps". The resource curse (also known as the paradox of plenty) refers to the *paradox* that countries and regions with an abundance of *natural resources*, like *minerals* and *fuels,* tend to have less *economic growth* and worse development outcomes than countries with fewer natural resources. Moreover, they tend to experience conflicts and civil wars. More than half the world's conflicts in 1999 occurred in sub-Saharan Africa (World Bank, 2007). At least ten countries in Eastern and Central Africa have been affected by conflict or political instability in recent years. In some African countries (DRC, Angola, Nigeria, and Sudan) access to resource revenues by belligerents was responsible for prolonging conflicts and civil wars, and is a major threat to poverty reduction and sustainable development.

Environmental Crisis

Figure 1.6 gives examples of some of the important environmental crises or problems in Africa. These include: forest degradation, land degradation, loss of biodiversity, threat to wildlife, climate change, looming water crisis, etc.

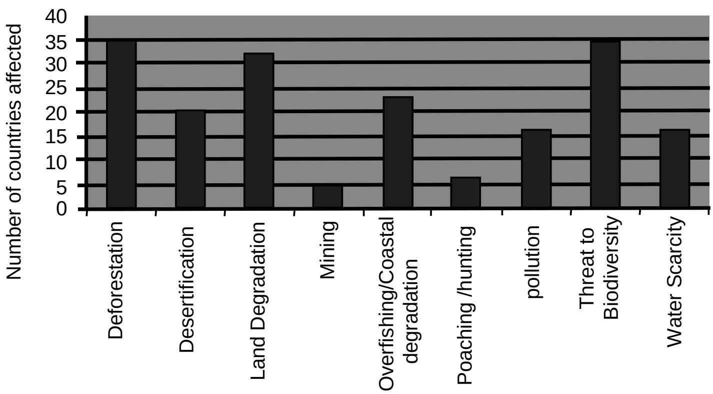

Figure 1.6: Examples of Important NRM Issues in Africa

Source: UNEP 2009.

Land Degradation

The Global Assessment of Soil Degradation (GLASOD) reports that degraded soils amount to about 494 millions hectares (ha) in Sub-Saharan Africa (SSA). This represents 65% of SSA's agricultural land that is degraded because of water and soil erosion, chemical and physical degradation (Oldeman *et al.,* 1991 in Bationo, 2009). This represents an estimated loss of US$ 42 billion in income and 6 billion ha of productive land every year due to land degradation and declining agricultural productivity. In Zimbabwe, soil erosion alone results in an annual loss of *N* and *P* totalling US$1.5 billion. In South Africa, 29% of the country suffered land degradation, affecting about 17 million people, or 38% of the South African population (Bai and Dent, 2007). The productivity of some lands has declined by 50% due to soil erosion and desertification. The annual cost of desertification is estimated at US$ 9.3 billion.

Water Crisis

Water scarcity will affect over 1.8 billion people by 2025 (AWDR, 2007). Within the next 15 to 20 years, the area considered to have relative water security in Africa will fall from nearly 53% to 35%, affecting some 600 million people. According to some estimates, by 2025, up to 16% of Africa's population (230 million people) will be living in countries facing water scarcity, and 32% (460 million people) in water-stressed countries (IAASTD, 2009). One major factor beyond agricultural, industrial and urban consumption of water is the destruction of watersheds and natural water towers, such as forests in watersheds and wetlands, which also serve as flood buffers (Gichuki, 2002). Watersheds are already heavily populated and cultivated, in ways that have reduced water infiltration and storage and increased soil erosion and sedimentation of dams. Serious conflicts are anticipated between water demand for agriculture and industrial use critical for economic development for hydroelectric power, and for local day-to-day use by rural and urban populations (Gichuki, 2002; Rosegrant, 2002).

Deforestation

Agenda 21 (Para 11.10) states:

> Forests worldwide are being threatened by uncontrolled degradation and conversion to other forms of land uses, influenced by increasing human needs; agricultural expansion; and environmentally harmful mismanagement, including: lack of forest fire control, anti-poaching measures, unsustainable commercial logging, overgrazing, airborne pollutants, economic incentives, and activities of other sectors of the economy. The impacts of loss and degradation of forests are in the form of soil *erosion, loss of biological diversity, damage to wild habitats* and degradation of waters the leaves of *Marantaceae* plants held areas, deterioration of the quality of life, and reduction of the options for development.

It is estimated that every year, nearly 17 million hectares of tropical rain forests are destroyed, thousands of irreplaceable plant varieties are lost, and millions of hectares of land turn into deserts. Deforestation causes loss of resources, loss of ecological function (e.g., carbon sequestration, hydrological function) and loss of biodiversity. A study has estimated that the global economy is losing more money from the disappearance of forests than through the current banking crisis: the annual cost of forest loss at between $2 and $5 trillion. This is much more than Wall Street's earlier loss of about $1 to $1.5 trillion.

Table 1.2 shows that some African countries have higher deforestation rates compared to global estimates for tropical deforestation of 0.5% to 1.0% per annum. The State of East Africa Report 2006 (SID, 2006) reports that an area larger than Rwanda has been deforested in four countries of East Africa in just the past decade due in part to population pressure on agricultural land. In Kenya, the forests have dwindled because large tracts of terrestrial and wetland ecosystems have been converted to farmland. The once extensive Mau Forest has been seriously degraded by human actions. Over the past decade, more than 46,000 hectares of the Mau have been cut off and converted to other land uses, such as human settlement and private agriculture. The large-scale encroachment of human populations, charcoal production and the logging of indigenous trees are causing massive deforestation with severe impacts on water resources, leading to the drying up of boreholes and rivers. This situation is threatening the very existence of the ecologically and economically important Masai Mara Game Reserve, and the Sondu Miriu and Mara rivers. These rivers are the lifeline of major lakes in Kenya, such as Lake Naivasha, and a number of transboundary lakes—Lake Victoria in the Nile River basin; Lake Turkana in Kenya and Ethiopia; and Lake Natron in the United Republic of Tanzania and Kenya.

Loss of Biodiversity

Africa is losing large amounts of biodiversity due to population pressure and associated exploitation of natural resources. Loss of forest biodiversity is due both to the total loss of forest cover (deforestation), as well as to the loss of biodiversity components within forest (degradation). The International Year (2010) of Biodiversity has a target of "achieving by 2010 a significant reduction in the current rate of biodiversity loss at the global, regional and national levels as a contribution to poverty alleviation and for the benefit of all life on Earth".

Climate Change

There is consensus that Africa will be most affected by climate change, especially the semi-arid regions north and south of the equator. As a result of global climate change, many SSA countries have experienced both droughts and floods in recent years, with considerable loss of life, environmental assets and infrastructure. The evidence is that climate change will lead to extreme rainfall events – droughts and floods – with dire consequences to agricultural production, especially for the vulnerable smallholder farmers (For details see Chapter 6). In Eastern and Southern Africa, climate change vulnerability is heightened by the large number of people who depend on the already marginalized natural resource base for their livelihoods. Chapter 6 discusses the impacts of climate change in more details.

Land Grab

The convergence of global crises in food, energy, finance and the environment has led to a scramble for Africa's farmlands which are increasingly perceived as sources of alternative energy (primarily biofuels), food crops, mineral deposits (new and old) and reservoirs of environmental services. This has been commonly referred to as "land grab' to describe the current explosion of (trans) national commercial land transactions revolving around the production and sale of food and biofuels, conservation and mining activities (von Braun and Meinzen-Dick, 2009). Bass *et al.*, (2009) suggest that the next decade will see a continuation of massive assetstripping and environmental degradation, the result of local and foreign elites driving land conversion to agriculture and poorly regulated extractive industries. Increasing demand for Africa's natural resources presents new and difficult challenges, but also new opportunities. It is feared that this scramble for Africa's farmland will dispossess communities and will have negative impacts on ecosystems and livelihoods in countries with weak regulations and governance systems (Friis and Reenberg, 2010).

Summary and Conclusion

In Africa, development and sustainable livelihoods remain the key goal in poverty reduction and in reversing degradation of natural resources. This chapter recognizes the complex challenges of linking NRM to development in a rapidly changing continent and the world at large. This chapter explored the different concepts and paradigms on NRM-Development nexus, and provided insights on the development challenges and opportunities in the region. Managing natural resources for development in Africa requires a fundamental paradigm shift that emphasizes the complexity of NRM-Development dynamics, entitlements and capabilities. This book advocates for a shift from the conventional orthodox view that presents poverty as a major cause of environmental degradation. This causal link is too simplistic and the nexus between NRM and development is governed by a complex web of factors. We advocate for a balance between development and sustainability and broaden the concept of sustainable development to take a more people-centred approach based on the sustainable livelihood approach. In the pursuit of sustainable livelihoods, poor people and resource user communities have the capacity to develop institutions and strategies to regulate the use of natural resources, prevent their degradation and improve their management. Given the multiple crises and increasing pressures on natural resources faced by African countries, we advocate for a resilience-based management approach to emphasize the key role of resilience in fostering adaptation and renewal to sustain the supply and opportunities to harness natural resources for human wellbeing in face of rapid change and uncertainty.

Development priorities should be based on a good understanding of the challenges and opportunities, as well as scenarios and prospects in the region. Designing projects, policies and research requires an appreciation and integration of the different dimensions of sustainability and livelihoods, focusing on particular NRM challenges in specific areas, with specific communities, and providing an encompassing and integrated framework for implementing and promoting solutions for livelihoods improvement in the face of rapid degradation of natural resources.

It is clear that Managing natural resources for development in Africa requires integrated, multi-sectorial, multi-institutional, multi-stakeholder and inter-disciplinary approaches that can resolve the often conflicting objectives and uncoordinated strategies by different sectors that contribute to the degradation of natural resources. A new approach to natural resource management must be developed so that new management systems can be tailored and adapted in a site-specific way to highly variable and diverse farm conditions typical of resource-poor farmers. Management options should be integrated as far as possible. NRM brings both challenges and opportunities for managers, resource users, and policy makers to make informed decisions that enhance sustainability of our planet. Since NRM processes are multi-stakeholder – incorporating the public and private sectors, communities, non-governmental and local organizations, donors and individual entrepreneurs – it is important to have clear governance systems and policies that balance development, equity and environmental sustainability. In the chapters that follow, these issues will be explored in more details in terms of socio-ecological resilience (Chapter 2), integrated natural resource management (Chapter 3), community-based natural resource management (Chapter 4), gender and natural resource management (Chapter 5), adaptation to climate change (Chapter 6), programmes and project management (Chapter 7), policy and governance (Chapter 8) and innovations in research for NRM (Chapter 9).

Learning Activities

Learning Activity 1.1: The Debate on Opposing Views on Environment Poverty Linkage

The literature on the linkages between NRM and development is characterized by two major scholarships: the environment-poverty trap and the NRM entitlements approach. Organize a debate on the strengths and weaknesses of each argument. The debate will have three groups:

1. Group of Proponents (Optimists, Supporters): to find convincing arguments to support one side of the debate, highlighting strengths and opportunities and the advantages of the perspective.
2. Group of Opponents (Sceptics-Against): to present convincing arguments to argue against the perspective highlighting its weaknesses and threats, problems and consequences of the perspectives.
3. Group of Pragmatists (Independents): to take a middle ground position demonstrating the strengths of each argument and how the different views can be combined to present a more realistic perspective.

The debate should be organized as an assignment, giving sufficient time for research and preparation and for group synthesis. The lecturer should introduce and moderate the debate (or assign this responsibility to students), giving each group 10 minutes to present a summary of their arguments. After one round of debate, groups will change roles, proponents will become opponents, and opponents will become proponents (supporters or pro). Each group will have time to prepare their arguments and select group spokespersons to present their summary). After the first round of debate, the group will be given 10 minutes to prepare a rejoinder and make their final arguments.

The Group of Pragmatists will then summarise the arguments presented by each group as conclusion and synthesis to the debate. They can also prepare prizes/awards and announce the winner of the debate (often recognizing that both groups have solid arguments and there is no winner.

Learning Activity 1.2: State of Natural Resources Management

Discuss the key features of the State of Natural Resources in your country with focus to the following natural resources (forests, water, biodiversity, energy, climate change) and their implications for the triple dimensions of sustainability (economic, social, and environment). Analyse your country's Poverty Eradication Strategy Documents and discuss the implications for sustainable development.

Learning Activity 1.3: Critique of Poverty Environment Initiative

Down the various World Bank Reports from 2003 to present and review the Poverty Reduction Strategy Paper for your country by identifying the major flaws in resource allocation and investment. How can the strategy documents be improved to ensure sustainable mainstreaming of environmental management in poverty reduction?

Learning Activity 1.4: The Paradox of Plenty

Using examples from your country, discuss the extent to which the "paradox of plenty" or the "natural resource curse" apply, and what can be done to avoid this situation.

Learning Activity 1.5: Discuss the Africa Position on Climate Change

In preparation for the Copenhagen climate change summit (CoP15), the African Ministerial Conference on the Environment (AMCEN) and the Conference of African Heads of State and Government on Climate Change (CAHOSCC), adopted a common position that provides African countries with a platform to make a strong case for support at Copenhagen 2009. Summarize the key highlights of the African position and their implications for Managing Natural Resources for Development in Africa.

Learning Activity 1.6: Actions for Managing Natural Resources for Development

Agenda 21 is considered as the blue print for integrating environment in development. In groups, or individually, select one of the following chapters: Managing Fragile ecosystems, Combating Deforestation, Conservation and Biological Diversity and Integrating Environment and Development. For each chapter, provide an analytical summary of (i) the development challenges, the policy objectives, the means for implementation and assess progress and challenges for implementation in your country.

The New Economic Partnership for Africa Development (NEPAD) developed an Action Plan for Environmental Initiative. Provide a critique of this Action Plan and discuss how best it can be implemented.

Revision Questions

1. Compare and contrast different perspectives on the linkages between NRM, poverty and livelihoods.
2. There are emerging opportunities for Africa to mitigate climate change by large scale production of biofuels. What are the prospects for achieving this objective in Africa and what are the implications for natural resources management and sustainable development?

3. Africa is facing a looming water crisis. How could African governments avert such crisis?
4. Sustainable natural resource management is an elusive concept. How can natural resources be managed to achieve the triple objectives of economic growth, social equity and environmental sustainability?
5. In preparation of the 15th Conference of Parties (CoP15) of the UN Conference on Climate Change held in Copenhagen in December 2009, African governments presented a common position. Highlight the key points of this position and discuss their implications for sustainable development in Africa.

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Concepts, Theories and Principles of Natural Resource Management

E. K. Maranga, P. H. Mugabe and R. K. Bagine

Introduction

Natural resources are intricately linked to the livelihoods of most countries in Africa and elsewhere and are the basis of subsistence in many poor communities. Natural resources account for 26% of the wealth of low-income countries (UNEP, 2007) and are the mainstay of many developing economies. The world's ecosystems are capital assets. If properly managed, they yield a flow of vital services, including the production of goods such as food, fibre and timber as well as life support processes such as pollination and water purification. They also confer other life-fulfilling conditions such as anaesthetic appeal and serenity. Moreover, ecosystems have value in terms of the conservation of options such as genetic diversity for future use (Gretchen *et al.,* 2000).

This chapter discusses selected theories, concepts and principles relevant in natural resource management (NRM). The NRM applies ecological and socio-economic theory in evaluating the impacts of physical and anthropogenic effects on qualitative and quantitative dynamics of natural resource components. Ecosystem concepts provide premises that link natural resources, components including man, as an integral part of biological systems with the physical systems upon which they depend. Ecosystem theory underpins biotic-biotic and abiotic-biotic relationships. This theory, therefore, provides a unifying strand for the contents of this chapter.

The Chapter defines natural resources and natural resource systems from an ecosystem perspective. This is followed by a discourse of a selected array of concepts, theories and principles which are discussed only to the extent that their plausibility in natural resource management is appreciated. The reader is encouraged to make reference to detailed presentation of respective concepts, theories, and principles in the subsequent chapters of the book or consult other basic textbooks in applied ecology.

The ecosystem concept provides a basis for novel ecosystem approaches such as systems analysis in studies of the impacts of physical and anthropogenic disturbances on the dynamics of natural resource components. These concepts are discussed in terms of energy flows and material cycling. The concept of trophic dynamics has gained popularity in descriptions of energy transfer circuits between and within autotrophic and heterotrophic elements. Autotrophic and heterotrophic interactions in relation to energy transfer efficiencies are succinctly articulated in this chapter in relation to NRM.

Increasing population pressure on natural resource systems in sub-Saharan Africa is a threat to ecosystem integrity and support of human livelihoods that depend on fragile ecosystems. This challenge is raising biodiversity concerns as well. The chapter explores the conceptual and theoretical underpinnings of the ecological contexts of natural resource systems and concludes with a section on resource management challenges and development.

The broad objective of this chapter is to present an overview of the concepts, theories and principles applicable in Natural Resource Management (NRM) with particular reference to the African continent. Specifically, the chapter aims to present an overview of the practical usefulness of ecological and socio-economic theory in NRM and to expose the reader to underlying concepts, processes, contexts and challenges of the application of ecological theory in the management of biodiversity resources in Africa.

Through the exposure to the contents of this chapter, the reader should be able to:

- Explain the fundamental concepts, principles and philosophy of NRM and apply relevant tools in maintaining the integrity of natural ecosystems.
- Recognize the role of biophysical and anthropogenic disturbances on ecosystem resources and apply resource management interventions to achieve sustainable natural resource management outcomes.
- Define and explain ecosystem processes that influence ecosystem goods and services and develop knowledge systems for the diagnosis of trends in ecosystem resilience.
- Discuss the varied contexts and challenges of resource management in Africa, offer advisory services on effective NRM and carry out effective research.
- Demonstrate professional acumen in multidisciplinary resource management initiatives.

Natural Resources, Natural Resource Systems and their Importance

The meaning of natural resources has kept changing over the years. The nature of the change has been characterised by divergences in disciplinary conceptualizations of the meaning of resources. Schools of thought such as ecology, sociology and environmental science define natural resources from disciplinary perspectives. For example, sociology and economics view natural resources from a humanistic and purely economic sense. Such definitions consider natural resources as material sources of wealth such as timber, mineral deposits, or water that occur in a natural state. Such materialistic definitions also embrace an economic perspective.

Economic perspectives of natural resources consider the commercial value of natural resources and the industries that they support. In this sense, economic theory considers that private ownership of natural resources tends to produce efficient consumption because the profit motive imposes realistic pricing. This materialistic and exploitative dimension of resources (as seen from the perspective of economic theory) is the basis of conflicts associated with the use of natural resources. The idea of natural resource conflicts is further developed in chapter 3 on *Community-Based Natural Resources Management (CBNRM)*.

In order to protect natural resources from overuse and destruction, natural resources ownership and rights to property of individuals, communities or even states have featured prominently in legal statutes (see Chapter 8: *Policy and Governance*). Legal distinctions have been drawn between natural resources that are a feature of real property or those that are not. Natural resources associated with real property include forest, timber, mineral deposits such as gold, copper, uranium and fossil based fuels. Natural resources that are not fixed on land such as air, are not ordinarily well associated with property rights.

The concepts of resource exploitation and depletion are well anchored in economic theory. In economics, the tendency of exhaustion of public natural resources is called the *"tragedy of the commons"*, as described in Chapter 4 of this book. In accounting, the write down of partially consumed natural resources is called *depletion.* Resource ownership relations and community based natural resource use concepts are further explored in the subsequent chapters.

Natural resources may be classified into *renewable* and *non-renewable* resources. Renewable natural resources are those that may be replaced after exploitation or extraction due to their ability for renewal through natural processes of growth or replenishment. These resources include animals, plants, rain, wind and tidal energy. Solar energy is not renewable but may be regarded as infinite. Non-renewable resources are natural resources which after exploitation or extraction, reach a level beyond which regeneration is impossible. This includes mineral substances such as coal, gold, aluminium, copper, and oils. Renewable natural resources are undervalued and overused. But they are also vital to livelihoods at community, national and international levels. Global Environmental Changes (GEC) such as climate change put more pressure on natural resources (for example by affecting ecosystems or increasing carbon emissions that precipitate thermal perturbations). Such changes, however, also present opportunities – for instance through global carbon markets and schemes to offset carbon emissions.

The emergence of the ecosystem concepts and considerations of natural resources as complex sources of interrelated elements existing in a state of ecological balance which must be sustained for life to survive on planet earth is gaining popularity. The ecosystem theory (Chapin *et al.*, 2009), considers the tangible and intangible values of natural systems that produce natural resources from the point of view of sustenance of life. This is an integrated and holistic perspective of natural resources.

In this context, an operational definition of natural resources that integrates materialistic, aesthetic (recreational), philosophical and moral values associated with the natural resources should reflect this integration. From this stand point, *a natural resource is any material from nature that has potential economic and ecological value to life such as water, natural tree products, minerals and vital gases. From the perspective of ecosystem theory, a natural resource is a material occurring in nature that has actual or potential value to a natural system that supports living organisms.* Such material resources include air, water, critical chemicals (abiotic resources), plants and animals (biotic resources). Biotic and abiotic resources are critical to life processes since they provide organic and inorganic products that drive life processes.

Management of natural resources embraces the ecosystem theory which considers tangible and non-tangible resource values from an integrated and holistic perspective. Natural resource management is a science because it applies systematized bodies of knowledge within the domain of natural science. The application of applied ecology and in particular ecosystem theory in the integrated management of natural resources will continue to provide plausible premises for the advancement of natural science and management of natural resources. It is also an art because management involves utilitarian considerations. These considerations invoke application of sociological domains of knowledge in the management of natural resources. Social-cultural perspectives that influence resource use are anchored in the value systems of society. Perspectives of integrated NRM are discussed in Chapter three while community based natural resource management scenarios are also further developed in Chapter four.

Ecosystem Concepts and Theories

In this section, selected concepts and theories are presented and discussed within the context of natural resource management. The section specifically describes ecosystem, ecosystem structure, ecosystem functions and services, patterns, hierarchies, energy flows and important nutrient cycles.

Ecosystem: description

The term ecosystem was proposed by Tansely (1935) in an effort to apply systems thinking to the complexity in nature. Ecological systems are assemblages of biotic (living) organisms in association with their abiotic or physical and chemical environment.

An ecosystem consists of organisms (plants, microbes, and animals—including people) and the physical components (atmosphere, soil, water, etc.) with which they interact. All ecosystems are influenced, to a given degree, by social processes (that is are social-ecological systems), although ecosystem studies tend to focus on biological interactions (Chapin *et al.,* 2009).

> Ecosystem theory is an approach to the study of ecological systems that consists of the 'scientific study of the progressive, mutual accommodation, throughout the biotic and abiotic processes, between and within active elements, and the changing properties of the immediate settings in which the processes occur, as this process is affected by the relations between the components of the ecosystem, and by the larger contexts in which the ecosystems are embedded'.

A woodland ecosystem in Southern Africa for instance, is typically comprised of vegetation that includes trees, grasses, shrubs, and forbs, as well as different animals with different feeding habits, insects, birds, soil organisms and microorganisms. All the plants and animals in an ecosystem are affected by the sun, the weather, terrain, soil structure, humidity and a host of other physical and soil chemical features. These animals, plants, soil and atmospheric features and the interactions that occur among them together form the ecosystem, a recognizable self-contained and self-sustaining unit.

The geographic size or scale of an ecosystem is relative to the ecologist’s interest. For instance, the collection of micro-organisms in the stomach of a grazing herbivore can be considered to represent an ecosystem. Woodland, a pond or a range of mountains are examples of macro-ecosystems. It is, therefore, less important to try to draw lines as to where the ecosystem ends than it is to describe the ecosystems in terms of all the various components in the system, and how they interact. This is what defines the extent and boundary of the ecosystem. It is also often difficult to see where one ecosystem ends and another starts. It is unusual for the edges of natural woodlands, for example to be distinctly or abruptly defined. Rather, the size of trees decreases gradually towards the edge, and they become further apart. This zone merges into wooded bush or grassland, where the trees are scattered, singly or in clumps. Often, they are of different species from those within the woodland. Such transition zones between two different ecosystems or communities are called ecotones. Since ecotones represent transitional ecosystem states, it is apparent that natural resource management requirements for such ecosystems must be considered carefully in relation to non transitional states.

Ecosystem structure

Ecosystem characteristics are best described in relation to their structural and functional attributes. *Ecosystem structure is about the components of ecosystem and their spatial relationships. Ecosystem function is the flux of biomass, nutrients and energy throughout the ecosystem*.

The magnitude of energy fluxes and intensity of material resource transformations define the dynamics and integrity of natural resource systems. Figure 2.1 illustrates the ecosystem structure and the nesting of relationships between elements of ecosystems**.**

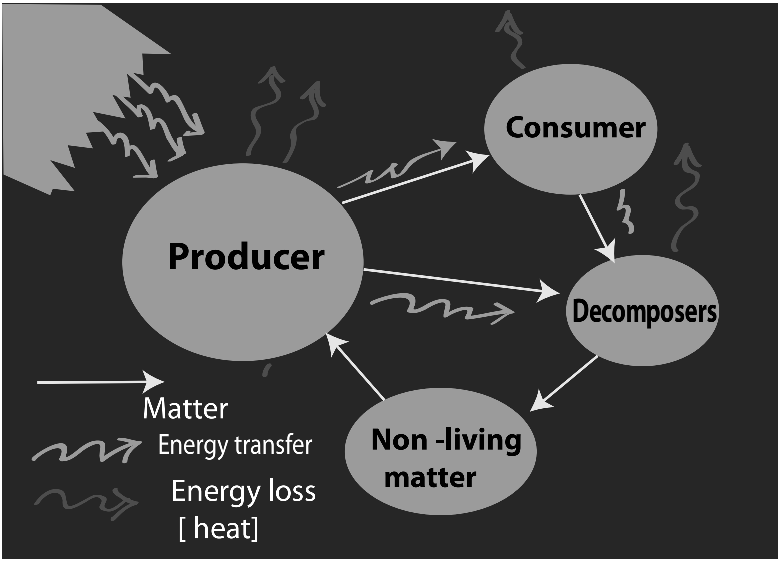

Figure 2.1: Ecosystem Structure Indicating the Components, Linkages and Associated Fluxes

Source: Chapin et al., 2009

The implications of trophic dynamics to NRM must be considered at the spatial and temporal levels and the ecosystem level for the following reasons. The major problem faced by all organisms is how to obtain adequate energy and nutrients to support growth, survival and reproduction. It is often time consuming and expensive to unravel the feeding relations of every species in detail and its interactions with others in an ecosystem. It is, however, relatively easy to consider feeding interactions, for example, between herbivores and consumers and implications on ecosystem dynamics. The classification of biotic components on the basis of trophic levels provides an appreciation of the importance of each living organism in the flow of energy and cycling of nutrients in an ecosystem.

Abiotic components are the non-living factors, both physical and chemical which make up the organism's environment. The abiotic component is intimately linked to the biotic component in terms of energy flows and material cycling. *Abiotic* *factors* include soil and all its physical and chemical components, climate, atmosphere, radiation and geography. Soil is a complex system of fragments of parent mineral material, organic matter, water, minerals and gases. It provides an anchor and supplies nutrients for growing plants. It is also a habitat for a variety of decomposer micro organisms. Soil type influences the type of vegetation that can grow and hence the types of animals that can live in an area. Climatic factors such as temperature, rainfall and humidity all affect the growth of organisms. Temperature influences metabolic transformations through the catalytic function of enzymes. The rate of catalytic activity is a function of temperature.

Temperature affects many other processes that dictate the role of natural resources to human well-being and are critical considerations in NRM. Such processes include control of energy release. Temperature affects the germination of seeds, the growth and development of plants, and plant metabolic and physiological processes. Temperature also affects decomposition processes that are vital in the cycling of nutrients.

The ecological importance of water is an extension of its physiological significance. It is a medium of transfer of assimilates and excretion of toxic substances from body fluids. Water provides a dissipative mechanism for thermal energy and regulation of thermal energy balance of organic and non-organic surfaces. Climate, therefore, primarily affects plants, which provide food and shelter for animals. The atmosphere acts as an important pool of inorganic and organic materials in particulate or gaseous form. The atmosphere must therefore interact with other ecosystem components for a continuous cycling of nutrients. Solar radiation or photosynthetically active radiation is the source of energy used in photosynthesis and is the starting point of almost all life processes. Geographic factors such as slope, aspect and topography affect the distribution of organisms. These factors affect water retention and runoff in an area, the amount of radiation available to plants, the growth of plants, and the ease with which animals can move about in search for food and the availability of shelter for animals.

Ecosystems Services and Human Wellbeing

Ecosystems are the basis for social and economic development. Human well-being and development depend on ecosystem goods such as food, timber and medicines, and services such as water and air purification, carbon storage, pollination, soil formation, and the provision of aesthetic and cultural benefits. The challenge is to sustain the resilience of ecosystems – their capacity to cope with disturbances and maintain an adequate supply of goods and services. This is especially important in the face of global environmental change including climate change which may cause more frequent and intense disturbances. When the supply of ecosystem goods and services is diminished, human societies suffer from effects such as soil erosion, floods and crop failure. These effects can have grave implications for human health, wealth, livelihood, food security, social cohesion, and even democracy. Actively promoting ecosystem resilience is, therefore, critical to ensuring future human welfare.

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning, regulating, and cultural services, which directly affect people, and supporting services needed to maintain the other services. Changes in these services affect human well-being through impacts on security, the necessary material for a good life, health, and social and cultural relations. These constituents of well-being are in turn influenced by and have an influence on the freedoms and choices available to people (Figure 2.2.).

Swallow *et al.*, (2009) define "environmental service" as a positive benefit that people obtain from the environment. The environmental services of forests and landscapes, for example, are usually categorized into watershed protection, biodiversity conservation, atmospheric regulation (including greenhouse gas mitigation) and landscape beauty.

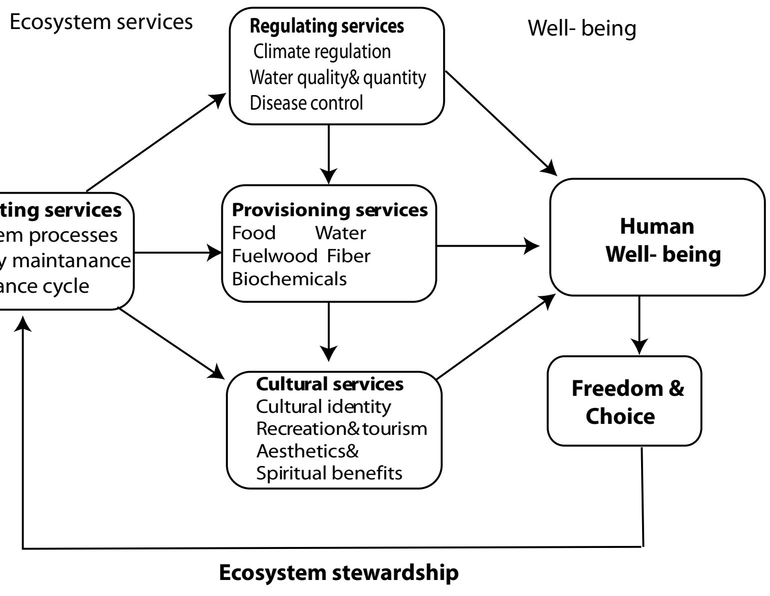

Figure 2.2: Ecosystems Services and Human Well-Being

Source: Chapin et al., (2009).

Supporting services are the foundation for the other categories of ecosystem services that are directly used by society. In addition, the goods harvested by people are influenced by landscape processes, which include regulatory services, and, in turn, influence people's connection to the land and sea (cultural services).

The goal of ecosystem management is to provide a sustainable flow of multiple ecosystem services to society today and in the future. As an integral component of natural resource stewardship, ecosystem management recognizes the integrated nature of social–ecological systems, their inherent complexity and dynamics at multiple temporal and spatial scales, and the importance of managing to maintain future options in the face of uncertainty, that is many of the factors governing the resilience and vulnerability of social-ecological systems.

Swallow *et al.,* (2009) describe four extreme circumstances of tradeoffs or complementarities between environmental conservation and human well-being:

i). Ecosystems may be conserved and the poor made better off;
ii). Ecosystems may be conserved at the expense of the poor who rely on the ecosystem services;
iii). The poor may be made better off, but at the expense of ecosystem services that are highly valued by the larger society; or
iv). Ecosystems may continue to degrade at the same time as the rights and well-being of the poor decline.

In recent years, there have been efforts to promote mechanisms for Payment for Ecosystem Services (PES) or Compensation and Rewards for Environmental Services (CRES) for the dual goals of improved ecosystem management and enhanced human well-being. Payment for Environmental Service (PES) is "....a voluntary, conditional transaction where at least one buyer pays at least one seller for maintaining or adopting sustainable land management practices that favour the provision of a well-defined environmental service (Swallow *et al.*, 2009). A CRES mechanism may be mostly viewed as a possible alternative income stream for poor people, that is, a new way to "put money in farmers' pockets." CRES are viewed as mechanisms for resolving conflicts over resource access and benefit sharing.

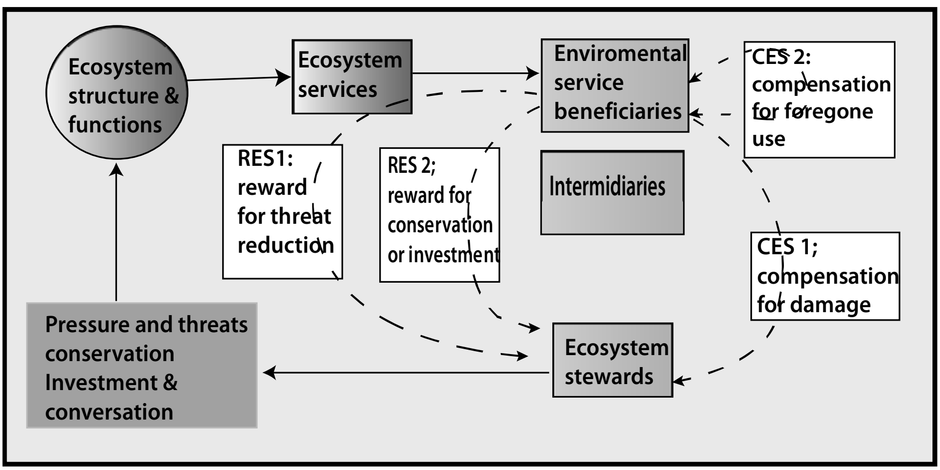

Figure 2.3: A Framework for Compensation and Rewards for Environmental Services (CRES)

Source: Swallow et al., (2009)

Figure 2.3 shows a conceptual framework for typifying and characterizing different types of mechanisms that link ecosystem stewards, ecosystem service beneficiaries, and intermediaries. This framework for Compensation and Rewards for Environmental Services (CRES) is viewed as a way to provide positive incentives for good environmental stewardship to go along with the standard set of environmental regulations (Swallow *et al.*, 2009). In Eastern and Southern Africa, projects such as Pro-poor Rewards for Environmental Services in Africa (PRESA) – http://presa.worldagroforestry.org – are working to foster the development, implementation and assessment of workable environmental service agreements in four core landscapes and four associate landscapes in the highlands of East and West Africa.

Ecosystem Function

Ecosystem function is the flux of biomass, nutrients and energy throughout the ecosystem. Energy and material transfer between and within ecosystems influences ecosystem behaviour in terms of the capacity of the ecosystem to provide goods and services. An understanding of ecosystem function is critical in NRM. Energy transfer efficiencies that regulate ecosystem productivity are a function of abiotic and biotic influences. The interaction between abiotic and biotic factors and mechanisms of regulation of ecosystem processes central to ecosystem performance are depicted in Figure 2.4.

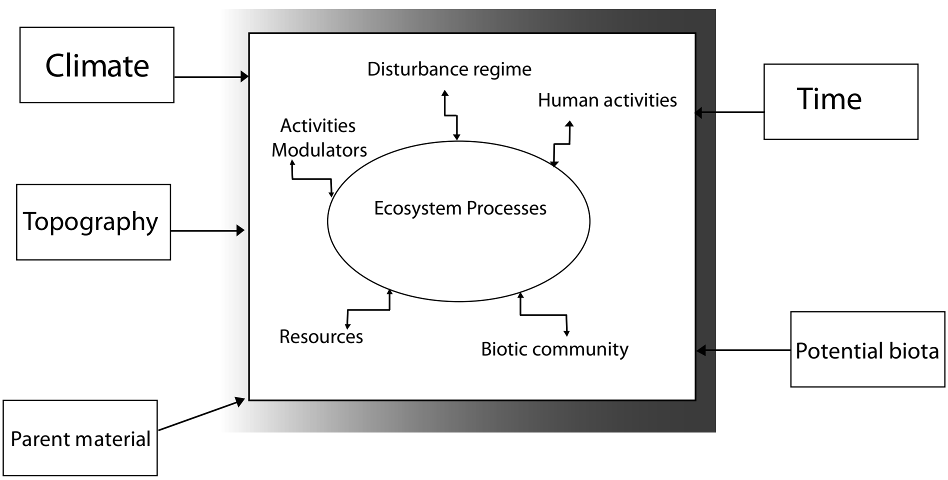

Figure 2.4: Relationship Between State Factors Interactive Controls and Ecosystem Processes

Source: (Adapted from Chapin et al., 1996)

As shown in the figure, climate (light and carbon dioxide) and below ground material resources (soil nutrients derived from soil parent material and decaying biota) influence ecosystem processes. The water factor in climate exerts the most pervasive influence on ecosystem structure and function.

For example, the availability of material resources is a function of climate, vegetation, soils and topography. Light availability at the plant level may be regulated by cloudiness, leaf orientation, leaf architecture and arrangement, associated shading characteristics in addition to leaf optical properties. Temperature regimes may be a function of heat energy exchange processes involving the soil-plant-atmosphere continuum. At the leaf boundary layer, the magnitude and direction of sensible heat transport and latent heat transfer dictate the thermal energy dynamics that have important implications on metabolic transformations associated with such processes as CO_2 assimilation, carbohydrate metabolism, protein synthesis, and rates of respiratory activities.

Soil moisture availability is subject to the influence of physical and chemical characteristics of soils that control water infiltration rates (such as soil structure and texture) water retention capacity and moisture release characteristics. Soil compaction due to anthropogenic activities reduces water infiltration rates, and affects soil moisture content and water availability for plant use. Soil chemical properties (such as soil mineralogical composition may interact with physical and biological effects to determine soil water acceptance, subsurface water flow, soil, moisture release characteristics and soil water available capacity. Similarly, soil fertility depends on biotic and abiotic factors that influence humification and mineralization. These factors include climate, litter quality, organic matter, and species diversity of decomposer micro organisms. In aquatic ecosystems, availability of dissolved oxygen, the depth of light penetration, temperature conditions and the pH of water determine plant and animal species diversity, complexity of food chains and trophic dynamics.

The physical and chemical properties that affect the activities of organisms, also known as modulators, are not depleted by organisms (Field *et al.,* 1992). However, modulators such as solar radiation, temperature, pollutants, pH, redox state of the soil etc., are constrained by climate and are sensitive to ecosystem processes such as latent and sensible heat transport.

Ecosystem perturbations (disturbance regimes) induced by such factors as fragmentation of forests, blocking of wildlife migratory corridors, fire, wind, environmental catastrophes (floods, droughts, wind storms) influence biotic structure and process rates in ecosystems. Disturbance regimes like other interactive controls are a function of state factors and ecosystem processes. For example, the rate of spread of fire, intensity of fire and resultant fire effects depend on wind regimes, moisture content of the fuel load and the flammability of the plant material. Similarly, climate influences plant species diversity and quantity of available inflammable biomass (fuel load). Plant life forms both in their relative botanical composition, relative abundance and species interactions (biotic community interactions) influence ecosystem processes in their own right just as much as climate differences or other differences such as parent material (geologic substrate material).

Box 2.1: Ecological and Management Perspectives: The Growing Challenges of Prosopis Juliflor

i). Prosopis juliflora is endemic in South and Central America and the Caribbean (Pasiecznick *et al.,* 2004).

ii). The tree has a red brownish rough bark and a deep tap root system.

iii). It grows rapidly, tolerates aridity, salinity and fixes nitrogen.

iv). The tree growth form which often attains a height of 14m produces compound leaves, dark bluish green in colour with a high tannin content (Matthews and Brand, 2004.)

v). Prosopis juliflora produces yellow persistent leaves year round and a prolific production of pods with a high sugar content. The leaves are unpalatable to livestock when ripe. On average, a mature tree may produce up to 40kg of pods per year with approximately 60 000 seeds (Alban *et al.,* 2002).

Emerging Issues

vi). Prosopis juliflora was introduced into Kenya for purposes of rehabilitating the cement mining quarries in Bamburi in the 1970s. In the 1980s, the tree was introduced into the Baringo rangelands through the Fuel Afforestation Extension Project (Kariuki, 1993 and Lenachuru, 2003).

vii). Prosopis juliflora is an invasive species. Its rapid spread through allelopathic interactions in Kenya presents many challenges (Nakano *et al.,* 2003).

viii). In the Baringo rangelands, the tree has outcompeted the indigenous Acacia spp and occurs as a pure stand in many low lying areas around the shores of Lake Baringo and proximal areas. The ecological implications of biodiversity loss associated with Prosopis juliflora raise important issues that require attention.

ix). There have been claims that the leaves of Prosopis juliflora produce negative health responses in goats. The leaves damage goats' teeth. The thorns of *Prosopis juliflora* may be highly poisonous to humans.

Semi-arid plant life forms are typically characterized by small boundary layer surfaces (small leaf area index) with low rates of photosynthesis, high cooling efficiency and less probability of thermal loading and accumulation of secondary compounds such as anthraquinones, saponins, tannins, glucosinolates, alkaloids and cyanogenic compounds. Plant succession induced anthropogenically may have significant implications on key functional plant species on ecosystem processes and ecosystem change. For example, the introduction of *Prosopis juliflora* into the semi- arid rangelands of Baringo District in Kenya for purposes of arresting soil water erosion and conservation of soil moisture has instead caused biodiversity erosion. *Prosopis juliflora* has an aggressive growth habit due to its allelopathic interactions.

Anthropogenic factors influence interactive controls such as water availability, disturbance regimes, and biotic diversity. Human activities such as deforestation impact evapotranspiration rates by reducing water vapour input into the atmosphere. In view of the climatological significance of water vapour in the atmosphere, deforestation regimes impact water availability directly. Similarly, deforestation influences the hydrological conditions that determine surface runoff and rainfall infiltration rates. Increased surface runoff and reduced soil moisture recharge have been linked to deforestation (FAO, 2005). Table 2.1 indicates that deforestation in the eastern African countries was a significant feature in the period of investigation (1990-2000). It should be remembered that shrinkage of forest cover remains as the most important factor in the atmospheric increase of CO_2 emissions.

Table 2.1: Forest Cover Change in the Eastern African Countries 1990-2000

Total land area Country	**Total forest area ('000ha)**	**% of land area ('000ha)**	**Annual change '000ha (1990-2000)**	**Annual rate of change % (1990-2000)**
Burundi	2568	94	3.7	-15
Djibouti	2317	6	0.3	Not available
Eritrea	11759	1585	13.5	-5
Ethiopia	11430	4593	4.2	-40
Kenya	56915	17096	30.0	-93
Rwanda	2466	307	12.4	-15
Somalia	62734	7515	12.0	-77
Uganda	19964	4190	21.0	-91

Source FAO, 2005

Carbon emissions from combustion of fossil based fuels and particulate pollutants that influence turbidity affect state factors through regional and global climate change. Human activities have been associated with shrinking biodiversity through clear cutting of forests logging, encroachment on gazetted forest lands, etc. Such disturbances influence the structure and functioning of ecosystems resulting in novel conditions that lead to new ecosystems. The disturbances are aggravated by global changes such as climate change (See chapter 6 for more details).

Competitive interactions and symbiotic relationships produce both negative and positive feedbacks. For example, allelopathic interactions associated with *Prosopis juliflora* depress the species that would have naturally co-existed with it resulting in the exclusion of competitors. This is an instance of a negative feedback. However, leguminous trees such as *Acacia tortilis* house nitrogen fixing Rhizobium in their nodules. Cyanobacteria and its associates fix nitrogen in the soil that is made available to the plant. These nitrogen fixing bacteria obtain assimilates in return for nitrogen fixation. This symbiotic and mutualistic relationship benefits both partners until constrained by other factors. The partners in a symbiotic relationship have a positive effect on each other (positive feedbacks).

Strong negative feedbacks provide resistance to changes in interactive controls and stabilize ecosystems. In plant community interactions, the differential acquisition of material resources such as light, water and mineral elements makes these resources unavailable to others, constraining the productivity of an ecosystem. Ecosystem dynamics involve feedbacks associated with acquisition of material resources.

Human activities related to changes in land uses, application of management interventions etc. affect ecosystems both directly and indirectly. The indirect effects include alterations of the chemistry of the atmosphere, changes in the hydrological conditions of the surface and climate change. Direct human effects are associated with production of natural resource system goods, and ecosystem services. Manipulation of ecosystems for goods and services affects species composition, species diversity and ecosystem integrity and resilience. Therefore, such ecosystems may become unstable and less resilient requiring large subsidies of inputs in order to stabilize them and maintain their productivity.

Intensive use of agrochemicals and insecticides increases the probability of environmental poisoning often seriously affecting the organic-detritus-food chain. Similarly, overharvesting of fish, particularly in commercial fisheries drastically alters species composition and may negatively affect population dynamics of target species.

Disposal of organic domestic and industrial effluents into aquatic bodies create conditions that trigger algal blooms. High densities of algal blooms place a high demand on dissolved oxygen resulting in conditions of oxygen deficiency (asphyxiation). Asphyxiation conditions are detrimental to fish and may cause substantial declines in fisheries production. Land use changes associated with the globalization have resulted in increased international trade and exchange of plant and animal materials. A concomitant rise in biological invasions (see chapter 1) characterizes many terrestrial biomes. For example, exotic species account up to 20% of plant materials on many islands (UNEP, 2007). Biological invasions such as those of *Prosopis juliflora* in Kenya are problematic because of adulteration of the gene pool of local plant materials arising from cross breeding. Invasive species are responsible for biodiversity erosion and loss due to allelopathy. Invasive plant species are usually superior competitors in the new ecosystems that they invade because they have no natural enemies. Biodiversity loss has strong underpinnings on economic loss as well as health induced losses as in the case of allelopathic species (see also section titled Ecosystem Function).

Human activities including crop agriculture, animal agriculture, agroforestry, ecotourism and many others influence material cycles (N, C, water cycle, phosphorous etc.). The water cycle is the medium for the transfer of material elements through the biotic and abiotic compartments of the ecosystem. Agro-technical practices in agriculture such as alley cropping, contour furrows, non-rain fed agriculture, application of fertilizers and use of insecticides to control vectors impact substantially the organic detritus food chain. Processes of humification and mineralization are dependent upon the quality and quantity of litter, species composition of soil micro-flora, soil moisture content, and soil temperature conditions. Since soil micro-climate and crop canopy architecture are subject to agro technical interventions, the rate of mobilization of critical chemicals and the pools and fluxes of materials and energy in the atmosphere-soil-vegetation compartments is a function of human and physical factors.

Industrial processing of agricultural and non-agricultural commodities heavily depends on fossil based fuels. Increased urbanization and industrialization in recent years has witnessed spiralling consumption of natural resources, increased demand of wood products for the building industry and rapidly diminishing forest cover. As a consequence, accumulation of carbon dioxide and other green house gases including carbon monoxide, methane, chlorofluorocarbons (CFC_{11} and CFC_{12}) continue to radically impact global climate change. CFC_S react with ozone (O_3) resulting in the depletion of the ozone layer. Ozone shields the earth from ultra violet radiation. Increasing depletion rates of ozone will enhance global warming and produce drastic effects on the atmosphere and ecosystems.

Energy Flow

Consumers get their energy from the carbon bonds made by the producers. The transfer of energy from sun to producer to primary consumer to secondary consumer to tertiary consumer can be shown in a food chain. A trophic level (feeding level) refers to the organism's position in the food chain. Autotrophs (producers such as flowering plants) are at the base. Organisms that eat autotrophs are called herbivores or primary consumers (e.g. herbivorous invertebrates and vertebrates). An organism that eats herbivores is a carnivore (secondary consumer). Lions and sharks are common carnivores in tropical ecosystems. A carnivore which eats a carnivore which eats an herbivore is a tertiary consumer (e.g. eagles and foxes) and so on. Another way of showing the transfer of energy in an ecosystem is the energy pyramid (Figure 2.5). Energy pyramids show that the amount of available energy decreases down the food chain. It takes a large number of producers to support a small number of primary consumers and it takes a large number of primary consumers to support a small number of secondary consumers. Food webs are interconnected food chains and they show the feeding relationships among different populations in an ecosystem, see Figure 2.7.

"Pyramid of *energy* is a graphic representation of the amount of *energy* trapped per unit time and area in different trophic levels of a food chain with producers forming the base and the top carnivores at the tip". Energy "flows" through the ecosystem in the form of carbon-carbon bonds. When respiration occurs, the carbon-carbon bonds are broken and the carbon is combined with oxygen to form carbon dioxide. This process releases the energy, which is either used by the organism for metabolism and other bodily functions or the energy may be lost as heat. All energy comes from the sun, and that the ultimate fate of all energy in ecosystems is to be lost as heat, hence does not recycle. Figure 2.5 shows that energy transfer diminishes with subsequent transfer along the trophic levels. These entropic losses have important implications on livestock production systems based on grazing systems. Because of low energy transfer efficiencies, the fundamental ecological dilemma in grazing ecosystems such as African savannas is the inability to maximize energy capture by plants and efficient energy harvest by grazing animals.

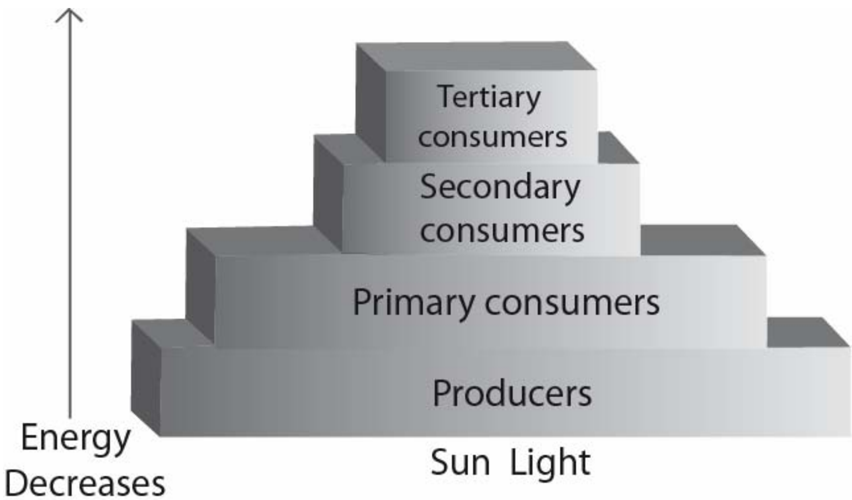

Figure 2.5: Pyramid of Energy

Source: TutorVista.com (2008)

Although severe grazing makes possible efficient harvest of primary production, reduced photosynthetic surface area minimises subsequent energy harvest. Similarly, light grazing maximizes primary production. However, large energy pools from ungrazed biomass is diverted into the decomposer compartment. The challenge in grazing management, therefore, is to formulate grazing management strategies based on our understanding of ecological principles in relation to energy flows that optimise the use of grazing resources without compromising the ability of grazing ecosystems to continue to produce primary production on a sustainable yield basis.

Nutrient Cycling

Nutrient cycling is the movement of chemical elements from the inorganic form into living organisms and then the return of these elements back into inorganic forms through metabolism or death and decomposition. Nutrient cycling in the ecosystem is also referred to as biogeochemical cycling because it involves movements of chemicals through the biological and geological components of the ecosystem. Each chemical has its own unique cycle, but all of the cycles have common features. Reservoirs such as oceans are those parts of the cycle where the chemical is held in large quantities for long periods of time. On the other hand, in exchange pools such as the atmosphere, the chemical is held for relatively shorter time periods. Figure 2.6 depicts the present carbon cycle and shows the dynamics of carbon exchange between the atmospheric and oceanic reservoirs. The length of time a chemical is held in an exchange pool or a reservoir is termed its residence time. The oceans are a reservoir for water, while a cloud is an exchange pool. Water may reside in an ocean for thousands of years, but in a cloud, for a few days at best. The biotic community may serve as an exchange pool (although for some chemicals like carbon, bound in a sequoia for a thousand years, it may seem more like a reservoir), and also serve to move chemicals from one stage of the cycle to another. For instance, the trees of the tropical rain forest bring water up from the forest floor to be evaporated into the atmosphere. Likewise, coral endosymbionts take carbon from the water and turn it into limestone rock. The energy for most of the transportation of chemicals from one place to another is provided either by the sun or by the heat released from the mantle and core of the earth (McShaffrey, 2006).

The global carbon cycle shows the carbon reservoirs in GtC (1 gigatonne = one thousand million tonnes) and fluxes in GtC/year. The indicated figures are annual averages over the period 1980 to 1989. The component cycles are simplified and the figures present average values. Evidence is accumulating that many of the fluxes can fluctuate significantly from year to year. In contrast to the static view conveyed in figures like this one, the carbon system is dynamic and coupled to the climate system on seasonal, interannual and decadal timescales. It is instructive to note that land use changes including alterations of natural plant cover giving rise to changes in carbon sinks (carbon reservoirs) account for between 0.5 GtC and 1.5 GtC. Combustion of fossil based fuel to generate energy for domestic and industrial use is responsible for up to 5.5 GtC on a global scale.

The biogeochemical cycles of all elements used by life have both an organic and an inorganic phase. For most of these nutrients, how efficiently these elements cycle from the organic component back to the inorganic reservoirs determines how much is available to organisms over the short term. This cycling involves the decomposition of organic matter back into inorganic nutrients. The major reservoirs for all metabolically important elements are found either in the atmosphere, lithosphere (mainly rock, soil and other weathered sediments) or hydrosphere. Flow from these reservoirs to the organic phase is generally slower than the cycling of nutrients through organic matter decomposition (Pidwirny, 2006).

Macronutrients that constitute more than 1% each of dry weight of organisms include *carbon, oxygen, hydrogen, nitrogen, and phosphorus*. Macronutrients that constitute 0.2 to 1% of dry organic weight include *sulphur, chlorine, potassium, sodium, calcium, magnesium, iron,* and *copper*. Micronutrients such as boron, bromine, cobalt, selenium and zinc are needed in trace amounts and constitute less than 0.2% of dry organic matter (Pidwirny, 2006).

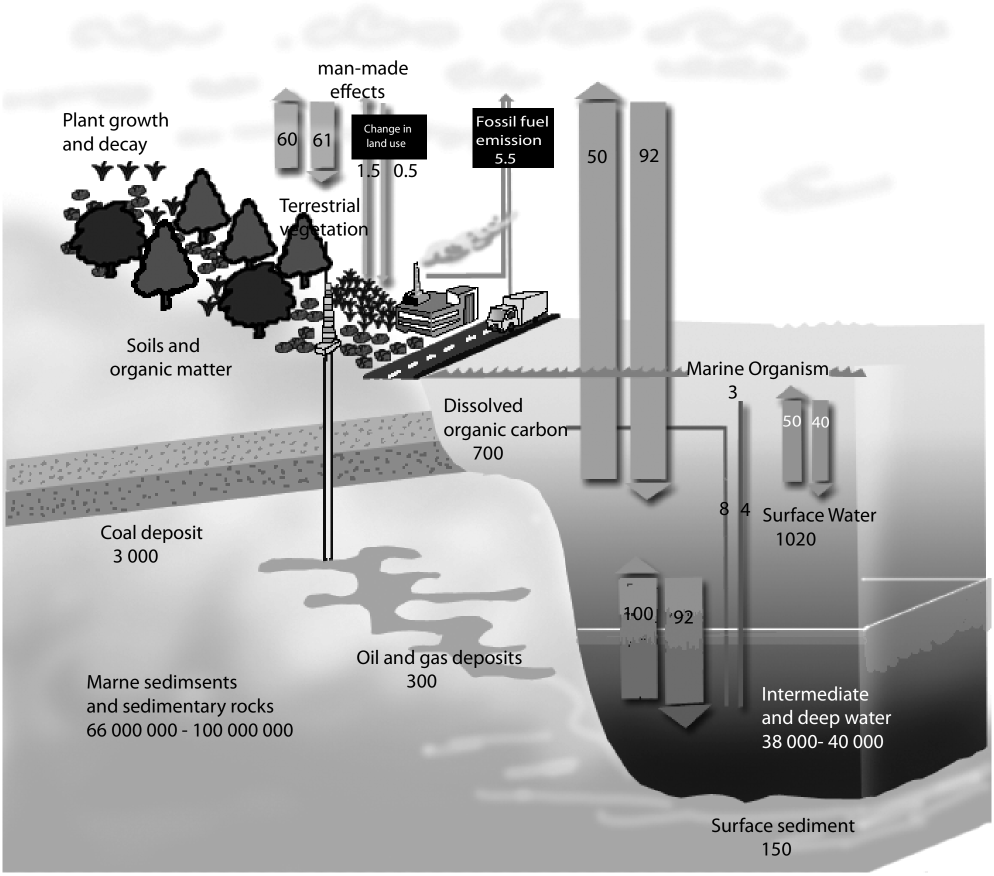

Figure 2.6: Dynamics of Carbon Exchange Involving the Atmospheric and Oceanic Compartments of the Ecosphere

Source: Centre for Climate Research, Institute for Environmental Studies, University of Wisconsin at Madison; Okanagan University College in Canada, Department of Geography; Woods Watch, November-December 1998; Climate Change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge Press University, 1995

Grazing animals impact grassland ecosystems by influencing energy flows and nutrient cycles through alterations of plant canopy architecture, leaf surface area available for energy capture, water interception and nutrient availability. Nutrient availability in turn governs the efficiency of energy acquisition and processing. Grazing transfers nutrients from plants to herbivores and decomposers and affects the rate of nutrient conversion from organic to inorganic forms. Transfer of plant materials to the animal body is occasioned by chewing, ingestion and rumination. The animal body provides a favourable environment (temperature and rumen micro flora) for microbial activity. Faecal matter and urea deposited by herbivores constitute sources of nitrogen, potassium, magnesium and sulphur that become readily available for plant absorption.

Ungrazed plant material and faecal matter are sources of bound nutrients that become available through mineralisation by decomposer microorganisms prior to absorption. Nutrients that are incorporated directly into primary production are readily available for reabsorption when transferred through the grazing food chain than directly into the decomposer compartment. Research evidence from grazing ecosystems indicates that higher nutrient concentrations occur in grazed than ungrazed ecosystems (Cid *et al.*, 1990). This finding authenticates the role of herbivory in accelerating rates of nutrient cycling. It is clear that an understanding of the role of herbivores in nutrient dynamics (nutrient cycling) is essential in the formulation of natural resources management interventions that would favour maintenance of favourable nutrient budgets for plant growth and animal production.

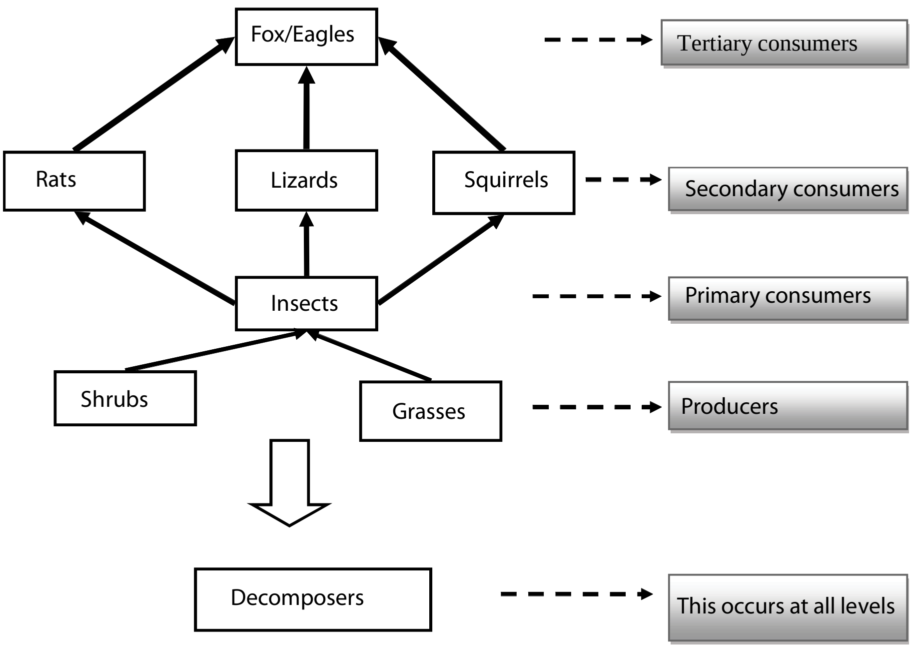

Figure 2.7: An Example of a Simplified Food Web Showing Interlinked Food Chains

Food chains represent linear linkages in the trophic levels of living organisms. A simple food chain would show linear transfer of energy from a producer such as a savanna shrub to an herbivore such as an insect (Figure 2.7). An insect may later be consumed by a lizard and the latter by other consumers along the food chain. Energy transfer along food chains involves energy transformation with consequent energy loss since energy transformation efficiency is not 100% in accordance to the second law of thermodynamics. These entropic losses in the chain result in energy decrease from the base of the chain to the top. Energy transfer from one organism to the next is about 10% to 20%. This means that anything between 80% and 90% is lost in the form of metabolic heat. Food webs represent interlinked food chains.

In grazing systems, energy transfer efficiencies have important implications on primary productivity and livestock performance. Transfer of energy in grazing systems occurs through the grazing food chain. Similarly, energy is transferred from the grazing to the detrital food chain. Biotic constraints such as inefficiencies in energy capture and inefficient transfer of organic matter (gases, faecal losses and urinary losses) place limitations on the energy required for internal maintenance of livestock. Entropic losses mean that animals utilize a large portion of the total energy ingested for basal metabolism thereby diminishing the amount of energy available for growth or transfer to subsequent feeding levels within the system.

Nitrogen Cycle

Nitrogen is one of the most important elements in life because it is a constituent of amino acids, proteins, enzymes and genetic molecules and thus its cycle is presented here as an example of a nutrient cycle, as described by McShaffrey (2006).

The chief reservoir of nitrogen is the atmosphere, which is about 78% nitrogen. Nitrogen gas (N_2) in the atmosphere is composed of two nitrogen atoms bound to each other. It is a relatively non-reactive gas. Nitrogen gas can be taken from the atmosphere (fixed) in two basic ways. First, lightning provides enough energy to "burn" the nitrogen and fix it in the form of nitrate (NO_3-). This process is duplicated in fertilizer factories to produce nitrogen fertilizers. The other form of nitrogen fixation is by nitrogen fixing bacteria, which use special enzymes instead of the extreme amount of energy found in lightning to fix nitrogen. These nitrogen-fixing bacteria come in three forms: some are free-living in the soil; some form symbiotic, mutualistic associations with the roots of bean plants and other legumes (rhizobial bacteria); and the third form of nitrogen-fixing bacteria are the photosynthetic cyanobacteria (blue-green algae) which are found most commonly in water. All of these fix nitrogen, either in the form of nitrate or in the form of ammonia (NH_4^+).

Most plants can take up nitrate and convert it to amino acids. Animals acquire all of their amino acids when they eat plants (or other animals). When plants or animals die (or release waste) the nitrogen is returned to the soil. The usual form of nitrogen returned to the soil in animal wastes or in the output of the decomposers, is ammonia. Ammonia can be taken up by nitrite bacteria in the soil and in the water and converted to nitrite (NO_2^-). Nitrite is converted by nitrate bacteria to nitrate which can be taken up by plants to continue the cycle (Figure 2.8).

Besides its important role in the living organism, nitrogen can have negative effects on the ecosystem where there are imbalances. Excess nitrate and nitrite can be leached and washed away into water bodies where it can cause eutrophication and health problems in human beings. *Denitrification* is a process in which organic nitrogen compounds such as fertilizers are decomposed and gaseous nitrogen (N_2 and N_20) is released. N_20 is a greenhouse gas associated with climate change.

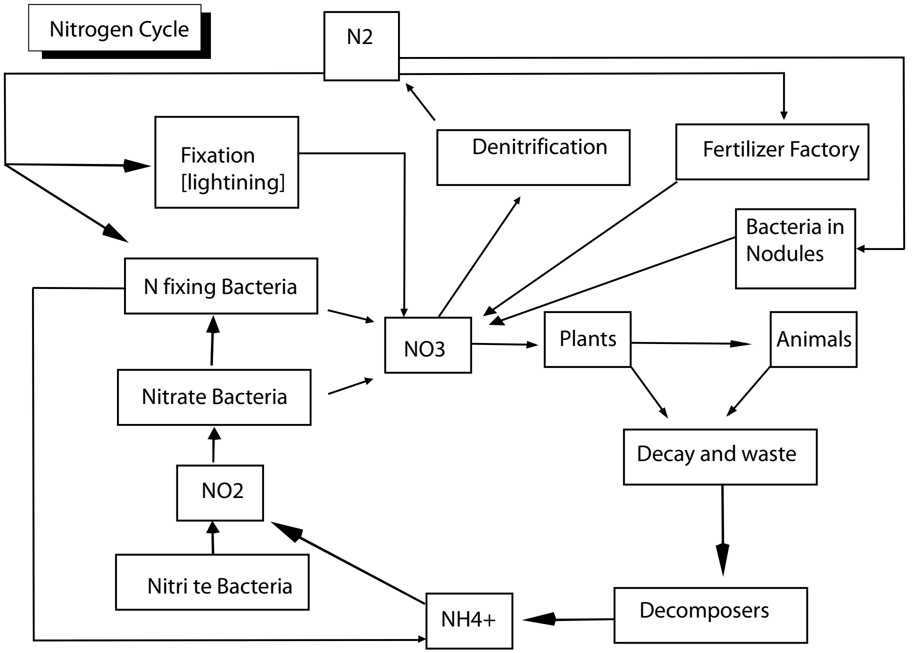

Figure 2.8: The Nitrogen Cycle

Source: After Mcshaffrey, 2006

Ecosystem Hierarchies

Ecological systems are complex and are organized in *hierarchies*. A hierarchy is a graded series with several levels of organization, or a series of ordered groupings within a system. Examples of hierarchies are: cell, organ, organism, population, community, ecosystem, landscape, and species, genera, family, order, class, phylum, kingdom. All levels within a hierarchy such as the cell or organism are definable in time and space. No single level in the hierarchy is fundamental and each level of the hierarchy has characteristic functions that contribute to the functioning of the whole hierarchy. Interaction occurs among the different components and within different organisms.

These ecological hierarchies are important because when we study ecosystems, we need to understand the behaviour of the system at a specified level of the hierarchy and ascertain properties of the ecosystem emerging at that given level (Figure 2.9). Since ecological hierarchies constitute different levels of complexity of biological organization, an understanding of the functional, interactive and integrative role at different levels is critical in predicting the consequences of management impacts on system level compartments in relation to the integrated life support system.

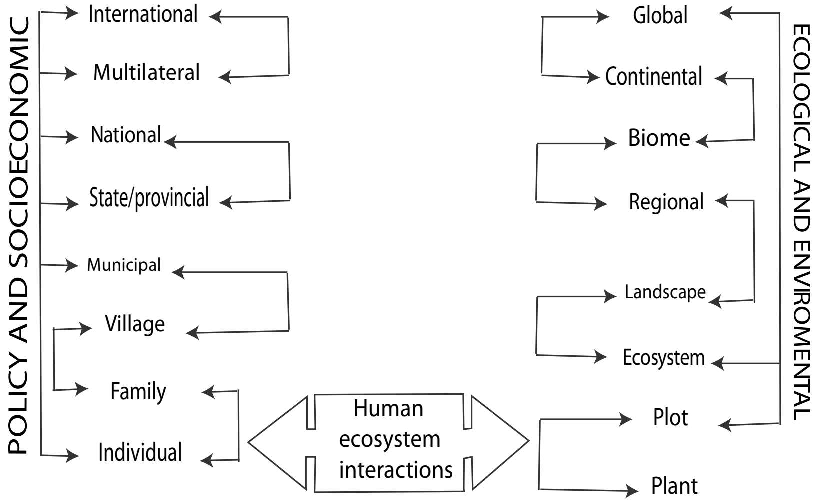

Figure 2.9: Scale and Cross Scale Interactions in Human and Ecological Systems

Source: MA 2005

Population

A population is a group of interbreeding, or, potentially interbreeding organisms of the same species occupying a particular space at the same time. A population grows by adding new members through reproduction and immigration. The difference between gains and losses is the rate of population growth. Defining individuals within a population is not always an easy task. Mammals, birds, reptiles and insects are easier to define because they are unitary organisms which have determinate growth i.e. each individual has a pre-determined number of components (a lion has 1 head, 2 eyes, 4 legs). Definition of individuals is less clear for modular organisms which have indeterminate growth i.e. organisms that have the genetic potential to grow and branch such as many marine invertebrates, many plants and filamentous fungi, grasses and trees.

A metapopulation is a set of local populations which interact via individuals moving among them. A metapopulation can be considered as a population of populations. It is an abstraction of the population concept to a higher level. The metapopulation scale is the scale at which individuals infrequently move from one place or population to the next. Movement is typically across habitat types which are not suitable for their feeding and breeding activities and often with substantial risk of failing to locate another suitable habitat in which to settle. Any local population has its own dynamics independent of dynamics of other local populations. Population's changes are a consequence of biotic-biotic interactions and biotic-abiotic feedbacks. For example, the migratory spectacle associated with the wildebeest in East Africa across the savanna often through a number of migratory corridors is of great ecological significance in relation to trophic dynamics, population regulation factors and management.

Communities

A community may be defined as an assemblage of different populations which occur together in space and time or, a group of organisms of different species occupying the same area. The focus of community ecology is the manner in which this grouping of species are distributed in nature and how they interact among themselves and with their environment. Plants and animals of a woodland or forest community tend to be stratified i.e., formed in layers, both vertically and horizontally. For instance, a forest may consist of a tall tree layer, a shrub layer and a lower herbaceous layer with ground dwelling insects and birds of the upper tree layers. In most communities, one or a few species become the most influential because of their numbers, size or activities. These species are known as the dominant species of the community. Keystone species are those whose presence is critical to the integrity of the community. Examples are predator species that control the structure of the community by preying on species of similar habitats, thereby reducing their competitive interactions. If the predator is removed, the less competitive prey species disappear and one becomes dominant.

Communities form patterns in space, whereby they vary in composition, structure, diversity and other characteristics as changes occur in the environment. Gradual environmental changes tend to produce gradual transitions from community to community while abrupt environmental change results in an abrupt community change. Communities also exhibit temporal change through time due to the interaction of many physical factors of the environment as well as biological interactions.

Communities are highly organized assemblages of co-evolved species. Each species is competitively superior in its own niche in the habitat. Competitive interactions among these species maintain a state of equilibrium and diversity without continual change in species composition. After a disturbance, the species eventually re-occupy their former positions; the community arrives again at equilibrium or some degree of stability. Although equilibrium theory has long dominated ecological thought, ecological communities seldom attain equilibrium. Disruptions are common, preventing species assemblages from reaching any highly ordered state. Contrary to the equilibrium theory, communities exist at some level of disequilibrium, held in state by environmental disturbances.

Landscapes

A landscape may be defined as a heterogeneous land area consisting of a cluster of interacting components repeated in a similar format throughout. A landscape has the following characteristics: a cluster of ecosystems, flows or interactions among the ecosystems of such a cluster and disturbance regimes in such a cluster. Landscape ecology is the study of the structure, function and change in a heterogeneous landscape composed of interacting ecosystems. The primary focus of landscape ecology is on the structure or the spatial relationship among distinctive ecosystems and the distribution of energy, materials and species in relation to the sizes, shapes, numbers, kinds, and configuration of ecosystems; function or interactions among the spatial elements i.e., the flow of energy, materials, and species among the component ecosystems; and, change or alteration in the structure and function of the ecosystem over time.

Landscape ecology is important in natural resource management because, for instance, wild animals generally occupy landscapes, often moving from one ecosystem to the other. We need to be aware of the connectivity and interactions among these ecosystems. It is, therefore, not enough to consider only the ecosystem level but also how those ecosystems in a landscape are related. This inevitably affects how we select wildlife species and wildlife management strategies.

Biomes

A *biome* is a recognizable plant and animal community that is determined primarily by global climatic patterns, or a broad ecological unit that represents major life zones extending over large natural areas. Within each biome, other environmental factors like soil type, herbivory and fire determine the recognizable sub-classifications. Biomes or ecoregions are used to describe the general ecosystem types at the global levels. Many classifications are used for this description such as Whittaker (1975). The Whittaker classification (Figure 2.10) is based on mean annual precipitation and mean annual temperature. In view of the vastness of biomes, it has been possible to use *geospatial technologies* in defining macro ecological and multi scale level indicators of ecosystem productivity related to natural resource management.

"Panarchy": Multiple Scales and Cross-Scale Dynamics

One of the fundamental principles of complex systems is that they are nested in hierarchies across different scales. No system can be understood or managed by focusing on it at a single scale. All systems exist and function at multiple scales of space, time and social organization, and the interactions across scales are fundamentally important in determining the dynamics of the system at any particular focal scale. This interacting set of hierarchically structured, dynamic and nested scales has been termed "panarchy" (Gunderson and Holling, 2002).

The term "parnachy" is an antithesis to the concept of ecosystems hierarchy as a series of ordered and distinct groupings of a system. Parnachy is based on the notion of hierarchies of influences between embedded scales to represent structures that allow adaptive evolution (Holling *et al.,* 2002). Panarchy theories present the notion that there is a connection between different levels, and that there are potentially multiple connections between phases at one level and phases at another level. The concept of panarchy provides a useful framework for understanding how these nested systems interact, and that disturbance at one scale has an influence on other scales. For example, the feedback loops that regulate a wetlands ecosystem

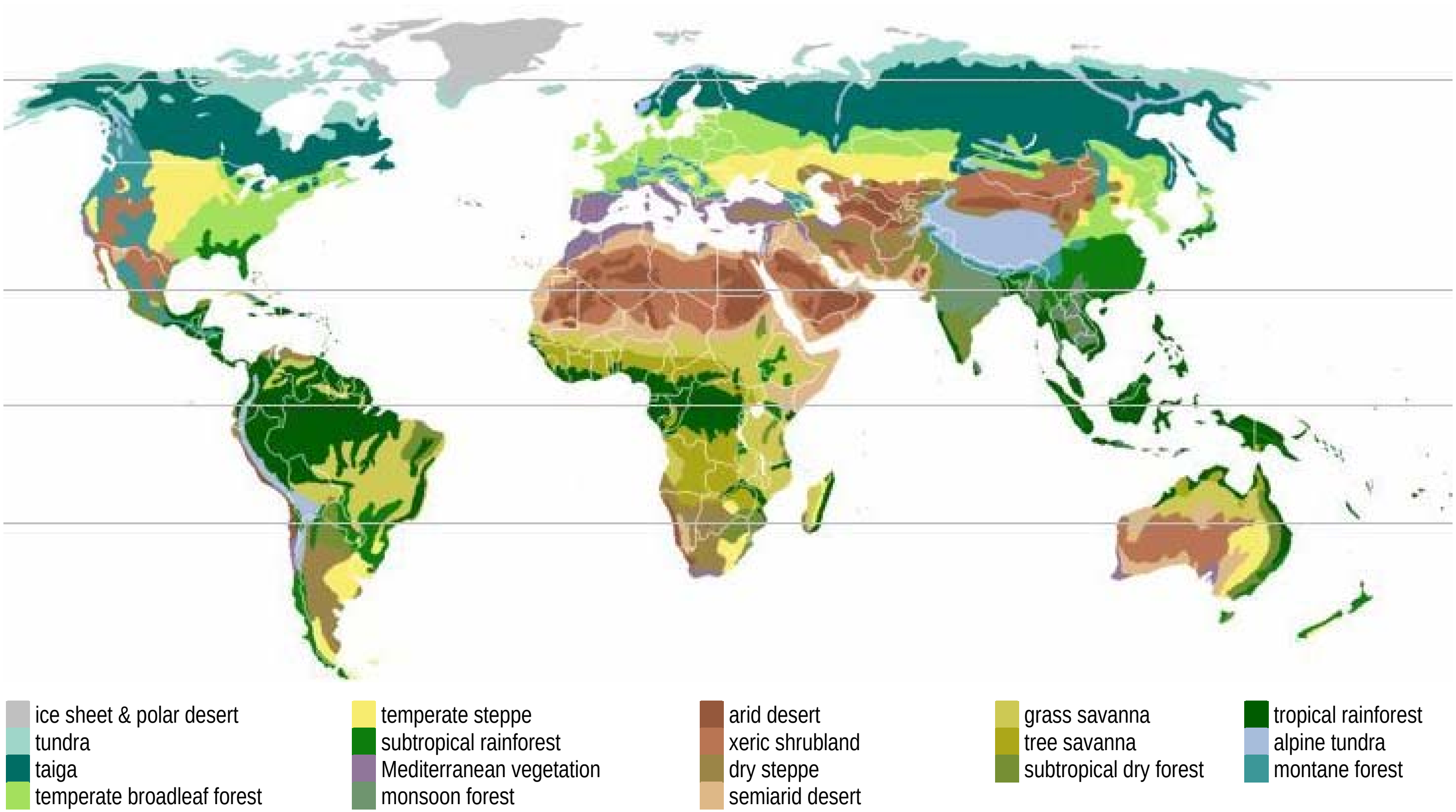

Figure 2.10: Global Terrestrial Biomes

Source: MA, 2005

are dependent also on the inputs of water and nutrients from outside the system, and on the economic and political systems that influence human migration and agricultural colonization on the periphery of the wetlands. All of these systems at different scales operate on similar principles (growth, conservation, release and re-organization), but often over much different time frames.

Ecosystem Pattern

Repeated patterns emerge at varying scales of the ecosystems. Ecosystem pattern is determined by the abiotic variations such as soil type and depth and precipitation. These variations in the abiotic environment give rise to a differentiation in processes such as primary production. Climate largely determines the plant and animal communities that can thrive in a region. Within regions of similar climate, further differentiation in spatial pattern arises from the local abiotic and biotic characteristics such as soil depth, soil pH, slope and levels of herbivory. Understanding the processes that lead to different spatial patterns is important for understanding their dynamics and how they respond to management.

A possible way to describe the factors which are thought to control eco-climatic units, and the scale at which they operate, is described by Bailey (1987). Macroclimate accounts for the largest share of systematic environmental variation on the macroscale or regional level. On the mesoscale, the broad patterns are broken up by geology and topography (landform). At the macroscale, the ecosystem patterns are controlled by latitude (irregular solar energy), distance from the sea (continentality or oceanic influences), or elevation. Each eco-climatic zone is clearly defined by a particular type of climatic regime and, with a few exceptions; the zones largely correspond to zonal soil types and climatic climax vegetation. These zones are reflective of those major ecosystems that bio geographers have traditionally recognized as biomes (Whittaker, 1975).

There are many applications of the study of ecosystem patterns, such as research and management. Ecosystem analysis must be performed at multiple levels. The significance of multi-level analysis is that local systems or sites are seen within the context of the larger system. This perspective can be applied in assessing the connections between action at one scale and effect at another. For example, logging on upper slopes of an ecological unit may affect downstream riparian habitats. A lake's ecosystem is related to the ecosystem of the stream that feeds it, and the stream's ecosystem is related to the forested mountain side through which it runs.

Landscapes function differently as a whole than would have been predicted by analysis of the individual elements (Marston, 2008). The relationship between systems at different scales must be examined in order to analyze the effects of management. Since management occurs at varying levels from national to site-specific, a hierarchical system of units, defined according to criteria that make them relevant to the kinds of questions being asked at different levels of management decisions, is needed (Bailey, 1987).

Ecosystem Dynamics

Ecosystem dynamics refer to changes within and between ecosystem components as a consequence of the interactions involving abiotic and biotic components. These changes are associated with qualitative and quantitative variations in energy flows and material fluxes. Ecosystem dynamics is the product of exchange processes involving the interactions between abiotic and biotic components of the environmental-life-support system. The rates of ecosystem processes are constantly changing due to variations in environmental conditions and organismic activities on time scales ranging from a few micro seconds as in the case of light capture by chlorophyll pigments in photosynthesis in response to light energy fluctuations incident upon a leaf to many hundreds of years associated with global climate change. CO_2 fixation rates into organic food molecules in green plants change over time scales of seconds to decades due to variations associated with light, temperature, and leaf area (Chapin *et al.*, 1996).

Many factors control ecosystem dynamics. The host of factors that control population dynamics of organisms in ecosystems may be studied in homogeneous physical entities of a lake, a stream, forest ecosystem or even an agricultural ecosystem. These studies or measurements may be done at different scales. For example, local, regional or continental measurements of the spatial variability of green house gases in the atmosphere may require careful long-term measurements in order to ascertain long-term trends and their impacts. Spatial variability of CO_2 due to differential production and global atmospheric exchange may be monitored globally over time in order to obtain estimates of CO_2 fluxes involving the soil-plant-atmosphere system. Local CO_2 exchanges involving the air-vegetation-soil compartments at the level of a water catchment may exhibit spatial and temporal variations depending upon the sources and sinks of CO_2 and the intensity of vertical exchange processes.

Ecosystem dynamics affect ecosystem structure and function. For instance, the coupling of heat energy and water budgets in the brown belt has significant implications on metabolic transformations associated with synthesis of organic materials in photosynthesis, carbohydrate metabolism, protein metabolism, organic material decomposition rates etc. Systems approaches have opened new frontiers in studies of ecosystem dynamics. For example, large scale terrestrial ecosystem processes affect the atmosphere and oceans. Evapotranspiration from terrestrial vegetation contributes significantly to the total water vapour pool in the atmosphere. Water vapour influences heat exchange processes in the atmosphere and impacts the water cycle as well. Since elemental fluxes between and within ecosystem compartments take place partly through the water cycle, a general understanding of these ecosystem processes and the factors that influence them is of vital importance. The scale of ecosystem effects must be studied by advanced tools that capture the spatial and temporal scales. The application of geospatial technologies based on satellite remote sensing of ecosystem properties, global networks of atmospheric sampling sites and development of global models must replace traditional ecosystem tools of systems analysis. The dynamics of CO_2 on a global scale and other green house gases in the atmosphere can be addressed by use of geospatial technologies such as Geographical Information Systems (GIS).

Ecosystem Integrity

Ecosystem integrity, albeit a useful concept, in sustainable natural resources management, poses a number of problems that science has yet to resolve. The concept is vague and often does not incorporate the dynamic view of ecosystems. Ecosystem integrity is a complex issue. A single indicator may not provide an operational definition. Integrity presupposes “unimpaired state”, the quality or condition of being “whole” or “complete”. However, managed ecosystems are always subject to disturbances arising from anthropogenic and abiotic effects. These effects impair the ecosystem and reduce its resilience.

The organization of ecosystems into structural and functional components, that is, species, populations, and communities of organisms which process energy and recycle critical chemicals for the production of goods and services, means that operational definitions of integrity must include the maintenance of community structure and function considered desirable to society (Cairns, 1977). This definition underscores the significance of the human perspective in the sense that the system must be able to provide goods and services desirable to humans. Other operational definitions such as those of Karr and Dudley (1981) emphasize the capability of an ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having species composition, diversity and functional organization comparable to that of natural habitats in an area.

In spite of the criticism against vagueness of the concept of ecosystem integrity in relation to operational definitions and tractability to quantification, it is instructive to characterize in detail the structural and functional aspects of ecosystems that would provide a conceptual framework for evaluating the impact of human activities on biological systems.

Reductionist and Holistic Approaches

Reductionist and holistic approaches are different perspectives of studying the behaviour of ecosystems and implications in the selection of strategies for management. Reductionist approaches emphasize the structural aspects of natural ecosystems and focus on individual species and population dynamics of species within isolated ecosystems. On the other hand, holistic approaches focus on macro level functional aspects such as energy flows, nutrient cycles and productivity, often ignoring the effects of past disturbances on the performance of the ecosystem and micro level organization and spatial and temporal distribution of organisms.

Although the functional and structural perspectives of ecosystems are not mutually exclusive, they have provided the premises upon which many branches of ecological theories have flourished. Of interest is that they have provided the basis for different definitions of ecosystem integrity.

Adherence to the structural composition of ecosystems leads to the definition in which damage of the link between species components or loss of species implies loss of ecosystem integrity because the ecosystem is no longer "complete" or "whole" (De Leo and Levin, 1997). However, it may be argued that on the basis of functional integrity, redundancies within functional groups make species composition less relevant. Either definitions or their combinations have merit; their relevancy is a function of the manner in which ecosystem goods or services are viewed. Structural and functional dimensions of ecosystems are linked. Ecosystem goods and services are the product of macroscopic properties which are resilient to changes in structure over short time scales. Systems may be able to preserve macro level functions such as productivity even under circumstances of high levels of disturbance engendering substantial changes in structure with no appreciable change in some macro level indicators.

According to De Leo and Levin (1997), a change in ecosystem structure that does not appreciably change the qualitative and quantitative functional aspects should be considered as a minor loss of integrity. This view, however, does not embrace the fact that loss of diversity within functional groups may reduce the resilience of the system over longer time scales.

It is apparent that structuralism or functionalism may not be conceptually adequate in providing an operational definition of ecosystem integrity; however, the plausibility of both occurs within some boundaries. Assessments of ecosystem integrity based on some macro level indicators such as productivity, energy flows or nutrient cycling may obscure the macroscopic properties that finally determine the resilience and stability of the ecosystem to perturbations. Natural resource management options based on structuralism or functionalism approaches represent inflexion points in a multidimensional continuum in which a variety of measures of differing resolution of detail may be applied (De Leo and Levin, 1997).

Equilibrium vs Non-equilibrium Theories in Ecosystem Management

Scientific literature is replete with controversies on the efficacy of equilibrium versus disequilibrium theories in explanations of ecosystem dynamics (Reice, 1994; Chapin *et al.*, 1996, De Leo and Levin, 1997). The proponents of equilibrium theory of ecosystem structure and function recognize that ecosystems reflect properties of closed systems characterized by internal recycling of elements, self regulation and deterministic dynamics and stable endpoints.

Equilibrium and non-equilibrium theories originated from population and community ecology. These concepts have now crossed over and pervaded applications in resource economics, social and cultural anthropology, range ecology, land use policy and law and many others. In view of the "hybridization" and non-contextual usage of these concepts in a variety of disciplines, confusion in the interpretation of the meaning and management implications of research results characterises the literature in social and natural sciences (Behnke *et al.*, 1993, Sullivan and Rohde, 2002).

Social scientists and natural scientists view people-environmental relations in different ways. For example, the concept of non-equilibrium dynamics may be used in social science to describe behaviour patterns and decision making in environmental contexts characterised by uncertainty such as African pastoral societies where pastoralist development (flexible movement of livestock), opportunism and responsive livelihood adaptation are central components of human-environment interactions. Similarly, in natural resources ecology, ecologists contend that natural systems are better understood if they were somehow separate from human intervention and perception. The relevance and significance of non-equilibrium models (that are quickly replacing range condition and trend concepts) provide insight into the evolution of savanna ecosystems subjected to a myriad of perturbations including stochastic events such as drought, fire, and management interventions over many centuries. It is, therefore, apparent that uncritical application of equilibrium and non-equilibrium concepts in the management of semi-arid and arid ecosystems would continue to fuel polarised debates and dilute the conceptual underpinnings of these theories (Sullivan and Rohde, 2002).

According to Wiens (1984 a, b), non-equilibrium systems are characterised by a general “decoupling” of close biotic interactions. For example, livestock populations may be tightly coupled to the availability of forage resources. This resource- consumer relations, however, is governed by abiotic conditions such as rainfall that determine the abundance of the forage resource that dictate herbivore-plant resource relations. In other words, abiotic factors and stochastic environmental events disturb populations in a manner that is independent of density dependent factors. Similarly, equilibrium systems are characterised by biotic coupling, density dependent relations (biotic-biotic and abiotic-biotic interactions) that disturb populations with consequences that result in rapid ecosystem resilience (ability of the system to return to its original state following disturbance).

In the context of the management of African pastoral landscapes, the application of the equilibrium and non-equilibrium models as defined is qualitatively distinct. For example, nomadic pastoralism characterised by flexibility in mobility and opportunistic decision options make the most of unpredictable non-equilibrium environments whereas conservative optimisation is the most appropriate land use option in equilibrium contexts.

Since equilibrium and non-equilibrium states represent opposite poles of a spectrum of system states, ecosystems from a conceptual standpoint exist across a continuum of transient states. Equilibrium or non-equilibrium states are subject to the scale of observation. In the long term, all phenomena tend toward a non-equilibrium state. This is a consequence of unpredictable events that effectively decouple system attributes and bring about system change. From a theoretical perspective, equilibrium dynamics associated with defined temporal and spatial scales are an explanatory ideal for problems far removed from broader temporal contexts. In other words, all biological systems are intrinsically non-equilibrium states with predictable and tightly coupled interactions occurring at certain scales of observation (Sullivan and Rohde, 2002).

Current developments in the science of ecosystem ecology support the significance of past disturbances and external forces in shaping the direction of ecosystem change. It is now recognized that most ecosystems are open systems with export and import channels for transfer of energy and recycling of material resources. The dynamics of open systems are influenced by internal and external impacts and subject to pervasive anthropogenic influence. This non-equilibrium perspective of open ecosystems demands a more dynamic and stochastic view of controls over ecosystem processes (Pickett and White, 1985, Chapin *et al.,* 1996). Bormann and Likens (1979) contend that ecosystems may be considered to reflect steady states if exports and imports of energy and elemental fluxes show no indications of trends over time. Steady state assumptions are at variance with equilibrium postulations since they treat spatial and temporal variations as normal aspects of ecosystem dynamics.

Most African savannah ecosystems and forest ecosystems may be said to exhibit non-steady states due to disturbances caused by rainfall variability, fire, overgrazing, forest clearing, crop farming, logging etc. However, it is easier to understand the response behaviour of ecosystems in the absence of large past disturbances in order to appreciate the impacts of recent disturbances on ecosystem change. In the African savannas, the wet seasons representing the equilibrium end of the gradient, plant-herbivory relations (density dependent factors) are a primary factor influencing vegetation change in the short to medium terms. However, in the non-equilibrium end of the spectrum, plant- animal relations are qualitatively different. In times of abundance of resources, underutilisation is typical. During drought, there is no or little vegetation resources to support herbivory upon which great impacts may occur. Destocking becomes inevitable, removing surviving livestock to areas with abundant resources.

Managing and Mismanaging Ecosystems

Scientific literature is replete with bodies of knowledge on the theoretical foundations and practices on sustainable natural resource management. Strategies of ecosystem management to a certain extent dictate the achievement of sustainable NRM. However, context based political and sociological considerations generally override such efforts (Ludwig *et al.,* 1993) and may influence the outcomes of ecosystem processes. Unregulated open-access resources such as fisheries can be both economically viable and ecologically inefficient in the context of energy transfer processes and material cycling. Effective ecosystem management regimes using integrated approaches can shift over-exploited resources from unacceptable bio-economic equilibria to more acceptable conditions. For water resources like

Lake Victoria, clear normative methods can be implemented in the form of time, place, and catch controls/restrictions, total and allocated quotas, harvesting tool restrictions, and license limitation. Incentives schemes and alternative livelihoods are also known to shift the strain from an ecosystem, thus controlling mismanagement. Conversely, other regulation instruments may embody financial disincentives such as subsidy cuts and taxes, or royalties on effort and harvested biomass. The concept of payment for ecosystems services, CRS and Polluter Pays Principle (PPP) are emerging financial schemes aimed at reversing and avoiding ecosystems degradation.

Although the management of ecosystems is well researched, there are very few examples of ecosystems in which sustained exploitation has proved to be successful or degraded ecosystems have been reverted to their original pristine states. In sub-Saharan Africa and the world at large, renewable resources have been systematically overexploited causing biodiversity erosion and in extreme cases, extinction of valuable species has occurred. A number of factors contribute to the mismanagement of ecosystems. According to the UNEP (2007) report on an integrated environmental assessment using the Drivers-Pressures-States-Impact-Response (DPSIR) model, the antecedent factors underlying degradation of resources in Africa were embedded in the inherent complexity of biological communities and environmental stochasticity (De Leo and Levin, 1997). Sustainable ecosystem management requires meticulous implementation of adaptive methods of management that focus on the mutual interactive linkages between biological factors, economic factors and natural variability.

Ecosystem-based NRM even when included in an adaptive framework, has traditionally focused on relatively small scales of spatial and functional organization, ignoring the broader ecological and environmental context in which exploited resources are often, if not always, embedded. This approach ignores, to the detriment of the ecosystems, second-order, indirect, and sometimes irreversible impacts. Only first-order direct impacts have been targeted with the consequence of resource unbalanced exploitation. For instance, ecosystem management could be sustainable with respect to the commercial species, but may seriously threaten the viability of other components of the ecosystem. Community-based and ecosystem-level planning may be the most efficient way of avoiding such eventualities. Chapter three presents detailed insights into this.

Ecosystem Resilience

Ecosystem resilience describes the capacity of an ecosystem to cope with disturbances such as fire, herbivory, pollution, drought etc. without shifting into a qualitatively different state. In other words, resilience describes a measure of resistance to disturbance and the speed of return to the equilibrium state of the ecosystem. In a resilient ecosystem, the process of rebuilding after disturbance promotes rejuvenation and renewal. The loss of resilience in an ecosystem leads to vulnerability to disturbances that may bring about structural and functional changes.

For example, extreme defoliation pressure by herbivores may lead to the conversion of shrub lands into semi arid grasslands dominated by annual plants. The capacity to recover from specific stress factors is quantifiable and amenable to experimentation and scientific testing. Since natural ecosystems react to stress and adjust to changing environmental conditions, the degree of resilience can be measured and interpreted by an examination of trends. The response of an ecosystem to the intensity of induced stress can be evaluated in terms of the impact of stress on ecosystem change. The different perspectives of resilience are illustrated in Figure 2.11.

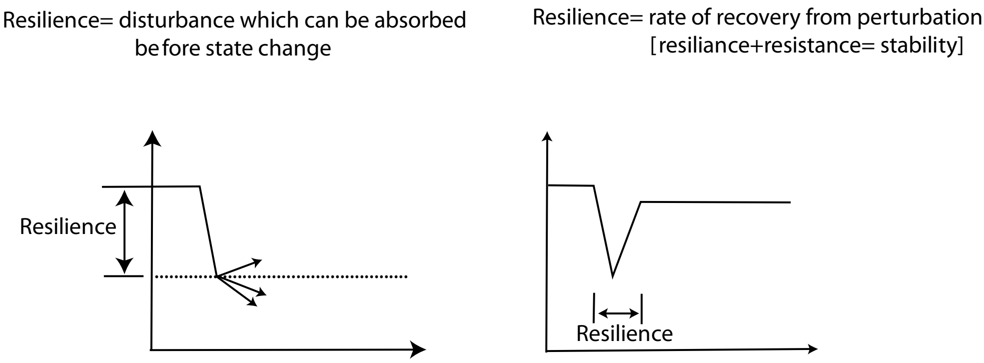

Figure 2.11a: Different Perspectives of Resilience

Source: Resillence Alliance (2007).

A resilience approach is much more challenging than a conventional conservation or productivity approach because:

There is not usually a stable equilibrium, so the notion of some desired "outcome state" or carrying capacity is not meaningful without extensive qualification.

- It can be difficult to tell if a system is resilient, even with careful observation, because there are not yet clear criteria, and even if there were, the slow processes that control systems can be hard to identify.
- Conventional "state" indicators and measures are inappropriate as guides to desirable ecosystem features: overall system characteristics and emergent properties (i.e. things you can't see yet) are more important.
- Resilient systems respond well to small-scale disturbance because these generate renewal and opportunity while creating "memory" of adaptive response to broaden response repertoire. But most organizations have a hard time seeing the need to "generate disturbance" (typically see their role as avoiding disturbance).

It is important to recognize that change is the normal state of complex systems, although sometimes it proceeds quickly and other times slowly. As external conditions change, the system reacts to the changes. Some variables change quickly (e.g. stream flow after heavy rain). Others change much more slowly (groundwater recharge or lake levels, fish population in the lake). In general, "slow variables" affect broad spatial scales and / or operate over long time periods. Typically, the crucial defining features of an ecological system (its species structure, its function, the kinds of goods and services it provides to humans) are sensitive to one or more of these slow variables. Systems proceed through four predictable phases that can be characterized as: growth (r) phase; conservation (K) phase; release (omega) and reorganization (alpha) (Figure 2.12).

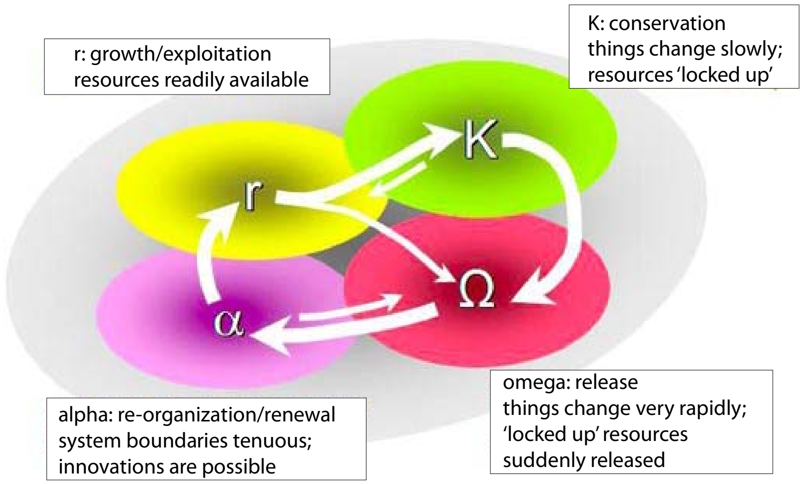

Figure 2.11b: Adaptive Cycle Stages

Source: Holling, et al. (2002)..

Resilient ecosystems buffer the environmental life support systems from effects of erosion, sequestration of carbon and nitrogen, regulate hydrological conditions and mitigate effects of floods, in addition to providing ecosystem services such as maintaining CO_2–O_2 equilibrium conditions and supporting decomposer micro organisms that drive the organic-detritus-food chain. Anthropogenic induced loss of resilience can make an ecosystem susceptible to random effects of drought or fire that the system could have potentially coped with. Ecosystems with low resilience may continue to produce goods and services until the impact of a disturbance causes them to exceed a critical threshold. When the critical threshold is reached, even a minor disturbance can cause a shift to a less desirable state that may be difficult and even expensive to reverse.

There is need to increase resilience of ecosystems considerably if we have to cope with global catastrophes such as climate change. Natural catastrophes have become more common due to a combination of anthropogenic induced disturbance patterns in nature and diminishing resilience of ecosystems. Resilient ecosystems reflect functional redundancy particularly if there are many species performing the same essential functions (such as photosynthesis or respiration) and if species within such "functional groups" do not respond in the same way to disturbances. Species functional redundancy serves to replace or compensate for each other in times of disturbances.

There are three defining characteristics that relate to resilience as applied to ecosystems, or to integrated systems of people and the natural environment:

- The amount of change the system can undergo and still retain the same controls on function and structure;
- The degree to which the system is capable of self-organization ;
- The ability to build and increase the capacity for learning and adaptation.

Social resilience is the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval. In other words, social resilience is the ability of groups or communities to adapt in the face of external social, political or environmental stresses and disturbances (Adger, 2000). Three general characteristics of social systems may need to be present to enable societies to be resilient, notably: the ability to buffer disturbance, the capability to self-organise and the capacity for learning and adaptation (Carpenter *et al.*, 2001; Trosper, 2002).

Adaptive Management

The essential feature of a social-ecological system is a multi-scale pattern (both spatial and temporal) of resource use around which humans have organised themselves in a particular social structure (distribution of people, resource management, consumption patterns, and associated norms and rules). The aim of adaptive management is to keep the system within a particular configuration of states that will continue to deliver desired levels of ecosystem goods and services, and to either prevent the system from moving into un-desirable configurations from which it is either difficult or impossible to recover, or move from a less desirable to a more desirable configuration.

The concept of *Adaptive Management* has drawn particular attention in natural resource management since Holling's 1987 seminal publications on *Adaptive Environmental Assessment and Management*, and the subsequent publication of *Adaptive Management of Renewable Resources* (Walters, 1986). Adaptive management not only pursues the goal of greater ecological stability, but also that of more flexible institutions for resource management (Walters, 1986; Holling, 1978). Adaptive co-management systems are flexible community-based systems of resource management tailored to specific places and situations and supported by, and working with, various organizations at different levels. Folke *et al.*, 2002 p. 20 define adaptive co-management as a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized process of learning-by-doing. This is – learning-by-doing – therefore recommended when scientific knowledge is limited while communities and stakeholder groups have high leverage or power to manage their resources. It is different from crisis management or a command and control approach that excludes stakeholders groups and follows a schematic cyclical process (Figure 2.12).

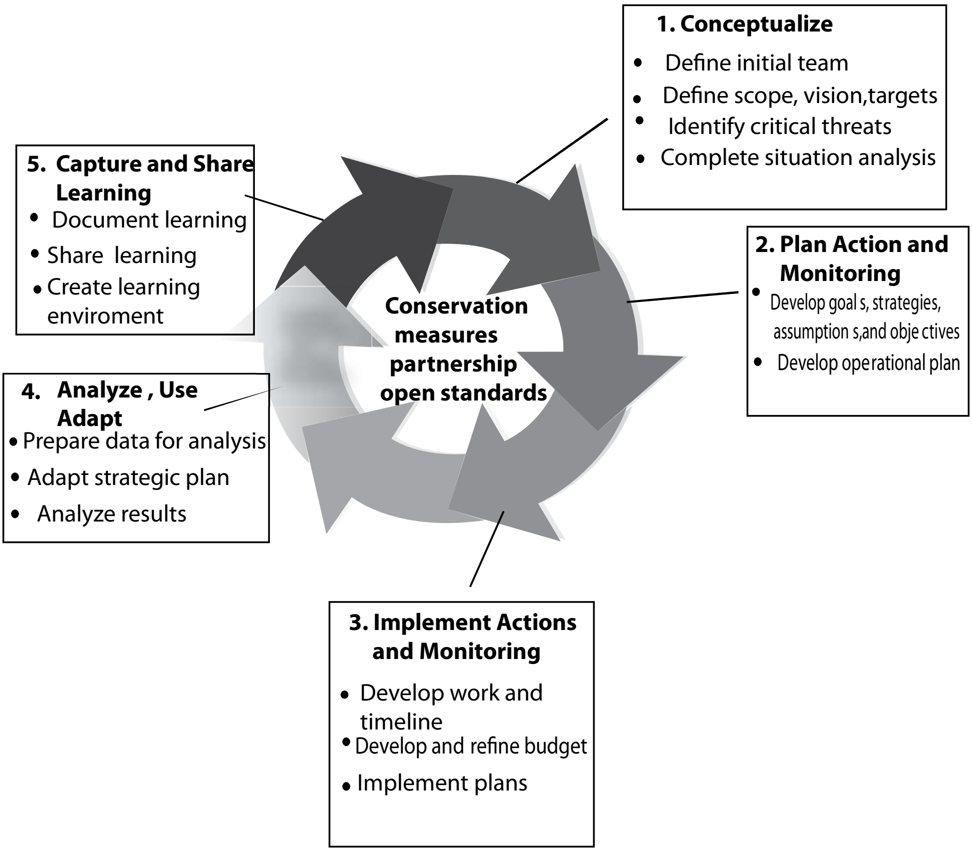

Figure 2.12: Schematic Representations of the Cyclical Steps of Adaptive Management for Natural Resource

Adaptive management is an approach to management of natural resources that emphasizes how little is known about the dynamics of ecosystems and that as more is learned management will evolve and improve. Ecosystems are very complex and dynamic, and human observations about natural processes are fragmentary and inaccurate. As a result, the best way to use the available resources in a sustainable manner calls constant learning and changing of strategies. Ecosystem management demands application of Adaptive Management (AM), also known as Adaptive Resource Management (ARM), which simply refers to a structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. It allows making simultaneous decisions that maximize one or more MRM objectives and accumulates new information for the improvement of future management. AM is heavily characterized by "learning by doing." Adaptive management proceeds through key steps:

i). Assessment of the problem;
ii). Formal design of a management and monitoring programme;
iii). Implementation of the programme in an ecosystem;
iv). Evaluation and adjustment.

Adaptive management requires the integration of multidisciplinary scientific knowledge and structuring of formal dynamic models to predict decision outcomes. It also requires integrating conservation and development approaches by including collaborative resource management that would appear to be central to reducing vulnerability and increasing resilience thus improving the well-being of those societies and ecosystems dependent on natural resources.

Biodiversity

Biodiversity is crucial in ecosystem resilience in the sense that it provides “insurance”, spreads risks and promotes ecosystem renewal and re-organization after disturbance. Biodiversity plays a crucial role in ecosystem resilience by spreading risks, providing “insurance”, and making it possible for ecosystems to reorganise after disturbance. Ecosystems seem to be particularly resilient if there are many species performing the same essential function (such as photosynthesis or decomposition) and if species within such “functional groups” respond in different ways to disturbances. Then, species can replace or compensate for each other in times of disturbance. When humans reduce biodiversity or favour monocultures, ecosystems tend to become vulnerable. It is argued by many ecologists that resilience is the key to biodiversity conservation and that diversity itself enhances resilience, stability and ecosystem functioning (Schulze and Mooney, 1993; Mooney and Ehrlich, 1997; Tilman, 1997). Ecological economists also argue that resilience is the key to sustainability in the wider sense (e.g., Trosper, 2002; Folke *et al.,* 2002).

In Africa, terrestrial and aquatic biodiversity resources are an important life support system for millions of people. Direct and indirect values of African biodiversity systems include sources of energy (wood fuel), food, medicine, fibre and provide a broad array of other uses. For example, indirect uses of forests in Africa will continue to service important tangible and intangible obligations such as protecting catchments, regulating river regimes, purification of water, preventing soil erosion, provision of shade, meeting places, aesthetic values, symbolic values and many others. This section provides an overview of biodiversity concepts, sketch the potential natural resource endowments of forest and grassland biodiversity and expose salient biodiversity trends.

Biodiversity is the sum of the variety of the life forms consisting of genes, species, and ecosystems of an area. In the context of this definition, biological variety occurs at three levels, that is, genetic diversity, species diversity and ecosystem diversity. In 1992, the United Nations Convention on Biological Diversity defined "biological diversity" as the variability among living organisms from all sources including 'inter alia' terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes diversity within species, between species and of ecosystems.

Ecosystem Diversity- Ecosystem diversity may be defined as the variety of habitat types including forests, grasslands, wetlands, etc.

Species Diversity- Species diversity is the totality of different species of plants, animals and micro organisms in an area.

Table 2.2: Examples of Biodiversity Effects on Ecosystems

Ecosystem Services	Diversity components and mechanisms
1. Production by societally important plants	*Functional composition*: (a) fast-growing species produce more biomass; (b) species differ in timing and spatial pattern of resource use (complementarity allows more resources to be used) *Species number*: large species pool is more likely to contain productive species
2. Stability of crop production	*Genetic diversity*: buffers production against losses to pests and environmental variability. *Species number*: Cultivation of multiple species in the same plot maintains high production over a broader range of conditions. *Functional composition*: species differ in their response to environment and disturbance, stabilizing production.
3. Maintenance of soil resources	*Functional composition*: (a) fast-growing species enhance soil fertility; (b) dense root systems prevent soil erosion.
4. Regulation of water quantity and quality	*Landscape diversity*: Intact riparian corridors reduce erosion. *Functional composition*: Fast-growing plants have high transpiration rates, reducing stream flow.
5. Pollination for food production and species survival	*Functional composition*: Loss of specialized pollinators reduces fruit set and diversity of plants that reproduce successfully. *Species number*: Loss of pollinator species reduces the diversity of plants that successfully reproduce (genetic impoverishment). *Landscape diversity*: Large, well-connected landscape units enable pollinators to facilitate gene flow among habitat patches.

6. Resistance to invasive species with negative ecological/ cultural effects	*Functional composition*: Some competitive species resist the invasion of exotic species. *Landscape structure*: Roads can serve as corridors for spread of invasive species; natural habitat patches can resist spread. *Species number*: Species-rich communities are likely to have less unused resources and more competitive species to resist invaders.
7. Pest and disease control	*Genetic diversity or species number*: Reduces density of suitable hosts for specialized pests and diseases. *Landscape diversity*: Provides habitat for natural enemies of pests.
8. Biophysical climate regulation	*Functional composition*: Determines water and energy exchange, thus influencing local air temperature and circulation patterns. *Landscape structure*: Influences convective movement of air masses and therefore local temperature and precipitation.
9. Climate regulation by carbon sequestrations	*Landscape structure*: Fragmented landscapes have greater edge-to-area ratio; edges have greater carbon loss. *Functional composition*: Small, short-lived plants store less carbon *Species number*: High species number reduces pest outbreaks that cause carbon loss.
10. Protection against natural hazards (e.g., floods, hurricanes, fires)	*Landscape structure*: Influences disturbance spread and/or protection against natural hazards. *Functional composition*: (a) extensive root systems prevent erosion and uprooting; (b) deciduous species are less flammable than evergreens

Source: Adapted from Chapin et al., (2009)

Genetic Diversity- Genetic diversity is the variation of genes within a species and genetic variation within and between populations.

Forest and Woodlands Ecosystem Biodiversity- Forest and woodlands ecosystems vary from one ecosystem to another in relation to structural complexity and functionality. Structural and functional complexity depends on climatic characteristics, nutrient cycling regimes and water budgets. Latitudinal and altitudinal gradients in forest and woodland ecosystems reflect the effects of abiotic and biotic interactions. These effects are responsible for differences in vertical and horizontal aggregation of plant species, spatial cover, species frequency, density and plant species richness.

Forest Ecosystem Endowment and Opportunities

The forest resource in Africa accounts for 6% of the Gross National Product (GNP), the highest in the world (NEPAD, 2003). In Western and Central Africa, the contribution of the forest sector through export of forest products is 60% of GDP (FAO, 2003b). In Uganda, forests and woodlands contribute in excess of US $546.6 million to the national economy (Emerton and Muramira, 1999). Forest woods such as wood fuel, timber, and non- timber products including ecotourism, crafts industry, traditional medicine and pharmaceutical products have been recognized as economic assets for possible linkages in NEPAD partnerships for realizing long term social and economic goals and in addressing the Millennium Development Goals (MDGs).

Forest and woodland systems may have a variety of tree forms shrubs and under storey species. These structural components provide a habitat for a variety of microorganisms that drive the organic-detritus-food chain and support small animals and plants in the forest floor, insects, birds, reptiles, amphibians and mammals. Insect- pollinator and bird-pollinator mutualisms link plants with specific insects and birds. Nutrient cycling and energy flows in forest ecosystems are complex processes that provide a life-support system that constitutes the basis for the production of goods and ecosystem services.

In Africa, forests and woodlands occupy 21.8% of the continental landmass. This represents approximately 650 million hectares (FAO, 2005). Forest and woodland distribution varies from one sub region to another. The Central African region (Congo Basin) constitutes the second largest continuous block of tropical rainforest in the world. The northern region of Africa has the least forest cover due to below average rainfall conditions which cannot support continuous forest cover. Figure 2.13 illustrates the extent of forest cover in Africa.

The African forests may be classified into the following categories (FAO, 2003a)

- Tropical rain forests;
- Tropical moist forests;
- Tropical dry forests;
- Tropical shrubs;
- Tropical mountain forests;
- Sub tropical humid forests;
- Sub tropical dry forests;
- Sub tropical mountain forests;
- Plantation forests.

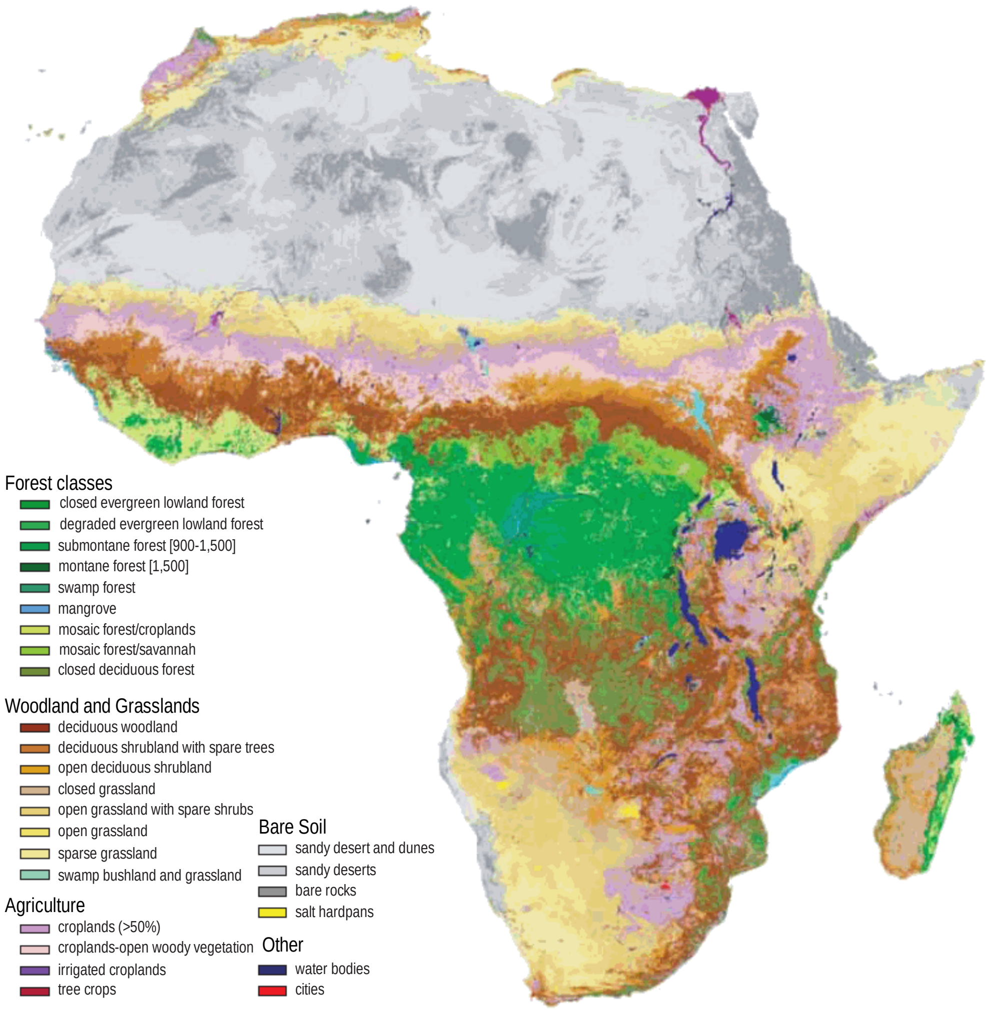

Figure 2.13: Forest Cover in Africa

Source: UNEP (2006)

Grassland Ecosystem Biodiversity

Grassland ecosystems in Africa are found in the bimodal rainfall areas characterised by wet-dry cycles. The grassland sub regions include sudano-sahelian zone in North Africa and northern parts of western regions of Africa. Natural grassland areas in Africa are non-existent. The grassland ecosystems in Africa represent succession sub climaxes due to interactive controls of fire, herbivory, climate, and soils. Grasslands consist of a variety of tropical grass species, forbs and herbs. The grasslands of Eastern and Central Africa are famous for their rich ungulate fauna including zebras, elephants, giraffes, buffaloes, oryx and carnivorous animals such as the lion and a variety of small herbivores. A variety of birds and insects occur in this ecosystem. The grasslands of Africa support large populations of domestic livestock as well as wildlife. The wild beast migration spectacle is one of the biologically distinctive features that attract large numbers of tourists to Africa in addition to the rich wildlife and cultural heritage. According to FAO (2005) forests and woodlands occupy an estimated 650 million ha or 21.8% of the land area in Africa. These constitute some 16.8% of the global forest cover.

The distribution of forests and woodlands varies from one sub-region to the other, with Northern Africa having the least forest cover while Central Africa has the densest cover. The Congo basin in Central Africa is home to the world's second largest continuous block of tropical rain forest (UNEP, 2006). Grassland ecosystems are sources of wild relatives of major cereal crops such as wheat, rice, barley, sorghum, rye and millet. However, there are growing concerns about the ability of grasslands to sustain a rich assemblage of species. Biodiversity restricted studies suggest that introduction of invasive species, conversion of natural grasslands into croplands and fragmentation of grasslands is responsible for decreases in biodiversity (White *et al.,* 2000).

Human activities, including land fragmentation and cultivation, continue to modify grassland ecosystems. Fragmentation of grassland ecosystems has been invoked in explanations of:

i). Declining bird and animal populations due to genetic isolation promoting inbreeding, genetic drifting and extinction;
ii). Diminished endemic species because of less variety in successional stages in grasslands;
iii). Decreased probability of species re-colonization;
iv). Increased incidences of predation and reduced nest success;
v). Introduction of invasive plants and animals (invasive species spread rapidly changing the composition of grasslands and outcompete indigenous species).

Trends in grassland biodiversity point to declines in bird populations and large grassland herbivores. Habitat loss and destruction of migratory corridors are the major causes of biodiversity declines in grassland ecosystems. The spectacular migration of large herbivores such as the wild beasts and zebra of East Africa across the savannah now occur over a much less extensive area in East Africa and central Zambian region (Olson and Dinerstein, 1997).

Impacts of Exotic and Indigenous Organisms

Invasive species are biological organisms that have moved beyond their normal range of occurrence. Invasive species are found in all phyla, from micro-organisms to various aquatic and terrestrial plant and animal organisms. The 1995 National Research Council's study on marine biodiversity listed invasion of exotic aquatic species as one of the five most critical environmental issues facing the oceanic marine life (MA, 2006).

The impacts of invasive species have broad economic and ecological manifestations. The ecological impacts of invasive species have economic implications and vice versa. Not all invasive species produce ecological or economic impacts. Some introduced species do not acclimatize in the new environments and would have no effect on the structure and functioning of indigenous species. However, some invasive species have the potential to cause enormous ecological and economic impacts.

Ecological Impacts of Invasive Species

Deliberate or inadvertent species introductions cause structural and functional modifications to the receiving ecosystems. In some cases, introduced species interfere with trophic dynamics of receiving ecosystems. Established food chains and food webs may be disrupted by introduced organisms which compete with the indigenous organisms for space and resources. Since invasive species may have no natural enemies in the areas where they become naturalized, invaders have the potential to cause extinction of indigenous species. Biological invasions are also associated with the threat of new diseases which may be lethal to plants and animals including humans. Allelopathic interactions associated with some introduced species are responsible for biodiversity erosion and in actual reductions and loss in biodiversity (UNEP, 2004 b). In instances where conditions favour hybridization between exotic and indigenous species, adulteration of the gene pool may cause declines in populations of organisms, species extinction and reductions in biodiversity. This may increase the susceptibility of an ecosystem to diseases and vectors.

The interactive mechanisms associated with biological invasions have not been extensively studied for many biogeographical regions of the world. Some scientists have found evidence that many introduced species rely on mutualisms in their new habitats to overcome barriers to establishment and attain naturalization (Richardson *et al.*, 2000). Plant and animal mediated mutualisms include symbiotic relationships and pollinator mutualisms. Some invasive exotic plants such as woody species are known to spread through insects and birds. Seeds of many notorious plant invaders are dispersed mainly by birds and mammals.

Susceptibility to invasion by exotic species in many ecosystems has been attributed to:

a) Presence of an increasing array of potential mutualistic partners such as generalist frugivores and pollinators, mycorrhizal fungi with wide host ranges, rhizobia strains with infectivity across genera.
b) Increasing abundance of conditions that favour establishment of various exotic/exotic synergisms.

Economic Impacts of Invasive Species

The threat of invasive species to developing modern economies is real. There are many examples of widespread economic losses associated with elimination of profitable indigenous species by invasive species. Many governments in Africa are grappling with the challenges of restoring degraded ecosystems due to loss of biodiversity in addition to the threat of new diseases and vectors with a potential to cause enormous economic losses in food crops and other profitable natural resources (Box 2.2).

Box 2.2: Invasive Species with Economic Impact

Some of the well known notorious invasive species in Africa with considerable economic impact include:

Leucaenia leucocephala (Conflict tree)

Multipurpose tree, fixes nitrogen, source of forage for animal production, leaves may also be a source of mulch and wood fuel .The tree has a prolific growth habit and forms dense thickets that suppress under storey local vegetation. Invasibility of this species giving it characteristics of a weed and its promotion as a source of forage for livestock explains the essence of its generic name "conflict tree".

Eichhornia crassipes (Water hyacinth)

This is a common water plant in lotic fresh water habitats and inland lakes such as Lake Victoria and Lake Naivasha. E. crassipes provides a habitat for vectors and disease causing organisms. The high incidence of malaria and water borne diseases with broad socio-economic implications in the Lake Victoria basin may be partly explained by the presence of high densities of the water hyacinth.

Oreochromis mossambicus (Mozambique tilapia), also known as African tilapiine cichlid fish.

Mozambique tilapia has a large potential for producing fertile hybrids. O.mossambicus is a threat to local fishes because of its excessive proliferation out of captivity and its superior competitive ability for food and nesting space.

Acacia mearnsii (Black wattle)

Has a high water demand (evapotranspiration), dries up habitats during periods of poor soil moisture recharge. Annual total evaporation rates from riparian zones covered with black wattle of the order of 1500mm have been reported (Dye and Jarmain, 2004). Acts as a nutrient pump, selectively removing specific nutrients thus impoverishing soils.

Acridotheres tristis (Indian myna)

A. tristis is an omnivorous open woodland bird. Acridotheres also means "grasshopper hunter". Although this bird is endemic in Asia, it has a wide distribution in other parts of the world including Africa where it has been introduced. According to the IUCN Species Survival Commission, the Indian myna is considered among the world's worst invasive species. It is a serious threat to ecosystems in South Africa. It is

also a threat to crops and pastures including local bird populations. The "grasshopper hunter" is an aggressive competitor for breeding grounds successively outcompeting and displacing local bird populations.

Prosopis juliflora (Mesquite tree)

Synergistic allelopathic effects depress pollinator mutualisms that would otherwise favour nectar harvest by bees and honey yield; hybridization with local plant materials results in adulteration of the local gene pool thus undermining local biodiversity and diminishing livelihood opportunities; alter nutrient cycling, causing reductions in the quality and quantity of decomposing substrate.

Lantana camara (Spanish flag)

L.camara is commonly associated with abandoned fields, footpaths, sacrificial grazing areas and even farms. In Kenya, the Spanish flag has been naturalized in the Kenyan highlands. Outside its endemic regions in India and Australia it covers large areas in Africa. It has a prolific growth habit with an excellent coppicing capacity. The plant produces pentacyclic triterpenoids which cause hepatoxicity and photosensitivity in white grazing animals.

Maesopsis eminii (commonly known as Musizi in Uganda)

M. eminii was introduced to Africa because of its desirable characteristics fulfilling several ecological and economic demands. It is a fast growing multipurpose forest tree, highly desired for its high quality hardwood, and compatible co-existence with mono cultural tree species in agro forestry systems. In Tanzania, this tree has invaded the East Usambara forests and also spread into the natural forests. In East and Central West Africa, the tree has replaced rain forests and riparian vegetation systems.

Clidemia hirta (Soapbush)

C.hirta colonises disturbed habitats including landslides, riverbanks, burned areas, old fields and roadsides. In spite of its negative impacts associated with biodiversity erosion, it is a useful plant material in re-vegetation of disturbed areas, provides reliable food for wild life and is a source of natural pharmacological remedies for the treatment of infectious diseases. It is a serious weed in tropical rubber plantations (Hevea brasiliensis).Goats suffers toxicity from hydrolysable tannin when fed the plant (Murdiat *et al.,* 1990).

Cyprinus carpio (common carp)

C.carpio is a fresh water fish associated with eutrophic waters in Europe and Asia. However, it has been introduced and domesticated in many parts of the world including Africa. It is an omnivorous fish that scavenges vegetarian food including water plants in the limnetic zones, zooplanktons, crustaceans and benthic worms. The feeding habits destroy and disturb submerged vegetation causing serious damage to local duck and fish populations.

Source: (GISP, 2004)

Invasive species are a problem to diverse ecosystems in Africa. Some of the important ecosystems are being undermined by the threat of exotic species causing biodiversity loss, diminishing livelihood opportunities and increasing human vulnerability to diseases. Some forest species such as *Pinus, Eucalyptus* and *Acacia* spp. are important sources of firewood, timber and pulp. However, they have caused considerable strain on water resources. In South Africa, invasive species consume up to 7% of available water (Preston and Williams, 2003). Nile perch (*Lates niloticus*) is an exotic species in East Africa of considerable economic value.

However, its negative impacts associated with loss of indigenous species and livelihood opportunities are of great concern.

The World Conservation Union has identified 81 exotic species in South Africa, 49 in Mauritius, 44 in Swaziland, 37 in Algeria and Madagascar, 35 in Kenya, 28 in Egypt, 26 in Ghana and Zimbabwe and 22 in Ethiopia (IUCN/SSC/ISSG, 2004).

Exotic Species: Exotic species directly impact ecosystem functions that are of considerable economic significance. For example, invasive species alter ecosystem services such as nutrient cycling, flood water control, conservation and regeneration of soils, CO_2-O_2 equilibrium, etc. These environmental services have a direct bearing on soil fertility; soil loss, food production, and human health among others (GISP, 2004). Exotic species also cause economic damage by hybridization with indigenous valuable species resulting in the adulteration of the gene pool of indigenous plant materials. Low yielding unproductive cross breeds may also be less resistant to diseases.

Invasive species: They support a reservoir of disease causing organisms and harmful vectors. Disease transmitting vectors and pathogenic organisms cause reductions in the aesthetic quality of the environment and may have negative social cultural manifestations as well. This often takes the form of increased disease burdens and social responsibilities in mitigating the adverse consequences of disease.

Ecosystem Approach

The significance of ecosystem approaches in sustainable resources management is that they focus on biotic and abiotic interactions and the interacting components in a single integrated system. An understanding of ecosystems in terms of what constitutes them and the interactions therein is important for natural resources management because in NRM, human beings are interfacing with these natural systems to extract goods and services. This extraction cannot be limitless due to the natural limitations of the systems to replenish and replace the removed resources.

Definition and Principles

In 1995, the United Nations' Convention on Biological Diversity (CBD) adopted the ecosystem approach as the primary framework for action under the Convention. CBD gives the following description for the ecosystem approach:

> It is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems (MA, 2005).

The ecosystem approach recognizes that the ecosystem is not defined just by the bio-physical variables but incorporates the human factor as well as institutional, social and economic factors that affect human activities within the ecosystem.

The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time-lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of "learning-by-doing" or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically.

Box 2.3: Principles of the Ecosystem Approach

CBD defines the 12 principles underlying the ecosystem approach namely:

1: The objectives of management of land, water and living resources are a matter of societal choices. This means that similar ecosystems in different geographic locations can be differentially managed depending on the needs and aspirations of the various stakeholders.

2: Management should be decentralized to the lowest appropriate level for effectiveness, efficiency and equity.

3: Ecosystem managers (and researchers) should consider the actual or potential effects of their activities on adjacent, downstream and other ecosystems.

4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should: reduce those market distortions that adversely affect biological diversity, align incentives to promote biodiversity conservation and sustainable use and, internalize costs and benefits in the given ecosystem to the extent feasible.

5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

6: Ecosystems must be managed within the limits of their functioning with respect to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity.

7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term and not focus on short-term gains.

9: Management must recognize that ecosystem change is inevitable, adapt to the changes and, consider mitigating actions to cope with long-term changes such as climate change.

10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.

12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines and stakeholders at the local, national, regional and international level, as appropriate.

(MA, 2005)

According to the CBD, the ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations (MA, 2005). There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions.

Operational Guidance for Application of the Ecosystem Approach

In applying the 12 principles of the ecosystem approach, the following five points are proposed as operational guidance.

1. Focus on the relationships and processes within ecosystem.

The many components of biodiversity control the stores and flows of energy, water and nutrients within ecosystems, and provide resistance to major perturbations. A much better knowledge of ecosystem functions and structure, and the roles of the components of biological diversity in ecosystems, is required, especially to understand:

a) ecosystem resilience and the effects to biodiversity loss (species and genetic levels) and habitat fragmentation; and
b) underlying causes of biodiversity loss; and
c) determinants of local biological diversity in management decisions.

Functional biodiversity in ecosystems provides many goods and services of economic and social importance. While there is a need to accelerate efforts to gain new knowledge about functional biodiversity, ecosystem management has to be carried out even in the absence of such knowledge. The ecosystem approach can facilitate practical management by ecosystem managers (whether local communities or national policy makers).

2. Enhance benefit-sharing.

Benefits that flow from the array of functions provided by biological diversity at the ecosystem level provide the basis of human environmental security and sustainability. The ecosystem approach is a strategy that guarantees that the benefits derived from these functions are maintained or restored. In particular, these functions should benefit the stakeholders responsible for their production and management. This requires, inter alia: capacity building, especially at the level of local communities managing biological diversity in ecosystems; the proper valuation of ecosystem goods and services; the removal of perverse incentives that devalue ecosystem goods and services; and, consistent with the provisions of the Convention on Biological Diversity, where appropriate, their replacement with local incentives for good management practices.

3. Use adaptive management practices.

Ecosystem processes and functions are complex and variable. Their level of uncertainty is increased by the interaction with social constructs, which need to be better understood. Therefore, ecosystem management must involve a learning process, which helps to adapt methodologies and practices to the ways in which these systems are being managed and monitored. Implementation programmes should be designed to adjust to the unexpected, rather than to act on the basis of a belief in certainties. Ecosystem management needs to recognize the diversity of social and cultural factors affecting natural-resource use. Similarly, there is need for flexibility in policy-making and implementation. Long-term, inflexible decisions are likely to be inadequate or even destructive. Ecosystem management should be envisaged as a long-term experiment that builds on its results as it progresses. This "learning-by-doing" will also serve as an important source of information to gain knowledge of how best to monitor the results of management and evaluate whether established goals are being attained. In this respect, it would be desirable to establish or strengthen capacities of parties for monitoring.

4. Carry out management actions at the scale appropriate for the issue being addressed, with decentralization to the lowest level, as appropriate.

As noted in the description of the ecosystem approach, an ecosystem is a functioning unit that can operate at any scale, depending upon the problem or issue being addressed. This understanding should define the appropriate level for management decisions and actions. Often, this approach will imply decentralization to the level of local communities. Effective decentralization requires proper empowerment, which implies that the stakeholder both has the opportunity to assume responsibility and the capacity to carry out the appropriate action, and needs to be supported by enabling policy and legislative frameworks. The most appropriate scale for management decisions where common property resources are involved would necessarily be large enough to encompass the effects of practices by all relevant stakeholders. Appropriate institutions would be required for such decision-making and, where necessary, for conflict resolution. Some problems and issues may require action at still higher levels, through, for example, transboundary cooperation, or even cooperation at global levels.

5. *Ensure intersectoral cooperation.*

As the primary framework of action to be taken under the Convention on Biological Diversity, the ecosystem approach should be fully taken into account in developing and reviewing national biodiversity strategies and action plans. There is also need to integrate the ecosystem approach into agriculture, fisheries, forestry and other production systems that have an effect on biodiversity. Management of natural resources, according to the ecosystem approach, calls for increased intersectoral communication and cooperation at a range of levels (government ministries, management agencies, etc.). This might be promoted through, for example, the formation of inter-ministerial bodies within the Government or the creation of networks for sharing information and experience.

Practical Operation of the Ecosystem Approach

A report on the implementation of the ecosystem approach, based on discussions in Southern Africa, South America and Southeast Asia as well as 26 case studies from these regions is presented by Smith and Maltby (2003). According to this report, adoption of the ecosystem approach would benefit considerably from new mechanisms that would allow the economic and wider value of ecosystem functions to be realized. Greater community-level understanding of the ecological thinking that underpins the approach is best achieved when empowered community members train one another. Regional centres may be appropriate for training, stakeholder empowerment and building awareness among professionals and non-specialists. Smith and Maltby (2003) present case studies to illustrate that the ecosystem approach is highly flexible though its successful use depends on stakeholder participation. The case studies demonstrate that the ecosystem approach can be applied from an individual farm to transnational regions as well as at the global scale. Although decentralised management is often needed, in practice, there are a number of significant obstacles to it. A combined bottom-up and top-down approach may be the best way to identify the most appropriate management scales and mechanisms.

Management should adapt to lessons learned in the field and be responsive to ongoing advances in scientific understanding. Monitoring of appropriate indicators is vital for adaptive management. There are many possible innovative approaches to benefit sharing under the ecosystem approach, although further guidance is needed.

The Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA) was initiated in 2001, the objective being to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. From 2001 to 2005, the MA involved the work of more than 1,360 experts worldwide. Their findings, contained in five technical volumes and six synthesis reports, provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide (such as clean water, food, forest products, flood control, and natural resources) and the options to restore, conserve or enhance the sustainable use of ecosystems (MA, 2005; 2006, for more on the Millennium Assessment, see *http://www.millenniumassessment.org).*

The Millennium Ecosystem Assessment used a conceptual framework that places human well-being as the central focus for ecosystem assessment, while recognizing that biodiversity and ecosystems also have intrinsic value and that people take decisions concerning ecosystems based on considerations of wellbeing as well as intrinsic value. The MA conceptual framework (Figure 2.14) assumes that a dynamic interaction exists between people and other parts of ecosystems, with the changing human condition serving to both directly and indirectly drive change in ecosystems and with changes in ecosystems causing changes in human well-being. At the same time, many other factors independent of the environment change the human condition, and many natural forces influence ecosystems.

The MA focuses particular attention on the linkages between ecosystem services and human well-being. The assessment deals with the full range of ecosystems—from those relatively undisturbed, such as natural forests, to landscapes with mixed patterns of human use and ecosystems intensively managed and modified by humans, such as agricultural land and urban areas. The multiscale nature of decision-making allows the examination of driving forces that may be exogenous to particular regions, and provides a means of examining the differential impact of ecosystem changes and policy responses on different regions and groups within regions.

Key Findings of the Millennium Ecosystem Assessment

Box 2.4: The Following are the Major Findings of the Assessment

1. Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fibre and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth.
2. The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.
3. The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals.

4. The challenge of reversing the degradation of ecosystem while meeting increasing demands for services can be partially met under some scenarios considered by the MA, but will involve significant changes in policies, institutions and practices that are not currently under way. Many options exist to conserve or enhance specific ecosystem services in ways that reduce negative trade-offs or that provide positive synergies with other ecosystem services.

(MA, 2005)

The bottom line of the MA findings (Box 2.4) is that human actions are depleting the earth's natural capital, putting such strain on the environment that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted. At the same time, the assessment shows that with appropriate actions, it is possible to reverse the degradation of many ecosystem services over the next 50 years, but the changes in policy and practice required are substantial and not currently underway.

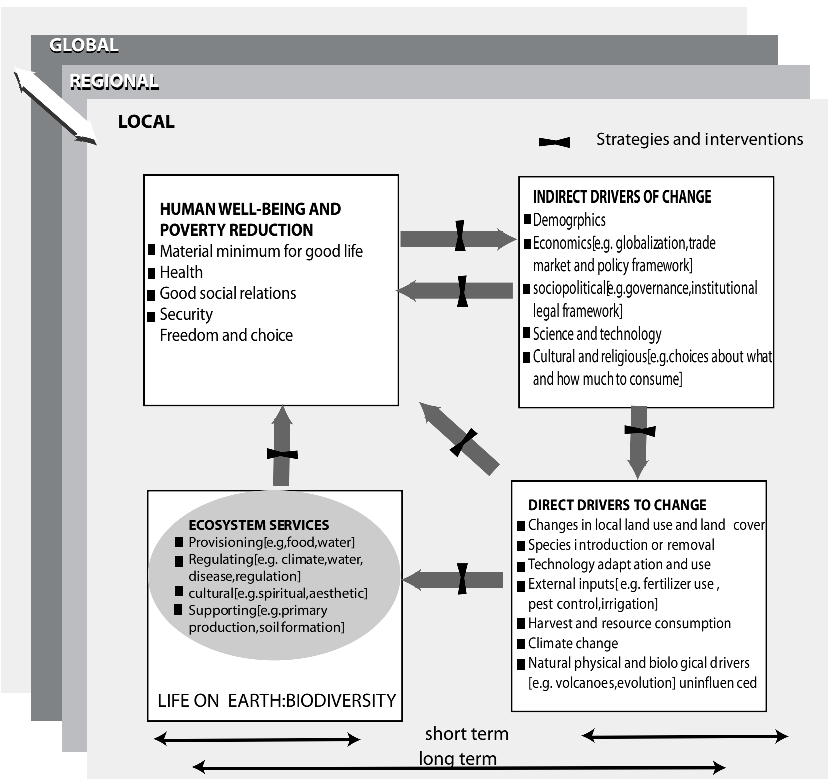

Figure 2.14: The Millennium Ecosystem Assessment Conceptual Framework

Source: MA, 2005

Changes in factors that indirectly affect ecosystems, such as population, technology, and lifestyle (upper right corner of figure), can lead to changes in factors directly affecting ecosystems, such as the catch of fisheries or the application of fertilizers to increase food production (lower right corner). The resulting changes in the ecosystem (lower left corner) cause the ecosystem services to change and thereby affect human well-being. These interactions can take place at more than one scale and can cross scales. For example, a global market may lead to regional loss of forest cover, which increases flood magnitude along a local stretch of a river. Similarly, the interactions can take place across different time scales. Actions can be taken either to respond to negative changes or to enhance positive changes at almost all points in this framework (black cross bars).

Ecohealth Approach in Ecosystem Management

Lebel (2003) presents an integrated ecosystem management framework that focuses on human well-being. He argues that it is impossible to improve the environment without including the human population, with inherent social, cultural, and economic concerns, in the management of resources. A sectoral approach is no longer adequate but co-management of human activity and the environment is essential. This challenge requires multidisciplinary approaches to studies of human–environment relationships. Lebel argues that the ecosystem approach gives equal importance to environmental management, economic factors, and community aspirations (Figure 2.15). The economy, the environment, and community needs all affect the health of the ecosystem. Focusing on just one of these factors to the detriment of others compromises ecosystem sustainability. The Ecohealth approach is thus part of the sustainable development process which promotes positive action on the environment that improves community well-being and health.

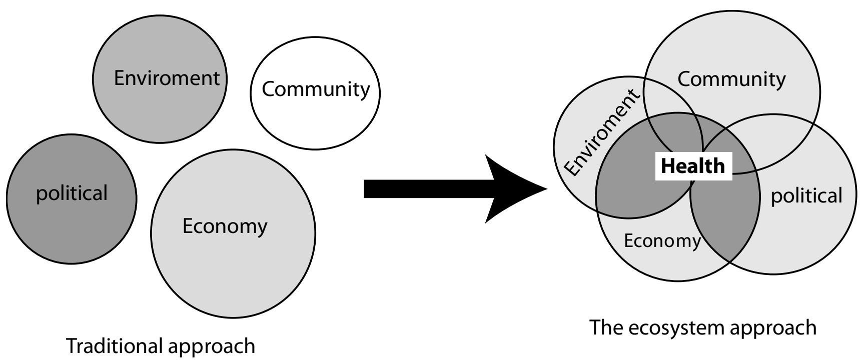

Figure 2.15: Ecohealth Approach in Ecosystem Management Showing Environmental, Community, Political and Economic Interactive Domains

Source: Adapted from Lebel (2003)

The complexity of the interactions between the various economic, social, and environmental components of an ecosystem requires integrated research strategies that go beyond multidisciplinary frameworks. A transdisciplinary approach enables researchers from different disciplines and key actors to develop a common vision, while preserving the richness and strength of their respective areas of knowledge. By adopting this approach at the outset the research team avoids carrying out parallel studies whose results are pooled only at the end. Going beyond one's own discipline requires a great capability for synthesis as well as sensitivity to the strengths and limitations of others.

Summary and Conclusion

Natural resources are the pillar for development in most developing countries particularly in Africa. Sustainable Development Goals are impossible to attain in the face of natural resources management regimes that lead to the degradation of this resource base. NRM research and development interventions should adequately focus on meeting the needs of the stakeholders.

These discussions on various ecosystem theories, concepts and principles including management and research frameworks demonstrate that due to the complexity of ecosystems in terms of structure, processes and human factors, not one framework exists that adequately fulfils management and research requirements. Campbell *et al.*, (2004) observed that the ecosystem approach, integrated natural resources management, integrated soil and water management, integrated catchment management, integrated coastal zone management, landscape approaches and eco-regional approaches, among others, have common features. The ecosystem approach is popular in biodiversity assessments whereas integrated natural resource management approaches are commonly preferred by international research centres. The challenge is to formulate a framework that adequately addresses the bio-physical characteristics of ecosystems as well as social, technical, economic, institutional and other parameters that affect ecosystem management.

Natural resources are life support components that are intricately coupled to abiotic and biotic systems. Interactions between ecosystem components have important consequences on the qualitative and quantitative attributes of natural resources. Ecosystem and socio-economic theory provide a superstructural framework for integrated management of holistic life support systems. The application of ecosystem approaches in natural resource management is tractable to system analysis. Systems analysis frameworks (ecological and socio-economic models) are powerful multilevel and macro scale tools for evaluating the role of impacts of management activities on ecological and social systems in which resources occur and are managed. Systems analysis approaches provide analytical frameworks for predicting the consequences of disturbances on the integrity and resilience of natural ecosystems.

Socio-economic theory provides fundamental premises governing resource allocation and investment such as stakeholder preferences, decision criteria, perceived costs, benefits in natural resource conservation and management, and understanding of the wider structural and policy context which may govern individual's economic behaviour. Understanding the need and challenges of Integrated Natural Resource Management is the special focus of Chapter 3.

Learning Activities

Learning Activity 2.1

Using the examples of a tropical lake and a named forest, identify the major components of an ecosystem and explain how they function. What ecosystems services do they provide?

Learning Activity 2.2

Identify morphological features and functional attributes of Prosopis juliflora and other three selected allelopathic species in the African continent and explain why an understanding of the biotic-biotic and abiotic-biotic synergies of natural systems is critical in the selection of management interventions for such systems. Hint: Consider; Resource partitioning, niche specialization and allelopathy.

Learning Activity 2.3 : Identifying System Drivers and Disturbances

Using your country's Environmental Outlook, discuss the set of critical, controlling (slow) variables, and the trends in critical controlling (often "slow") variables (like the accumulation of phosphate in lake sediments).

What are the trends in the major resources (soils, water, biota), and the major resource uses? What important ecological and social changes are currently taking place (e.g.), changes in species, in land cover, land-use practices, human demography, economics)?

How have they changed over time?

Consider, in particular, changes in disturbances; are there changes in frequency or intensity of the characteristic disturbances in the system? What are the characteristic disturbances, in both the social and ecological domains, at each relevant scale? Are there changes in the patterns of these disturbances? For example, are they changing in spatial scales, or temporal scales ('events' becoming more or less frequent)? Are there novel kinds of disturbances emerging? Are there attempts by managers to control or modify these disturbance events?

Disturbances are the shocks that can push a system over a threshold on a controlling variable, so we need to know if there are changes in the levels of controlling variables (once we have identified these controlling variables) and if there are changes in the shocks the system is subjected to.

Consider drivers vs. shocks. They can sometimes be the same – like changes in climate, where a climate trend is a driver, and a shock is a particular event (drought, flood). Changes in the controlling variables are often due to changes in system drivers (e.g., demography, climate trends, new technology, external markets, etc.). The 'shocks' to which social-ecological systems tend to be subjected, fall into the following categories:

- Physical - weather (e.g., droughts, very wet periods, hurricanes, etc.).
- Distinguish between trends in climate and individual weather events, earthquakes, volcanic explosions, etc.
- Biological – mainly diseases.
- Economic – market shocks, trade bans, etc.

- Social – preference changes, but also population issues and labour availability.
- Policy.

Source: The Resilience Alliance, 2007. Assessing resilience in social-ecological systems: A scientist's workbook. Available online [http://www.resalliance.org/3871.php].

Learning Activity 2.4

Review the ecological and socio-economic challenges of management of specific invasive species in your country.

Revision Questions

1. Attempt a multidisciplinary discourse of the meaning, importance and classification of natural resources.
2. Critique the plausibility of ecosystem concepts with particular reference to natural resource management.
3. Natural resource management is defined as a science and an art. Discuss the contextual dualism of this definition.
4. What are the merits and demerits of density dependent explanations of ecosystem change associated with African Savannas?
5. Why is the recognition of ecosystem pattern important in natural resource management?
6. Differentiate between landscape ecology and ecosystem ecology.
7. Compare and contrast the applications of equilibrium and non-equilibrium theories in natural resource management.
8. "The need to understand the structural and functional attributes of managed ecosystems is a critical consideration in natural resource management options". Discuss.
9. Describe the mechanisms of invasibility of alien tree plant species in African savannas.
10. What are the ecological and economic ramifications of invasive plant species?
11. What are the challenges and opportunities of natural resource management in the new millennium?
12. Conduct a literature review on the subject of the ongoing debate regarding equilibrium and non-equilibrium models and provide a summary of your findings within context of the applicability of these models in natural resource management.

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Integrated Natural Resource Management

R. K. Bagine, G. Kironchi, and E. K. Maranga

Introduction

The world is becoming more integrated resulting to *Integration* emerging as the most important concept in modern society in the field of Natural Resource Management (NRM) because of the complexity of the systems involved (Catacutan and Tanui, 2008). The linkages that occur in NRM systems create the need to integrate across spatial and temporal scales (Poulsen, 2003).

This chapter presents holistic perspectives in the Integrated Natural Resource Management (INRM) systems and explores the trends, drivers and tools for natural resource management, particularly in sub-Saharan Africa. The INRM is a process that uses holistic approach for managing natural resource research and development programmes. It provides an operational framework for facilitating interventions in natural resource management and conservation which integrate multiple scales of interaction and response, embrace a high frequency of non-linearity, uncertainty, and time lags, and involve multiple stakeholders with often contrasting objectives and activities. The INRM describes natural resource management as a comprehensive systemic process involving a number of key functions which need to be in place or developed if interventions are to be successful. It seeks to respond to major drivers of land-use change, such as climate change, population growth, degradation, poverty, socio-political interests, rural-urban migration and large scale changes to technology adoption. It aims to help solve complex real-world problems affecting natural resources in agro-ecosystems in order to improve livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services.The overall objective of the chapter is to provide the reader with adequate information on the concepts and principles as well as the implementation tools of integrated natural resource management. Specifically, the chapter aims to:-

a) Provide the reader with basic information on the concepts and principles of integrated natural resources management;
b) Identify the tools needed in integrated natural resource management and to explain their use, application, and techniques; and apply, implement or adopt integrated natural resource management in different situations;
c) Layout a detailed account of the strategies and procedures for developing successful and practical integrated natural resource management programmes;
d) Provide prototype integrated natural resource management frameworks and well critiqued cases from which to draw lessons learnt.

Natural resource components such as biodiversity, water, air, soil etc. are interrelated. Impacts on one component affect the other components. Similarly, natural resource systems are holistic and impacts at any point in the system create chain interactions that determine ecosystem health. Human beings depend on the exploitation of natural resources for subsistence and income. Management interventions must, therefore, take cognizance of the interrelatedness of the natural resources usage. The INRM involves technical skills and knowledge about biophysical processes as well as social components, i.e., negotiation of rules and sanctions, policy formulation, organization development, land use planning, conflict and information management. The greatest handicap in sustainable resource use is the application of single-disciplinary and single-scale focus approaches that fail to address the multi-scale aspects and issues of the complexity of the management of natural resources.

Natural resources should be managed in such a way that human demands and use levels are permanently kept within the bounds of the resources' natural reproduction rate. Integrated approaches to resource management have been advocated in many fields, such as river basin management, regional planning and ecosystem management (Born and Sonzogni, 1995), coastal zone management (Cicin-Sain, 1993), wetlands management, and oceans management (Costanza *et al.,* 1999).

These approaches, including the INRM concepts and principles, are addressed in various subthemes in this chapter and where necessary, case studies are provided. Similarly, the chapter emphasizes the resource sustainability as an integral consideration in NRM. The chapter attempts to discuss the following themes:

- Concepts and context of INRM;
- Ecosystem components - functions and services;
- Conservations perspectives in integrated NRM;

- Participatory land uses and resource planning;
- Tools for INRM; INRM conflict management;
- Mitigation and adaptation strategies in NRM; and
- Integration of technological and indigenous knowledge systems in INRM.

This chapter clarifies the concepts and approaches of INRM, and applies them to the context of specific natural resources in Africa. A major shortcoming of single-disciplinary and single-scale focus of natural sciences is the failure to address all interrelated issues at different scales and for different resource uses. There is need for change in approach towards integration between disciplines, natural resource assets, uses, scales and approaches. This gives a noble rationale for integrated conservation and development – the INRM approach. The INRM, a conceptual and overarching framework, makes it possible to integrate different tools in order to cope with the complexity of real-life NRM problems. The INRM provides a comprehensive way of managing natural resources while considering the inherent complexity of socio-ecological components and processes in an ecosystem. It also facilitates better resilience (or less vulnerability) and overall effective management of natural resources.

Philosophy of INRM

Natural resources support human beings to produce goods and services to meet their needs. These resources include the geophysical resources of water, soil and its productive qualities, intermediate and long-term carbon stocks, biodiversity of the managed landscapes, and the stability and resilience of the ecosystem of which agriculture is a part (CGIAR, 2003). Natural resources are not static features but change with time and space, reflecting changes in the desires, will and ingenuity of man. Historically, they can come into being e.g. many deposits of alloy metals became natural resources only after the Industrial Revolution; they can disappear or become extinct due to over exploitation; they can cease to be resources, the mulberry trees in many silk-worm growing areas lost value as natural resources with the development of competing synthetic fibers.

Natural resources and the whole resource complex must be considered as being dynamic because they owe their material existence to the continuously changing interplay of all inorganic and organic factors which determine the general character of natural environment. Natural resources are usually classified into *renewable* and *non-renewable* categories. While this is convenient, it cannot be followed too strictly for many so called renewable resources e.g. Teak Forests, are replaced so slowly that they can be considered *non-renewable*; while from the other side, many *non-renewable* resources e.g. mineral extraction from earth rocks, can readily be substituted by non-mineral resources. Natural resources are normally limited to non-human resources. However, they serve man`s physical and psychological needs and are a function of his activities. It is man who transforms elements of natural environment in an endeavour to convert and/ or adapt them for his benefits.

The NRM is congruent with the concept of *sustainable development*, a scientific principle that forms a basis for global land management and environmental governance to conserve and preserve natural resources. The NRM specifically focuses on a scientific and technical understanding of resources and their *ecology* and the life-supporting capacity of those resources. There is an increasing consensus about the need to find an approach to resource management that encourages environmentally friendly economic development by treating economic growth and environmental management protection as a continuum that traverses the boundaries of various scientific disciplines. The need to develop a process for formulating and implementing a course of action that explicitly takes into account social, political, economic, and institutional factors is also acknowledged. Such a process must be inclusive and should fully address the scale and scope of environmental and human issues and their consequences (Born and Sonzogni, 1995). Such realization has led to a gradual but fundamental shift in the resource use and management paradigm.

Natural resources are inter-related to one another within a defined ecological system. Therefore, they need to be managed in an integrated fashion. This has given rise to the concept of *Integrated Natural Resources Management*, which drives home the need to take a holistic integrated approach in dealing with natural resources, and to be conscious of the interactions among the constituent components of the resource base (Atta-Krah, 2004). Integrated Natural Resource Management involves the management of the impact of people on natural resources in a way that is:

- *Holistic*, including all elements of rural landscapes;
- *Systematic*, considering the interactions between these elements;
- *Comprehensive*, embracing the range of values attached to rural landscapes.

Although INRM has been heralded as the approach to addressing resource utilisation and management, adopted by agencies and communities in developed countries, and advocated by many international development donor agencies, it yet to have a systematic methodology. As part of the conceptual development based on their experience with INRM, theoreticians and practitioners alike have outlined elements and principles that are integral to the process. It is generally accepted that any systems approach adopted should integrate synergetic disciplines, span spatial and temporal scales, and involve multiple stakeholders in planning and implementation.

However, Bellamy and Johnson (2000) argue that the application of INRM still poses significant problems even when all of the key elements are in place. These problems are related mainly to the predispositions of stakeholders, researchers, and technical experts as well as managers, farmers, and other end users (Resource Assessment Commission, 1993).Because of these problems, many researchers are attempting to further their understanding of INRM with peer-reviewed publications as a measure of their success. They identify important research problems viewed from within the paradigms that they themselves use to structure research based on a positivist philosophy (Guba, 1990). The researcher adopts a non –interactive position, and analysis is regarded as value-free.

Methodologically, the researcher states a hypothesis and sets out to test it, that is, confirm or disconfirm it empirically. However, achieving practical outcomes is rarely the goal of researchers. It creates a problem when research results are linearly transferred to end users. Managers who have narrow, legislatively mandated terms of reference, duplicate each other's roles, and act inconsistently to represent a different set of problems (Resource Assessment Commission, 1993). End users are also reluctant to alter their behaviour without incentives compelling enough to bring about changes in their fundamental decision making processes and or outcomes.

To address these problems effectively, all stakeholders, including users, researchers, and managers whose decisions and/or activities influence actual outcomes, would have to make significant changes in their techniques, and probably in their attitudes as well. Furthermore, changes are required in the scale of analysis and action, which could be at the level of the plot, the farm, the community, the region, or even the nation—whatever works. These modifications can be developed by farmers (farmer experimentation), scientists, and/or the private sector. All stakeholders, including researchers, must be involved in developing strategies for change. These strategies will also require changes in the way research is identified, developed, and conducted as well as in the behaviour of managers. The types of strategies that lead to alterations in end-user behaviour would also need to be reviewed, so that individuals are given incentives, rather than directed, to change.

Concepts and Context of INRM

This INRM concept has been known or referred to by very many alternative terms (Downs and Gregory, 1991). Some of these include *"integrated catchment management," "integrated environmental managemen*t," *"ecosystem management,"* and *"systems analysis.*" In this chapter, we choose to use the term "Integrated Natural Resource Management".

INRM Components

The term *Integrated Natural Resource Management* has been defined as the responsible and broad-based management of the land, water, forest, and biological resources base (including genes) needed to sustain agricultural productivity and avert degradation of potential productivity (CGIAR-INRM-Group, 1999). INRM operates on the principle that natural resources are neither indestructible nor infinite. They can be destroyed or depleted through agriculture and other land use malpractices. They require to be managed in a holistic and integrated manner, catering for the complexity of ecosystem and the inter-relations amongst its various components. Thomas (2002, pg 53) defines INRM as:

> An approach that integrates research of different types of natural resources into stakeholder–driven processes of adaptive management and innovation to improve livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services at community, eco-regional and global scales of intervention and impact.

The INRM has the ability to:

- empower relevant stakeholders;
- resolve conflicts of interest among stakeholders, foster adaptive management capacity;
- accommodate complexity by focusing on key causal element;
- integrate levels of analysis;
- merge disciplinary perspectives;
- guide research on component technologies; and
- generate policy, technological and institutional options for stakeholders.

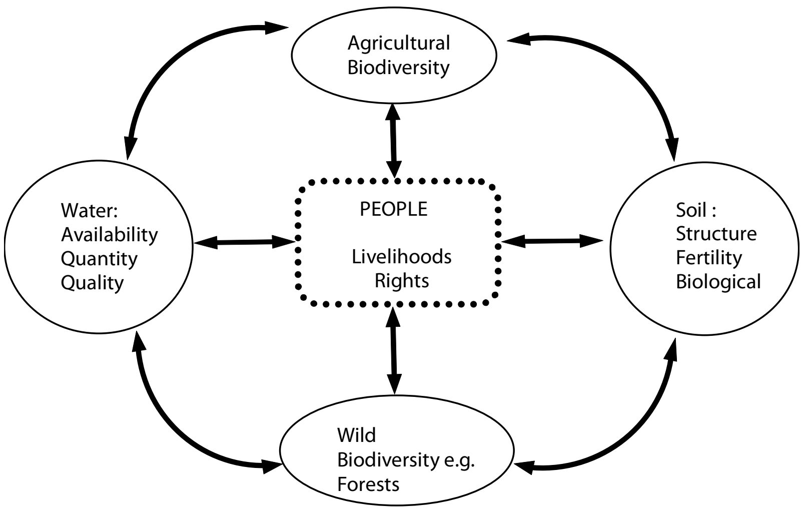

Figure 3.1: Key Elements of INRM and Complexity of Natural Resources Interaction

Modified After Atta-Krah Kwesi, 2004

A central dimension in INRM is the way in which the natural resources interact within and among themselves, and how their management and interaction relates to people and livelihoods. At the centre of INRM are people, their needs, their livelihoods and their rights, and how these needs interact with management of the natural resources. Any use of natural resources must, however, be within the framework of sustainability, and people need to be involved in their management and conservation. The key elements of INRM and complexity of interactions within its domain gives an indication of how broad and important natural resources are (see Figure 3.1). For example, biodiversity represents natural, uncultivated ecosystems (e.g. forests) while agricultural biodiversity represents ecosystems used in agriculture. The soil supports living entities such as biological diversity and retains moisture and minerals for use by living organisms. People and livelihoods are at the centre of INRM components.

Research in INRM

Integrated Natural Resource Management research can meet the challenge of accelerating the use of natural resource management practices that improve human well-being. INRM must be based upon sound research findings across numerous countries and diverse Agro–Ecological Zones (AEZ) so that substantial tested packages are disseminated to various communities. For example, complex investigations are needed to come up with recommended soil fertility management approaches that will give the highest and most sustainable gains in crop productivity per input unit. Several mixtures of inorganic fertilizers and organic inputs must therefore be tested in consideration with their time of application if better packages are to be developed (see case study 3.1).

Thus, decentralized initiatives, supported by relevant institutions, and guided by suitable information management tools, can lead to the widespread use of suitable management options from INRM research. This, in turn, can improve agro-ecosystem productivity and resilience, thereby helping achieve the goals of poverty alleviation, food security, and environmental protection. Integrated natural resource management that integrates multiple disciplines across spatial and temporal scales and involves stakeholders in key decisions will probably be more effective than the single-disciplinary management approaches of the past. However, for INRM to succeed in practice, it must focus on how people make decisions and how they interact with each other and with their natural environment. The main strategy is to foster and improve the adaptive capacity of all relevant stakeholders.

Case Study 3.1: The Strategy of ISFM for Upland Rice Production in West Africa

This case study presents a system of ISFM for upland rice. Basically, soil fertility management is conducted in three stages, with organic inputs and P and K fertilizers applied prior to planting, nitrogen fertilizers applied on demand and lower quality crop residues retained in the field as trash lines or surface mulch (Meertens, 2003). Legumes such as *Mucuna spp., Canavalia* and *Stylosanthes* that are established as dry season green manures provide significant amounts of nitrogen to the following crop (up to 270 kg N ha^{-1}) and significantly, suppress weeds but relay cropping with green manure legumes is often counterproductive because of unwanted crop competition. A salient feature of ISFM is the use of improved crop varieties that better respond to increased nutrient supply, otherwise, benefits of improved fertility may not be obtained with poor varieties. Use of ISFM with improved New Rice for Africa (NERICA) varieties improved production by 200% compared to local varieties in the conventional cropping systems (Sanginga and Woomer, 2009).

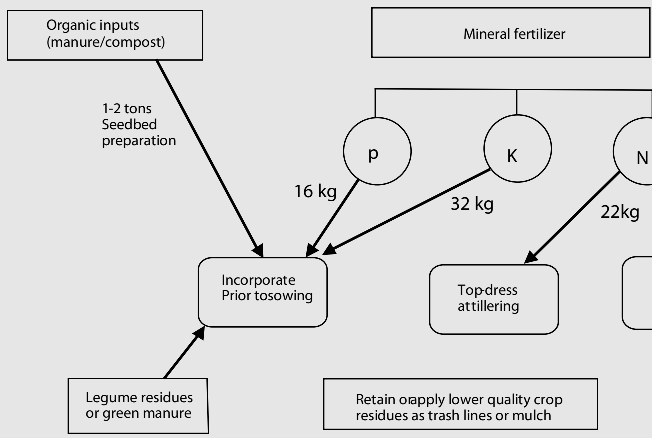

Figure 3.2: Illustration of Integrated Soil Fertility Management Strategy Applied in Upland Rice Production

(Source: Sanginga and Woomer, 2009). Note:- P= phosphorus, K= Potassium and N= Nitrogen.

First, all relevant stakeholders will probably have to change their behaviour to allow for the planning, research, and implementation of management strategies across traditional and legislatively mandated roles and disciplinary biases. Second, constructivist philosophy should guide a dialectic decision-making process supported by rigorous individual or interdisciplinary research. Third, the specific problem should dictate the scale, scope, and disciplinary mix of the research, and the desired outcomes should be identified through participatory action research, which may require a spatial-analytical framework of hierarchical scales of analysis from local to global. Fourth, research should be integrative and synergistic, traversing disciplinary boundaries and bridging gaps in the perceptions, values, and perspectives of different stakeholders. Actions and policies should be developed in a participatory manner and implemented at different scales to bring about the outcomes that have been identified as desirable based on the decisions that stakeholders actually make in the field. These cycles of behavioural change followed by the search for appropriate management strategies then occur iteratively, with continuous adaptive learning as the cornerstone of the decision-making process.

Ecosystem Approach to INRM

Ecosystem Processes

The significance of interconnectedness of ecosystem components, the plants, animals, microbes, humans as well as air, soils and water is not that simple. In

Chapter 2, detailed ecosystems interactions and processes have been presented. A large number of complex physical, chemical and biological interactions make it possible and in general, they are called *ecosystem processes*. *Photosynthesis*, the conversion of solar energy into chemical energy (food for animals) by green plants, is one such process that is essential to support life on Earth, just as *decomposition*, the breaking down of waste (complex organic matter) into plant nutrients by microbes. Were it not for the myriad of microorganisms that live on this planet, it would have been buried under its own waste and plants would have perished without nutrients, a long time ago. These processes/interactions between components, therefore, are crucial in maintaining life on Earth. In other words, in perpetuating the regenerative capacity of living organisms. Changes in the components or the conditions that they are in will greatly affect the speed at which these interactions take place, for instance, when the water is polluted with organic waste, dissolved oxygen in water rapidly depletes and the water becomes unfavourable for life as a result of its being excessively used by microorganisms that multiply faster under the circumstances. Naturally, the consequence is a fish-kill, the indicator that the processes are under stress and the systems' life supporting capacity is at stake.

Similarly, any degraded ecosystem affects life on earth, for example, degradation of forest habitats affects the delivery of ecosystem services to humans and wildlife; shortage of water, clean air, tourism, etc. The extent and the type of vegetation cover in Kenya has changed dramatically in the recent past due to both natural causes and human activity. Most watersheds, agricultural land and rangelands (Figure 3.3) have been heavily degraded and this has resulted in serious environmental consequences affecting livelihoods, biodiversity and natural systems. For example, most of the Rift Valley lakes e.g. Naivasha, Nakuru and Elementaita in Kenya are shrinking at an alarming rate due to increased human settlement and land use change in the watersheds.

Figure 3.3: A new settler clears indigenous trees to cultivate crops in the Mau Forest Complex, which is Kenya's largest water tower. (Photo, February 2005).

Source: UNEP, 2005

Ecosystem processes may undergo changes due to a multitude of reasons that hamper the ecosystems ability to perform functions and thus deliver the services. Livelihoods are either directly or indirectly dependent on ecosystem processes, giving rise to functions that eventually provide the services from which the livelihoods are derived. Making charcoal out of mangrove wood is directly dependent on mangrove productivity facilitated through *photosynthesis.* Clear felling of mangrove areas for other land uses such as shrimp culture or salt production will diminish the photosynthetic process and its production function, thus reducing the mangrove biomass available for charcoal production.

Ecosystem Functions

Ecosystem health is the self maintenance of the processes that gives rise to a multitude of functions beneficial for humans and other life, which are commonly known as *ecological/environmental goods and services or amenities,* such as supporting the food chains, provision of resources for livelihoods, clean water, fresh air and scenic views. *Ecosystem processes,* therefore, are responsible for *ecosystem functions* that serve the well-being of humanity. According to Rudolf *et al.,* (2002) ecosystem functions can be classified as follows:

- Regulation functions (regulation of air, climate, water, water supply, disturbance prevention, soil formation and erosion, nutrient cycling, waste treatment, pollination, biological control of pests and diseases);
- Habitat functions (refuge and nursery functions);
- Production functions (food, raw materials, genetic, medicinal and ornamental resources);
- Information functions (aesthetic information, recreation and ecotourism, cultural and artistic inspiration, spiritual and historic information, scientific and educational information).

Ecosystem Services

Ecosystems functions or benefits constitute the core of life support systems on earth and cater for the well-being of humanity. Resources and opportunities for livelihoods, the means through which people make a living, such as fishing, farming, shrimp aquaculture, crab fattening, eco-tourism, hydroelectric power generation in rivers, as well as extraction of oil and gas trapped deep down in the ground, are provided to humans through ecosystem functions. As such, they are called ecosystem services. Viewing ecosystem functions as services makes them valuable to those who benefit. Thus, ecosystems are linked to economics. The value of ecosystems, like that of any other asset, derives from the services they provide. In reality, attaching values to ecosystem functions has not proven successful hitherto because the interactions among ecosystem components or the processes themselves, as well as their link to human well-being, have not yet been sufficiently elucidated.

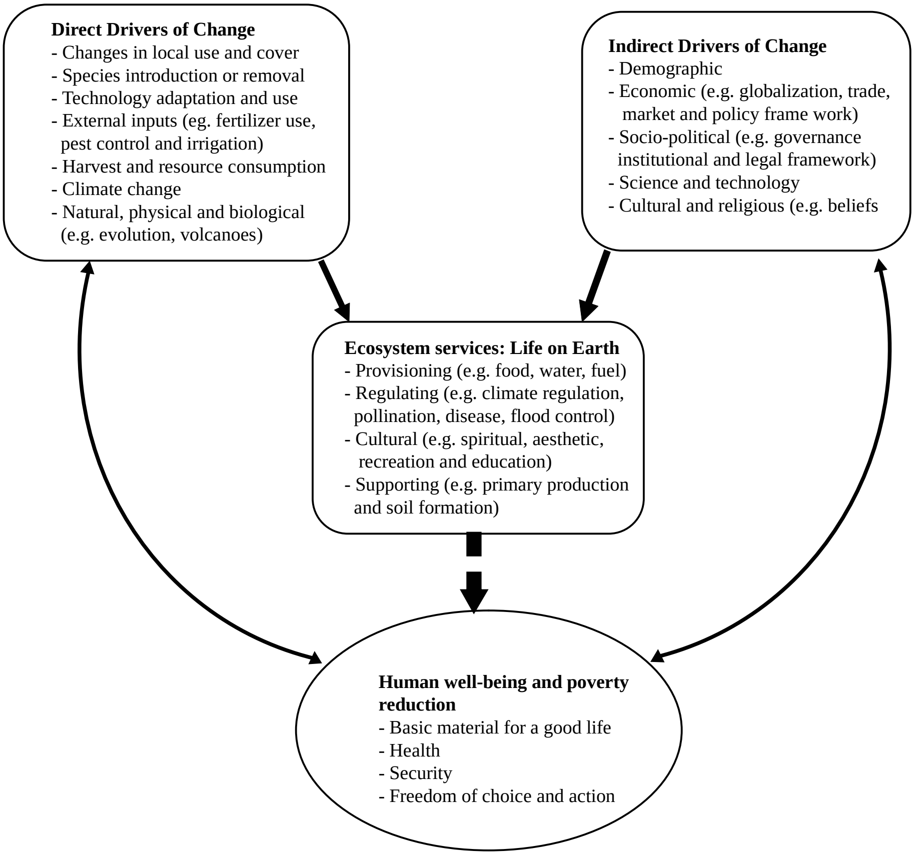

Figure 3.4: Interactions Between Ecosystem Services, Human Well-Being and Drivers of Change.

Ecosystems, however, are linked to social systems since humans depend on the ecosystem functions to fulfill their needs and aspirations. These links seem not to be simple. They demand scholarly effort to reveal the bearing of processes that define ecosystem health on human well-being. Besides, it’s also crucial to have elucidated how the direct and indirect drivers or the causalities of change of processes eventually affect the ecosystem services and human well-being (Figure 3.4). The International Commission for Science (ICSU), United Nations University (UNU) and UNESCO that jointly carried out the Millennium Ecosystem Assessment (MA, 2005) highlight in their draft report that 60% of the ecosystem services that have been investigated are degraded and do not deliver the expected goods and services to humanity. Effort should therefore be diverted to bridging the gap between ecology and social sciences, to understand the vital links between ecosystems and social systems that finally determine the overall well-being of humanity, with a view to developing appropriate strategies to alter this unfavourable trajectory of Earth’s ecosystems. The direct drivers of change affect the ecosystem services; in turn they affect the human livelihoods.

Linkages between Processes, Functions and Services for INRM

INRM emphasises that ecosystems are moving targets with multiple potential features that are uncertain and unpredictable. Therefore, management has to be flexible, adaptive and experimental. On the other hand, INRM can be used to analyse higher systems-level dynamics, stresses and interactions and to link global and local processes such as biodiversity loss and climate change; ecosystem functions and services (Figure 3.5).

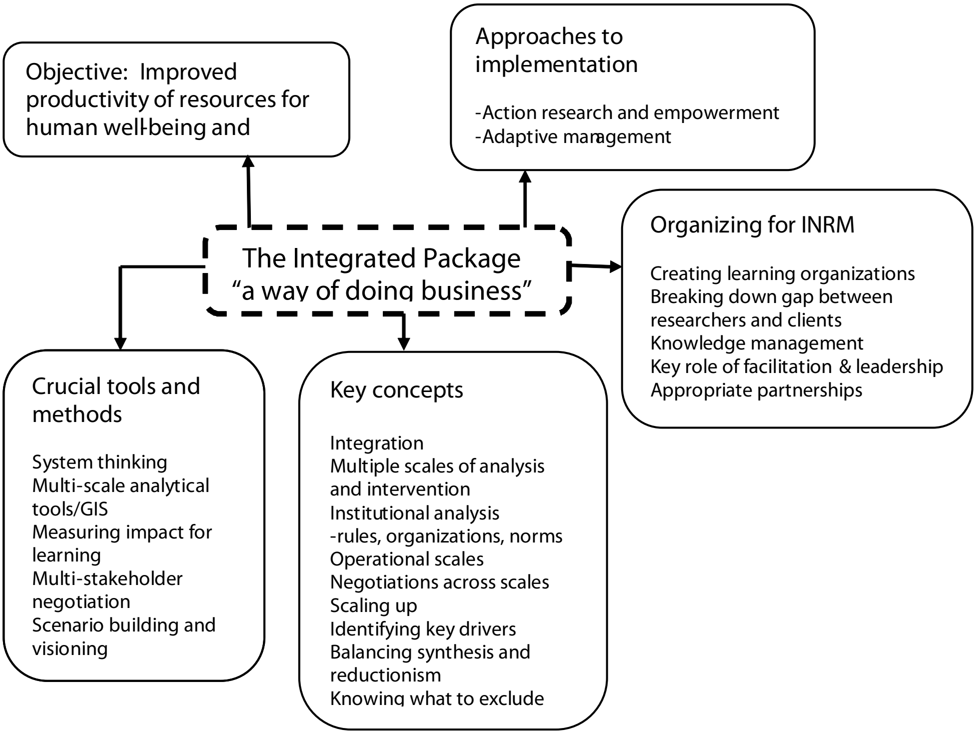

Figure 3.5: Natural Resource Management and Use: Ecosystem Approach and Linkages Between Processes, Functions and Services.

Source: Poulsen, 2003

The above figure demonstrates that an ecosystem approach to management will not only emphasise that different scales need to be considered but also that one needs to look beyond boundaries of the system in question. All goods and services must be balanced, all relevant stakeholders need to be included in negotiations, and solutions must be adapted to achieve desired outputs. Figure 3.5 shows the framework around which INRM is done, emphasising the role of dynamic and iterative impact assessment to ensure that goals and objectives are continuously reassessed against changing needs and state of the system.

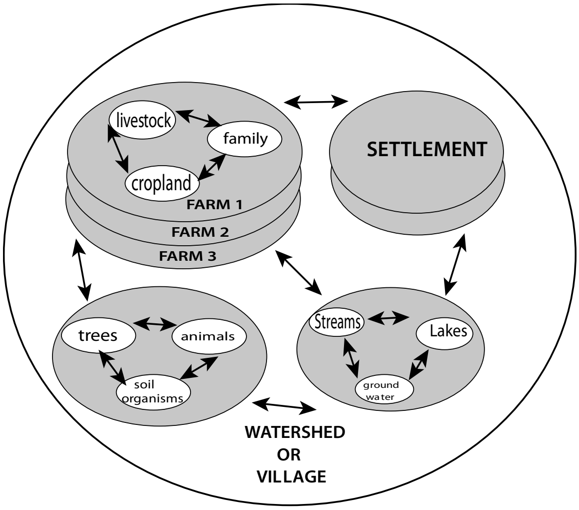

Figure 3.6: Nesting of Systems and Subsystems in INRM

Source: Bossel (2001)

Integrated Management deals with interacting nested systems (see Figure 3.6). Subsystems contribute to viability and performance of component systems, which again contribute to the total system. INRM also involves multidimensional scales including integration of diverse elements from disciplinary to inter-disciplinary; research to policy and field to regional scales (Figure 3.7). The adoption of a more integrated approach in NRM emanates from concerns, that "*ecological sustainability cover broader geographical areas than fields and farms, and NRM research ought to be able to benefit large numbers of people*" (Kam *et al.*, 2000, 3).

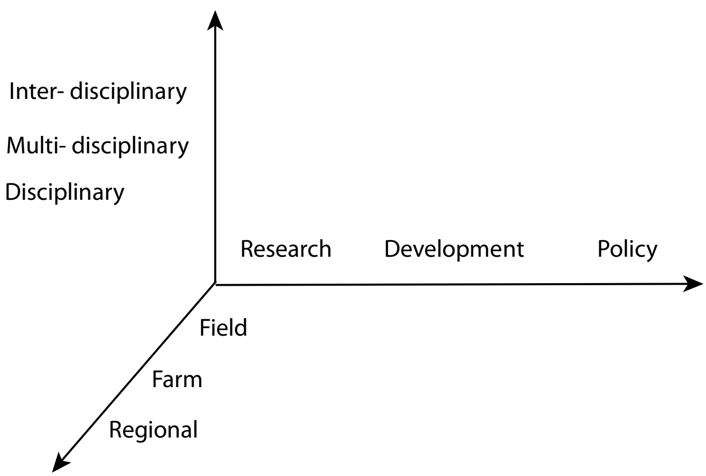

Figure 3.7: Integration of Diverse Elements in INRM

INRM is about understanding the existing interactions between the resource system and social dynamics and the relationships among levels of organization (Kam *et al.,* 2000). Campbell and Hagmann's (2003) have developed a conceptual and operational framework for INRM and they argue that: *"integration is the central concept in INRM"*. There are several dimensions of integration in integrated natural resource management. One is the integration of multi-stakeholders. This integration is divided into: (i) the integration of more stakeholders in more communities and (ii) the integration across scales, i.e. local and national government organizations called *"strengthen linkages along the research-development-policy continuum"* (CGIAR, 2003).

According to Lovell *et al.,* (2002), INRM is complex and must address many interactions. The scale of operation can restrict the generality and utility process and its outcomes. It is critical to consider temporal, biophysical, and institutional scales when planning and executing an INRM process. Every scale has unique context and dynamics. The conceptual framework in Figure 3.8 is useful for scaling and addressing critical issues in INRM.

Experiences from different parts of Africa clearly show that successful INRM initiatives have the preconditions set in Figure 3.9 in place and have the following common features:

- *A reasonable degree of social organization through which the necessary critical mass of collective action can be organized.* Where this does not exist, it has to be created, requiring significant development of trust and platform building. The social units most appropriate for participation need to be tailored to the particular setting, and the approach may not work where "community" is not the norm and people are devoted to individual actions (e.g., tribals, absentee landlords, landless people);
- Clearly defined roles for the different organizations: state departments, NGOs, and CBOs;
- *Emphasis* on introducing government personnel to participatory farmer-to-farmer extension and on reorienting initial projects and extension approaches away from "treatment" of specific problems toward whole-catchment management focused on livelihood priorities;
- *Flexibility*. A thoroughly predesigned and pre–planned project is not considered a good project. Indicators of success focus on adaptation rather than adoption;
- *Group access to finance* through credit or other means;
- *Highly subsidized* by government and donors, with local residents contributing only a small percentage of the value of the development works in cash or as labour. Adequate financial and institutional support is considered critical where authorities are handing responsibility for complex, costly, and conflict-ridden problems back to local people;

- *Planning units that are collective*, i.e., a Community-Based Organization (CBO) rather than individual farmers, with the emphasis on working with people who have something important in common (e.g., caste, blood, class, common dependence, common priority);
- *Tangible benefits* to participants in a short space of time.

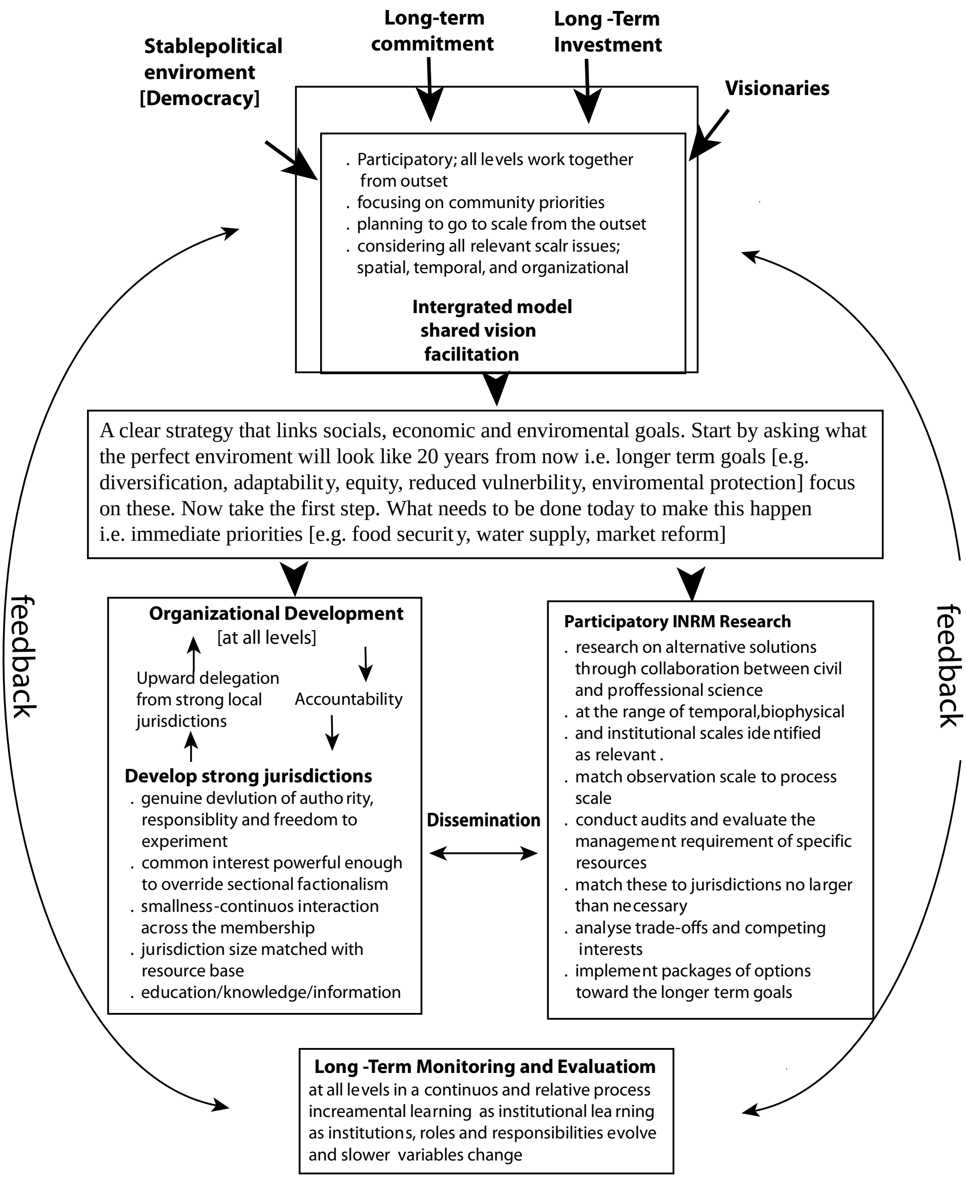

Figure 3.8: Conceptual Framework or Strategy to Deal with Scaling Issues in INRM.

Adapted from Lovell et al., (2002)

Intergrated Cathment Management

- Overall strategy that defines the managment objctives
- Mechanisms and policies that enable long-term support
- A range of delivery mechanisms that generate the interest and participation of local institution and communities
- Decision-making and action take place at region and local levels
- A monitoring schedule that evaluate program performances

common property management[group management]

- Access to external facilitation to help advise on organizational development systematic analysis to identify all stakeholders and ensure their representation
- The operative unit is small enough for local people to participate meaningfully
- Members of the group must benefit directly from the resource
- Group membership and resource are agreed upon and defined
- Constitution [rules and norms] gorverning management agreed upon and defined
- Compromises for resource sharing negotiated with other group using
- charters of access and compensation mechanisms
  Penalties for infringement of rules and a mechanism to enforce these

The ideal initial d evelopment project

- Produces a range of benefits to many people in a short space of time
- Generates cash-lack of income is a huge impediment to new activity
- Create sufficient incentive for communities to overcome the increased managerial problem associated with joint action
- Build social capital e.g. provides a meeting place for problem solving and builds confidence in tackling natural resource problems
- Prompts the awareness of the need to protect natural resource in order to
- protect their initial investment- in some cases this intrinsic awareness may need to be inforced through enviromental education

Devolution of control for natural resource management

- Ratification of community -based organization [CBOs] as apprropriate authorities
- Ratification between customary and modern leadership systems
- Security of tenure
- Access to credit facilities
- Management rules and maintanance arrangements evolved and enforced locally with higher level support
- Revenue f rom fines, levies and royalties maintained locally
- Conflict management arrangements in place and arbitration available
- Demand -led technical support services with official tarrff s where applicable
- Access to enviromental education
- Local-level resource monitoring and evaluation
- Open lines of communication between groups and with higher levels of authority

Figure 3.9: Some Generalized Preconditions for Successful INRM

Adapted from Lovell et al., 2002

The INRM allows us to develop effective and relevant solutions, under real life operational conditions, to facilitate better decision making and to manage complex technical changes with multiple impacts. We also need it to be able to maintain a range of options and resilience, to reconcile conflicting objectives and to facilitate or improve access to resources and benefit sharing. Finally, we need it as a means of examining resource degradation over time. It can be used to analyse higher systems-level dynamics, stresses and interactions and to link global and local processes such as biodiversity loss and climate change. In addition, it can be utilised to evaluate future system scenarios and promote adaptation and learning. Integrated approaches need not integrate everything and be all-embracing—the problem drives the integration. We need to integrate only those additional components, stakeholders or scales that are essential to solving the problem at hand. Even more demanding is research in INRM which considers the elements in Figure 3.10.

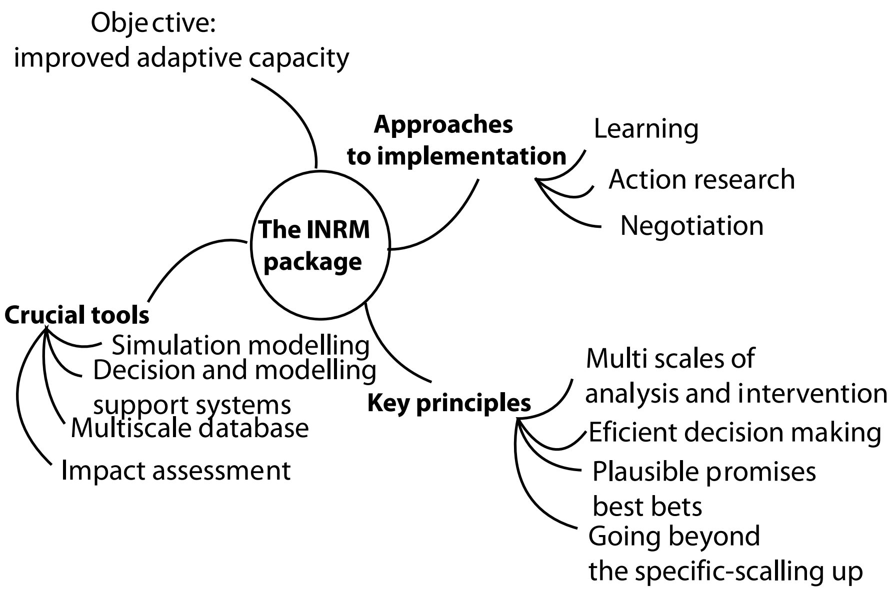

Figure 3.10: Some Elements of INRM Research

Source: CGIAR, 2004

Operationailizing INRM requires a set of some eleven "cornerstones" (Campbell and Hagman, 2003) depicted in Figure 3.11. The eleven are a set of principles that guide the resource users, researchers and development organizations during the planning, implementing and evaluation processes of an Integrated Natural Resources Management Project. These 'cornerstones' offer a classical conceptual design for research and development.

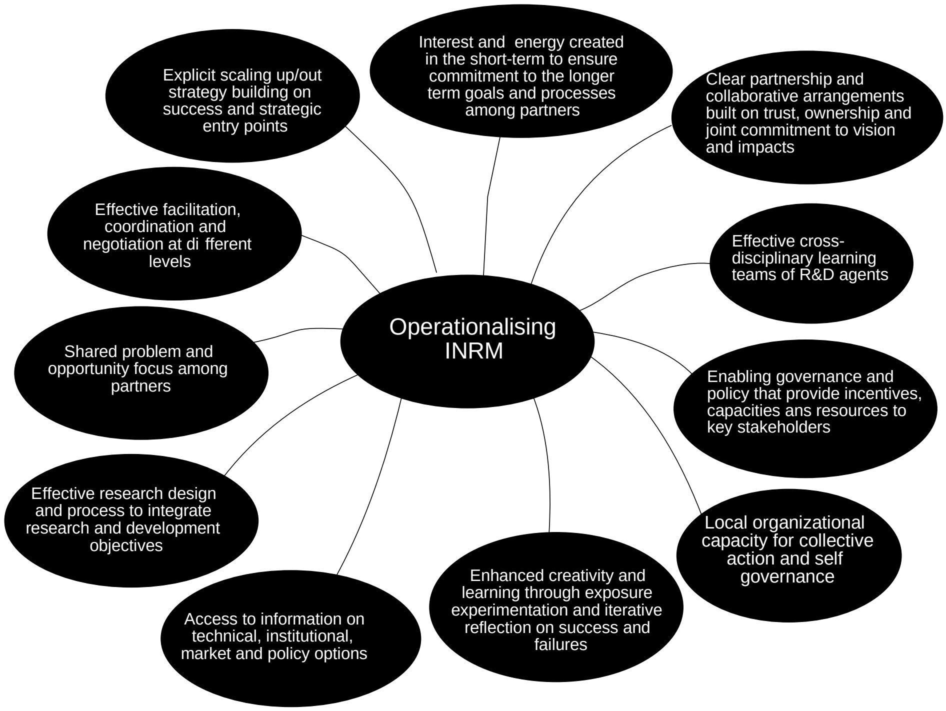

Figure 3.11: The Eleven Cornerstones of INRM

Source: CGIAR-INRM Group, 1999

Figure 3.12 reflects different factors and the multiple dimensions of stakeholders and scales, which are a main characteristic of Integrated Natural Resources Management Systems. The arrows illustrate the multiple scales of interaction and response (Campbell, 2004). This illustration is a useful framework to consider alongside Figure 3.11 in designing, understanding and operationalizing INRM projects. It comprehensively takes into account the fact that natural resource management systems involve multiple stakeholders with multiple perceptions and objectives and, therefore, multiple management strategies. It is these characteristics a researcher or INRM practitioner needs to consider while paying particular attention in identifying integrated natural resources management aims and also find trade-offs that meet the often-contrasting stakeholder interests (Lovell *et al.,* 2002). The illustrated components of Integrated Natural Resources Management give a rough outlook of the natural resource system and its resource users. These frameworks were used by Amede *et al.,* (2006) to design the extended schema of a fisheries integrated resource management framework (Figure 3.13).

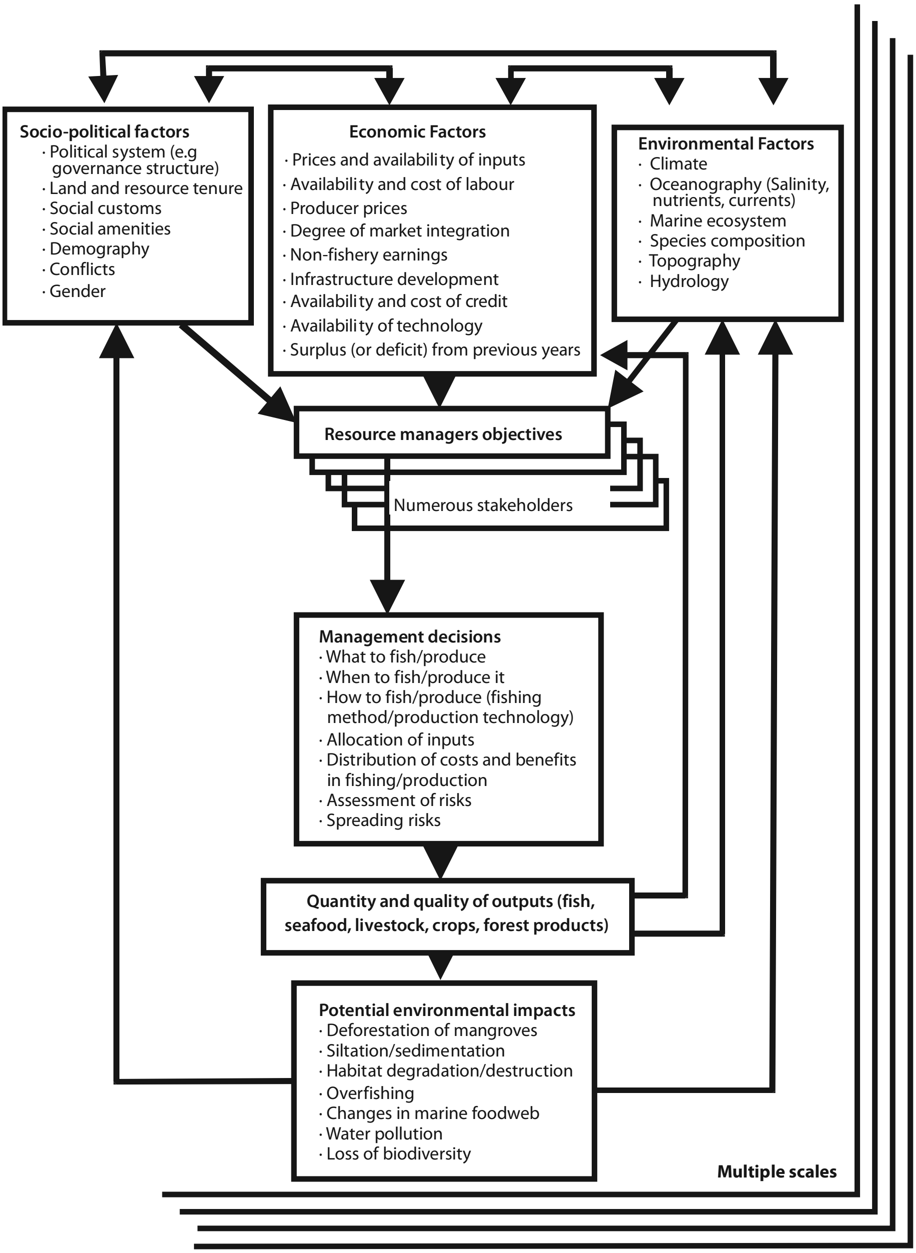

Figure 3.12: Components of Integrated Natural Resource Management

After Campbell (2004)

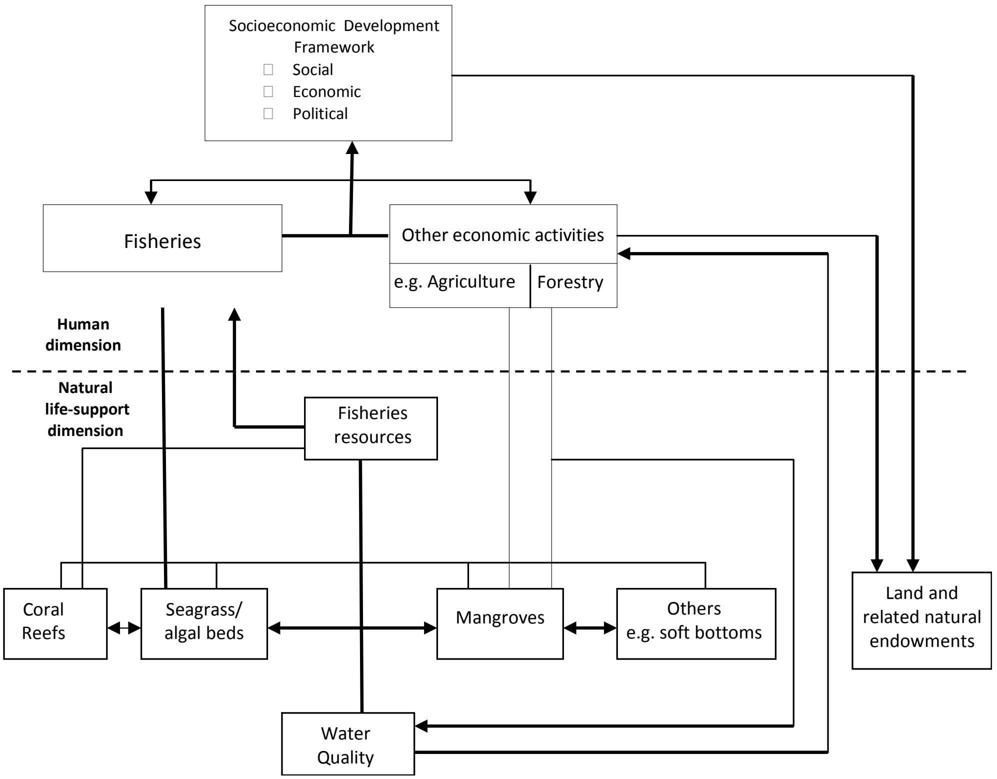

Figure 3.13: Schematic Representation of an Expanded Framework for Fisheries Management.

Amede et al, (2006)

Conservation Perspectives in INRM

Africa has a distinctive natural heritage and biological diversity, which pose several challenges and opportunities for conservation, sustainable use and stewardship. As a continent, we need to recognize, protect and manage this natural resource base by improving our knowledge and developing technology, designs, systems, approaches and strategies to contribute to a safer and healthier environment for all.

The aim of INRM is to manage natural resources so as to achieve a balance between their functions for the quality of the environment and their functions for the quality of human life. The efficiency of INRM approach in solving real life natural resource management problems derives from its ability to:-

- Focus on key factors that cause changes in the integrity of resources (i.e. dealing with the complexity of natural resource systems);
- Merge disciplinary contexts;
- Integrate resource level components in analytical frameworks;

- Involve relevant stakeholders in tackling resource management problems;
- Manage conflicting resource use interests by various stakeholders;
- Foster adaptive management capacity;
- Guide research on component technologies;
- Make use of a broad spectrum of available technologies;
- Generate policy, innovations and institutional alternatives.

Integrating Spatial Typologies and Temporal Dynamics

Spatial differentiation of resources and changes are discernible through time. Use of advanced tools such as geospatial technologies permits investigation of natural resource management problems by tracing macro scale and micro scale changes, for example, in land cover through time—line surveys and connection of such landscape changes with livelihoods. Knowledge of the patterns of trends is critical in predictions of future changes and management scenarios of natural resources.

Integration of casual factors in landscape changes in relation to livelihoods provides useful perspectives in understanding the management realities of natural resources and designing appropriate interventions for tackling existing management problems. For example, natural scientists can no longer afford to be external actors preoccupied with investigation of ecological phenomena far removed from the realities concerning day-to-day trial and error episodes of natural resources managers such as livestock keepers who utilize grazing resources at the landscape/ ecosystem level.

We need action oriented research that values the contributions of natural resources managers and technical experts in developing appropriate solutions to existing management problems (Campbell *et al.,* 2003).

Integrating Biophysical and Socio-economic Perspectives

Changes associated with the integrity of the environment may be due to a combination of causal factors ranging from exploitation of natural resources goods such as fiber, timber, medicines, wood fuel energy etc by humans, grazing and browsing of vegetation by domesticated and wild animals, and natural changes such as climate (e.g. drought, floods, temperature, etc). Other causes of environmental changes associated with land use and land cover may be lodged in the socio-economic and political sphere. Both biological (natural) and non-biological causes of environmental changes affect the ability of the environment to produce natural resources and support ecosystem functions and human livelihoods.

Development of appropriate interventions to deal with natural resource management problems must of necessity integrate across spatial and temporal scales and consider connectivity between households, villages, districts and international institutions. *Multistage approaches* are necessary to capture interconnectivity and offsite effects, while solutions to problems will require interventions at different scales (Campbell *et al.*, 2003). *Multilevel analytical frameworks* that include socio-economic and political causes of environmental problems (e.g. degradation) and biophysical methods that facilitate collection of thematic and qualitative baseline data (contemporary or historical), measurements of attributes of natural phenomena (e.g. shifts in structure, density, frequency of vegetation species, patterns of rainfall, temperature etc), of environmental, ecosystems changes, assessment of the changing natural phenomena and human activities are required to support informed decision-making. Natural resource stakeholders are an important driving variable in natural resource dynamics in view of their activities and contrasting objectives. Sustainable use of natural resources requires considerations of the socio-cultural, socio-economic and institutional framework that influence resource use objectives on varying landscapes and temporal scales.

Stakeholder's Dimensions

Integrated natural resource management and its many closely related approaches are generally considered to be more effective than *single-disciplinary approaches* for managing complex resource issues currently facing many countries. INRM approaches aim to integrate several disciplines and involve different stakeholders operating in their own subsystems across different spatial and temporal scales. These approaches focus on identifying management strategies for sustaining natural resource stocks and flows of goods and services as well as their underlying ecological processes. Changes in the behaviour of consumers and producers and in the allocation of resources among uses, users, time, and space will be necessary to achieve sustainable development. To accomplish this, changes in focus, attitudes, and approaches to research and management will also be necessary.

The key focus of INRM should not be the natural resource itself, but rather the interactions of humans with each other and with their natural environment, and the decisions they make about using and managing resources. Such decision-making processes aim to identify and implement action-oriented strategies and to apply economic and noneconomic instruments that motivate behavioural changes, allowing for different responses to various economic imperatives. This process should be guided by constructivist philosophy and supported by rigorous cross-disciplinary research and active stakeholder participation. It must be compatible with dialectic decision making to reflect the different views and objectives of the stakeholders, the presence of incomplete information, and, at times, the fact that researchers have only a poor understanding of the dynamics of subsystems and their interactions. There must also be iterative, regular monitoring and fine-tuning of the management strategies chosen. We prefer to call the entire process an Adaptive Decision-Making Process (ADMP).

Paradigm Shift in Natural Resource Conservation

The underlying rationale is to involve and support Community Based Enterprises (CBEs) that will relieve pressure on the natural environment by providing an economic benefit from the preservation of the biodiversity (an eco-system, landscape, flora, fauna, etc.). This is certainly not, however, the only paradigm. Other modalities for providing an economic benefit for preservation of the environment (direct payments to communities to not utilize land in destructive ways, provision of social infrastructure as compensation) have been been promoted since early 1990s. There is significant support of the CBEs approach not only in Kenya but also in other countries in Africa. However, the success of this approach is dependent upon the local promoters, effective policies and its sustainability in contributing to natural resources conservation Kenya Forestry Service, for example, devised a system of involving all stakeholders in forest conservation and management (see case study Box 3.2).

Case study 3.2: Integrated Forest Management in Kenya

Kenya has embraced Participatory Forest Management (PFM) as an approach towards achieving sustainable forest management. This is out of realization that involvement of the wider stakeholders would significantly contribute towards sustainable management of forests. In this approach, local communities and other stakeholders participate in the management of forest resources as provided for by the Forest Act 2005. The guidelines have been prepared by stakeholders spearheaded by the Kenya Forest Service (KFS), with technical support from the Commonwealth Secretariat. The ideas and details in the guidelines were collected and collated from government, non-governmental organizations and community groups. The fundamental objective of these guidelines is to provide a simple set of steps that stakeholders can easily understand and apply. It is envisaged that the guidelines will provide a more coordinated and efficient use of forest resources. The guidelines have been presented in 8 basic steps that summarize the PFM process. These steps do not always have to be followed in a progressive manner due to the iterative nature of PFM process. The key steps include; 1. Identifying the community and verifying resources 2. Assessing forest area and the community 3. Preparing draft forest management plan 4. Facilitating the formation of a forest association 5. Negotiating, drafting and signing a forest management agreement and to declare the area a PFM area 6. Implementing the plan 7. Reviewing and revising the plan on the basis of the experiences 8. Monitoring and evaluation on the process.

Source: KFS, 2007.

Participatory Land Use and Resource Planning in INRM

Land planning is an integral component of natural resource management. Therefore, INRM is considered a very useful approach to tackle land degradation because of its comprehensive nature and simplification of the inherent complexity of socio-ecological systems, that is, people are an inherent part of the ecosystem in which they live. People-centered conservation currently enjoys international popularity as an environmental philosophy that seeks to link conservation concerns with local needs and governance.

Judicious and efficient use of natural resources is essential for sustaining livelihoods. Community based planning, combined with implementations of sustainable practices and technologies, can help to improve environmental conservation (*see case study 3.3).* A multi-scale framework could be used to understand the interactions and dynamics of the complex resource use systems at different bio-physical and social economic levels.

Case study 3.3: The District Environment Action Planning and Local level Scenario Planning in Zimbabwe

Two interventions, namely, District Environmental Action Planning (DEAP) and local level scenario planning, iterative assessment and adaptive management that both aim to empower local level natural resource users to better manage their natural resources for their own livelihood benefits, whilst conserving the environment were implemented in Zimbabwe. Despite the participatory methodology used, the DEAP programme had little impact and did not result in ownership by the local people, nor result in any substantial improvement of either human or environmental well-being (Manjengwa, 2004, 2007). The DEAP programme did not establish, the required institutional arrangements at sub-district level, such as the Community Strategy Teams, to ground such a programme at local level. There was no mechanism for upward transmission of plans. Despite the rhetoric of being bottom-up, and including participatory rural appraisal exercises with local people, the approach used in DEAP was top-down and ownership was perceived as being at national level, or with the international agencies.

Local level scenario planning, iterative assessment and adaptive management was implemented by the Centre for Applied Social Sciences (CASS), University of Zimbabwe, with financial assistance from the International Development Research Centre (IDRC). The main objective of this initiative was to enhance the ability of local level natural resource managers to collectively manage and benefit from their natural resources through the development and refinement of the research and managerial methodology of scenario analysis. It takes the methodology of scenario modelling and makes it a people-centered set of collective experiments, iteratively reflecting their aspirations, their assessments and their adaptations over time. The concept was developed by Marshall Murphree, and draws on his long experience with the Communal Areas Management Programme for Indigenous Resources (Campfire) and holistic analysis of community based natural resource management.

The local level scenario planning initiative was piloted with communities in the Great Limpopo Trans-frontier Conservation Area (GLTFCA) in Zimbabwe, Mozambique and South Africa. It aimed to improve the understanding of GLTFCA planners of the needs and aspirations of the resident populations and ensure their consideration in overall planning and implementation. The process involved action research in which interdisciplinary teams of scholars participate in local planning and assessment, but only in an invited and facilitative manner. This initiative aimed to refine a methodology that places professional and local civil science into a new relationship, in which the former is less intrusive and the latter less marginal. Local level scenario planning, iterative assessment and adaptive management, implies more than just scenario visioning and planning; it links the implementation of the plans, self-assessment and adaptive management in an iterative process. The local communities participated in planning process and institutionalised the plan at local level. This methodology has the essential characteristic of successive evaluative iteration, and it is a powerful tool.

Source: Manjengwa, 2009

Tools for INRM

Tools are needed to assist natural resource managers in better focusing investments, more efficiently allocating scare resources available to regional bodies and demonstrating ongoing improvements in resource condition. These tools should be underpinned by robust scientific analysis and promote enhanced understanding of cause and effect through adaptive learning, then they can assist regional bodies in planning, monitoring and evaluating the success of investments.

This section outlines some of the concepts and procedures involved in generalizing and propagating the results of natural resource management research ("scaling out"), with a few forays into the area of externalities and scale of analysis ("scaling up"). Some examples of several methods and tools for accelerating the scale of geographical coverage and impact of INRM practices are also provided. Methods and tools illustrated include site similarity analysis through Geographic Information Systems (GIS), the linking of simulation models with GIS, and farmer and land type categories. Finally, it is argued that these tools are most useful when they provide information in the context of a bottom-up learning process to a wide range of stakeholders who need this information to make decisions.

A problem Solving Approach

Research on Integrated Natural Resource Management must be capable of solving problems (or seizing opportunities) in ways that improve livelihoods for the poor while conserving resource quality and protecting the environment. Within a problem-solving process, we can distinguish among problem sets, causes, intervention points, and measurement tools.

Problem sets are situations in which agro ecosystem performance, i.e., the processes that affect the resource quality or the environment, is unsatisfactory. Examples include low agro ecosystem productivity, excessive resource degradation and environmental pollution, low levels of environmental services, low agro ecosystem biodiversity, reductions in soil fertility, unsatisfactory water quality for consumers, and excessive greenhouse gas emissions. These problems can be characterized in terms of their costs and consequences, spatial and temporal incidence, and pace of change. They can be recognized and defined by farmers, communities, Non-Governmental Organizations (NGOs), scientists, and/or policy makers.

Causes are the factors that drive or contribute to problem sets. Typically, many causes at several levels are at work. Causal chains can be long and complex, linking policies, institutions, farmers or community behaviour, biophysical processes, and their consequences for livelihoods and the environment. In other words, policies and institutional arrangements affect people's behaviour, people's behaviour affects plant and animal growth and biophysical processes, which result in outcomes that cause changes in system productivity and resource and environmental quality. Chains of cause and effect typically link different scales of analysis. For example, regional policies on the burning of crop residues may influence mulch management at the farm level, affecting soil water and organic matter levels and fractions and rates of erosion at the plot level, with consequences for water quality in the watershed as well as for crop yields and family incomes at the farm level.

Intervention points are opportunities for addressing the problem set. They are not restricted to new farm-level technologies; they may also include changes in policies and institutional arrangements, e.g., rules governing community forest management. However, policy change as an intervention is most effective when cause-and-effect relationships are clear, that is, when there is a reasonable likelihood that a change in policies or institutions will modify farmer or community behaviour in ways that lead to desired changes in biophysical processes, system productivity, environmental and resource quality. Interventions, then, can be at any level of analysis: plot, farm, community, watershed, or region. They may be developed by farmers via farmer experimentation, by scientists, by policy makers, or by the private sector. Early successful interventions have been referred to as "sparks" (CGIAR, 2004). For example, a problem set may revolve around the siltation of the lowland irrigation infrastructure, leading to substantial productivity losses and heavy public investment in renovation. Causes may include heavy erosion from upland areas driven by policies that encourage communal livestock grazing of crop residues, thus reducing incentives to use these residues as a soil cover. An intervention point might feature policy changes to foster modifications in grazing practices that encourage the use of crop residues as a soil cover mulch to reduce erosion and ameliorate the original problem of siltation.

There is a need to develop tools that can link analyses from different spatial and temporal scales. INRM toolbox may be conceived to contain the three compartments, namely; diagnostic tools, problem solving tools and optimization of opportunities, and process tools.

Diagnostic Tools

These are Multilevel Analytical Framework (MLAF) and Indigenous Knowledge (IK) tools that are employed to diagnose problems by means of participatory approaches involving land use stakeholders (farmers, researchers, policy makers, rural development organizations etc). They have two distinct components, i.e., spatial pillar and stakeholder pillar. MLAF is useful in INRM for analyzing technologies and modus operandi of natural resource use. Different processes of landscape change in response to land uses that take place over different time frames are amenable to analysis by means of MLAF. Spatial comparison involving landscapes over different time frames can be mapped using MLAF as a basis.

The INRM is an approach that integrates research of different types of natural resources into stakeholder-driven processes of adaptive management and innovation to improve livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services at community, eco-regional and global scales of intervention and impact' (Thomas, 2002). In short, INRM aims to help to solve complex real-world problems affecting natural resources in agro-ecosystems. The main strategy to achieve this is to foster and improve the adaptive capacity and learning of all the involved stakeholders. To achieve full-blown INRM, there is need to overhaul the way science of NRM is practiced. According to Campbell, *et al.*, (2003), the following strategic directions will facilitate this change:

- Merging research and development to ensure a close relationship and an approach to NRM and research that is driven by actual problems and based upon shared learning from complex real-life situations at operational scales;
- Setting up a system for adapting and learning to address the constantly changing challenges of NRM in order to nurture systems that are resilient to changing pressures;
- Balancing biophysical and socio-economic sciences in the assessment of resource degradation as a shift away from geomorphology towards development studies; and
- Focusing the right type of science at the right level to enable appropriate and scale sensitive management regimes with complementarity between scales and approaches.

At both spatial and temporal scales, there is need for more explicit use of scientific approaches, and to develop tools that can link analyses from different spatial and temporal scales. The use of multi-level analytical frameworks (see example in Figure 3.14) can provide the necessary diagnostic, process and problem-solving tools.

Tools for Livelihood Analysis

Livelihood analysis seeks to identify gender sensitivities and community organization roles in natural resources use and management. It is a vital diagnostic tool component since it incorporates stakeholders who are a critical driving variable in natural resources dynamics. This approach identifies strategies of natural resources utilization adopted by rural households, problems and constraints as well as opportunities and challenges of land users. Livelihood analysis also reveals available ecological, socio-economic, socio-cultural and human potential that underpins the capacity to respond to change. Information on livelihood strategies facilitates linking resource dynamics with specific livelihood strategies, assessing the impacts of policy recommendations and targeting appropriate technologies.

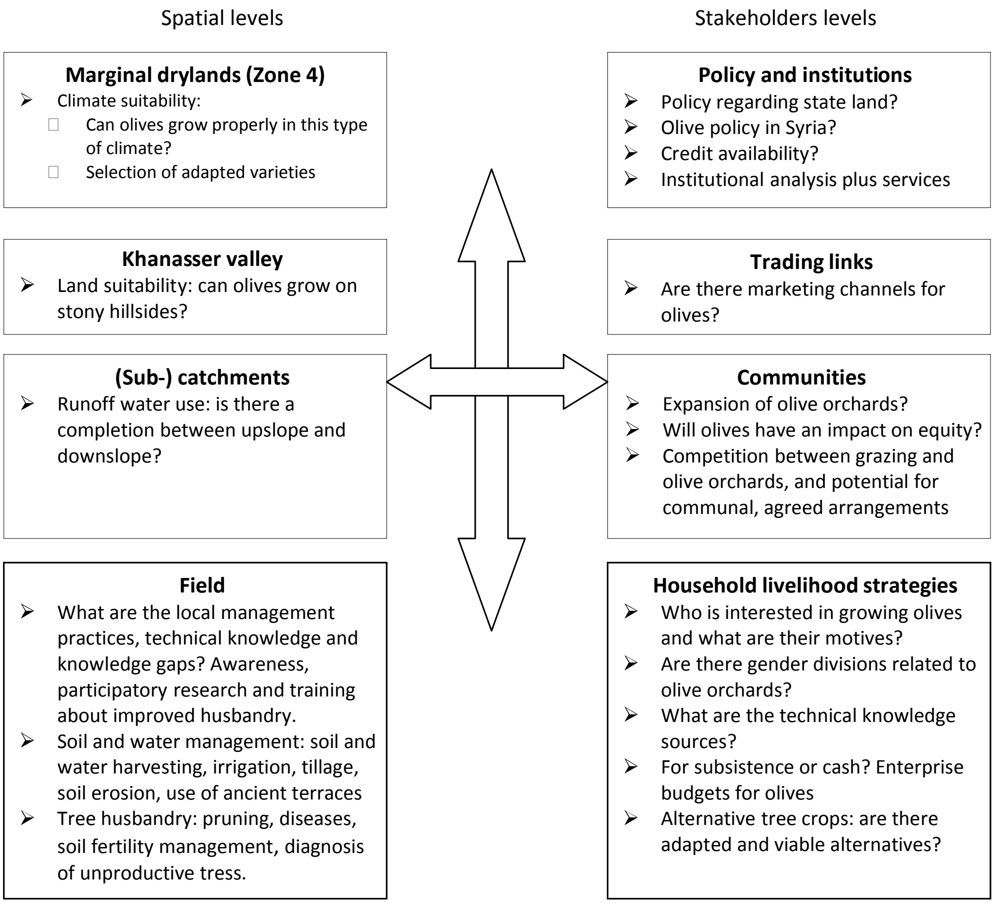

Figure 3.14: The Multi-Level Analytical Framework (MLAF) to the Management of Natural Resources

Adapted from Campbell et al., (2003)

Tools for Policy Analysis

Policy framework and institutions impact natural resource use. In some instances, existing institutions that regulate property access and property resources such as forests, water, pasture, and fisheries may inadvertently be responsible for environmental degradation. In many African countries, there are no concrete land use policy frameworks and environmental legislations to provide holistic frameworks for the use and protection of natural ecosystems. For example, in Kenya, the Environmental Management and Coordination Act, 1999 and National Land policy of 2009 does not provide adequate protection of natural resources (e.g. soil biodiversity is not addressed). Holistic frameworks focus upon diverse ecological and social contexts and must involve local people in the planning and implementation of projects linked to the use and development of land resources (Campbell, 2004).

Tools for Resources Status Analysis and Dynamics

a) Characteristics of land use potential

Analysis of land use potential reveals ecological potentials for various uses of the land such as forestry, crop agriculture, dairy farming, crop-livestock production enterprises, etc. Since the water factor in climate places important restrictions on land uses in relation to the capacity of ecosystems to support specific land use activities, detailed analysis of rainfall patterns and critical rainfall thresholds for various land use activities are important.

b) Indigenous knowledge systems and perceptions about natural resources.

Local people have developed land use strategies. Indigenous pools of knowledge, often transmitted across generations, on various aspects such as soil types, animal breeds, ethno botanical perspectives of plant materials, pharmacological utility and value of a myriad of plant species, sensitivity and resilience of plant materials to perturbations and environmental dynamics in relation to intensities of natural resources use. These information systems need to be synthesized and integrated with scientific innovations in order to broaden social acceptability and applicability of innovations arising from the joint efforts of all stakeholders in natural resources management.

c) Field assessment of physical and biological resources.

In fragile ecosystems such as semi-arid ecosystems where aridity is a pervasive factor driving ecosystem change, use of empirical models can serve as important tools for assessments of land degradation. Such models may be used to predict land degradation in scenarios where the model conditions are satisfied. Land degradation may also be evaluated by means of GPS surveillance techniques and interpretations of high resolution satellite imagery. Land cover changes may be evaluated by means of Geospatial technologies such as geographical information systems (Loveland *et al.,* 2000; Schmidt-Vogt, 2000).

It may be instrumental to use geospatial technologies in analysis of spatial-temporal flows of resources such as nutrient cycling (nutrient flows), water budgets (water flows) in order to determine sustainability of resource use. Community participatory models may also be employed to facilitate gathering of semi-quantitative data to develop scenarios of resource flows through participatory mapping, monitoring and field measurements. Resource flow analyses to determine the processes underlying biodiversity erosion, sensitivity of resources to anthropogenic pressures under different management regimes and ecological implications of anthropogenic related climate change on ecosystem integrity, soil fertility, ground water etc. may produce important data for assessment of resource resilience, resource use risk and in predictions of sustainability of resource use.

d) Holistic system analysis

Current theoretical frameworks suggest that in spite of system complexity, certain key variables often drive system complexity. These key variables are enmeshed in the socio-economic and ecological frameworks. Rainfall variability is a pervasive factor driving natural resource dynamics in dry environments. Key response variables that influence key intervention points in natural resources management are socio-economic factors that embrace population dynamics, capital differentials associated with local traditional production systems, and accessibility to markets among others.

Problem solving tools embrace technological innovations from national and international research networks; testing and screening of technological innovations and policy options under on-station and farm conditions. In order to credibly characterize the links between investments and outcomes, four key steps are suggested:

i). Participatory systems thinking approach is needed to define problems;
ii). Strong evidence-base is required to further characterise links between cause and effect (e.g. investments and outcomes);
iii). Sensitivity assessment is required to simplify relationships to the core controlling variables and identify a suite of interventions likely to achieve the desired outcomes;
iv). Impact of interventions need to be updated through a process of adaptive learning, involving follow up monitoring and modelling review.

Process and Information Management Tools for Scaling Out INRM

According to Campbell *et al.*, (2003), tools for operationalizing INRM include, among others):

1. *Systems modelling:* It enables users to understand and predict the behaviour of complex systems that are characterized by non-linearity's, time delays, and feedbacks; it also allows stakeholders from ''different sides of the fence'' to start building common concepts and language.
2. *Participatory action research with stakeholders*: Crucial adaptations of general methods cannot be achieved without feedback from our clients.
3. *Decision and negotiation support tools:* These are practical forms of system models.
4. *Multiscale databases:* Theory can only be applied with success if site- and situation-specific data are available; this is crucial for up scaling and out scaling.
5. *Impact assessment*: This is a key feature since it helps in adaptation, performance enhancement, negotiation, and allocation decisions.
6. Geographical information systems (GIS).

For decades, holistic and multidisciplinary approaches to natural resource management have been accepted in principle in scientific research, such as Farming Systems Research, Eco-regional Research, Integrated Water Resources Management (IWRM), Integrated Soil Fertility Management (ISFM), Integrated Pest Management (IPM), and Community-Based Natural Resource Management

(CBNRM) (CBNRM is exhaustively discussed in Chapter 4). Over time, these approaches evolved from being ‘‘descriptive’’ (stating how the main state variables change in time and in response to key environmental drivers) to being more ‘‘explanatory’’ (showing the underlying relations between variables and the environment of the system, and hence explaining why processes proceed as they do). Exploratory modelling (‘‘what if?’’) then becomes feasible at least in confined geographical areas. During the same period, participatory approaches gained significant momentum and it is now recognized that farmers’ socio-economic context is at least as diverse as their biophysical environment. This does not ease the development of models, which combine socio-economic and biophysical data and clarifies that any related up scaling is only possible with significant loss of information. However, the integration of different scales remains important at least from the biophysical perspective (e.g., for the analysis of offsite effects, groundwater depletion, etc), while interventions have to be client-, location-, and scale-specific.

In view of the complexity of natural resources management having technical, social, economic, institutional, and policy dimensions, the need to develop new models that have significant impacts in solving NRM problems have been recognized by Campbell *et al.,* (2003). During the last decade or so, NRM research has produced multidisciplinary approaches including eco-agriculture, integrated conservation and development, integrated watershed management and integrated natural resources management that consist of advanced tools for solving some problems associated with NRM.

It is apparent from these approaches that *management scenarios* (see details of scenarios in Chapter 6) and technologies, policies and institutional frameworks, distribution of benefits, power relations and interests may not necessarily be in balance. Risks may exceed management capacity, ecological processes may be disrupted, economic forces may outstrip conservation forces, cultural and ownership patterns associated with management may be no longer in operation. What is required in NRM is a new conceptual and overarching framework that would integrate these different tools in order to satisfy the needs of real-life NRM problems. The natural environment is so complex that simplification through abstraction is necessary to communicate concepts and relationships, to comprehend possible reactions, and to decide upon a course of action for management. Today, nearly every decision concerning the management of natural resources is based on a model of one kind or another. Modelling in Natural Resource Management offers a much-needed overview of the basic principles for understanding and evaluating models. Modelling in Natural Resource Management brings the best and most current information that is applicable on the ground and able to provide a valuable reference both for scientists involved with issues of natural resource management and for managers who apply the science to real-world problems.

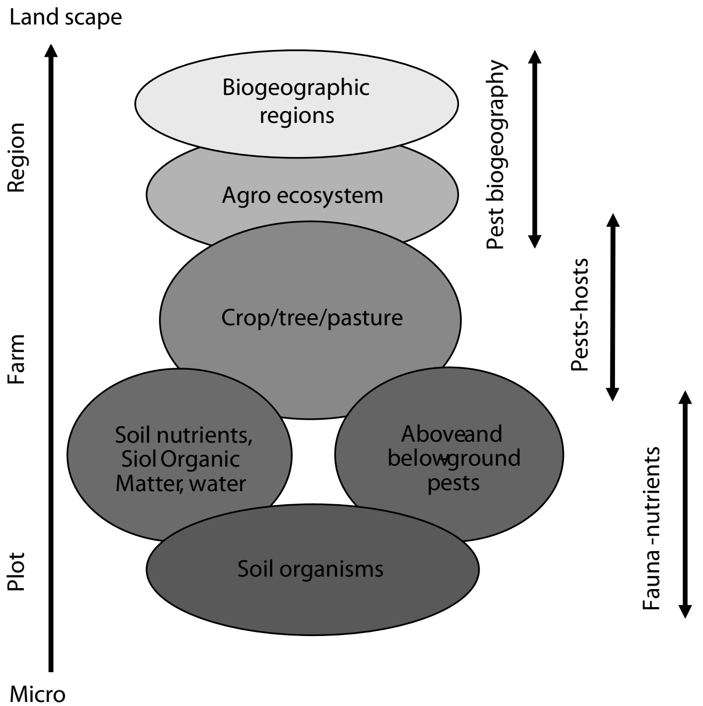

Figure 3.15: Biophysical Processes at Different Spatial Scales of Analysis

Modified from Harrington et al., 2001

Measurement tools allow us to understand cause-and-effect links, trace and even anticipate the consequences of interventions, and understand biophysical processes at any scale of analysis. Indicators of sustainability fall into this area, as do most modelling approaches. In this vein, *ecosystems analysis* provides an analytical framework that makes it easier to understand the consequences of changes in both short- and long-term states at a range of scales. The processes can be linked conceptually within a framework as shown in Figure 3.15 and the effects of given scenarios can be quantified using simulation models linked to spatial and temporal databases through GIS. Thus, at the plot level, scale changes are specific but at the landscape level, there are many factors and processes that are in play.

Most models need to be refined in the critical areas of edaphic and pest (insects, pathogens, and weeds) interactions and constraints. Ecosystems analysis can provide two critical services at relatively minor cost:

i). Assessment of both genetic and environmental productivity and sustainability and;
ii). A framework for impact assessment and the definition of problem-cause relationships, especially those involving biophysical processes, and how

those relationships affect system productivity and sustainability. INRM will fail if we do not have a problem focus and include plenty of work to identify intervention points; we cannot simply conduct academic work on measurement tools.

Obviously, putting the persons (the poor) managing agricultural and natural resources, including water, at the centre of attention and underlining the means they need to have at their disposal for improved management, emphasizes their livelihoods.

The role of integrated natural resource management in "delivering the goods," that is, in fostering improvements in the livelihoods of large numbers of the poor, is often referred to as scaling out. This phrase conceals as much as it clarifies, because the notion of "scale" is perceived in many different ways, among them:

- *Scale of analysis*: from plant, to plot, to farm, to watershed, and to region;
- *Scale of intervention point*: high-level interventions such as policy changes, adjustments in institutional arrangements or property rights, and the fostering of collective action vs. lower-level interventions such as farmer experimentation or extension for specific practices;
- *Scale of investment in intervention strategies*: small vs. large investments in extension, farmer experimentation programmes, or efforts to provide information to policy makers;
- *Scale of community empowerment*: the number of communities able to undertake their own research and adaptation through processes for local learning;
- *Scale of geographical coverage of an INRM practice*: whether it is limited to a village or watershed or has attained regional or national relevance;
- *Scale of impact:* for example, the extent to which desirable outcomes, e.g., improved system productivity and resource quality, have been achieved through INRM research.

In principle, these scales are linked. Greater impacts are generated from higher levels of investment in suitable intervention strategies, or from more efficient use of these investments through greater reliance on community empowerment, leading to expanded geographical coverage of suitable practices. The heart of scaling up is anticipating, modelling, monitoring, and assessing positive or negative externalities, unconsidered complexities, or unintended consequences that emerge at higher scales of analysis from widespread scaling out, and then contributing to the management of these factors.

Methods and Tools of Scaling Out INRM

The methods and tools discussed include site similarity analysis through GIS, the linking of simulation models with GIS, and the use of farmer and land type categories. Although, in most instances, the tools and methods show considerable promise for use in scaling out INRM practices, on-the-ground experience remains insufficient. The strengths and weaknesses of these methods and tools are presented in Table 3.1.

Table 3.1: Weaknesses and Strengths of Selected Methods and Tools for Scaling Out INRM

Tool or method	Strengths	Weaknesses
Site similarity analysis	▪ Simple tools available ▪ Conceptually accessible	▪ May oversimplify, ▪ Criteria for similarity often subjective,
Interfacing GIS with models	▪ Allows examination of time trends, including climatic risk ▪ Can express outputs in terms of specific variables of interest to stakeholders	▪ Dependent on quality of model ▪ Requires specialists to implement
Land type and farmer categories	▪ Outputs conceptually accessible ▪ Outputs suitable for use by extension workers and farmer experimenters	▪ Outputs possibly too subjective ▪ Labour-intensive data acquisition. ▪ May ignore interactions across land types within a household
Participatory extension, e.g., whole family training	▪ Outputs readily accessible to farm families ▪ Can be scaled up in terms of organizational capacity required for implementation	▪ Deals only with the family as a unit, does not extend to collective action at the community level ▪ Does not have an explicit spatial dimension

A recurring question in efforts to scale out promising interventions is how a practice developed at one location will perform over a broader range of environments. Geographic Information Systems (GIS) can address such concerns, allowing scientists to share relevant results with colleagues elsewhere, to find new sites for testing and adapting discoveries, and to design more effective research programmes (Corbett *et al.*, 1999). One simple GIS-based approach is to identify areas that are similar to a given location, using criteria relevant to the problem at hand.

INRM and Conflicts Management

In INRM, the stakeholders are very diverse, including: property owners and resource users, community based organizations, government officials and politicians; NGOs and parastatal organizations; research and development institutions including the academe; the business sectors, among others. This apparent diversity in NRM stakeholders gives rise to conflicting motivations and aspirations; if left unattended, such conflicts can border on hostilities. Chapter 4 discusses conflict management in community based natural resource management, causes and types of conflicts and strategies for conflict management.

Sources and Levels of Conflicts

Conflict over natural resources such as land, water, and forests is ubiquitous (Ortiz, 1999). These conflicts are disagreements and disputes over access to, and control and use of, natural resources. Disagreements also arise when these interests and needs are incompatible, or when the priorities of some user groups are not considered in policies, programmes and projects. People every where have competed for the natural resources they need or want to ensure or enhance their livelihoods. However, the dimensions, level, and intensity of conflict vary greatly.

According to Chenier *et al.*, 1999, conflicts over natural resources may have class dimensions, pitting those who own the resource against those who own nothing but whose work makes the resource productive. Political dimensions may dominate where the state has a keen interest in a public good such as conservation (Fisher *et al*., 1999) or in maintaining the political alliances it needs to remain in power (Suliman, 1999). Differences in gender, age, and ethnicity may inform the use of natural resources, bringing to the fore, cultural and social dimensions of conflict (Hirsch *et al*., 1999). Even the identification of natural resource problems may be contested in light of different information sources, world views, and values (Pérez Arrarte and Scarlato, 1999).

Conflicts over natural resources can take place at a variety of levels, from within the household to local, regional, societal, and global scales. Furthermore, conflict may cut across these levels through multiple points of contact. Conflicts occurring mainly in local contexts may extend to national and global levels because of their special legal relevance (Weitzner and Fonseca Borrás, 1999) or as a result of efforts by local actors to influence broader decision-making processes (Oveido, 1999). The intensity of conflict may also vary enormously from confusion and frustration among members of a community over poorly communicated development policies (Kant and Cooke, 1999) to violent clashes between groups over resource ownership rights and responsibilities (Chenier *et al*., 1999).

With reduced government power in many regions, natural resource management decisions are increasingly influenced by the resource users, who include small-scale farmers and indigenous peoples as well as ranchers, large-scale landowners, and private corporations in industries such as forestry, mining, hydropower, and agri-business. Resources may be used by some in ways that undermine the livelihoods of others. Power differences between groups can be enormous and the stakes a matter of survival. The resulting conflicts often lead to chaotic and wasteful deployment of human capacities and the depletion of the very natural resources on which livelihoods, economies, and societies are based. They may also lead to bloodshed.

It is widely believed that resource-use-conflicts are the main environmental problems and the obstacles for local and regional sustainable development due to population pressure and economic driving forces. For example, most development models of regional governments use a demand-oriented approach or market-based model to determine regional socio-economic development objectives. Such an approach is short-sighted, and may cause conflicts and disputes in natural resource use, and lead to the over-exploitation, degradation and depletion of natural resources. Therefore, a demand-oriented approach is not a sustainable development model.

Methods and Tools for Conflict Analysis

Addressing conflict is a prerequisite for sustainable natural resource management. Conflicts over natural resources are growing in scope, magnitude and intensity. If not addressed in an effective and timely manner, natural resource conflicts can adversely affect community livelihoods and result in resource degradation. Alternative conflict management offers an innovative, multidisciplinary approach to understanding, analysing and managing conflicts both before and after they occur. It seeks the development of participatory and consensus-building strategies, and it builds upon existing formal and informal conflict management mechanisms within local communities. Alternative conflict management also seeks to strengthen the capacity of local institutions and communities to manage conflict and promote sustainable resource management.

Appropriate conflict management and resolution strategies need to be incorporated into natural resource management policies, programmes and projects. Many methods and tools are available for analyzing conflicts (see Table 3.2) No single set of procedures or practices works for all situations. Nevertheless, *guiding principles* for what strategies and techniques are available, and what sort of information might be gathered are available. For example:

a) conflict analysis must be based on a wide range of views about the sources of conflict. Conflicts are about perceptions and the meanings that people attribute to events, policies and institutions;
b) conflict analysis helps stakeholders to reconsider their perspectives, which are often heavily influenced by emotions, misunderstandings, assumptions, suspicions and mistrust;
c) conflict analysis must examine the broader development context (social, economic, political) and not just consider natural resource management concerns;
d) any conflict analysis is only preliminary and must be refined and studied carefully as the process gets under way;
e) conflict analysis is not an end in itself. It is part of the process of defining and learning about the issues (capacity building). For this learning process to happen, conflict analysis must be carried out in a participatory manner. Through exchanges of information it becomes more likely that people will focus on real problems in the negotiation process. However, people are likely to be cautious about revealing some types of information, and;

f) it is important to know what is worth knowing. The type and amount of information needed from conflict analysis varies from case to case. While it is often assumed that more information is better than less, not all information may be relevant, truthful or useful.

Table 3.2: Examples of Simple, Practical and Adaptable Tools for Analyzing Conflicts

Tool	**Purpose**
Root cause analysis	To help stakeholders examine the origins and underlying causes of conflict.
Issue analysis	To examine the issues that contribute to conflict and the specific issues that give rise to a specific conflict in more detail, focusing on five categories: 1) problems with information; 2) conflicting interests; 3) difficult relationships; 4) structural inequalities; 5) conflicting values.
Stakeholder identification and analysis	To identify and assess the dependency and power of different stakeholders in a conflict.
4Rs analysis (rights, responsibilities, returns, relationships)	To examine the rights, responsibilities and benefits of different stakeholders in relation to natural resources, as part of improving understanding of a conflict. To examine the relationships among (or within) different stakeholder groups.
Conflict time line	To assist stakeholders in examining the history of a conflict and to improve their understanding of the sequence of events that led to the conflict.
Mapping conflict over resource use	To show geographically where land or resource use conflicts exist or may exist in the future. To determine the primary issues of conflict.

Analysis of the causes of conflict begins with identifying and describing the conflict, its boundaries and interrelationships. These elements may include: the origins, levels and issues of conflict; the history and chronology of events; geographical and temporal relationships; interrelationships with other conflicts; and earlier attempts to resolve the conflict.

INRM stakeholder analysis is a necessary step, to identify the most significant stakeholder, their roles and relations. A number of methods exist to decide how these should be dealt with. Manjengwa (2009) and Catacutan and Tanui (2007) present some guidelines for stakeholder engagement as follows:

a) *Master the stakeholders.* A fundamental step in engaging stakeholders in NRM is to master their nature, interests and positions. As mentioned earlier, this can be done only through stakeholder analysis and mapping. This allows for better understanding of the stakeholders' in terms of their legitimacy, power and interest on the issues at hand.

b) *Make use of existing structures.* As far as possible, avoid re-organizing structures that are already there. Analyze the strengths, weakness, gaps and improvements needed within existing working structures, and introduce new structures only where necessary - innovate, rather than re-invent.
c) *Allow time for trust building.* Trust building and relationships do not happen just magically.
d) *Ensure clarity of goals, costs and benefits.* Work towards defining a clear set of goals and identifying the costs and benefits of the engagement. Build consensus on the terms of engagement, rather than push on external rules. Making false hopes is dangerous.
e) *Transparency.* Work on maintaining transparency at all times. Coming to terms with what is available and doable at the onset is practical and beneficial to all stakeholders. Although sky is the limit, when it comes to opportunities in engaging stakeholders, it is better to be transparent about the potential constraints so that early or mid-course actions can be easily detected.
f) *Knowledge management.* Be clear about what needs to be monitored, assessed/evaluated and or documented at the onset. Stakeholder engagement is a journey of complex processes - without learning from it is a wasteful endeavour.

Conflict Management

According to Chevalier and Buckles, (1995), Conflicts are only fully resolved when the underlying sources of tension between parties are removed, a state of affairs that may be antithetical to social life. For those who view conflict as a normal and potentially positive feature of human societies, conflict should not be eliminated through "resolution" but rather "managed" so that it does not lead to violence but achieve change. In contrast to *litigation* and other confrontational modes of conflict resolution, *alternative dispute resolution* refers to a variety of collaborative approaches including conciliation, negotiation, and mediation (Pendzich *et al.*, 1994; Moore, 1996). *Conciliation* consists of an attempt by a neutral third party to communicate separately with disputing parties to reduce tensions and reach agreement on a process for addressing a dispute. *Negotiation* is a voluntary process in which parties meet "face to face" to reach a mutually acceptable resolution of the issues in a conflict. *Mediation* involves the assistance of a neutral third party, a mediator, who helps the parties in conflict jointly reach agreement in a negotiation process but has no power to direct the parties or enforce a solution to the dispute. Through alternate dispute resolution multiparty "win–win" options are sought by focusing on the problem (not the person) and by creating awareness of interdependence among stakeholders.

Although these approaches to conflict management are appealing, do the principles really work in conflicts involving natural resources? Techniques of alternative dispute resolution depend on both cultural and legal conditions, such as a willingness to publicly acknowledge a conflict, and administrative and financial support for negotiated solutions (Pendzich *et al.*, 1994). They also depend on the voluntary participation of all relevant stakeholders. These conditions are not present in many contexts in both the North and the South. Enlightened self-interest among stake holders may not be apparent or sufficiently urgent in situations involving the interests of national elites or others with coercive measures at their disposal. Alternative dispute resolution may even be counterproductive if the process only manages to get certain groups together to mediate their differences when the causes of conflict and obstacles to resolution are beyond their control. It is also critical to recognize that although negotiation, mediation, and conciliation are seen as best alternatives, people in diverse societies use other "mechanisms to handle disputes at a local level, including peer pressure, gossip, ostracism, violence, public humiliation, witchcraft, and spiritual healing".

There are several strategies that local communities, resource users, project managers and public officials can use to manage and to resolve conflicts.

Strategies for Conflict Management

Customary Systems for Managing Conflict

A vast repertoire of local-level strategies and techniques for managing and resolving conflicts regarding natural resources has evolved within communities. There are many cross-cultural similarities – negotiation, mediation and arbitration are common practices, as are more coercive, as mentioned earlier, measures such as peer pressure, gossip, ostracism, supernatural sanctions and violence. Customary natural resource conflict management strategies have both strengths and limitations.

Table 3.3: Strengths and Limitations of Customary Natural Resource Conflict Management Strategies

Strengths	Limitations
Encourage participation by community members and respect local values and customs.	Have been supplanted by courts and administrative laws.
Are more accessible because of their low cost, their flexibility in scheduling and procedures, and their use of the local language.	Are often inaccessible to people on the basis of gender, class, caste and other factors.
Encourage decision-making based on cost, their flexibility in scheduling and from wide-ranging discussions, often fostering local reconciliation.	Are challenged by the increasing heterogeneity of communities due to cultural change, population movements and other factors that have eroded the social relationships that supported customary conflict management.
Contribute to processes of community empowerment.	Often cannot accommodate conflicts between communities or between a community and the State.

National Legal Systems

National legal systems governing natural resource management are based on legislation and policy statements, including regulatory and judicial administrations. Adjudication and arbitration are the main strategies for addressing conflicts. However, some national systems take into account legal systems based on local custom, religion, ethnic group or other entities.

Table 3.4: Strengths and Limitations of National Legal Systems

Strengths	Limitations
Are officially established with supposedly well-defined procedures.	Are often inaccessible to the poor, women, and marginalized groups and to remote communities because of cost, distance, language barriers, political obstacles, illiteracy and discrimination.
Take national and international concerns and issues into consideration.	May not consider indigenous knowledge, local institutions and long-term community needs in decision-making.
Involve judicial and technical specialists in decision-making.	May involve judicial and technical specialists who lack the expertise, skills and orientation required for participatory natural resource management.
Result in decisions that are legally binding.	Use procedures that are generally adversarial and promote a winner-loser situation.

Alternative Conflict Management

The multidisciplinary field of alternative conflict management addresses natural resource conflicts through promotion of joint decision- making. It arose in part as a response to the adversarial style of managing conflicts used by legal systems. The field also draws upon conflict management strategies long relied upon by communities in settling their disputes. Practitioners use methods such as negotiation and mediation to help parties reach a consensus. The goal is to seek long-term mutual gain for all stakeholders.

Specifically, alternative conflict management interventions aim to:

i). Improve communication and information sharing among interest groups; address the causes of conflicts in a collaborative manner;
ii). Transform the conflict management process into a force;
iii). Promote positive social change;
iv). Build the capacity of communities to manage their conflicts; and
v). Limit the occurrence and intensity of future conflicts.

While alternative conflict management usually addresses specific latent and manifest conflicts, it supports broader changes in society to address the root causes of conflict. Table 3.5 summarizes the strengths and limitations regarding natural resource conflicts. Alternative conflict management is gaining popularity, due in part to its capacity to address – in a participatory and consensus-building manner – complex situations with many stakeholders. For such an approach to work effectively, conflict management procedures need to be considered from the earliest stage, and stakeholder consultations need to be thorough.

Table 3.5: Strengths and Limitations of Alternative Conflict Management Interventions

Strengths	**Limitations**
Promote conflict management and resolution by building upon shared interests and finding points of agreement.	May encounter difficulties in getting all stakeholders to the bargaining table.
Involve processes which resemble those already existing in most local conflict management systems, including flexible and low cost access.	May not be able to overcome power differentials among stakeholders, so that vulnerable groups such as the poor, women and indigenous people remain marginalized.
Foster a sense of ownership in the solution process of implementation.	May result in decisions that are not legally binding.
Emphasize building capacity within communities so local people become more effective facilitators, communicators, planners and handlers of conflicts.	May lead some practitioners to use methods developed in other countries and settings without adapting them to local contexts.

The case of Mt Elgon presented in Box 3.1 describes some issues in stakeholder engagement with deep historical conflict over natural resources.

Box 3.1: Mt. Elgon National Park and the Benet

The Benet, traditionally hunters and gatherers have resided in the forests and Moorlands of Mt. Elgon National Park in eastern Uganda for a long time. Shifting conservation policies, informal acceptance of Benet residence and use of protected area resources under British rule and forced exclusion from the park, have created tensions between the people and protected area officials. In addition, official fines, and excesses committed by local level protected area officials have exacerbated the conflict. Negative conceptions of each party prevailed. The Uganda Wildlife Authority (UWA) officials treated the Benets as encroachers and the Benet considered the UWA officials as having an interest only on trees and animals.

The history of the Benet's marginalization from their traditional resource base led them to pursue a legal resolution to resolve the conflict at the national level. A court case was passed to seek reinstatement of Benet land rights. A first gesture of reconciliation was initiated by the Kapchorwa District Land Care Chapter (KADLACC) and its supporting institution, the African Highlands Initiative (AHI). Identifying the stakeholder, to work with closely, at the initial stage was problematic - the issue was so sensitive that any wrong move could easily spark a fire between the two parties. KADLACC officials started with identifying allies and lobbying with both parties. Through constant communication and negotiation, the impasse was unlocked by focusing on "interests" rather than "positions" within Mt. Elgon. Later, both parties agreed on certain "bottom line", that is, "biodiversity conservation" in Mt. Elgon.

The lesson learned is that, conflict among stakeholders can be reduced if each party concedes something to the other, in the spirit of reconciliation and collective good. In this case, KADLACC has served as the honest broker and negotiator. Finally, KADLACC learned that effective stakeholder engagement can be done by breaking communication barriers and by making "common interest" more explicit between parties, rather than what one holds in society.

Source: Tanui 2007

Mitigation and Adaptations Strategies in INRM

The terms *mitigation* and *adaptation* are strategies that can be applied in Integrated Natural Resource Management (INRM). The concept of adaptation for instance can be used to describe how systems, both natural and human, evolve over time when faced with environmental changes. Most spontaneous or autonomous adaptations have taken place as part of the evolutionary processes through which biotic communities have migrated or modified their structures and functions in order to accommodate shifts in temperatures, rainfall, available nutrients and habitat. Similarly, in the face of climate change, the global community, nations and local communities are undertaking action along two primary tracks: mitigation – the process of reducing greenhouse gas emissions and, thereby, associated climate change; and adaptation – the process of adjusting in response to, or in anticipation of, climate change. In anticipation of foreseeable shocks, vulnerable communities have long employed adaptive measures. Today, adaptation is considered a central element in societies' efforts to cope with the expected shocks and climatic shifts associated with climate change.

The conservation of natural systems is critical for disaster risk mitigation: *Conservation is "imperative":* the conservation of nature to reduce vulnerability to disasters may present one of the greatest and most-consistently under-valued natural services provided by biodiversity. The protective value of ecosystems may exceed income from the use of their resources. Ecosystems' protective services, such as the prevention of erosion, floods, landslides, avalanches, cyclones and other natural and unnatural disasters, deserve far more attention when it comes to assessing their value. For example, the loss of vegetative cover on steep hillsides contributes to runoff and slope failure due to the loss of stabilizing root structures. Trees in a mixed forest also catch snow and hold it, preventing avalanche. The draining of swamps and clearing of mangrove wetlands may disrupt natural runoff patterns and magnify flood hazards. Local clearing of cover vegetation can prolong dry periods, changing the reflectivity of the land surface and accelerating soil loss. Paving of surfaces decreases infiltration and increases runoff, exacerbating the impacts of high rainfall events on river flow regimes. River levees that are built to provide flood protection can destroy riparian habitat and heighten downstream floods. Forest fire suppression may increase the magnitude of fires, when they escape control, and the replacement of traditional forms of multicrop agriculture by monocrop practices may increase farmers' vulnerability to climate related extremes. Some of the natural resource management tools that could be useful in addressing vulnerability to climate change, and which have been applied as drought-proofing and/or anti-desertification techniques around the world include:

- *Soil Management:* This approach for increasing the stability and productivity of soil is a general term that involves a range of specific techniques such as *fallow cycling, forest buffering, selective planting, managed grazing*, etc. Soil management is recognized as central to combating desertification;
- *Water harvesting technique:* Around the world, this approach has many variants – from the construction of johads (earthen dams) in Northwest India, to rooftop collection in the Caribbean, to the forest zai in West Africa – and many champions. Water harvesting techniques have been used as a drought proofing tool to increase water available for households, irrigation, as well as baseline water flow for watershed restoration. (In Western Sudan, for instance, the trunk of the *Adansonia digtata* tree is used for water harvesting, purification and storage);
- *Windbreak Construction* - As wind erosion contributes significantly to the process of desertification, a number of environmental management methods have been applied, both through formal desertification projects and autonomous activities of farmers, to reduce its effect. Replanting of indigenous trees and shrubs for windbreaks, as well as ridging, mulching and rock bunds, are but a few methods;
- *Intercropping* - The technique of planting selected food crops within stands of trees (e.g., in the case of Sudan, gum Arabic stands) can provide local communities with added food security and income through livelihood diversification, while at the same time reducing deforestation and desertification;
- *Adaptation through Conservation:* The potential for targeted natural resource management to play a key role in the toolkit of disaster mitigation and adaptation strategies is based on the range of benefits hypothesized: reduction in vulnerability, biodiversity conservation, enhanced livelihood security among the poorest and most vulnerable, and greater carbon sink capacity. Conservation of natural resources in support of livelihoods can address the needs of the poorest and most vulnerable, in contrast to large-scale structural adaptation strategies;
- *Biodiversity*: This provides many direct benefits, including the natural resource base essential for many livelihoods, genetic material for breeding and new medicines, aesthetic beauty, and tourism revenues. Moreover, according to the World Resources Institute, "the diversity of species undergirds the ability of an ecosystem to provide most of its other goods

and services. Reducing the biodiversity of an ecosystem may well diminish its resilience to disturbance, increase its susceptibility to disease outbreaks and decrease productivity". In addition to directly providing livelihoods, therefore, biodiversity is important in ensuring the long-term viability of natural buffer systems in the face of disaster;

- Adaptation measures focused on enhanced natural resource management can also more effectively benefit the poor than large-scale structural measures. It is the poor who are most dependent on natural resources, both directly for their livelihoods, and for succour during times of crisis. It is also the poor, who live on marginal lands and in vulnerable locations, who would benefit most directly from enhanced resource management. Coping strategies typically employed in the wake of a disaster include changing the mix of livelihoods, creating new livelihoods, seeking new sources of resources (by force of arms or otherwise), and migrating. The poor usually have the least choice among strategies, receive the least assistance from government authorities and are therefore most dependent on the state of the environment for providing alternative livelihoods. Thus, investing in the natural resource base that sustains their livelihoods may have a direct positive impact on their immediate lives and long-term resilience to climate variability;
- A number of environmental management-based adaptation activities can also serve as *mitigation* measures. For example, sustainable rangelands management activities have in the past been employed in a number of countries in Africa to combat desertification. In order to mobilize the economic potential of natural resources for the benefit of the entire population, a framework of good local governance and an assured involvement of civil society and the private sector is needed. The work of Inter-cooperation in natural resources management aims at a balance between production and protection for the benefit of the poor. Short-term needs of increased production have to be reconciled with longer term conservation interests.

Integration of Technology and Indigenous Knowledge in INRM

According to World Bank, (1998), Indigenous Knowledge (IK) is used at the local level by communities as the basis for decisions pertaining to food security, human and animal health, education, natural resources management, and other vital activities. IK is a key element of the social capital of the poor and constitutes the main asset in their efforts to gain control of their own lives. For these reasons, the potential contribution of IK to locally managed, sustainable and cost-effective survival strategies should be promoted in the development process.

Indigenous institutionsindigenous appropriate technology, and low-cost approaches can increase the efficiency of development programmes because IK is a locally owned and managed resource. Building on IK can be particularly effective in helping to reach the poor since IK is often the only asset they control, and certainly one with which they are very familiar. Utilizing IK helps to increase the sustainability of development efforts because the IK integration process provides for mutual learning and adaptation, which in turn contributes to the empowerment of local communities. Since efficiency, effectiveness, and sustainability are key determinants of the quality of development work, harnessing indigenous knowledge has a clear development business case. Early indications point to significant improvements in development project quality if IK is leveraged with modern technologies.

Participation by the local community in development initiatives such as decision making and policy planning processes is critical for achieving sound natural resource management to utilize the full potential of IK systems. IK plays an important role in sustainable management of natural resources and can also have an impact on issues of global concern. However, sustainable development may be served better by a system that incorporates both indigenous and scientific knowledge systems which means integrating information collected from farmers with scientific information and technology as demonstrated in Figure 3.16.

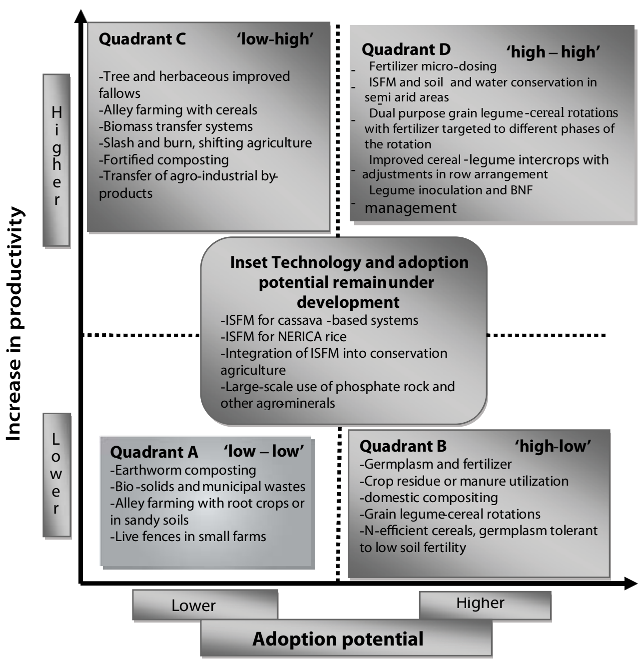

Figure 3.16: The Relative Adoption Potential and Contribution to Soil Fertility Enhancement for Various Tested Soil Fertility Management Interventions.

Source: Sanginga and Woomer, 2009

Different soil fertility management technologies may be grouped in terms of effectiveness and potential for widespread adoption:

- Technologies appearing in Quadrant A have reduced potential in terms of their productivity gains and adoption by small-scale farmers;
- Technologies in Quadrant B are attractive to small-scale farmers but usually do not result in farm-level benefits. Use of low quality crop residues or insufficient and improperly handled livestock manures in absence of mineral fertilizers provides too few nutrients for substantial gains in field crop production;
- Practices in Quadrant C have proven abilities to increase nutrient supply and improve both crop productivity and nutrient use efficiency, but they remain unattractive to farmers for a variety of reasons;
- However, the technologies capable of delivering rapid benefits to large numbers in sub-Saharan Africa are presented within Quadrant D. Fertilizer micro-dosing involves spot placement of fertilizers, sometimes timed to rainfall in split applications. In semi-arid areas, ISFM practices may be strategically combined with water harvesting, usually through the creation of mini-catchments within the field. Combining cereal and grain legumes through rotation, intercropping and relays and providing these crops with strategically applied mineral fertilizers and organic inputs are a key to ISFM and food security in Africa. In the case of crop rotations, additional information is required on optimal crop sequencing and for crop intercropping, adjustments must be made in row spacing, orientation and crop combinations. In many cases, biological nitrogen fixation by field legumes can be increased through inoculation with elite strains of their microsymbiont rhizobia made available to the host through improved delivery systems.

Documentation

The documentation and mapping of indigenous knowledge and traditional knowledge helps to preserve and honour knowledge held by local people whose ancestors have long inhabited a region, or people who are new to a region and bring their own traditions to a new community. Proper storage and management of such knowledge must be ensured if the information is to be made available and accessible for quick analysis and manipulation to all those who need it, e.g., planners and decision makers involved in the management of land resources. Programmes involving the integration of GIS and IK have for the most part been used within natural resource management projects where increased food or income source choices for communities and effective participation in benefits are the main goals (Mbile *et al*., 2003). GIS technology is an important decision-making tool for Natural Resource Management used to also address the problems associated with the storage, analysis and processing of indigenous information. It is also employed in the integration of scientific and indigenous information.

Many researchers have integrated indigenous knowledge into GIS for various purposes. Though almost all approaches are participatory in nature, the application has differed according to the needs and objectives of the project or the community where such an approach is used. Waldron and Sui (1999) have described the use of GIS for integrating indigenous knowledge for land suitability analysis. Gonzalez (1995) used participatory approaches for integrating IK into GIS for natural resource management. All the approaches adopted by researchers for integrating GIS and indigenous knowledge for natural resource management have been participatory in nature involving local inhabitants (Tipathi and Bhattarya, 2004). Participatory GIS is widely used for community mapping or for participatory resource mapping with little variation in techniques and participatory tools used by different researchers (Tipathi and Bhattarya, 2004). In Uganda, the Indigenous Knowledge has been integrated in national programmes (Case Study 3.4).

Case Study 3.4: Utilization of IK in Agriculture and Health sectors in Uganda

In July 1999, the Uganda National Council for Science and Technology (UNCST) initiated a study, supported by the World Bank, to explore the potential of utilizing IK in the agriculture and health sectors. This was the basis for a national workshop involving policy makers, scientists, development practitioners, NGO and CBO representatives, traditional healers, and farmers to draft a national strategy and framework for action. This was the genesis of the Kampala Declaration on Indigenous Knowledge for Sustainable Development.

The Declaration urges the government to support the development of IK and planners to include IK in the national planning process. The strategy is to be implemented in several ways, such as including IK in Uganda's Poverty Eradication and Action Plan (PEAP). The World Bank has provided an Institutional Development Fund (IDF) grant to support the development of a National Centre for Indigenous Knowledge and the incorporation of IK into the operations of the health and agriculture ministries. A Steering Committee monitors the implementation process. The National Agricultural Research Organization has drafted a plan to incorporate IK in its activities.

(The National Agricultural Research Organization, 2001).

Technological Intervention in the Natural Resource Management practices as implemented by resource managers such as farmers, communities, fishers, and forest dwellers are typically complex. Rules governing the use of land and water resources or forest or fishery stocks are usually complicated and difficult for outsiders to understand. However, intervention points, including new technologies or practices for resource use, can be relatively simple. Interventions are usefully seen as options or alternatives for exploration by resource users, who can best judge the attractiveness of an option by testing it under local circumstances.

Even for simple interventions, however, the consequences of widespread adoption can be hugely complicated. The introduction of relatively simple options can significantly change farming or resource management systems and their accompanying biophysical processes and system outcomes. For example, farmers who deal with irrigated crop systems use complex practices to manage soil fertility and water quantity and quality. These include managing crop residues, fertilizers, and farmyard manure; arranging for biomass transfer from outside the farm; choosing alternative fuels for household use; deciding among alternative uses for canal and tube well water; making decisions related to the timing and frequency of irrigation; and selecting crops for well-drained vs. poorly drained areas, among other things (Fujisaka, *et al*., 1994).

However, the introduction of a relatively simple practice such as zero-tillage crop establishment can improve the timeliness of sowing, increase the efficiency of water and nutrient use, reduce water pumping, stop groundwater depletion, reduce fuel use, drastically lower carbon emissions, change crop rotations to take advantage of the earlier grain-crop sowing, and change soil chemistry and soil health via new rotations (Hobbs and Morris, 1996). Some of these consequences, e.g., changes in the quality and quantity of groundwater, may become apparent only at higher scales of analysis. A good understanding of ecological, biophysical, economic, and social processes is needed to anticipate, model, assess, and manage such changes. Otherwise, farmers and scientists alike can only react to changes as they unfold.

Summary and Conclusions

In this chapter, it has been shown that INRM is the result of an evolution of learning from experiences with many participatory development planning and researched approaches. INRM is an approach to research and development that builds the capacity of communities and other natural resource managers to manage change in sustainable ways. The historical evolution of INRM school of thought reflects developments in the research, development and innovation processes. INRM acknowledges that natural resources and ecosystems are inherently indeterminate and complex entities, involving the interactions and co-learning of a network of actors, of which communities and researchers are just part. The focus of INRM is that of a shift from resource accountability to supporting learning and adaptive management of all the stakeholders and components involved in managing an ecosystem or natural resource.

The natural resource components such as biodiversity, water, air, soil etc. are interrelated and impacts on one component affects the other components. Similarly, Natural Resources Systems are holistic and impacts at any point in the system create chain interactions that determine ecosystem health. Human beings depend on the exploitation of natural resources for subsistence and income. Therefore, management interventions must take cognizance of the inter-relatedness of the natural resources usage. Natural resource management is congruent with the concept of *sustainable development,* a scientific principle that forms a basis for *sustainable* global land management and environmental governance to conserve and preserve natural resources. Natural resource management specifically focuses on a scientific and technical understanding of resources and *ecology,* and the life-supporting capacity of those resources.

Integrated Natural Resources Management helps in solving complex real-world problems affecting natural resources in order to improve livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services. Natural resources management remains complex and specific to the (local) context and therefore, requires tailor-made research and development approaches. However, any natural resource management interventions must take cognizance of the interrelatedness of various components of natural resources. Hence, natural resources should be managed in such a way that human demands and use levels are permanently kept within the bounds of the resources' natural reproduction rate. INRM that integrates multiple disciplines across spatial and temporal scales and involves stakeholders in key decisions will probably be more effective than the single-disciplinary management approaches.

INRM is of prime importance for ensuring sustainable use and conservation of natural resources. Use of INRM to tackle land degradation and other environmental problems calls for people-centered initiatives and participation of all stakeholders. INRM is a strategy that may be implemented at different scales on the different components, by various stakeholders and across several disciplines. The strategy may appear to require a lot of research but this is not exactly so. It is equally relevant and significant for farmers, communities and development agents. Research in INRM should be redirected toward enhancing adaptive capacity by incorporating more participatory approaches, by embracing key principles such as multi-scale analysis and intervention, and by the use of a variety of tools. Measurement tools allow us to understand cause-and-effect links, trace and even anticipate the consequences of interventions, and understand biophysical processes at any scale of analysis. Resource-use-conflicts are the main environmental problems and the obstacles for local and regional sustainable development due to population pressure and economic driving forces and can be only fully resolved or managed when the underlying sources of tension between parties are addressed.

INRM should incorporate both indigenous and scientific knowledge systems. This means integrating information collected from farmers with scientific information and technology. Indigenous knowledge plays an important role in sustainable management of natural resources and can also have an impact on issues of global concern.

Learning Activities

Learning Activity 3.1

Despite the high prevalence of research projects in Africa, the impacts of research results are still below expectations in many farming communities. Discuss the factors that limit the application of research results and their implementation in African communities.

Learning Activity 3.2

An international non-governmental organization has agreed to fund a project that aims to rehabilitate a heavily degraded watershed. Design a project that outlines the existing natural resource management challenges, and propose viable interventions that can be implemented to reverse the degradation trend.

Learning Activity 3.3

Describe the socio-economic factors that limit the adoption of INRM practices in Africa and explain how adoption rates can be improved.

Learning Activity 3.4

The inclusion of communities in the management of state owned or formerly state owned forest resources has become increasingly common in Africa in the last decades.

i) Citing a case of any country, Describe the processes of institution Participatory Forest management (PFM)

ii) Discuss the essentials of using PFM as a means of reducing poverty

Revision Questions

1. Discuss the concepts and principles of integrated natural resource management processes.
2. Explain how natural resources interact within and among themselves and how their management and interaction relate to people and their livelihoods.
3. Why is the management of natural resources of greater societal concern today than it was 100 years ago?
4. What are the positive and negative effects of managing natural resources using the integrated approach?
5. Describe some of the Methods and Tools for scaling out INRM.

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Community-Based Natural Resource Management

V. O. Wasonga, D. Kambewa and I. Bekalo

Introduction

The preceding chapter discussed integrated approach to Natural Resource Management. The central question in Integrated Natural Resource Management is how humans should participate in the planning, allocation and management of natural resources together to reconcile ecosystems and for development interventions. This chapter provides an in-depth presentation of this scenario under Community-Based Natural Resource Management.

Community-Based Natural Resource Management (CBNRM) has numerous definitions based on both process and strategy. According to Armitage (2005), CBNRM is a mechanism that addresses both environmental and social-economic goals and, therefore, balances the exploitation and conservation of valued ecosystem components through some degree of devolution of decision-making, power and authority over natural resources to communities and community-based organizations. This definition is based on the role of communities in natural resource management and participation in the development of conservation initiatives and projects. Josserand (2001) defines CBNRM as the joint management of resources by a community, based on a community strategy, done in partnership with other legitimate stakeholders. This implies that the community plays an active role in the management of natural resources, not because it asserts sole ownership over them, but because it can claim participation in their management and benefits for practical and technical reasons. Central to all these definitions is the element of long-term sustainability through broad participation of community members and resource users in decision-making (Zanetell and Knuth, 2004; Soeftestad, 2006).

The CBNRM approach has been used to correct mistakes in cases where Governments have excluded communities in the management of natural resources. For decades, Governments categorized natural resources with some attaining 'protected areas' status while others remained under communities. Both the disenfranchisement of communities and lack of proper management have led to degradation, and in some instances, loss of resources. Some natural resources that received 'protected' status have been ruined because Governments do not have the support of the communities and often because they are financially unable to sustain management of these resources. As an approach, CBNRM has been conceptualized by multiple actors including bilateral donors, the World Bank, international Non-Governmental Organizations (NGOs) and National Governments as a way of achieving sustainable use of natural resources and economic development while improving quality of environments. There are various reasons why the CBNRM approach has gained support and publicity. At the centre of these are the reasons that the approach empowers communities, transfers ownership of resources to communities, ensures sustainability of natural resources and provides a myriad of benefits to the communities.

Since the mid 1980s, extensive scholarship has challenged Garret Hardin's earlier assumption that the users of a commons were trapped in inexorable tragedy and unable to engage in sufficient collective action to extract themselves from drastic overuse and destruction. There is now a plethora of studies that suggest that local users themselves can and have constructed institutions to use their resources sustainably (Baland and Platteau, Berkes, Hanna, Folke and Mäler, Ostrom etc). Empirical studies have found both success and failures for all broad types of resource ownership regimes: private property, common property and government property. The evidence points to the argument that simple blue print solutions imposed externally are not the answer to resource management problems and other central problems of development.

This Chapter demystifies the concept of CBNRM and its fundamentals in order to understand the underpinning principles, ideals, application and benefits. Thus presenting, concepts and the underlying theories, frameworks, strategies and methods in the CBNRM approach.. Case studies and examples from sub-Saharan Africa are provided to show how CBNRM approach is designed and executed. It also presents the benefits of CBNRM, the mechanisms for conflict management in CBNRM, and the role of indigenous knowledge in CBNRM. The Chapter is divided into interrelated sections. In the introduction, an overview of the CBNRM approach is provided to set the stage for the entire chapter. The next section presents concepts and principles of CBNRM. The third section deals with theories and frameworks of CBNRM. The other sections include approaches to CBNRM; designing, and implementing CBNRM projects; benefits of CBNRM approach; conflict management in CBNRM; role of indigenous knowledge in CBNRM; and a summary of the chapter; in that order. After each section, learning activities are provided to help the reader reflect on the key issues covered in the chapter. At the end of the chapter, review questions are provided for the reader to assess his/her understanding of the subject. References for further reading are provided.

The overall objective of this Chapter is to enhance the reader's understanding and appreciation of the role communities play in Natural Resource Management (NRM). Specifically, the chapter seeks to:

- Equip the reader with the underlying concepts, theories and principles of CBNRM;
- Provide the reader with various approaches including methods and tools for effective implementation of CBNRM;
- Expose the reader to emerging issues of conflicts management and indigenous knowledge in CBNRM;
- Impart knowledge and skills to enable communities to take the lead role in natural resource management.

The reader will then be able to:

- Explain concepts, theories and principles that underpin CBNRM, thereby guide practitioners and policy on CBNRM.
- Guide various processes in community participation in natural resource management including approaches, design and conflict management in CBNRM projects.
- Identify and analyze indigenous knowledge relevant to CBNRM and how this knowledge can be applied to improve the NRM.

Concepts and Principles of CBNRM

Chapter 2 gave a fuller description of NRM concepts. Before discussing the concepts and principles of CBNRM, however, it is essential to gain some basic understanding of key terminologies that will be used frequently in this chapter. These are:

- *CBNRM:* Joint management of resources by a community, based on a community strategy, done in partnership with other legitimate stakeholders;
- *Community:* A group of people bounded by geographical links, such as a village, settlement or district, politics or natural boundaries but also includes those brought together by lifestyle, culture, religion, hobby and interest;
- *Co-management:* A situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area, or a set of natural resources;
- *Institutions:* Sets of rules or humanly devised constraints that shape human interaction;

- "Local" or "traditional"or "Indigenous" knowledge: Matured long-standing traditions and practices.

The Rationale for Community-Based Approach in NRM

The history of NRM and conservation demonstrates a preference for programmes and strategies that alienated rural communities from the resource on which they subsisted. For example, colonization by Europeans in the 18th and 19th centuries, and the accompanying spread of conservation practices, did not respect the then existing traditional rights. The colonial models were based on American approach of pristine wild areas set a side for human enjoyment and fulfilment and was encouraged by concerns about the depletion of wildlife, timber, and other valuable resources. Ownership of land was gradually transferred from the traditional local authorities to the state in order to enable colonial authorities to exploit African lands, labour and resources. This shift in property rights regime became one of the main drivers of African independence movements seeking to recover entitlements to land and resources (Roe *et al.,* 2009).

Ironically, the post-colonial governments inherited the heavily centralized control and exploitation of natural resources, thereby disenfranchising local communities from management of natural resources These resource conservation strategies, mainly characterized by top-down approaches, generated conflicts between rural communities and conservation agencies because the indigenous rural economies were directly linked to the same natural resource base. This led to resentment and apathy by rural communities towards any conservation attempts and consequently a trend of declining natural resources.

Since 1980s, there has been a shift from the predominantly preservationist and state-driven strategies of natural resources management to a collaborative management approach with the rural communities. This shift in conservation paradigm to a more integrated approach was informed by the failures that characterized the top-down resource management approaches. It recognized the need to promote involvement and empowerment of rural communities by linking their economic and social development to natural resources management. The search for these vital linkages brought about the concept of community-based natural resource management programmes, which have been implemented across Africa.

Many governments have adopted a participatory approach to conservation as a result of pervasive loss of wildlife species and the challenges of a "fences and fines" approach (Wilfred, 2010). In Namibia, community-based wildlife conservation was pioneered in the mid-1980s in response to poaching, particularly of elephants and black rhinos. A community game guard programme contributed to addressing this problem and this was supplemented by experiments in wildlife tourism to generate income for local people and provide an additional economic incentive for conservation (Nelson *et al.,* 2009).

The three pillars identified by Murphree (2008) answer the question, "Why CBNRM?" The successes of a CBNRM project should be attested in:

i). Sustainable conservation;
ii). Benefits to the community and governing agencies;
iii). Empowerment of the community to manage their own resources; and
iv). Transfer of ownership of natural resources to the community.

The case study in Box 4.1 demonstrates how sustainable conservation of forests has been achieved through devolution of management to the surrounding communities in Tanzania.

Box 4.1: Devolution: A Case from the Forestry Sector of Tanzania

The devolution of management of Duru-Haitemba, Mgori and Shume-Magamba forests in Tanzania to the local communities was a World Bank CBNRM initiative. At the time if intervention, the three forests were in the process of diminishment in area, quality and utility. The causes were consistent rampant over-use of resources, much of which was illegal. A good proportion of the damaging activity was being implemented or indirectly supported by the very agents of state (foresters, officials and local leaders) in whose trust the protection and management of the forests was placed. The process of devolution involved a socio-political dialogue between Government Foresters and the villagers sharing boundaries with the forests. A final decision was reached that the communities take on as the controlling authority and that all Government Forest Guards are removed from the forest, to make way for full community-based custody.

The establishment of community-based management in the three case forests broadly led to similar effects. Firstly, degradation was dramatically slowed, with a sharp decline in damaging utilization. On their part, local users had no vested interest in over-using the resource, which is in effect, recognized as their own. The adoption by communities of full protection responsibility, and the fact that they had been able to do this much more extensively and effectively than state officials, rapidly closed illegal exploitation. Secondly, practical 'management' greatly improved because the forest-managing villages are able to field large numbers of patrolmen from their membership and in accordance with the demands of locality and season. As a result, the actual area of forest inspected on a regular basis has multiplied manifold. Some communities undertook direct rehabilitation of springs, repaired forest roads, closed off cattle tracks, or re-planted the major denuded areas of 'their' forests in a manner which Forest Officers have neither had the resources nor incentive to carry out. Thirdly, a workable and sustainable approach to resource management emerged and because both state and people were winners, the approach eliminate much of the conflicts which drove encroachment and degradation of the resource in the first, instance, and through a process which is uncomplicated and cost-free to the state. The forest-adjacent communities have gained control over resources of more direct importance to themselves than anyone else.

Source: Liz (1998)

The central lesson of this case study is that successful community-based resource management requires a transfer of power to the community, beyond just the right to use certain products of the forest, or invitation to participate in forest management.

Conceptual Framework of CBNRM

All CBNRM programmes are based on a conceptual framework, a theory that explains why a system is in the state it is, and how changes can be made. Conceptual frameworks constitute the fundamental building blocks of CBNRM programmes, and the effectiveness of a programme can be often directly linked to the validity of the framework. In any CBNRM programme, evaluation of conceptual framework is imperative for conservation and development to evolve and improve as a field. For example, a common feature of most, if not all, community based wildlife management conceptual frameworks is that "local people will have little interest in conserving wildlife if it doesn't have economic value. So if we give wildlife economic value, local people will be interested in protecting wildlife."

According to Thakadu (2003), CBNRM is based on the following key notions:

- All citizens share an interest in conservation of natural resources as their livelihoods are closely linked to natural resources;
- The people best placed to conserve and manage the resources are those living with and using the resources;
- The people that are likely to lose the most when it comes to negative changes in natural resource dynamics are those living with or closest to natural resources and therefore, given proper tools and incentives, are those most likely to conserve the natural resources;
- For sustainable and effective natural resource management, the benefits derived from management must outweigh the costs of conservation;
- For communities to effectively contribute to sustainable management of natural resources, they have to be supported and empowered;
- People will only conserve and manage what they perceive will make a positive contribution to their quality of life.

The term CBNRM is used in this chapter as an umbrella term that includes "co-management", "collaborative management" and "community management". Borrini-Feyerabend in his book defines co-management as “a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources” (Borrini-Feyerabend, 2004). She further refers to co-management in other terms such as participatory management, collaborative management, joint-management, mixed, multi-party or round-table management. In community management, local communities sustain and conserve valuable resources through developing and agreeing to shared rules that limit and regulate resource uses through their own self governance arrangements (Roe *et al.*, 2009). Establishment of Wildlife Management Areas (WMAs) on village lands in Tanzania that has led to benefit sharing between communities and local authority is an example of collaborative management of natural resources.

More recently, adaptive co-management, where institutions and individuals learn and work together and flexibly adjust their management strategies in response to new information, has emerged as a complementary concept to CBNRM. Adaptive co-management blends the adaptive management and collaborative management narratives and represents a potential innovation in natural resource governance under conditions of change, uncertainty, and complexity (Plummer and Armitage, 2007). As observed by Borrini-Feyerabend (2000), adaptive management approach acknowledges lack of unequivocal and definitive knowledge of the ways in which ecosystems work, and the uncertainty that dominates our interaction with them. It emphasizes cooperative governance, learning, adaptability and capacity development as opposed to CBNRM, where the emphasis is often on rights and power relations. While these concepts may represent slightly different ideas and approaches to natural resource management, they all tend to emphasize a strong role for communities in the control and management of productive natural resources.

In the context of this chapter, a community is defined as a group of people bounded by geographical links, such as a village, settlement or district, politics or natural boundaries but also includes those brought together by lifestyle, culture, religion, hobby and interest. A community group often pursues a common goal, concern or interest on an entirely voluntary basis. Communities are mostly thought to be homogenous but in real sense, are heterogeneous as community members often display different interests, problems and needs which vary according to age, gender, class and ethnicity (Gruber, 2008). This chapter depicts the community as being central to natural resource management.

Guiding Principles of CBNRM Approach

From the foregoing discussions and lessons learnt in the case study in Box 4.1, ten guiding principles of CBNRM, as advanced by Jagt and Rozemeijer (2002), emerge:

Decision-Making Authority Must Be at Community Level

Utilization of natural resources by a community is likely to be done in a more sustainable manner if the community has the authority to decide how, who and when to use these resources. More decision-making power will encourage (but not guarantee) more accountability to ensure an environmentally tenable use of the natural resources.

Decision-Making Must Be Representative

The decision-making structure, which is usually laid down in the Constitution of the community organization, must encourage broad dialogue and participation of all community members. Procedures to meet and to make decisions must be transparent. Similarly, time and other resources have to be made available to give every community member an equal opportunity to contribute to the discussion. This is not simply an issue of equity–strategically, it is important, that all community members agree, or at least not disagree, to be able to implement and adhere to decisions reached.

The "Community" Must Be as Small as Practical

It is obvious that distributing benefits and making representative decisions is easier in a small community. It is also obvious that the "right" size of the community will depend on the value of available natural resources (to allow benefits to exceed the costs of management). The trick, as usual, is to strike the balance. The other trick, especially in cases whereby a "community" consists of several villages, is to design layered decision making structures with as much decentralized authority at village or even sub-village level as practical.

Leadership Must Be Accountable

Representative decision-making and equal benefit sharing are prime guiding principles in CBNRM. Organizations and villages cannot function without "representatives" or leaders consolidating the various interests and making decisions on behalf of their constituency. In practice, this always means that some people win and some people lose. This cannot be avoided. What can and should be avoided is leadership not listening to their "voters" and/or not justifying the decisions made. Leaders, the board, committees, etc. must be accountable and responsible for their decisions. Accountability must be laid down in procedures and regulations as the membership is entitled to an explanation of decisions regarding the use of their resources.

Benefits Must Outweigh Costs

A community is more likely to exercise management authority and show responsibility for the use of natural resources when it feels the benefits of doing so. However, it is sometimes difficult to define costs (of meetings, discussion, missed opportunities, etc), and benefits as they are not always easy to measure. Sums of money and employment numbers are for instance quantifiable, but improved skills, enhanced cultural identity, pride and strengthened community organizations are not. The facilitator can clarify costs and benefits, but it is up to the perception of community members to decide whether community management pays or not.

Benefits Must Be Distributed Equitably

The various groups within a community (poor/rich, men/women, different ethnic groups, etc.) and all make use of natural resources; and are all entitled to benefits. This is not simply an issue of equity – strategically, all groups should assume their respective management responsibilities. If one group of resource users is excluded from the benefits, then they have no obligation to abide by community plans and regulations.

Benefit Distribution Must Be Linked to Natural Resources Conservation

The bottom line of any CBNRM intervention is the conservation of the natural resources, meaning, at a minimum, maintenance of the quality of the environment. Re-investing CBNRM benefits in natural resources (e.g. a management plan to reduce land-use conflicts, riparian woodland protection, purchase of valuable species, etc.) can increase the value of the environment and may yield higher returns. In the case of benefits being utilized in some other fashion, the impact of such an investment on the natural resource conservation should be well understood.

Planning and Development Must Focus on Capacity-Building

The ability of a community (organization) to manage its natural resources is not something that can be acquired through a few weeks' course. To the contrary, developing this management capacity is something that never stops. Committee members and community leaders come and go, as do community members. It should be clear to the community that the capacity to make informed decisions on the use of natural resources is the key to sustainable CBNRM. This means that the community has to make sufficient resources (money and time) available to build this capacity in a planned manner.

Planning and Development Must Be Coordinated

Communities in CBNRM never operate in a vacuum. Any community making natural resource management decisions or plans to re-invest benefits has an impact upon other stakeholders (e.g. District Council, Government Department, neighbouring village). CBNRM activities have conservation, rural development and good governance dimensions that reach beyond natural resource use and beyond the community. For these to sustain, the community must recognize and seek recognition among other stakeholders. Co-ordination in planning and developing CBNRM-related activities is important to gain this status.

The CBNRM Process Must Be Facilitated

Applying the above principles in the community capacity-building process requires skilled third party facilitation. A partner that is detached from the community (to effectively act as an 'honest broker'), yet is committed to facilitating the CBNRM process at community-level in the long-term is of paramount importance.

Theories for Community Based Natural Resources Management

Various theoretical orientations exist on how to organize natural resources management. Central ideas are ‘rational choice’ theory and the ‘institutional analysis’ approach. Rational choice theory underlies analyses that advocate market solutions, state or private arrangements, and individually rational strategies instead of collective action. It is argued in rational choice theory that cooperation or collective action cannot be achieved due to self-interests. The major question is how institutions that would be efficient in limiting individual self-interests, emerge. The rational choice theory forms the basis for models such as the ‘tragedy of the commons’ (Hardin, 1968).

The *tragedy of the commons* describes a situation in which multiple individuals, acting independently, and solely and rationally consulting their own self-interest, will ultimately deplete a shared limited resource even when it is clear that it is not in anyone's long-term interest for this to happen. This theory argues that human societies have an inherently destructive relationship to nature and ultimately overexploit natural resources for their own selfish individual interests, temporarily or permanently. This conception of natural resources has influenced the establishment of national parks, protected areas, enclosures and privatisation of natural resources.

This theory has been criticized for failing to distinguish between Common Property Resources (CPR) and open access resources. In some cases, however, there are real problems, and even limited situations where the tragedy of the common applies to real-world resource management. Institutional analysis approach, however, holds the view that rational individuals can still work together as long as they are organized around common interests and governed by rules. This theory, therefore, underscores the importance of CBNRM approach.

Common Property Resource Theory and New Institutional Economics Theory

The dominant theories in institutional analysis are the CPR (Ostrom, 1990) and the New Institutional Economics (NIE) (North, 1990). The central question in CPR theory is “how a group of individuals who are in an interdependent situation organize and govern themselves to obtain continuing joint benefits when all face temptations to free-ride, shirk, or otherwise act opportunistically”. The answer is by having clearly defined property rights. Supporting the CPR theory is the NIE whose main proponent is Douglas North (1990). Central in NIE are the institutions. North (1990), defined institutions as sets of rules and referred to them as “humanly devised constraints that shape human interaction”. The rules can be formal or informal. Ostrom and North take the conception of rules to argue that sustainable utilization of natural resources requires well-defined institutions (rule systems) and institutional frameworks. Box 4.2 provides characteristics or conditions that would be essential for gaining compliance to the rules from appropriators.

Box 4.2: Characteristics of a Successful CBNRM

- *Clearly defined boundaries:* Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must be boundaries of the CPR itself.
- *Congruence between appropriation and provision rules and local conditions:* Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labour, material, and/or money.
- *Collective – choice arrangements:* Most individuals affected by the operational rules can participate in modifying the operational rules.
- *Monitoring:* Monitors, who actively audit CPR conditions and appropriator behaviour, are accountable to the appropriators or are the appropriators.
- *Graduated sanctions:* Appropriators who violate operational rules are likely to be sanctioned (depending on the seriousness and context of the offence) by other appropriators, officials accountable to these appropriators, or both.
- *Conflict – resolution mechanisms:* Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.
- *Minimal recognition of rights to organize:* The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.
- *Nested enterprises (for CPRs that are part of larger system):* Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Adapted from Ostrom (1990)

This analysis by Ostrom has formed the basis for CBNRM programmes, and the rules are commonly found in the by-laws that communities follow when they have been organized to manage common resources. The rules range from those about access, use, exclusion, management, monitoring, and arbitration behaviour of users with respect to specific resources. In Zimbabwe, the strengthening of institutional framework and capacities at different levels in the Communal Areas Management Programme For Indigenous Resources (CAMPFIRE), shows how CPR and NIE theories have influenced wildlife management (see Box 4.3).

Box 4.3: The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE)

The CAMPFIRE spreads in thirty six of the fifty seven districts of Zimbabwe. Implemented in the context of decentralized management of natural resources, the CAMPFIRE was involved in sustainable utilization of renewable natural resources such as wildlife, forestry, cultural resources and eco-tourism. The authority was bestowed on the Rural District

Councils (RDCs) with various ministries, departments, research organizations and donors being involved. Before, the Department of National Parks and Wildlife Management owned the natural resources and all the revenues from wildlife benefited the central treasury. Local people who suffered from wildlife predation and destruction of crops did not benefit and had no decision-making powers on natural resources use and management. For them, clearing marginal lands for agriculture was, therefore, more profitable than 'preserving' or protecting wildlife. Consequently, there were conflicts between the Department of National Parks and Wildlife Management and local people, as the latter poached wildlife, which they largely viewed as pests.

Upon establishing the CAMPFIRE, capacities for institutions at national, district, ward and village level increased in terms of developing decisions regarding NRM. Management of natural resources was no longer for the State alone but a shared responsibility at various levels. Local people easily accounted for their resources. For example, poaching, which was widespread prior to the introduction of the CNBRM programme, declined significantly as communities started to receive economic benefits and were trained on conservation strategies and skills. Local communities generated income which was locally invested in schools, football club clinics and provided drought relief, among other developments. Above all, there was local employment for scouts, guards, and researchers, thereby enhancing rural development. The CAMPFIRE programme was a huge success in the 1980s. It inspired ongoing regional natural resource management programmes in other countries, including Namibia, Botswana, Zambia, and most other developing countries.

At its peak, the programme attracted international attention and numerous research studies by academics as an alternative model for conservation of natural resources. However, a recent article in the *Herald*, a newsletter published by the government of Zimbabwe, indicates that lack of full devolution and continuing interference by RDCs has made it difficult for local communities to actively participate in CBNRM activities. As a result, poaching and the unsustainable exploitation of natural resources are now rampant, as communities saw no benefit from engaging in CBNRM activities (Tsiko, 2010)

Adapted from Maveneke (1998)

Some of the lessons learnt from the CAMPFIRE project are as follows:

- For successful locally-based natural resource management, there is need to establish differential benefits for those who bear the cost of conserving natural resources such as wildlife. Focused incentives are key to keeping people's commitment to the programme;
- The CAMPFIRE was not a blue-print, but its principle was valid—local decision-making in the utilization of natural resources;
- Multi-agency/multi-disciplinary approaches work better for environmental issues. Ecological sciences, social sciences and local knowledge can be applied together for resource management. Public and private sectors can work hand in hand in conservation;
- For a CBNRM project to make an impact, it must satisfy some conditions, which would be at the national, regional, and/or local level. Although, no single CBNRM project will meet all these conditions, they influence effectiveness and success of a CBNRM project.

Although CPR and NIE support CBNRM approach, the theories assume that a community is homogeneous. Similar to most theories on the commons, the CPR focuses much on environmental problems and rarely addresses the issue of power. Both CPR and NIE fail to attend to inter- and intra-group politics, social and power differentiation such as ethnicity, gender, lineages, place of origin, religion, tribe, class, regional history, which may produce varied network outcomes within societies (Meagher, 2004). Usually, there is too much focus on sustainable management and successful institutions at the expense of the impact such institutions have on different categories of people (Agrawal, 2003). By ignoring social and power relations, CBNRM creates “enclosure of the commons”, whereby certain groups profit while others become marginalized and vulnerable because the rules provide opportunity for the powerful actors to exclude others from access and to privatize certain resources or user rights.

Political Ecology Framework

Other views in institutional analysis recognize that society is heterogeneous and they pay attention to social and power relations in access to and control over resources. These social and power relations would only be understood through coherent frameworks that bring together cultural ecology and political economy, hence, political ecology framework (Blaikie, 1994; Peet and Watts, 2004). Political ecology is concerned with understanding the relationship between social and environmental changes and puts power dynamics as central (Derman and Ferguson, 2002). These power dynamics could be at local level within the community, national level or at wider international level. The argument is that equal or unequal power relations among societies or within culture affect the environment and vice versa (Mayer, 1996). Figure 4.1 illustrates existing inter, intra and supra relationships between the community and the environment. In the relationships, the community is affected and so is the environment.

Through the lens of political ecology, a successful CBNRM would require detailed understanding of the economic, political and social factors and the physical environment. These factors make a CBNRM become holistic in nature. A CBNRM project informed by political ecology would therefore make people at different levels socially or culturally cohesive, politically empowered, economically developed and environmentally conscience. While political ecology framework is commended for paying attention to social and power inequalities in the management of natural resources, its main weakness is that it emphasizes either the ecological or political dimensions, and not both. Usually, political is privileged over ecological and environmental changes. In many cases, there is little politics in political ecology (Little, 1999; Zimmerer and Basset, 2003).

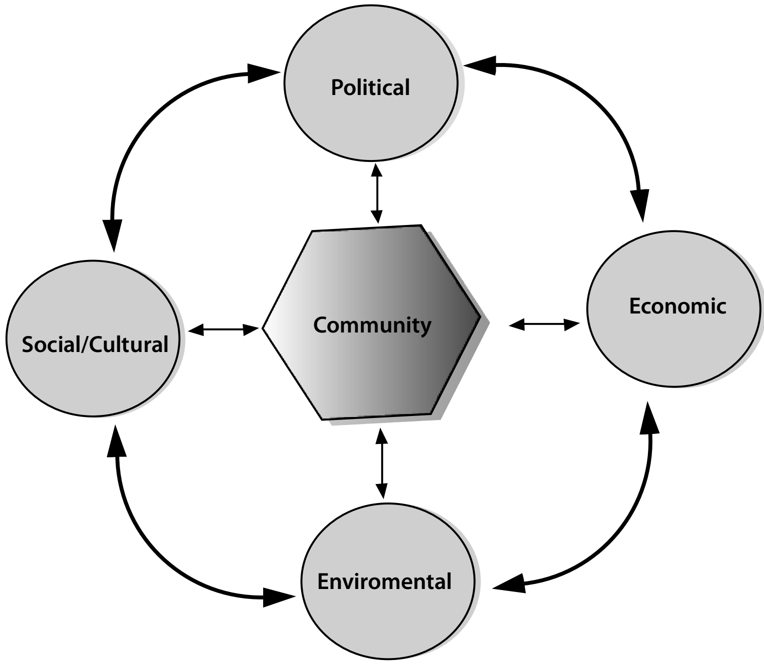

Figure 4.1: Inter, Intra and Supra Relationships Between the Community and the Environment.

Adapted from Campbell and Olson (1991)

The case of grazing lands in Botswana as reported by Peters (1987) presents the reality of political ecology. The grazing lands, once communally, became partly common, partly open access and partly illegitimate private. Private control resulted from private ownership of the boreholes established by the government in the grazing lands between the 1930s and 1970s. The boreholes gave the richer and powerful cattle-owners illegitimate control and powers to exclude others from the land around them. Their cattle were “fixed” around the boreholes and therefore, the areas became overgrazed. In return, those who could not afford boreholes were forced to use limited grazing pastures and increasingly moved cattle between water points. This resulted in overgrazing too. Peters (1987) found that overgrazing resulted from unequal access and conflict over the resources and not from over-stocking.

Another example of the political ecology notion, is that of access rights in Lake Chilwa wetland in Malawi (Kambewa, 2006). The wetland is important for fishing and agricultural production. Farmers negotiate access to plots especially for dry season cultivation. While some farmers have ‘secure’ access, others have ‘insecure’ access to the wetlands because of their social and power hierarchy in the society. Customary institutions enhance these inequalities. Those with insecure access to the wetland cultivate hill slopes without following proper soil conservation practices. The experience is that, rivers dry quickly and wetlands receive less recharge, resulting into reduced area for dry season cultivation. The social and power inequalities have led to land degradation and conflicts as members compete for land at the expense of conservation of the wetland (Kambewa, 2006). This defy the commonly held views that attribute environmental and social problems to increases in human population.

Approaches to CBNRM

Community based natural resource management takes many different forms in different locations and different socio-political and bio-physical contexts. The term itself is used and interpreted in many different ways. The nature of CBNRM approach is designated by the method and level of community involvement. In Southern Africa, for example, the most common approaches are those in which authority over natural resources has been devolved from the state to defined groups of resource users on communal land (Jones, 2004). In East Africa, the acronym, CBNRM is not commonly used, even though CBNRM is widely practiced across the region. In the wildlife sector in East Africa, 'community-based conservation' is the more common term used to refer to joint management involving the communities and central agencies. In forestry, 'participatory forest management' is used to refer to community-based forest management.

In practice, CBNRM may refer to a wide range of different modes of local involvement in natural resource management, including passive receipt of benefits from protected areas or other instances where communities are not actually empowered to manage resources themselves (Roe *et al*., 2009). The level of community involvement in natural resource management varies hugely between and within regions, from protected area outreach, where communities are passive beneficiaries of natural resource management conducted by others, to cases where communities participate through co-management agreements, to scenarios where natural resource management is actually carried out by communities for local benefit, among other forms of involvement (Barrow and Murphree, 2001).

Protected Area (PA) Outreach and Benefit-Sharing Approach

Under PA, the resource ownership is bestowed with the state. The level of participation of the community is largely limited to passive actions. Their role is to receive benefits from PA managers and cooperate with them in protecting the resources. The PA approach is exemplified in the case of tourism revenue sharing between the Uganda Wildlife Authority and the communities surrounding parks. This programme was initiated in the 1990s to improve local attitudes toward wildlife conservation. It has supported a range of community projects such as schools, clinics and other infrastructural developments (Archabald and Naughton-Treves, 2001).

Co-Management or Joint-Management Approach

In Co-Management (CM) of natural resources, the state owns the resources but may deconcentrate ownership. The level of community participation is medium and depends on the rights and responsibilities granted to local communities in a given situation. Their role is to cooperate with state authorities in management of the natural resources. An example of a co-management approach is the introduction of Wildlife Management Areas (WMAs) on village lands in Tanzania following pervasive decline of its wildlife between 1970s and 1980s. Some of the WMA established by the government of Tanzania included Enduimet and Loliondo in Arusha region; Twatwatwa, Ukutu and Wamimbiki in Morogoro region. This approach has evolved into a benefit sharing pact between communities and local authority (Wilfred, 2010; Nelson, 2007).

Community-Based Natural Resource Management Approach

In CBNRM approach, local communities participate in the management of natural resources through collective representative body. They are the resource managers through either delegated usufruct rights (user rights) or outright proprietorship. The level of participation of the community is, therefore, high because they are the decision makers and beneficiaries. Formation of conservancies on communal land in Namibia with rights over wildlife and diverse sources of income including hunting, tourism, and non-timber products, is an example (Nelson *et al.*, 2009). In Laikipia District of Kenya, communities are able to realize the benefits of wildlife on their lands through Community-Owned Ecotourism Enterprises. Examples of these enterprises, which include conservancies and eco-lodges are Il N'gwesi, Tassia, Koija Star Beds, Ol Lentille sanctuary and Ol Gaboli Community Bandas (Laikipia Wildlife Forum, 2010).

The Namibian model (Box 4.4) that allows communities to establish wildlife conservancies in communal lands and benefit from wildlife-based activities, shows the salient features of a CBNRM approach.

Designing and Implementing CBNRM Projects

CBNRM agreements involve both local user groups and the government. As such, they have the potential to reinforce user participation while remaining within the official administrative and legal framework. A co-managed system is developed through negotiation among the various stakeholders and can be partly based on customary practices. The desired end product is a contract between the state, user groups and other stakeholders that also recognize conflicts of interests and can be adjusted to changing circumstances (Hilhorst and Aarnink, 1999). In view of the foregoing scenario, there is no single or universal design of a CBNRM. The example of participatory conservation of wetlands in Ghana presented in Box 4.5 is, therefore, used to help the reader to visualize the steps involved in designing a successful CBNRM.

Box 4.4: The Namibian CBNRM Model

Namibian CBNRM model is one of the best examples of Africa's successful community-based wildlife management initiatives. Following the reforms of wildlife policy to provide for establishment of conservancies in 1996, residents of communal lands have been able to form organizations, defined by a governing constitution, membership, and land area, and apply to the government for user rights over the wildlife inhabiting their lands. By 2007, there were 50 wildlife conservancies covering approximately 14.4% of the country. The benefits have been immense—according to Namibian Association of Community Based Natural Resource Management Support Organization (NACSO) (2008), the conservancies generated revenue worth over USD2.5million from tourism, sport hunting, among other wildlife-based activities. In addition, wildlife populations, especially the rare species such as black rhino and predators, have increased in the conservancies.

There are several features of this model that are crucial for the design and implementation of a CBNRM. First, that the rights granted to communities over wildlife are relatively broad and secure, and although conditional and can be revoked, are not term-bo

und. Second, there is no tax levied on the revenue earned either by the local or state government. Third, the programme had a long history of development prior to

the involvement of external actors and donors. The key question posed by Nelson, et al (2009) is that despite the success story of Namibia, why have equivalent rights over wildlife not been devolved to local communities anywhere else in Southern and Eastern Africa? Are there particular inherent factors that have favoured devolution of rights over wildlife in Namibia? The answer is that there are favourable bio-physical characteristics including low population density and high aridity that favour wildlife over agriculture in Namibia.

In addition, it has been possible because of relatively low levels of institutional corruption in Namibia, which reduces policy makers' incentives for withholding authority over valuable resources. The other reason is a relatively low centrally-captured revenue from wildlife uses on communal lands, which also deters central incentives for maintaining control. Further, Jones and Murphree (2001) indicated that the foundations for wildlife management reforms in Namibia providing for communal conservancies were laid by the earlier devolution of rights over wildlife on private freehold lands in the 1960s. The opportunity to extend devolved rights over wildlife to communal lands was further boosted by independence from South Africa in 1990. Whereas the foregoing political context, which was central to CBNRM emergence in Namibia, is unlikely to be repeated in other countries, Namibia's CBNRM legislative itself is transferable. It provides a useful model for developing substantial rights over wildlife and wildlife-based revenues provided if there is political will to empower the community.

Adapted from Nelson et al., (2009)

Box 4.5: Community-Based Marine Turtle Conservation In Ghana

The conservation of wildlife in Ghana had been restricted to management of protected areas since early 1900s. By the time this project was initiated, the populations of all seven species of marine turtles in the country were declining and had been listed on the International Union for Conservation of Nature (IUCN)'s Red Data list. The major threat to marine turtle population in Ghana is predation on eggs and juveniles by domestic animals especially pigs and dogs. Human exploitation also contributes significantly to the decline in turtle population in Ghana. The turtle meat and eggs are eaten or traded for cash income. Other threats are coastal erosion and beach development, which together have destroyed some good turtle nesting habitats. The dumping of rubbish on the beaches has also contributed to the mortality of turtles.

The initiative by the Ghana Wildlife Society to adopt a strategy which actively involves the local coastal communities in the conservation of marine turtles emerged from the fact that the past policies which excluded local communities in the management of wildlife resources were ineffective. These past approaches generated antagonism and often resulted in conflicts between the local people and wildlife officers. Traditional and religious beliefs which helped to conserve biodiversity in the past were also no longer as effective due to socio-cultural shifts. The community participation process in the conservation of marine turtles started with a national workshop organized by Ghana Wildlife Society in 1995 to involve all stakeholders in developing a strategy for the conservation of marine turtles in Ghana. The workshop brought together chiefs, representatives of communities living along the coast, scientists and conservationists from the universities and relevant government departments. Some of the important recommendations from this workshop, were that:

- The District assemblies should be encouraged to formulate by-laws to regulate the rearing of domestic animals which prey on turtles;
- Animal rearers such as pig owners be assisted to construct structures to ensure better husbandry;
- Community task forces responsible for education and turtle conservation activities be formed;
- Alternative economic activities be promoted to reduce pressure on turtles as a means of livelihood; and,
- Fishermen whose nets are destroyed by turtles be compensated as an incentive to release them back into the sea.

Following the workshop, the Ghana Wildlife Society started consulting and working with the communities to form the Turtle Conservation Task Force. The communities, through the chiefs, assemblymen and other opinion leaders nominated two members from each of the 17 main communities in the project area for inclusion in the Task Force. The 34 member task force was formally inaugurated in June, 1996. A series of training programmes were organized by the Society to empower the task force members to take up the challenge of conserving turtles. The potential benefit for the people was the fact that through sustainable and non-consumptive uses such as eco-tourism, turtle conservation could contribute to improving their socio-economic status. The turtle conservation strategy is grounded in partnership between the local communities, the Ghana Wildlife Society as an NGO, and relevant Governmental agencies such as the Wildlife Department. In this partnership, the coastal communities are recognised as the key stakeholders who play a central role in the turtle conservation efforts with assistance from the external agencies.

The most important achievement of the turtle conservation project has been a dramatic change in people's attitude and behaviour towards marine turtles. This may be attributed to an increased awareness of the turtle problem due to the activities of the Society and the community turtle task forces. Task force members have reported that fishermen often invite them to come and witness the release of turtles, accidentally caught, back into the sea. Hitherto, accidentally caught turtles were killed. Most communities have also instituted by-laws to control the rearing of domestic animals which prey on turtles. Some communities are planning to ban the rearing of pigs. The Ghana Wildlife Society, in consultation with the communities, is exploring ways of assisting the people to keep the animals in enclosures.

In the long term, it was planned that the communities were to be involved in the promotion of community based eco-tourism in the turtle concentration zone. Revenue from this enterprise were to be used to construct clinics and schools, and improve domestic water supply. Community-based eco-tourism was to provide an employment avenue for some of the unemployed youth in these communities.

Source: Olesu and Ntiamoa-Baidu (1998)

In designing the NRM programme, the Ghana Wildlife Society:

- Identified key problems that the extinction of turtles may cause to national economy and how this may affect communities in particular;
- Conducted all inclusive workshop that puts the communities at the centre of the action;
- Identified key stakeholders including local authorities like chiefs, NGO leaders, regulating agents and others;
- Trained all those who will be involved so that they are technically competent to jointly manage the project;
- Organized the costal communities to play key role in the conservation with leadership provided through the multi agency task force;
- Trained the communities and all relevant stake holders; and
- Ensured tangible benefits so as to enlist consistent ongoing community commitment and support.

The key lessons learnt in this case study is that local people will support the conservation of natural resources if:

a) They are recognized and respected as equal partners by conservation officers and are empowered to contribute effectively to the conservation process; and
b) They have ownership of the resource and are convinced of the benefits that the conservation of a particular resource will bring to them.

The use of community task force has been very effective in creating awareness of the turtle problem within the communities in Ghana. This is because the suspicion which they had in the past with government officers or outsiders is eliminated. The fact that the task force members are part of the communities made them readily acceptable to the communities and helped them to sell the turtle conservation ideas to the community more easily. In addition, the involvement of the local communities created an opportunity for the Ghana Wildlife Society to gain better insight and to understand the turtle problem from the perspectives of the local people. The partnership between the communities and the Society was therefore mutually beneficial due to the two-way transfer of knowledge from one to the other.

(For details of CBNRM project design, see NRM project planning and Management, in Chapter 7.)

Benefits of Community Based Natural Resource Management Projects

The potential of CBNRM to generate economic benefits for local people has been the key driver of efforts for its application, because such benefits create incentives for resource conservation and contribute to local economic development and poverty reduction (WRI, 2005). The possible impacts of CBNRM projects on livelihood components include the expansion of community and household assets, through reduction in illegal harvesting, sustainable harvesting, restocking and better local management and enhanced human capital through training and skill development (Center for Applied Research, 2003). Others include the accumulation of financial assets, building of social assets, for example, by the formation of effective community organizations and reduced conflicts; and establishment of physical infrastructure. Table 4.1 presents the main benefits associated with CBNRM approach.

Table 4.1: Benefits of CBNRM

Category	Intangible Benefits
Capacity building and empowerment	▪ Improved institutions and organizations ▪ More accountable leadership ▪ Defined membership ▪ More open processes for making decisions and sharing information ▪ Greater equality for weaker community members especially women ▪ More cohesive social units ▪ New skills ▪ Confidence in dealing with outsiders ▪ Greater self belief and increased sense of control
More secure livelihoods	▪ Diversification and risk reduction ▪ More secure access to resources ▪ Ability to cope with change and surprise
Enhancement of cultural and aesthetic values	▪ Revival of traditions and traditional knowledge ▪ Awareness by outsiders of community world views and belief systems
Improvement to the natural resource base	▪ Better management when communities and the state cooperate

Source: Fabricius et al., (2004)

Indicators of CBNRM Impacts

The aforementioned benefits are crucial for success of CBNRM projects. In Uganda, for example, the communities around Budongo forest are involved in cultivation of *Ocimum kilimandscharicum,* a medicinal plant, to relieve pressure on the forest (see Box 4.6)

Box 4.6: Budongo Forests Community Development Organization (BUCODO)

BUCODO is a GEF Small Grants Programme (SGP) with technical support from International Centre of Insect Physiology and Ecology (ICIPE) and a number of partner institutions and organizations such as CARE-Uganda.

The Budongo forest conservation project tackles deforestation by providing alternative sources of income through community-based cultivation of the indigenous medicinal plant (*Ocimum kilimandscharicum*) for use in the commercial production of aromatherapeutic products.

Ocimum kilimandscharicum is now being cultivated by the community living around Budongo Forest as a sustainable alternative income generating activity, for the purpose of reducing pressure on the forest. As an additional activity, BUCODO promotes the conservation of customary forests around Budongo forest by mobilizing the adjacent community to form village forest committees to manage the forests. By enhancing the ability of Community-Based Organizations (CBOs) to promote more participatory, transparent and accountable governance at the local level, the project contributes to poverty reduction both directly, in terms of increasing local benefits from Participatory Forest Management (PFM), and indirectly, in terms of providing an entry point for a broader good governance agenda within decentralized government. The Empowering and Strengthening of Civil Society on Participatory Forest Management (EMPAFORM) programme focused on the promotion of a pro-poor approach to PFM achieved through strengthening and empowering CBOs that represent community interests and rights in community forestry management and utilization. BUCODO sells the products manufactured from *Ocimum kilimandscharicum* which is cultivated by the community. Extract from *Ocimum kilimandscharicum* is used to manufacture 'Naturub' balm ointment, currently on sale in more than 60 outlets in East Africa. BUCODO pays the farmers for the plant materials supplied. Percentage of the profit is ploughed back to the project for maintenance and upgrading of the equipment and improvement of the facilities and the enterprises in general. The rest of the profit is used for sustaining conservation activities around Budongo forest.

Particular emphasis is placed on the interests and rights of poorer households and other marginalized groups within the community, notably, women and children (i.e. gender equity). BUCODO promotes the conservation of customary forests around Budongo forest by mobilizing the adjacent community to form village forest committees to manage the forests. The Project also focuses on creating awareness on community forest management, undertake boundary demarcation, conduct stock inventory survey using participatory resource assessment techniques, develop community forest management plans, promote enrichment planting and form communal land associations as a means of securing customary certificates of ownership for the community forest lands. The project is pro-poor in the sense that it promotes a more demand driven approach to the establishment of community forestry management arrangements whereby communities are able to assert their right to PFM that exists under new forest policies and require government to take the necessary action, . This is in contrast to the existing situation where government agencies determine when, where and how PFM will be implemented.

Source: GEF, 2006.

Factors Influencing Success of CBNRM

The main factors that determine the success of CBNRM projects are social, economic, political and bio-physical in nature as discussed in the sections below.

Social Factors

Social factors are important for achieving cohesiveness of communities, organizing and mobilizing efforts of the members to manage resources and agree on the sharing and distribution of the benefits. Among the social factors, leadership plays an important role in the distribution of benefits from a CBNRM project. If leadership is responsive to the needs of its members and fair, it is more likely that benefits will accrue to most community members rather than a select few. Critical is therefore, whether the leadership is responsive at all, and equally responsive to the needs of various community groups as defined by social status, gender or age.

Economic Factors

One of the strongest recurring issues in CBNRM is that the perceived value of the resource to be managed must be large enough for the community to enter into the rigorous process of mobilization, planning and implemention of CBNRM activities. The perception of relative benefits and costs depends on how the community assesses or values the efforts by, and benefits to, certain social groups.

The perceived value of the resource to the community depends on the extent to which the community has access to a market, market information and value addition (if the resource is tradable). However, the perception of the benefit/cost from CBNRM is not always straightforward to the communities. In addition, some communities tend to have high discount rates and they would much rather have small benefits now than larger ones in a distant future. Others do not, and tend to accept short-term sacrifices for long-term gains. Finally, the composite assessment of a community's benefits/costs of CBNRM is often at odds with that of other stakeholders or potential partners, making negotiations difficult.

Policy Factors

Colonial legal frameworks on the use of natural resources did not explicitly grant rights or authority to local communities. However, governments in Africa have reformed their policies to allow for community participation. This has opened doors for CBNRM activities to be implemented. In some countries however the policies are not in use because they have not been taken to the communities. Some cases exhibit contradictions between policies on natural resource management and cross-cutting issues leading to inadequate policy guidance for CBNRM activities. The end results are conflicts that undermine the success of CBNRM.

Bio-Physical Factors

The focus is on resource manageability—the reciprocal of a community's capacity to carry out CBNRM. Because of the type of access or tenure (e.g. common property rights as opposed to open access to resource), certain resources are easier to manage than others. Scale can be a factor (e.g. a large pond rather than a sizeable lake, or watershed), the extent to which the resource is mobile (marine fishery, wildlife) can also be important, relative to the size of the community or groups of communities. Sometimes, changes in NRM practices require significantly different modes of resource management and use (this relates to the social concepts of quality of labour pool, and capacity for innovation).

In some cases, the shift from the previous pattern of resource use to a more sustainable CBNRM approach is relatively simple. In other instances, the state of resources or other constraints force the community to undertake a major shift in knowledge, practices, mentality and patterns of resource use. Both biotic and abiotic factors have direct influence on natural resources and their management regimes. Climatic factors, rainfall for example has a direct influence on quality and quantity of vegetation resources. This has a bearing on accessibility of forage for pastoral communities. During droughts when the resources are scarce pastoralist communities are forced to defy territorial boundaries, resource use pattern and to some extent, governing institutions, which results in conflicts and disruption of any community-based natural resource management plans.

Conflicts Management in Community Based Natural Resource Management

Management of natural resources is embedded in social and power dynamics of the community where people have to negotiate their access to the means of livelihoods. This exposition implies that CBNRM operates on a contested terrain, where people are busy finding ways to justify their claims to natural resources in order to access, control and use resources for livelihoods. Failure to win the claim is a loss of both the resources and the benefits. It is this loss that results into conflicts. Conflicts, therefore, emerge from inequalities in access to and control over resources. Seen this way, conflicts are contending forces used by those in power as tools to maintain or restructure economic, social and political relations in the society (Peters, 2002). A section in Chapter 3 is dedicated to discussions on conflict management in INRM; sources of conflict, methods and tools for analysis, and strategies for conflict management

Causes and Types of Conflicts in CBNRM

The conflicts over natural resources could be ‘intra’, ‘inter’ and ‘supra’ in nature (Table 4.2). Intra-conflicts take place between members of the same community. These conflicts can manifest themselves as quarrels over shared resources. Intra-conflicts are frequent but less intensive such that members easily reconcile without outside intervention. When the conflicts are grave, members of a community can turn into ‘strangers’ and in some cases, fights or even death occur.

Table 4.2: Types of Conflicts Arising in CBNRM

Type of conflict	Description
Intra-conflicts	▪ Disputes over land and resource ownership, eg between private and communal land owners; ▪ Disputes over land boundaries between individuals or groups; ▪ Disputes due to CBNRM projects/schemes being captured by elites and/or those who happen to own resources of a higher quality; ▪ Breaking of common property resource (CPR) constitutional or operational rules, such as protection agreements for grazing areas, fish net sizes, forests, or misappropriation of funds etc. ▪ Disputes over the unfair distribution of work and profits.
Inter-conflicts	▪ Conflict between 'land owners' and 'resource users'; ▪ Conflict between indigenous CPR groups, and more recent settlers; ▪ Resentment built up due to lack of representation in village committees.
Supra-conflicts	▪ Cultural conflicts between community groups and 'outsiders'; ▪ Project management disputes between community groups and outside project-sponsors; ▪ Disputes caused by political influence (national, provincial or local).

Source: Warner, 2000.

In most African communities, conflicts over natural resources are first referred to the court of elders for resolution. Although intra- conflicts are usually resolved by the lower courts, sometimes they reach the court of the chief. The land 'grabbing' case in Lake Chilwa Wetlands of Malawi (Box 4.7) is an example of intra-conflict over natural resources.

The lessons from this case are first, in natural resource management, the powerful actors may use power in their favour. Second, that at the local level, there are multiple institutions for resolving conflicts thereby allowing people to seek justice from a variety of platforms. However, some institutions are less impartial as they favour those in power. The key message in this case study is that for any CBNRM project to succeed, it must address the social and political inequalities inherent in customary institutions.

Box 4.7: Land Grabbing in The Lake Chilwa Wetlands, Malawi

During December, 2003 to March, 2005, there was a case in which a Group Village Headman (GVH) wanted to grab land in Lake Chilwa Wetlands from a member of his village. A nephew of the GVH (maternal uncle) asked a member of the village if the latter could lend him land to grow vegetables. The member refused, arguing that the land was for him and his children. The nephew took the matter to a group of Village Headpersons (VHs). Before the VHs heard the case, the GVH took it to the court of the Traditional Authority (TA). At the court, the GVH, instead of addressing the land case only, he complained that the concerned member was disrespectful and that he was challenging his chieftaincy. The TA's court maintained the case about the land and ordered that it be shared between the two. However, the ruling was not implemented, first because the GVH rejected it and, second, because the TA never followed to see that its ruling was implemented.

The GVH rejected the ruling, adding that the concerned member should be evicted because he was disrespectful and had challenged his chieftaincy. The TA then referred the case to the Senior Chief, who sent it back arguing that the TA's court was the right place. The TA then referred the case to the District Commissioner (DC) where it was also sent back to the TA. The TA sent the case back to the VHs. The case was never settled and during the time of the dispute the land was not used because each party destroyed the crops the other party planted. Apart from the TA's ruling that the land should be shared, the other authorities did not make any decision.

In this case, many institutions were involved but there was no resolution for almost two years. The VHs could not handle the case because they were junior to the GVH. In fact, the VHs considered the GVH as their boss. The advisors to the TA feared that the GVH would bewitch them. The GVH refused to share the land because his intention was not to share but to grab it. The GVH had a tendency of grabbing land to give it to people who would pay him bags of rice after harvesting, on a share cropping arrangement. Four families had since lost land to the GVH, most of them having obtained the land in the late 1980s. The TA failed to implement his ruling because of conflict of interest since the GVH shared with him the bags of rice collected from share cropping systems.

Source: Kambewa (2006)

Inter-conflicts occur among members of different communities in the same geographical area. These conflicts originate from the fact that most natural resources are customary in nature and belong to specific communities by default. Members of the communities that have customary rights of ownership are considered 'insiders' while those without are considered as 'outsiders'. Conflicts occur whenever 'outsiders' claim ownership of the resource upon which they do not have customary rights (Box 4.8).

Community members use local histories to make claims about natural resources they want to control. Such histories range from those about chieftaincy to the question about who came first to settle in the area. When an inter-conflict is strong, communities seek justice from a variety of institutions. Initially, the case would be heard in the court of the senior community leaders before being referred to the formal courts.

Box 4.8: Conflict Over Water and Land in the Lake Chilwa Wetlands, Malawi

In 2004, a conflict was reported in the Lake Chilwa wetland between communities of Nama and Phepe villages. The conflict originated following, the floods from Domasi River, which though not frequent, are intense. The floods damage houses and property in Nama Village every year. The river originates from Zomba Mountains and passes through Nama Village where it is diverted to Phepe Irrigation Scheme before joining the Wetlands. Forestry officials reported that floods were due to deforestation on Zomba Mountain.

Residents of Nama village constructed a bund to protect their property but farmers from

Phepe scheme demolished it, arguing that the bund forced more water into, and destroyed the main canal for the irrigation scheme. This led to conflict between the two villages., The residents of Nama village then threatened to block the water going into the scheme arguing that they wanted to use the water to start their own scheme. The conflict between the two communities was over access to Phepe Irrigation Scheme. Residents in Nama were unhappy because only a few of them had plots in the scheme. They felt they should have had more plots because they owned the Domasi River by virtue of it passing through their village, and that this should translate into ownership of the scheme itself. On the other hand, the scheme itself was on the land belonging to Phepe village. The scheme was actually supposed to be in Nama village but the then chief refused to give land arguing that the scheme would take away their customary land. However, after a while, residents of Nama village got interested and wanted access to the benefits accruing from the scheme.

Several institutions were involved to resolve the conflict. These included Malawi Social Action Fund (MASAF), which constructed a bund to retain flood waters and the Government of Malawi, which proposed planting trees in the catchment in order to prevent floods. The chiefs held meetings to reconcile the two villages. The residents of Nama village proposed to start their own scheme using water from the same river that supplied Phepe scheme. It was foreseen that if the residents of Nama village succeeded, there would be more competition for water between the two schemes.

Source: Kambewa (2006)

Supra conflicts take place between communities in a different geographical location or an organization, in this context, an implementing agency of a CBNRM project. Examples include conflicts between the government and farmers, where the latter refuses an irrigation scheme because of uncertainties about their livelihoods if the project is implemented. Some conflicts are between government and communities in protected areas such as national parks because people feel they have lost access to their means of livelihoods. In fisheries sector, conflicts exist among fishing groups or between government and fishermen.

Strategies for Conflict Management in NRM

Critical to the CBNRM is the emergence of institutions capable of efficiently resolving and managing conflict. The quest is for an alternative conflict management system neutral, efficient and fair in resolving conflicts at lower levels where natural resource management takes place. According to Warner (2000), key strategies for conflict management in CBNRM would include the following:

- *Use of force:* Conflict can be managed through ‘force’ when one party has the means and inclination to win regardless of the consequences for the other party, and whether the process of winning causes damage to one’s personal or professional relationships. Not all will be able to use the same force. It will largely depend on the power that one party holds relative to the other. In some cases, recourse to the legal system is a form of ‘force’ in that one party can use their superior resources to 'buy' better advice or raise the stakes, for example, by taking a lost case to an appeal court;

- *The power of withdrawal:* This approach is suited to those parties whose desire to avoid confrontation outweighs the goals they are trying to achieve. The power of 'withdrawal' can be used as a threat to force reluctant and sometimes more powerful parties to negotiate in a more consensual fashion. However, disadvantaged groups may also withdraw out of a feeling of helplessness;
- *Accommodation:* There are occasions when one party values a strong and continuing relationship with one or more of other parties above the attainment of its own goals. In these cases, the party may opt to 'accommodate' the other parties, conceding to all or most of their demands. Although such outcomes may look as though they have been the result of 'force', the difference is that rather than losing outright, the accommodating party gains by way of securing good relations, accompanied perhaps by element of 'good will' and the option to achieve some greater goal at a future date;
- *Compromise:* Compromise is often confused with consensus. To compromise in a negotiation may sound positive, but it means that at least one of the parties perceives that it has had to forgo something. Compromise as 'trade-offs'—is now prevalent, spurred on by the perceived 'tragedy of the commons' and the need to make rational resource allocation decisions. Stakeholder analysis is an example of the compromise approach. The tool is used to analyze the potential distributional impact of a project between the various stakeholder groups, which is then integrated into project design so as to minimize sacrifice and trade-offs;
- *Consensus:* In a consensus approach, the synergy of collaborative negotiations is used to widen the basis for decision-making. Negotiations are about engaging in trade-offs on a win-win approach.

In their study of conflict management in Uganda, Sanginga, *et al.,* (2007) distinguished the following conflict management mechanisms used by communities to resolve their NRM related conflicts:

- *Avoidance:* People don't report problems, they try to solve them. Avoidance was often used when the conflict was trivial. The desire to avoid confrontation outweighs the need to bring conflicts into public domain;
- *Mediation and Negotiation:* People usually rely on clan elders, relatives, neighbours and groups to solve conflicts;
- *Arbitration:* People report problems to local government leaders also called village council;
- *Adjudication:* People take problems to courts or are coerced to comply.

Most CBNRM conflicts are managed through community informal and customary mechanisms or through legal and formal mechanisms. Although some communities have long been known to effectively manage their conflicts from natural resources use. recent years have seen emergence of strict regulations or policies for sustainable management of natural resources. Table 4.3 presents different conflict management systems, their strengths and weaknesses. These are by-laws or negotiated rules, social norms and agreed behaviours that exist within communities to prevent and manage conflicts (Sanginga *et al.*, 2007). Chapter 8 discusses in details some policy and governance issues in NRM.

Role of Indigenous Knowledge in CBNRM

Information and knowledge management systems are vital for planning, operation, monitoring, and evaluation of CBNRM processes. Rising awareness of the cross-border environmental dimensions of CBNRM has fostered networking between organizations as an approach to share information and knowledge and to engage in national as well as regional policy dialogue. Knowledge systems that facilitate the information and knowledge sharing through networking between organizations or nations play an important role in this context. In general, information sources range from existing information storage systems, to traditional regimes of knowledge dissemination. This chapter will focus mainly on indigenous knowledge system against the background on CBNRM.

Local and indigenous knowledge can serve as valuable basis for interpreting information and data, and for solving problems identified by scientists, policy makers and resource managers. This knowledge is, however, not well documented or easily accessible to others including those in the same area with similar problems and challenges. Frequently, large investments are made in a top-down approach to conserve natural resource systems, often in disregard of the local knowledge and experiences. One of the important challenges is to find ways and means that provide the linkages between traditional knowledge of land-use management systems and modern scientific methods and technologies. The development of information systems where indigenous and scientific knowledge is integrated into a single expert knowledge system will go a long way in contributing towards greater awareness, education, training and capacity building of stakeholders in agriculture and natural resource management and conservation.

Studies have shown that indigenous knowledge is the missing link between development agencies and the rural communities, and that CBNRM projects that recognize the local knowledge systems yield better results compared to those that undermine the knowledge and practices of the local communities. Recognition of traditional techniques and practices would not only restore the confidence of the local communities in their own traditional knowledge and skills but also lead to the

Table 4.3: Strengths and Limitations of Different Conflict Management Mechanisms

Conflict management systems	Strengths	Limitations/ Weaknesses
Community-based (customary) mechanisms	▪ Encourages participation by community members and respect of local values and customs. ▪ Provides familiarity of past experience. ▪ Can be more accessible because of low cost, use of local language, flexibility in scheduling. ▪ Decision-making is often based on collaboration, with consensus emerging from wide-ranging discussions, often fostering local reconciliation. ▪ Contributes to a process of community self reliance and empowerment.	▪ Not all people have equal access to customary conflict management practices owing to gender, class, caste, ethnic or other discrimination. ▪ Courts and administrative law have supplanted authorities that lack legal recognition. ▪ Communities are becoming more mixed, resulting in weakened authority and social relationships. ▪ Often cannot accommodate conflicts among different communities, or between communities and government structures, or external organizations.
Legal and administrative systems (Policy)	▪ Officially established with supposedly well-defined procedures. ▪ Takes national interests, concerns and issues into consideration. ▪ Decisions are legally binding.	▪ Often inaccessible to the poor, women, marginalized groups and remote communities because of the cost, distance, language barriers, illiteracy and political discrimination. ▪ Judicial and technical specialists often lack expertise, skills or interest in participatory natural resource management.
Alternative conflict management systems (Synergy approach)	▪ Promotes conflict management and resolution by building on shared interests and finding points of agreement. ▪ Processes resemble those already existing in many conflict management systems. ▪ Low cost and flexible. ▪ Fosters a sense of ownership in the solution and its process of implementation. ▪ Emphasizes building capacity within communities so that local people become more effective facilitators and handlers of conflict.	▪ May encounter difficulties in getting all stakeholders to the bargaining table. ▪ May not be able to overcome power differences among stakeholders if some groups remain marginalized. ▪ Decisions may not always be legally binding. ▪ Some practitioners may try to use methods developed in other countries without adapting them to the local contexts.

Source: *Sanginga et al., (2005)*

preservation of unique indigenous knowledge. This should be done as a way of increasing the effectiveness, acceptability and success of CBNRM projects that are aimed at improving food security and livelihoods of the rural communities (Wasonga et al., 2003).

What is Indigenous Knowledge?

Several terms are used synonymously with Indigenous Knowledge (IK), such as local knowledge, indigenous skills, traditional knowledge or cultural knowledge. Generally, these refer to the matured long-standing traditions and practices of certain regional, indigenous or local communities. Traditional or indigenous knowledge also encompasses the wisdom, knowledge, and teachings of these communities. Typically, such knowledge has been passed on orally from one person to another over generations. Most forms of indigenous knowledge are expressed through stories, legends, folklore, rituals, songs and even laws, or are obtained through experience and experimentation. This long-term experimentation and experience means that indigenous knowledge cannot be quickly replaced by other knowledge systems. It also encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihoods (UNCCD, 1999).

There has been an attempt by social scientists to distinguish traditional knowledge from local knowledge. These scientists often place knowledge within a naturalistic framework, and emphasize the gradation of recent knowledge into knowledge acquired over many generations. These accounts use terms like ‘adaptively acquired knowledge’ and ‘socially constructed knowledge’, terms that emphasize evolutionary and social aspects of knowledge. Local knowledge and traditional knowledge may be thought of as distinguished by the length of time they have existed—decades to centuries versus millennia. Musimba and Nyariki (2003) argue that local technical knowledge may not necessarily be indigenous. It is knowledge developed or generated locally as opposed to Indigenous Technical Knowledge (ITK), which is principally ‘traditional’, again pointing to the time horizon involved in developing this knowledge.

In practical terms, traditional or indigenous knowledge can be defined as the ‘ideas, experiences, practices, and information that either have been generated locally or elsewhere, but have been transformed by the local people and incorporated in their way of life unique to their culture or society’ (Kellner and Bosch, 2003). Rai and Thapa (1993) simply refer to indigenous knowledge as ‘an organization or social activity that has been set up primarily as a result of local initiative’. Indigenous knowledge, then, refers to techniques that are ‘endogenously generated, enforced and maintained’ or those that result from the ‘local adaptation of methods from outside’. Indigenous knowledge can also be defined as local knowledge that is unique to a given culture or society (Nyariki *et al.,* 2005). It forms the basis for local-level decision making in natural resource management and a host of other activities in rural communities.

As opposed to what the term may literally mean, indigenous/traditional or local knowledge is not necessarily simple. It is dynamic, changing through indigenous mechanisms of creativity and innovation, and, because it does not occur in a vacuum, it borrows a lot from the outside, and therefore, is ever evolving. The term indigenous system is used as opposed to a sponsored system. A sponsored system is initiated through an external intervention such as by government agencies and non-governmental organizations (NGOs).

Indigenous Knowledge Systems (IKS) are a complex set of knowledge, skills and technologies existing and developed around specific conditions of populations and communities indigenous to a particular geographic area, and are often in contrast with international knowledge systems generated by research centres and private firms (Häusler, 1995). They form the basis for local level decision-making in agriculture, food preparation, healthcare, education and training, natural resource management and a host of other activities in rural communities (Warren and Rajasekaran, 1993). According to Warren and Rajasekaran (1995), IKS are diverse and include:

- Adaptive skills of local people usually derived from many years of experience communicated through 'oral traditions' and learned through family members over generations;
- Time-tested agricultural and natural resource management practices, which pave the way for sustainable development;
- Strategies and techniques developed by local people to cope with the changes in the socio-cultural and environmental conditions;
- Practices that are accumulated by farmers due to constant experimentation and innovation;
- Trial and error problem-solving approaches by groups of people with an objective to meet the challenges they face in their local environments.
- Decision-making skills of local people that draw upon the resources they have at hand.

Indigenous systems for natural resource management invariably include ecological and biological management and the social arrangements by which access to the natural resources is regulated. Much of the indigenous knowledge is based on accurate, detailed and thoughtful observations, which are collected and passed on across many generations. It allows informed decisions to be made by combining information and techniques to maximize production and minimize risks. Therefore, potential disappearance of many indigenous practices could have a negative effect primarily on those who have developed them and who make a living through them (Nyariki *et al.,* 2005).

Why Indigenous Knowledge?

Recently, there has been heightened interest in indigenous knowledge, especially in agriculture and natural resource management, for purposes of creating more appropriate and environment-friendly technologies, empowering people to have greater control over their destinies, and creating technologies that are more justifiable in their specific socio-economic situations. Indigenous knowledge is beneficial to sustainable agriculture and natural resource conservation because it is founded on a strong understanding of the local ecology, social structure, economy and culture of a community. This knowledge is normally a significant part of the lives of the rural poor, as their livelihood depends, for the most part, on specific skills and knowledge essential for problem-solving strategies, and therefore, for their survival. Furthermore, indigenous knowledge is relatively cheap, locally available, and less destructive to the local environment. However, according to Kellner and Bosch (2003), it is marginalized and even under attack for being backward, static and a hindrance to modernization. In fact, there are those who hold the view that indigenous or traditional knowledge is not 'knowledge' because it includes beliefs, values and practices. In the context of their argument, these elements are not considered 'knowledge' because they do not constitute 'justified true belief'— the definition of 'knowledge'.

The decline of indigenous peoples and their knowledge has often been associated with the neglect and marginalization of their practices and beliefs, frequently seen as inferior forms of knowledge to be replaced by 'universal' knowledge derived from western scientific culture. Attempts to apply western tradition universally without regard for indigenous knowledge systems have in many cases led to failure in sustainable natural resource use and the erosion of biological diversity. The level of contribution indigenous knowledge can make to the knowledge for conserving natural resources cannot be gainsaid, therefore. Unfortunately, the value of such knowledge has been recognized only recently, mainly due to international and donor project funding requirements (Kellner and Bosch, 2003).

Today, there is consensus on the need to see natural resource management in terms of long-term sustainability. This has led many people to argue that in order to ensure a more socially and ecologically sound approach to natural resource management, it is necessary to understand, respect and utilize the local knowledge systems. There is now an increasing awareness among development practitioners, extension workers and development agencies of the interrelationship that exists between conserving natural resources, food security and poverty alleviation in developing countries. Local people have a wide knowledge of the ecosystem they live in and ways to ensure that natural resources are used sustainably. Therefore, IK that has been accumulated over centuries has potential value for sustainable development. As observed by Ulluwishewa (1993), historical evidence shows that some communities have utilized natural resources over centuries without impairing their capability to support them and their successive generations. It follows then that the IK of resource management is capable of providing a valuable information base which could be used (with adaptations) in the management of natural resources for sustainable development.

IK represents the richness of the indigenous or traditional communities. It is a key element of the social capital of these communities; their main asset to invest in the struggle for survival, to produce food, to provide for shelter or to achieve control of their own lives. Any strategy to alleviate poverty should therefore recognize what the poor have, instead of what they do not have, and should transform their creativity into asset-creation. In Tanzania, the recovery of Shinyanga's agropastoral economy on a scale of hundreds of thousands of hectares through an indigenous natural resource management system known as *Ngitili* (Box 4.9), attests to the role of traditional land management practices in nature conservation and socio-economic development (Mlenge, 2004).

In Tigray, Northern Ethiopia, the local communities have successfully used traditional knowledge and institutions to conserve natural resource (Box 4.10).

Box 4.9: Ngitili System in Shinyanga, Tanzania

After decades of felling trees and clearing bushes to eradicate tsetse fly in Shinyanga region in Tanzania, Hifadhi Ardhi Shinyanga (HASHI) project embarked on a major restoration effort based on the traditional practice of restoring vegetation in protected enclosures or *ngitili* (Sukuma term for enclosure). Traditionally, *ngitili* were used to provide forage for livestock, especially oxen, at the end of the dry season when villagers plough their land. Vegetation and trees were nurtured on fallow lands during the wet season so that livestock fodder supplies are available for dry months. There are two types of *ngitili*: enclosures owned by individuals or families, and communal enclosures owned and managed in common. Both were originally developed by the Sukuma in response to acute animal feed shortages caused by droughts, the loss of grazing land to crops, and declining land productivity.

The HASHI project is being implemented by the Tanzanian government. It is based on the rich ecological knowledge and strong traditional institutions of the agro-pastoralist Sukuma people who live in the region. By 2004, 18 years into the project, at least 350,000 hectares of *ngitili* had been restored or created in 833 villages, encompassing a population of 2.8 million (Barrow and Mlenge, 2004). Residual natural seed and root stock have been used to restore *ngitili* enclosures. At first, active tree planting (first of exotic species, later of the indigenous tree species preferred by local people) was carried out, especially around homesteads. Some of the restored *ngitili* dated back to pre-villagization days. Others were newly created by farmers and villages.

In addition to restoring *ngitili*, implemented by the Tanzanian government, villagers were encouraged to plant trees around homesteads (particularly fruit and shade trees), field boundaries, and farm perimeters. This helped improve soil fertility and provide firewood, and had the side benefit of helping farmers to formalize their land rights within villages. Of the 16 natural products commonly harvested from *ngitili*, fuel wood, timber, and medicinal plants were found to be of greatest economic value to households (Monela *et al.,* 2004). Other valuable outputs included fodder, thatch-grass for roofing, and wild foods such as bush meat, fruit, vegetables and honey.

Source: WRI (2005)

Box 4.10: Use of Indigenous Natural Resource Management in Tigray, Northern Ethiopia

This case study partly illustrates the evolution of existing traditional institutions to address natural resource issues within a changing policy and tenure environment. The initiative was aimed at controlling soil erosion, managing grazing lands and forests in the Ethiopian Highlands. During the Derg regime, soil erosion problem was addressed through development of large-scale Soil and Water Conservation (SWC) activities supported by

"Food for Works". This approach was however essentially top-down and emphasized physical structures constructed with little attention paid to their impact on productivity. Farmers did not generally view this approach positively, and after the fall of the Derg, they destroyed many such structures. In relation to grazing land, under the mixed crop-livestock system, certain areas of village land are put aside for grazing particularly for oxen. In the Eastern Zone, there are two different systems of grazing land management. The predominant system is known as *hizati* where grazing land is common property and is managed at village (*kushet*) level. A less common system involves the division of grazing land to individual households. The problem in relation to *hizati* is primarily the pressure to convert such land to crop production or divide it to individuals, the problem actually intensified after the fall of the Derg due to the return of forced settlers and demobilized soldiers.

In relation to forests, there was only one substantial area of forest remaining in the Zone, the Dessa'e forest, covering about 125,000 ha. This forest area was managed for decades by local communities under the traditional *rist* land tenure system. Although this system was abolished by the Derg regime in 1975, the use-right system which replaced it was to some extent based on the traditional *ristegna* groups, so local communities continued to manage the forest. Essentially, the system enabled local communities to regulate forest use and in particular, to restrict claims of outsiders. Growing pressure on forest resources, particularly in the southern parts of the forest close to the urban centres of Mekelle and Qiha, and occasional incursions by Afar pastoralists, increased the pressure on the forest area. In 1991, following the fall of the Derg, the forest was gazetted as State forest.

The main institutional innovation, however, was the development of the *baito* system, which is essentially a system of local democracy, developed by the Tigrayan People's Liberation Front (TPLF) during the civil war, based on direct election of representatives at village (*kushet*) and inter-village (*tabia* or *kebele*) level. *Tabia* representatives then make up the *woreda* council, which has major responsibilities for planning and implementation of local development. At *tabia* level, social courts have been established, which amongst other tasks, deal with conflicts over sharing of natural resources.

The *baito* system facilitates detailed discussion at local level of development problems, including those of a common property nature. There are a number of strengths of the system: (i) it provides a forum to address local externalities such as degradation in upstream catchments, (ii) it is used to mobilize communities to directly deal with specific problems, both through labour mobilization and through rule-making and resolution of conflicts over resource sharing; (iii) the system is part of the overall governance system developed by the TPLF in Tigray, and therefore, there is a clear channel for natural resource issues to enter into the policy arena at regional level. In essence, the *baito* system, partly building on traditional community-based institutions, has enabled the region to mobilize significant social capital to resolve natural resource problems, in a way that was impossible during the Derg regime.

The *baito* structure provides the framework both for discussing the need for reducing land degradation and for mobilizing the social capital to undertake different SWC measures. Pilot participatory watershed management activities are now being developed to integrate conservation and productivity concerns. Since the takeover by the TPLF, there has been a tendency for grazing land to be managed at *kushet* level, whereas previous management in some areas was at *tabia* level. This localisation of management is one step in the planned intensification of resource use. Currently, there are pilot programmes in grazing land enrichment on *hizati* grazing areas. In relation to the Dessa'e forest, its designation as State forest and exclusion of the communities from using the forest has led to deforestation since communities now have no incentive to exert control. Outsiders and local people alike now take wood illegally, particularly under drought conditions. Discussions with local communities have clearly indicated that they will exercise locally sustainable management approaches of the forest if they can also derive benefits from it.

Source: Chisholm (1998)

The main lessons learned in this case study are as follows:

- Traditional forms of natural resource management are usually present and respond flexibly to changing situations such as increased pressure on resources;
- Indigenous Knowledge Systems are key in mobilizing rural people in environmental management. We must start from what the people know and what they appreciate;
- Forms of local democracy provide a forum to mobilize social capital around Natural Resource Management issues; such institutions are more likely to be effective if they are related with traditional community-based structures; and
- New institutions need mechanisms (such as *tabia* councils and social courts) to address externalities at catchment level, i.e. above the level of individual communities.

This combination of a form of local participatory democracy with more traditional, long-standing but flexible Natural Resource Management Systems is widely replicable, except perhaps in a highly stratified society.

Methods of Recording IK

Various methods have been used by researchers from various fields to collect data on indigenous knowledge. Some of the key ones, their purposes and values are outlined below as in IIRR (1996):

- *Identifying indigenous specialists:* This employs informal questioning and diagramming to identify individuals with specific know-how. This method quickly generates a list of individuals with specific skills or characteristics;
- *Case studies:* This helps to understand a situation, a sequence or procedure of activities to learn what, how and why it happened. It is useful for investigating processes such as documentation of activities from last to first step and investigates changes over time;
- *Field observation:* It supports the collection of supplementary data, validate information gathered through other means to learn and record IK. It helps discover new IK and see familiar IK in practice;
- *In-depth interviews:* These help uncover details about the who, what, where, when, how and why of practice, technologies and believes and tools.

Interviews help draw out the perceptions and experiences of individuals, experienced in their own words;

- *Participant observation:* It helps in the collection, understanding and validation of field data. It helps in learning and understanding IK and its advantages and problems from the community perspective;
- *Participative technology analysis:* It gives an understanding of different elements of a technology or technique, their uses and the local peoples reasons for using them. It helps in recording and validating indigenous technique, and helps outsiders and insiders discover local technologies upon which to build;
- *Surveys:* They help generate baseline and evaluation data and answer questions identified using other methods. They are useful when identifying and documenting IK practices and their cultural context;
- *Brainstorming:* It helps to pool the knowledge of several people to collect as much information on a topic as possible, and can produce a quick overview or rough assessment of IK on a specific subject;
- *Games:* It is used to build rapport, generate insights and encourage participation in discussions, and can be used to bring important concepts to the fore;
- *Group discussions:* Help generate information and build consensus, and clarify information on documents. They can help facilitator learn local terms and concepts;
- *Role play:* It captures movements, actions, sequence, roles and relationships of people, things and practices, and reveals to outsiders the what and how of IK;
- *Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis:* It helps the gathering, analyzing, evaluation of information and identifying strategic options facing a community, organization or individual at a given time. SWOT is used to learn how community members value their IK and how they can optimally use it.

When studying IK for both documentation and adoption purposes, there are important steps that are recommended. Figure 4.2 presents steps to follow in identifying IK relevant for a given CBNRM project.

Strengths and Weaknesses of Indigenous Knowledge in CBNRM

Strengths and weaknesses of IK have to be understood in order to know the conditions under which the knowledge can be used. The following are some of the strength, weaknesses and the challenges in using IK.

Strengths

- As they use resources and daily interact with nature, local people have a lot of accumulated knowledge about natural resources which can be used to improve its management.

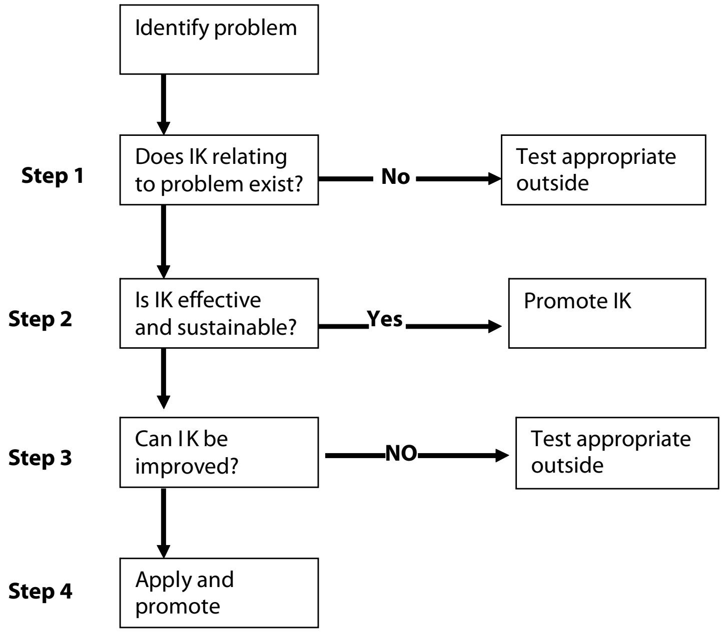

Figure 4.2: Steps in Identification of Appropriate Indigenous Knowledge

Source: IIRR, 1996

- Local systems of management of natural resources are cheap to implement because they make use of locally available resources and skills.
- Traditionally defined rights and locally promulgated rules foster community unity.
- Traditional natural resource management systems promote relatively equitable access to resources by weaker and poorer members of the society.
- Local knowledge systems and practices help in maintaining the cultural values of a community.

Weaknesses

- IK is oral and is verbally transferred through generations, and therefore vulnerable to loss and distortion.
- Common property rights as used in most traditional land-use systems are often susceptible to abuse (tragedy of the commons) especially where the traditional institutions have collapsed.
- Indigenous practices often adapt slowly to new challenges and therefore may not deliver the much-needed sustainable development if not integrated with modern techniques.
- Despite its relevance and potential for wide application in CBNRM, IK faces a number of threats, among them, the following:

- Overemphasis of formal education at the expense of traditional education systems is one of the main obstacles to promotion of IK.
- In many cases, the IK local people refer to is often old with little or no relevance to current situations. Often, the older generation is being replaced by younger ones who have limited interest. As a result, some IK being passed on is not authentic.
- Globalization incorporates the indigenous and minority communities into the larger society, and this leads to loss of autonomy and with it much of the indigenous knowledge and practices.
- IK systems are currently at the risk of extinction because of rapidly changing natural environments (including desertification, climate change and loss of biodiversity), and economic, political and cultural changes on a global scale. The practices can vanish, as they become inappropriate for new challenges.
- Piracy of IK due to lack of awareness on intellectual property rights among the owners of indigenous skills and resources.
- Unwillingness to pass on IK by the experts. This is also because these skills are confined to a few people in certain families in a community. Lack of interest to record and conserve IK because some equate use of indigenous local knowledge to backwardness and not being scientific.

Summary

The term CBNRM is used in this chapter as an umbrella term that includes "co-management", "collaborative management" and "community management". While these concepts may represent slightly different ideas and approaches to natural resource management, they all tend to emphasize a strong role for communities in the control and management of productive natural resources. CBNRM represents a paradigm shift from the old orthodoxy and mainstream view on communal property right regimes across Africa. Many governments in Africa have adopted a participatory approach to conservation as a result of pervasive loss of wildlife species and the challenges of a “fences and fines” approach. A co-managed system is developed through negotiation among the various stakeholders and can be partly based on customary practices. A CBNRM design, therefore, take cognizant of the desired end product, which is a contract between the state, user groups and other stakeholders, a contract that also recognizes conflicts of interests and can be adjusted to changing circumstances. However, there is no single or universal design of a CBNRM that suits all situations. Conflicts emerge from inequalities in access to and control over resources. Seen this way, conflicts are contending forces used by those in power as tools to maintain or restructure economic, social and political relations in the society. Conflicts are better addressed through involvement and transfer of natural resource ownership to the communities.The four pillars CBNRM are sustainable conservation, mutual benefits to the community and governing agencies, empowerment of the community to manage their own resources, and transfer of ownership of natural resources to the community.Successful Community-Based Natural Resource Management requires a transfer of power to the community, not just the right to use certain products, or invitation to participate in natural resource management.CBNRM interventions are based on the experience that under certain conditions, local people have not destroyed but rather enriched biodiversity and landscapes and that their knowledge can help to maintain stable environmental conditions, and, at the same time, maintain or reinstitute their traditional rights to resources. Recording and use of IK is a key to conserving Knowledge and experience for the coming generation.

Learning Activities

Learning Activity 4.1

1. In a small group or individually, form a strong argument for or against community managed or based NRM.
2. Identify clear role for communities, government agencies and other authorities to attain sustained natural resources management.
3. Identify preconditions or requirements for communities to effectively manage natural resources.

Learning Activity 4.2

1. Individually and in small groups, discuss key theories presented in this chapter in relation to:
   a) Key characteristics of each theory;
   b) Major strengths of each;
   c) Limitations of each;
   d) Your own or group conclusion and recommendations.

Learning Activity 4.3

1. This chapter deals with community-based natural resources management. However, other NRM approaches are also discussed:
   a) Compare and contract CBNRM with other approaches.
   b) Identify major strength and limitations of each of the other approaches in comparison to CBNRM.
   c) Share your finding with others.

Learning Activity 4.4

1. Identify other CBNRM approaches not included in the text.
2. Compare and contrast the various CBNRM approaches including those discussed in the text.
3. Identify strengths and weaknesses of each approach and recommend those applicable in a given context

4. Design simple CBNRM project outline following specific community participation principles and ensure all necessary steps are followed.
5. Present the project in class, lead discussion and answer questions from class members.
6. Finalize and submit report.

Learning Activity 4.5

1. Identify the different categories of benefits of CBNRM
2. Analyze other case studies not presented in this chapter but exemplify benefits of CBNRM
3. Present No.2 above in class or to a group for feedback
4. Finalize and submit report

Learning Activity 4.6

1. Identify specific NRM causes of conflict.
2. Analyze its causes and consequences.
3. Suggest ways of how to resolve the conflicts.
4. Present in class or to a group and get feedback.
5. Finalize and submit report.

Learning Activity 4.7

1. Select a specific natural resource (e.g. water, soil, forest, grazing land).
2. Adapt an IK recording tool relevant to the context.
3. Define method on how to engage community members actively.
4. Record and classify IK in terms of knowledge, skills, specialization.
5. Share findings with group or classmates.

Revision Questions

1. Explain the main concepts, theories, principles and frameworks of CBNRM.
2. Compare and contrast the various CBNRM approaches and draw conclusions.
3. Know tools to design CBNRM projects and be familiar on how to develop CBNRM projects.
4. Discuss the causes and consequences of various conflicts that arise from use or misuse of shared natural resources in given communities and design intervention measures.
5. Analyze the various CBNRM cases and draw lessons from them.

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Gender and Natural Resource Management

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Introduction

In a multiplicity of ways, whether in the realm of reproduction, production or income generation, men and women are differentially crucial to Natural Resource Management (NRM) in their pursuit of livelihoods. The implication of different engagements for men and women in resource use demands an appreciation of gender as key to understanding people—environment relationships and the prospects of sustainable natural resource governance. Gender identity is salient in NRM with regard to the context of culturally constructed roles and relations.

Women have unequal access to information and resources, and are under-represented in decision-making. Gender analysis in natural resources management focuses on the different roles that men and women or boys and girls play in relation to access, management and control in the use of natural resources. It particularly looks into the levels of participation in decision making by men and women. These relationships determine the benefits that women and men drive from natural resources which are important for their sustained engagement in protecting and sustainable use of these resources. In addition, gender analysis in the context of NRM determines how men and women are impacted together or differently by natural resources use or abuse.

Over the years, various tools to identify these gaps and the capacities have been developed which will be discussed in this chapter. In addition, this chapter looks into the various concepts and frameworks used for gender analysis in NRM. The chapter takes a particular view on the question of gender and natural resource management by exploring the specific concepts of gender differences. The chapter makes it possible to analyse livelihood pathways of communities and households by explicitly focusing on access to opportunities and workings of power. How gender difference is materialized through NRM practices is also presented in order to illuminate how gendered perceptions are defined and applied in NRM. The chapter presents a re-inscription of gender through case studies, historical reflections and learning activities depicting processes and practices in which gender comes to matter in people-environment relations at a variety of scales (household, community and beyond).

The overall objective of this chapter is to expose the reader to key gender issues and concerns that relate to management of natural resources in Africa and present useful approaches, tools and frameworks for undertaking specialized gender mainstreaming for sustainable NRM. Specifically, the chapter aims to help the reader to:

- Understand how natural resource management impacts differently on men and women;
- Gain knowledge, skills and understanding of tools to reinforce capacities of individual governments, civil societies and NGOs in gender responsive natural resources management;
- Understand the importance of sex disaggregated data to develop effective gender responsive policies and actions; and
- Understand the importance of women and men participating in decision- and policy- making process so that the needs and concerns of both sexes are represented equitably.

After reading the chapter, the reader is expected to:

- Demonstrate understanding of how the natural resource management impacts differently on men and women;
- Use knowledge and skill of gender disaggregated data in designing, implementing, monitoring and evaluation of natural resource management;
- Explain the use of various gender analysis tools, frameworks and approaches;
- Appropriately elicit the participation of women and men in decision- and policy- making process of NRM programmes and projects;
- Guide the process of gender mainstreaming in community based natural resource management.

Why Gender in NRM?

In parts of Africa, the sustainable management of natural resources, including forests, water, land and biodiversity, requires the involvement of multiple social actors or stakeholders, especially the local resources users (both men and women). Decision-making processes and outcomes concerning the use, management and conservation of natural resources requires a careful analysis and appreciation of problems and opportunities and working together to reconcile and integrate any underlying social issues and concerns that may be conflicting or complementary. All NRM initiatives require consideration of both the ecological and sociological aspects of natural resource management dynamics. This usually means looking at larger landscape units, such as, a watershed or a micro-watershed, a community forest or rangeland. It requires dealing systematically with the changing, and often complex interactions among components of a natural resource system or a production system, such as farming, fishing, forestry, herding, collecting edibles or combinations of these. It also requires considering the historical, socioeconomic and political forces that influence these interactions. These forces in turn are defined by such variables as class, gender, age and ethnicity.

Gender relations, like all social relations, are multi-stranded: they embody ideas, values and identities; they allocate labour between different tasks, activities and domains; they determine the distribution of resources; and they assign authority, agency and decision-making power. This means that gender inequalities are multi-dimensional and cannot be reduced simply to the question of material or ideological constraint. Agrawal (2001) and Kabeer (2003) clarify that these relationships are not always internally cohesive. They may contain contradictions and imbalances, particularly when there have been changes in the wider socio-economic environment.

Women have unequal access to information and resources, and are under-represented in decision-making. They have little or no access to important resources that could have made a difference if women were allowed to make use of and protect them. In most cases, gender neglect in natural resources in many African countries has resulted in sustained conflict between resource managers and users. This in turn has led to the failure of well-intentioned efforts towards sustainable management. There is need to reflect on and integrate social and gender equity, particularly as it relates to participation, inclusion and exclusion, decision making and power relations. For instance, Agarwal (2001) draws attention to processes of exclusion in the case of the formation and operation of community forest groups by expressing the concern that “ostensibly set up to operate on principles of cooperation, such (community forestry) groups are meant to involve and benefit all sections of the community. Yet, effectively, they can exclude significant sections, such as women”.

Many studies such as Agarwal (2001) and Cornwall (2007) improve our understanding of these key social and political processes informed by gender and other variables. However, the practical and context-specific implementation of more socially sensitive NRM interventions remains a very difficult process for many. Most of the social and gender analysis in natural resource management is primarily at the conceptual level.

Who participates in development (research) interventions, projects, programmes, and policies? How exactly? Who benefits from them? Who remains excluded or isolated? These are becoming crucial questions to be considered and integrated into intervention strategies if the aim is to support the more equitable - and sustainable - use of natural resources and the derived benefits. The challenge of integrating gender into natural resources and biodiversity research are, therefore, many (Vernooy and Fajber, 2004). Let us sample a few:

- Knowledge of and experience in social science research among natural resource management researchers and research managers is limited;
- Social science components are not well integrated with natural science components in most research efforts;
- Researchers and research organizations have different starting points, interests and expertise in terms of social and gender issues;
- 'Gender blindness' or the refusal to acknowledge the importance of gender issues is common in research and research policy making;
- Short-term training has limited impact;
- Resources in the area of gender and natural resource management in Africa are not widely available.

Farnworth and Jiggins (2003) note: “One of the strong reasons why different men and women of different backgrounds, have different [varietal] preferences is because they relate to the nature in different ways, and often at different times and places.” It is important to develop a better understanding and awareness of the social and power relations that govern access to, use of and control over natural resources. This involves understanding the differences and the inequities of social actors and is dependent on the local contexts.

As pre-requisite, it is also important for facilitating the recognition of the social and gendered nature of technologies, policies and interventions targeting NRM. Policies and technologies are value-laden; women men, and different social groups are involved and affected differently. Gender-awareness in policy and planning requires a prior analysis of the social relations of production within relevant institutions of family, market, state, and community in order to understand how gender and other inequalities are created and reproduced through their separate and combined interactions (Kabeer, 1997). Further, integrating gender in NRM creates space for social actors (women and men) to manoeuvre and to enhance the bargaining and negotiating power of vulnerable groups. This leads to empowerment and transformation where they have more access to, control over and benefits from natural resources.

Gender Concepts and Perspectives in NRM

Defining Gender

What is Gender? There is a difference between sex and gender. Sex refers to the physical and biological or morphological differences between men and women, boys and girls. *Gender* refers to the social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys (Cornwall, 2007). These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. They are contextual, time-specific, and changeable. Gender determines what is expected, allowed and valued in a woman or a man in a given context. In most societies, there are differences and inequalities between women and men in responsibilities assigned, activities undertaken, access to and control over resources, as well as decision-making opportunities. Gender is part of the broader socio-cultural context. Other important criteria for socio-cultural analysis include class, race, poverty level, ethnic group and age.

Gender is also one of the principal influencing factors – alongside race and caste or class – used for distribution of privileges, prestige, power and a range of social and economic resources. Gender defines the differences and relationships that are socially formed which often vary from people to people and place to place. Understanding these differences and similarities is pivotal in dealing with the inherent complexities of managing natural resources since the roles of both men and women are perceived differently.

The significance of this in NRM is that the lives and experiences of women and men, including their pursuit for livelihoods, occur within complex sets of differing social and cultural expectations and relations. The term *gender relations* is concerned with the relationships between people and their broader community. These relationships vary with the sex of the people concerned. For example, the relationship between villagers in a given community and their local government entity is a gender relationship, if men and women experience different benefits and controls from it. Effective NRM requires participation of all members of communities which includes men and women at the centre. Understanding of these relationships will help to maximize the contributions of both sexes. The differences due to sex are universal and unchanging.

Gender roles and *relationships* are the assigned activities and relative position in society of men and women. They help to determine access to opportunities and resources based on local cultural perceptions of masculinity and femininity. Gender relations have been identified as important determinants of the capacity for collective action for NRM. Understanding gender differences in several aspects of social capital for NRM is crucial and should be ultimately mainstreamed in development planning. In NRM, gender analysis:

- Aims to achieve positive change for both men and women;
- Examines the differences in women's and men's lives, including those which lead to social and economic inequity for any gender group, and applies this understanding to NRM practice, policy development and service delivery.

Gender analysis in NRM is the process of assessing the differential impact of proposed and/or existing NRM initiatives on men and women of different characteristics. It makes it possible for natural resources to be managed with an appreciation of gender differences, of the nature of relationships between women and men and of their different social realities, life expectations and economic circumstances. It also enhances the understanding of social processes and for responding with informed and equitable options. Gender analysis recognizes that:

- Different strategies may be necessary to achieve equitable outcomes for women and men and different groups of women;
- The life experiences, needs, issues, and priorities vary for different groups of women dependent on age, ethnicity, disability, income levels, employment status, marital status, sexual orientation and whether they have dependants;
- Lives of women and men, experiences, needs, issues and priorities are different within and across;
- Women's lives are not all the same; the interests that women have in common may be determined as much by their social position or their ethnic identity as by the fact they are women.

Gender analysis aims to achieve equity, rather than equality. *Gender equality* is based on the premise that women and men should be treated in the same way. This fails to recognize that equal treatment will not produce equitable results, because women and men have different life experiences. *Gender equity* takes into consideration the differences in the lives of women and men and recognizes that different approaches may be needed to produce outcomes that are equitable. Gender analysis provides the basis for robust analysis of the differences between women and men's lives, thus removing the possibility of basing analyses on incorrect assumptions and stereotypes. Frameworks and tools for gender analysis are presented later in the chapter.

The Evolution of Gender Perspectives in NRM

The genealogy of gender and natural resources debates is well documented in the literature. According to Resurreccion and Elmhirst (2006) two key strands may be identified:

i) Liberal correctives to gender-blind scholarship within development policy and practice; and
ii) Relational perspectives that emphasize binary power relations between men and women. Common to both is a sense in which experiences of the NRM

are differentiated by gender through the materially distinct daily work activities and responsibilities of men and women.

Consequently, men and women hold gender-differentiated interests in natural resource management through their distinctive roles, responsibilities and knowledge. Gender is thus understood as a critical variable in shaping processes of ecological change, viable livelihoods and the prospects for sustainable development. However, relational perspectives on gender purport to give greater emphasis to the dynamics of gender, emphasizing power relations between men and women over resource access and control, and their concrete expressions in conflict, cooperation and coexistence over environments and livelihoods.

In recent years, new work in this area has been influenced by feminist and post-colonial theories. These theories effectively destabilize 'gender' as a central analytical category. They explore multidimensional subjectivities, emphasizing how gender is constituted through other kinds of social differences and axes of power such as race, sexuality, class and place, and practices of 'development'. The feminist approach to gender were intensified earlier on through the United Nations' World Commission on Environment and Development (Brundtland) report in 1987, and the United Nations Conference on Environment and Development (UNCED) in Brazil in 1992, where alliances amongst feminist activists from across the world were forged to produce the Women's Action Agenda 21 (Leach, 2007). This effectively linked concerns with women and gender with environmentally sustainable development: both having been traditionally marginal issues on the development agenda (Dankelman and Davidson, 1988).

Aspects of eco-feminism and Women, Environment and Development (WED) posited natural connections between women and environmental resources, indicating that rural women are the unrecognized caretakers of the nature’s assets, and in whose care the Earth and its resources had better chances of surviving for future generations (Sontheimer, 1991). The logic of WED' was that women were adversely affected by environmental degradation due to an *a priori* gender division of labour in which they are usually assigned reproductive roles. Both in terms of exploration of the 'feminine principle' in human nature relationships and in the analysis of gender divisions of labour in NRM, the emphasis had been clearly on women and women's roles (Cornwall, 2007).

This feminist notion is clearly challenged from the viewpoint that women have fixed caretaker roles and that they may just end up being key assets to be 'harnessed' in resource conservation initiatives (Rocheleau, 1991). These challenges were also reflected in the advancement of Women In Development (WID) that saw women as a stand-alone homogeneous group with a set of static and predefined roles that translated into their disadvantaged social lives (Rathgeber, 1990). Over the years, there have been strong arguments for more context-specific and historically nuanced understandings of the relationship of specific groups of women with specific natural resources, especially as these are mediated by their complex relations with men, kin and other social actors. Many other schools of thoughts and perspectives have subsequently emerged with a focus on the dynamic nature of social and political relations and contextual analysis, rather than universal assumptions and essentialist views of men's and women's engagement with nature. Besides the gender analysis approach associated with Gender, Environment and Development (GED) Green, *et al.*, 1998) emphasize the material aspects of the gender-environment nexus, in particular, gender divisions of resource-based labour and culturally specific gender roles.

Table 5.1: Key Conceptual Differences Between WID and GAD

Characteristic	**WID**	**GAD**
Focus	Women and their exclusion from development initiatives.	The socially constructed relations between men and women, and the subordination of women.
Perceived core problem	Women's exclusion	Unequal power relationships
Goal	Women's inclusion and more effective development.	Equitable and sustainable development, appropriate participation and decision making.
Solution	Full integration of women in development process.	Empowerment and social change
Main strategies	Women's projects; increasing women's productivity and income; increasing women's ability to look after the household.	Reconceptualising the development process taking gender and other inequalities into account; identifying and addressing practical needs of women and men; addressing women's strategic interests; addressing strategic interests of the poor and marginalized.

Source: Adapted from Connelly et al., (2000).

As a response to the above concerns, the Gender and Development (GAD) emerged as an approach that allows space to comprehensively consider other kinds of gender relations that may be significant in people's lives beyond conjugal partnerships. For example, seniority, status, co-sanguinity (Cornwall, 2007). In GAD, gender is seen as structuring people's interactions with and responses to environmental change or shaping their roles in NRM. It also emphasizes the ways in which changing environmental conditions bring into existence categories of social difference including gender. In other words, gender itself is re-inscribed in and through practices, policies and responses associated with shifting environments and natural resource management, and whilst inherently unstable, through repeated acts, it comes to appear as natural and fixed. This approach moves away from single focus on women and individual gender groups in relation to nature. Table 5.1 summarizes the key conceptual differences between WID and GAD approaches. While Table 5.2 presents key milestones in the evolution of gender concept.

It is to be noted that some authors distinguish a third approach—Women, Environment and Development (WED), (Leach *et al.*, 1995). The WED approach has portrayed women as key users and managers of natural resources based on a special (nurturing) relation with nature. As none of the six case studies exemplifies a WED approach, we do not provide further details.

Table 5.2: Major Milestones in the Evolution of Gender

Year	Global actions
1975	Mexico Conference for Women agreed on a women's decade
1981	Convention on Elimination of all Forms of discrimination Against Women (CEDAW)
1985	Nairobi Looking Forward Strategy was held which brought about the Women In Development (WID) approach.
1992	In 1992: The Rio Declaration which came up with Agenda 21 and has chapter 24 focusing on women
1993	Human Rights Conference in Vienna
1994	The Cairo Conference on Population
1995	The Beijing Conference
2002	World Summit on Sustainable Development which came up with the Millennium Development Goals (MDGs)
2005	Beijing+ 10 in New York

Basic Tenets of Key Gender Perspectives

Women In Development (WID): WID first came to prominence in the early 1970's as an approach to include women in development. It emerged from a notion that women are untapped resources who can provide an economic contribution to development in their countries. Research and information collected throughout the UN Decade for Women (1975-85) highlighted the existing poverty and disadvantage of women and their invisibility in the development process. Different policy responses and interventions focused on women as a separate group. This resulted in women's concerns being "added on'' and being peripheral to mainstream development efforts. WID policies and interventions have in the main concentrated on women's productive work. The failure to make an explicit link with their reproductive work often adds to women's workload. Focusing on women in isolation means that unequal gender relations in various social and economic settings remain unaddressed. The proponents' assumed that women do not have a contribution in the economy. Yet in sub-Saharan Africa, women are the ones who take up agriculture but their reproductive roles are not put into consideration. In the context of NRM, WID focuses on the inclusion of women in NRM activities already designed and the approach does not go far enough to analyze the different roles men and women play in NRM.

Women and Development (WAD): WAD came up as a criticism of WID. This was brought about by developing world feminists. Hence, there was need to think of women away from the patriarchal structure and showing their contribution. The focus was equity. This approach was faced with strong resistance in most of the developing countries as being western and which did not respect traditional values and cultures.

Gender in Development (GID): The GID emerged in the late 1980's as an alternative to the prevailing Women In Development approach. Unlike WID, which focused on women only, and called for their integration into development as producers and workers, GID focuses on the interdependence of men and women in society and on the unequal relations of power between them. The GID approach aims for a development process that transforms gender relations in order to enable women to participate on an equal basis with men in determining their common future. The GID approach emphasises the importance of women's collective organization for self empowerment.

Gender and Development (GAD): GAD looks at society holistically. This means not excluding the men. The ultimate goal of the GAD is empowerment. However, this has been potentially challenging with emphasis on Third World and women's self reliance, and largely, unsupported by governments and agencies. It is meant to help countries achieve transformation, socialization and attitudes in the development process.

In addition to these perspectives, other concepts like empowerment, equity and equality have evolved and are in use in various aspects of social analysis of NRM. *Empowerment* refers to the "collective undertaking, involving both individual change and collective action.'' It means developing an individual's or community's ability to collectively and individually take control over their own lives, identify their needs, set their own agendas and demand support from their communities and the state to see that their interests are responded to. In most cases, the empowerment of women and men in society requires transformation of the division of labour and of society (see Sarah Hlupekile Longwe's Framework in Longwe, 1991).

Gender equity refers to fairness and justice in the distribution of benefits and responsibilities between women and men. The concept recognizes that women and men have different needs according to their roles and responsibilities as well as power, and that, these differences should be identified and addressed in a manner that rectifies the imbalance between the genders, especially in managing and distribution of benefits derived from natural resources. Gender equity is concerned with the promotion of equitable personal, social, cultural, political, and economic benefits for all.

The term gender equity emerged out of a growing recognition in society of pervasive gender inequities. Continuing traditions of stereotypical conceptions and discriminatory practices have resulted in the systemic devaluation of attitudes, activities and abilities attributed to and associated with girls and women. The negative consequences of stereotypical conceptions and discriminatory practices adversely affect males as well as females. However, in the short-term, greater emphasis in the gender equity initiatives need to focus on improving conditions and attitudes as they affect girls and women. In the long-term, these initiatives will also improve the situation for boys and men. In NRM, the gender equity concerns are related to equitable access to and control of natural resources by both men and women and boys and girls.

Gender equality refers to equal treatment of women and men in all aspects of development including laws, policies and opportunities as well as access to all resources and services in families, communities and society at large. It implies the absence of discrimination on the basis of the person's gender with respect to opportunities and the allocation of resources or benefits. In the context of international human rights, the legal concept of gender equality is enshrined in the 1948 Universal Declaration of Human Rights as well as in the 1979 United Nations Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW). The Convention which has been ratified by 100 countries, including Kenya, states clearly and unequivocally that "discrimination against women violates the principles of equality of rights and respect for human dignity." The governments of the world reaffirmed their commitment in 1995 to "the equal rights and inherent human dignity of all women and men" in the Beijing Declaration and Platform for Action.

Gender and Specific Natural Resources

Gender and Land

Food is the basic requisite for survival. Its absence disrupts the link between the environment and survival. Lack of food may be the result of a variety of factors ranging from the lack of land or infertile piece of land, lack of rain, lack of fuel to prepare it and others. These factors are essentially environmental and one could safely assert that environment crises automatically lead to food crises.

Food production is an economic activity which takes place within the natural environment sustained by natural resources. Deterioration of the environment threatens the provision of food. For instance, in Kenya the resource base has been affected by overstocking, water and soil pollution (Muia, and Otiende, 2004).

As land managers, women play a central role in food production. Their activities determine the amount of food available for consumption in the house and provide 60-80 per cent of the labour required in the country (Kameri-Mbote, 1992).

In Kenya, agricultural policy stresses food production with the aim of achieving self-sufficiency (Wanjama, 2004). The determining factor in this respect is women. Of the total Kenyan population, 75 per cent are to be found in the rural areas. Of this, 60 per cent are women who must ensure adequate food for their families regardless of the poor quality of the land (Kameri-Mbote, 1992). Unfortunately, women in Kenya and other African countries do not own land. Both modern land distribution systems and customary land ownership exclusively bestows land ownership to the male counterpart. It means that women cannot use such land as collateral to obtain credit facilities. This also means that women cannot invest on sustainable land management practices which limit their creativity and actions. There is an urgent need for legal and policy instruments to consider women as part and partial of new processes of natural resource management. If we are serious to accelerate promotion of sustainable livelihoods at the community level, women must be given the right to inherit land and have access to recourses and credit. In Kenya, the new constitution has recognised land ownership and inheritance by women.

Gender and Forests

All over Africa, women play a big role as managers of natural resources. Forests are important to subsistence farmers in many ways for which women assume primary responsibilities. Forests maintain atmospheric balance by protecting watershed; protect soil from erosion, attract rain, provide bio-fuel, food and medicine – vegetables, wild roots, medicinal leafs, tubers and honey – and provide grazing grounds. Through each of the above activities, women come in contact with forests daily and have been at the forefront of forest protection and a forestation programmes locally, nationally and globally. Unfortunately, they have not been involved in the decision making on the conservation of these forests.

Depletion of forest resources severely increases women’s labour, especially with regard to the time required to gather fuel-wood and the cost of purchasing it. Without adequate fuel-wood for cooking, household nutrition may be negatively impacted. Without access rights to trees and forests, women’s ability to survive is limited. Access to particular non-timber forest products, such as honey and fodder, is often guided by traditional and cultural norms, regardless of whether they are collected for subsistence or for market. Knowledge of trees and other forest products by both women and men should be incorporated in forest management and conservation plans. Including and applying this often heavily gendered traditional and indigenous knowledge can be critical to the success of a project.

Gender and Climate Change

It is becoming clear that *vulnerability* to specific impacts of climate change will be more severe when and where they are felt together with stresses from other sources.[1] The UNEP GEO-4 report has highlighted the increase in human vulnerability caused by effects of climate change on biodiversity and ecosystem services, such as water and food supply. The Intergovernmental Panel on Climate Change in its fourth assessment report (IPCC, 2007) has further predicted that climate impacts will be differently distributed among different regions, generations, age, classes, income groups, occupations and genders and that the *poor*, primarily but by no means exclusively in developing countries, will be disproportionately affected, while the UNDP 2007 *Human Development Report* states that climate change is likely to magnify existing patterns of gender inequalities.

One of the most apparent examples can be found in the agricultural sector in Africa, where women constitute a majority (70%) of the workforce (Todaro, 2003). As weather patterns change and extreme weather events are expected to increase in number and magnitude, women will be affected more. It will become increasingly difficult for women to follow the traditional growing and harvesting cycles and provide for subsistence of their families. For example, as wells and springs dry up because of droughts and climate change, both men and women suffer, but the ones who suffer most are women because it is women who walk long distances to fetch water. One way of addressing such issues is by involving women in the design, implementation, monitoring and evaluation of the above projects, because they are the ones who bear the heaviest burden when water is scarce.

Since men and women hold gender differentiated interests in natural resource management through their distinctive roles, responsibilities and knowledge, gender, therefore, must be understood as a critical variable in shaping processes of ecological change, viable livelihoods and the prospects for sustainable development. (Sontheimer, 1991).

Jackson (1993a, 1993b) was among the first to propose that gender analysis should focus on power relations between women and men and that women be treated as a disaggregated group of subjects as gender roles are socially and historically constructed are and being continually reformulated. He challenged the idea of women as a natural constituency for environmental projects, underscoring the contingent nature and fluidity of gender interests.[2] It is also clear that various studies hold views that gender is relational (Meinzen-Dick and Zwarteveen, 1998; Agarwal, 1997; Guijt and Shah, 1998; Cleaver, 2003; Colfer, 2005; Momsem, 2007): involving the interaction of men and women, structured through norms and institutions, reconfigured through individual agency. This is an indication that gender is salient within policy and practice across a variety of scales, and within institutions central to natural resource management; from gendered property relations to the gendered positions of actors within organizations charged with

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1 A fuller account of effects of climate change is discussed in Chapter 6.

2 See Moser, 1993, for more details of practical and strategic gender needs in the wider field of gender and development.

governing or managing natural resources. This is the more reason gender-blind scholarship within development policy and practice is questionable. Expressing feminist environmentalism, Agarwal (1992, 1994) emphasizes the material aspect of gender, in particular, gender divisions of resource-based labour and culturally specific gender roles. His political ecology draws focus on resource access and control, and gendered construction of knowledge. This is a discussion that is geared towards capturing the gender-environment nexus in various geographical and resource use contexts, for instance, in forestry, land and agriculture, and water (Tinker, 1997; Cranney, 2001; Rocheleau, 1984; Leach, 1994; Sachs, 1996).

Studies on the victims of climate-change-related-disasters both in developing and developed world have shown that it is the economically and socially weaker groups who suffer most. To a larger extent, this group consists of women (Todaro, 2003 p.230). The impact of environmental degradation on the economic and social well being of the world community has become very severe and is expected to deteriorate. We can no longer carry on business as usual. Each individual government and the world community as a whole, have to re-think the way it operates, or else, the timely achievement of the MDGs or Vision 2030 becomes increasingly unrealistic. Due to their gender differences, adaptive capacities of men and women also differ (Figure 5.1).

Figure 5.1: A Maasai Pastoral Woman (Left) Unable to Compete With Men (Right) in Securing Watering Rights for Livestock in Kajiado, Kenya.

Photo by W.O. Ochola, 2007

The gender differentiated impacts of environmental degradation exacerbated by climate change require the integration of gender perspectives in design and implementation of policies and laws to capture economic and social opportunities that have so far been neglected. For example, after the over exploitation of the woodland cover that led to lack of firewood in Kambiri area of Kenya, women's project of re-forestation led to increased vegetation cover, increased soil fertility, availing firewood and reducing over exploitation of the nearby forest. Food and

Agriculture Organization (FAO) has acknowledged these initiatives as instrumental in addressing the consequences of the emissions of green house gases in Africa There are a number of factors that continue to constrain the development of gender responsive policies and strategies:

Firstly, for a full understanding of the connection between gender and the environment within the context of climate change, *the collection of gender-disaggregated data in key sectors,* such as agriculture, forestry, fishing, energy and water is mandatory. *Secondly*, to ensure that *policies are truly gender responsive*, the concept of gender has to feature throughout the life-cycle of a policy, i.e. *design, implementation, monitoring and evaluation,* meaning that gender sensitive indicators have to be developed. *Thirdly*, both women and men should *participate in decision and policy making process* in order to ensure that their interests are equitably represented.

The argument for the increased participation of women in natural resource management is built upon a claim that women had privileged knowledge and experience of working closely with environment (Apusigah, Dec. 2009 pp.51-52). Since the early 1980s, considerable interest has been shown in the relationship between women and the environment. Efforts have been made to identify effects of the international environmental crisis on women worldwide. At one NGO workshop, which ran parallel to the first World Conference on Women in Nairobi (1985), the themes of women and environment were coupled for the first time at the policy level. Since then, the issue of women and environment has always played a role in the policies of both donors and developing countries. The process received a further boost in the early 1990s when the Women Action Agenda 21 was drawn up in the follow-up to the 1992 UN Conference on Environmental and Development (UNCED) (Sterling, 1999).

During the early years, the so called WED debate framed this discussion. Women's network participated in the 1992 Rio Earth Summit. The policy document *Women's Action Agenda 21* and the Planet Femea event held at the Global Forum at Rio helped to infuse a gender perspective into the output of the Rio Summit. Because of these activities, gender is now an established item on the international environment and development agenda.

The above issue was highlighted further when 189 heads of states and Governments from the North and South, as representatives of their citizens, signed onto the Millennium Declaration at the 2000 UN Millennium Summit where special emphasis was drawn to *promote Gender Equality and Empower Women* as its seventh goal to be achieved by 2015. This Millennium Declaration gave a further boost to the issue of linking women and environment at the policy level to frame effective policies, which can be beneficial to all.

Gender and Fisheries

The role of women and men in the management and use of natural resource-based livelihoods such as fisheries in Africa has already been acknowledged but has rarely been valued on an equitable basis. In many fisheries, women have traditionally occupied the pre and post-harvest sector concentrating on financing the fleet, processing and marketing the catch. The many concerns in this sector are evident in many fish landing bays in the region. Further, women have also had to look after the household unit taking care of the family's educational, health and dietary needs. It is increasingly becoming important to take a gendered view of natural resource management, although this view is still rare in the fisheries sector. The social space occupied by women in the fish industry has remained invisible to researchers, policy makers and other actors in the sector. This has been attributed to cultural stereotypes. The minimal documentation on women's role in the sector can be explained by a number of factors.

Figure 5.2: Fishing as a Natural Resource Exploitation Activity Requires Understanding of Underlying Gender Issues.

Photo from Mzondwe Village- Mozambique (Credit: Henrich Böll Stuftung)

Firstly, the debate on fish catch and production goals and solving the 'over-exploitation' problem is dominated by men and continues to dominate national policy agendas. As a result, research attention continues to be focused on the catching sector (male dominated) rather than the processing and marketing sector (female dominated). *Secondly*, research which purports to be gender-neutral is often 'genderblind' and fails to see the bigger livelihoods picture. Gender roles in the fisheries sector are dynamic and have to change in relation to each other and their activities in order that livelihoods are protected and the ultimate goals of food provision, family security and socio-economic advancement can be attained. Box 5.1 summarizes a case of fisheries related gender issues in West Africa.

Box 5.1: Gender and Fishing in West Africa

Many fisheries throughout the West African region are pre-financed by women who, because they often control the processing and marketing sectors, are the most readily available source of credit. Women are involved in many complex networks and alliances that enable them to negotiate access to fish and market them successfully. There is thus, a symbiotic relationship between the women and men in the fishing industry: neither could survive without the other. Economic reforms and recent global trends have radically changed the context within which the fisheries sector operates in West Africa. Many countries in the region face competition from foreign fleets. This is putting added stress on stocks and catches. Environmental factors, notably the continued erosion of the coastline in the Bight of Benin, are affecting the ability of communities to fish. Globalization is also changing the context within which fishing-dependent communities and artisanal fish markets operate and is impacting upon gender relations and how these are negotiated. In particular, the innovative coping strategies developed to confront these challenges need to be documented and understood.

The establishment of gendered social space across the industry is neither static nor guaranteed and only exists in its current form because it is constantly changing - its dynamism driven by the needs of men and women to provide an income for their families and to protect their livelihoods. Whilst in many societies fishermen's income is theirs to spend as they wish, income received by women from their activities has to be spent on upkeep of the household - providing a real economic and financial incentive for women to innovate in order to ensure that all their needs (housing, health, education and nutrition) are met. The economic environment of the fishing-dependent community can have a dramatic effect on the ability of the women to be "active agents of change". Although the situation of women involved in fish processing is often more stable than that of men (women frequently have access to greater wealth, more credit, etc.) their vulnerability due to a lack of control over this wealth was telling.

Source: Based on Article by Bennet (2005)

Gender and Community Based NRM Institutions and Groups

Community Based Natural Resource Management (CBNRM) is based on the premise that local populations have a greater interest in the sustainable use of resources than the state or corporate organizations. The local communities by virtue of their everyday practices have an enhanced knowledge of local ecological processes and that these communities are more able to effectively manage resources through local forms of access (Tsing *et al.,* 2005). Interest in CBNRM has coincided with specific efforts to target gender equity in policy interventions through gender mainstreaming, which theoretically inserts gender concerns across policies and development practices at a number of levels (McIlwaine and Datta, 2003; Molyneux, 2004; Radcliffe, 2006). This institutionalization of gender should not lose its focus by slipping into a focus on women alone but this should be a tool to address messy politics of gender equality and equity.

The most appropriate strategy to reach and assist greater numbers of rural women is to integrate them in mainstream agricultural services and resources management. The integration of women in agricultural programmes can be achieved by specifically including them as target in all major agricultural and natural resource management components, such as credit, technological skills and other trainings, delivery of extension and inputs, access to expanding markets, agricultural research, natural resource management research and education and price support of agricultural products.

The changes needed to make existing policies; programmes and projects gender sensitive will require close monitoring and evaluation and are best achieved by pressure from groups within countries. The role of Community Based Organizations (CBOs) and Non-Govermental Organizations (NGOs) in leading and setting an example is now being recognised. The holistic approach, which forges links between all stakeholders, including the various ministries of governments, NGOs and CBOs, the private sector, the academic community and the broader civil society is over due. The management and social sustainability of CBNRM institutions is also gender-bound. According to Westermann and Ashby (2008), the different and complementary roles of women and men in social capital formation for NRM occur in different forms:

i) Women and men commonly depend on different kinds of social relations or networks;
ii) Women and men may value collaboration differently with women often having more everyday experiences of informal collaboration based on reciprocal relationships and higher dependence on social relations for access to household resources;
iii) Women are better able to overcome social division and conflicts because of their greater interdependency and their everyday experiences of collaboration.

Any examination of the complex causal relationships between gender and collective NRM through different gender-related stocks and usage of social capital requires an innovative three-dimensional framework that combines elements of gender analysis, collective NRM, and social capital based on previous frameworks developed for environmental collective action. Box 5.2 illustrates a case of gender complexities in management of CBOs.

Box 5.2: Gender Issues in CBO Management: Case of Nomadic Integrated Development and Research Agency (NIDRA)

NIDRA is a Community Based Organization (CBO) in Kajiado district - Kenya started in 1997 by women in response to the impacts of HIV&AIDS with a desire to care for orphans. After gaining registration by social services, the group got financial assistance from Arid Lands Resource Development Programme (ALRDP) and engaged in buying, fattening and selling of steers. NIDRA converted to an umbrella organization with over 50 women groups across Kajiado district. It has received funding from many development partners. Each women group has between 17 – 20 members. There were initial challenges including men "feeling threatened" as the group grew bigger. Current programme areas include: environmental protection, health and nutrition (mobile clinic, environment/personal hygiene, education/awareness, and immunization); food security; water and sanitation; education for girls, capacity building and Income Generating Activities (IGA); and emergency preparedness and mitigation in response to climate change and variability.

The food security activities have been driven by the women who feel overburdened due to neglect from men who have control of high value resources. The projects under IGA component are of high value thus "inviting" men to participate for guaranteed food security. Milk value addition activities include improved livestock kept by the women group - to avoid gender-related "strains" at the households. The group also carries out maize value addition activities e.g. packaging and sale, and is planning to introduce indigenous vegetable production. The activities in education include education for girls (9 – 16 years old) rescued from early marriages and circumcision. Often, after loss of livestock to drought and other disasters, the need to restock leads to pressure to marry off young girls. The capacity building and IGA activities include training of women groups on value addition, management, entrepreneurship and group dynamics.

The CBO faces a number of challenges of a gender kind including political interferences and conflicts over land and cattle ownership including access to communal holding ground. Technological challenges include appropriate milk processing plant requirements and the need to meet environmental conservation standards set by the National Environment Management Agency (NEMA). The gender issues of concern to the organization include traditional control over land and cattle by men. Women can only be members but with husbands' authority. Other gender related challenges include:

- Independence of women threatens family stability,
- Role of women in Maasai culture (family care) may be compromised due workload,
- Development with family values,
- Girl child education conflicts with boy child education (Tipping of the scale),
- Concern by men as to "how did the women identify and bring such big animals into our community without our notice" – men are responsible for matters related to cattle.

The CBO recognizes that with husbands' permission, progress in women groups is possible. The men should not be neglected but integrated appropriately in the projects including assigning them paid roles in the group that is ordinarily done by men among the Maasai such as marketing and treatment of livestock. Project activities are based on household gender division of labour (e.g. men are assigned roles like dipping, watering, health, fencing, drought preparedness, setting of prices, marketing, identification of cows to be bought, management decision). Group meetings take place mainly during schools holiday when women have less workload.

The main benefits of the CBO to its members and their families include income from sale of products such as milk; improved nutrition and health; reduced disease prevalence; reduced health expenditure and time spent looking for health services; extra meals for the whole family; income for men involved in project activities; enhanced skill/knowledge; maintenance of men's cultural and social status e.g. decision on sale and priority to buy bulls.

Source Ochola et al., (2008)

Theoretical and Conceptual Frameworks of Gender Responsive Natural Resource Management

Any given development process should focus at improving the standard of living of all people. This means that women, girls, men and boys should actively participate and benefit from any development programme meant to improve their socio-economic status. Yet, many communities in developing countries discriminate against women especially in access to and control of natural resources resulting to girls bearing the largest and most direct costs of the inequalities in our society. These inequalities go unnoticed. For instance, in the agricultural sector, where according to the World Bank Report (1998); African women perform ninety per cent (90%) of the work of processing food, hoeing, weeding, storage and transport from farm to village; and sixty per cent of work of harvesting and marketing. Yet, inequalities in land ownership make it impossible for women to get agricultural credit to enable them improve their farms or take charge of the management of the same farms. This is further compounded by denying the girl-child the right to education in many communities which impacts on the range of expertise and skilled labour that she would use to improve the production capacity of the natural resources.

Traditionally, natural resource management and conservation has been the domain of men because of their earlier hunting activities and later on the preservationist-focused policies that were established during the colonial period (Tedla, 2007). The mutually supporting links between local communities and their environment and wildlife were broken as powerful leaders, influenced by western conservationist organizations, gave priority to the conservation of mega species rather than local livelihoods (Tedla,. 2007). People were alienated from policies and processes that had an impact on their land and access to natural resource. As the conservation movement strengthened, local communities increasingly found their access to land and natural resources curtailed and their role in decision-making diminished. Women played little role in the conservation processes, the movement itself being seen as a man's domain and where this world interacted with communities, it did so through local male leaders (McClintock, 1995).

With time, conservation has moved from that based on protectionism to more community-focused and inclusive processes; the importance of including all natural resource users having become evident. Western, *et al.*, (1994) and Rihoy (1995) say that Integrated Conservation and Development Projects (ICDPs) and CBNRM re-established those broken linkages between conservation of natural resources and people's development. Natural capital became an important factor in the success and sustainability of local livelihoods. Slowly, the value of women's contribution is being recognised: Their knowledge and experience, together with their roles in both protecting and destroying the natural resources base is being valued.

As we have noted, emphasis on WED in the 1980s replaced the increasingly ineffective WID policies of the 1970s. However, women are still missing out with processes being inefficient in explaining the variety of interests, motivations and power relations in which women found themselves in regard to natural resources and the environment resulting in a lack of appropriate interventions. Gender became a priority and thinking shifted to GAD and GED. Seemingly, this had opened up more constructive opportunities for a better understanding and engagement with women, gender relations and environment. To achieve equity and equality both men and women must be involved and interventions developed based on a clear understanding of relations, roles, responsibilities, and participation in decision making processes etc (Tedla, 2007).

Gender-Related Differences in Natural Resource Management

Many aspects of life affect women and men differently. Even the natural resources that we have are used by women and men differently. For instance, both men and women utilize forests, wetlands and other ecological zones and their products differently. This may also vary with age, ethnicity, socio-economic status, location of forests, exposure and level of technology (Ghatak, 1995; Flintan, 2003; Flintan, 2004). For example, men may focus on the use of timber while women use medicinal plant or wild fruits for their economic needs.

Certain roles are specifically associated with different gender groups while others are not. Predominant male roles are construction, that is, building of houses in some communities, cultivation and charcoal making. Predominant female roles at household level include: drawing water, fetching firewood, and domestic chores like cooking, washing, cleaning and taking care of children. Cultivation, cutting grass and tree planting are shared roles, but in some traditions, women are not allowed to plant or cut trees.

Women tend to collect natural resources closer to home so that they can attend to house chores, while men travel long distances. Culture also plays a big role in influencing gender roles. For instance, Flintan (2004) in his research in Ethiopia says that cultural restrictions prevent women from collecting the wild cardamom and firewood. Their husbands collect them on their behalf so that women can only do the selling in the markets closer home or even use them at home. Such cultural taboos can serve as a hindrance for gender equitable division of labour. For instance, in some Kenyan communities, there are taboos that prevent married women from planting trees such as eucalyptus. It is believed that if this married women plants a tree that will be used for timber, the roots of this tree will grow towards the house and overturn it, (Mwangi, 1993). In other communities, women are prevented from planting trees along the boarders with neighbours for the fear that they may not know the exact boundaries.

These roles are learnt through socialization whereby boys and girls are taught what is expected of them when they grow up as women and men. Thus, the gender perceptions are culturally constructed by what is considered as the norm for different gender groups in the society. The roles that different gender groups play at household level are not different from the roles they play at the community level. Gender roles and relations are deeply rooted within the society that when in a village, a young man is seen carrying out a role that is perceived to be feminine, he is isolated by his age groups and at times, even warned by elders that he is developing a behaviour which is not masculine.

Such cultural practices give men certain advantages over their women colleagues. For example, men are more privileged to focus on certain planned activities which give them the opportunity to specialize and land on better economic incentive. As the result, they tend to be more involved in commercial activities and less concerned with the domestic ones. For example, charcoal making tends to be the responsibility of men, where as trading can be dominated by women, particularly those from near market places (Tedla, 2007). The irony is that although women do the marketing, they surrender the sale to their husbands. The reasons for these assigned roles and responsibilities vary from community to community and from culture to culture. For some, they say that they inherited these cultural beliefs and customs. Unfortunately, some of these practices were strengthen by the colonialists when they introduced cash crops predominantly produced by men while women participated in the subsistence production. Others linked to their religion beliefs that god designed men and women to play the roles they play, because they are inborn talents (Tekla, 2007).

Deeper into the pre-colonial societies, we find that even though there were different roles for women and men; women were equipped to manage their environment competently despite the limitations placed on them. Checks and balances existed in these societies to ensure that women were protected against abuses by men (Kameri-Mbote ed. 1992). For instance, while the woman was expected to grow certain crops, her husband was supposed to avail to her the land suitable to grow crops. Although public and political positions were the preserve of men, women had institutions where they could question what they did not like in the society, in which case, women were not totally powerless, because they were able to participate and question the actions of men (Kameri-Mbote, 1992). In this set up, natural resources like land were common properties owned by a community. But even then, land was traditionally owned by men. Women had usufructuary rights through their male relatives. The situation may not have been ideal but was dynamic in as far as gender was concerned. Colonial period drew boundaries apportioning responsibility, authority and wealth. They redefined and re-established modes of access to natural resources, thereby creating antagonism between men and women.

Privatization of land and colonialism in general eroded women's autonomy in decision making regarding what crop to grow. This was due to the competing needs for land and labour.

Gender Mainstreaming

Gender mainstreaming is a systematic inclusion of gender concerns in all aspects of the organizations life such as programmes, policies, budgets, skills, financial and human resource systems. This can be achieved more effectively through an organization and not through isolated individual efforts. Support for women organizations is a key strategy to promoting women's empowerment. Women must empower themselves, and women organizations are an important part of women's individual and collective empowerment. Women organizations that are effective are perquisites for women's empowerment their support may be financial, but must also involve helping to create networks, and establish connections between autonomous women organizations and those in key positions of power. Funding mechanisms which minimize the bureaucracy in funding women initiatives need to be further developed.

Promoting women empowerment also involves examining organizational culture, political will and accountability of its leadership. Structural and process that constraint and cause conflict with women empowerment goals in the organizational must be identified and dealt with. Increased flexibility in funding procedures and greater transparency in relationships with communities are key for success. Mainstreaming, a gender perspective in all policy work, is fundamental, because it assesses the implication of women and men in all planned actions and at all levels. It is also a strategy for making men as well as women's concerns and needs an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that men and women benefit equally and the impunity of inequity is done away with.

Presently, donor agencies have come to see women as vulnerable: "their responsibilities as day-to-day environmental managers…make women both victims of and contributors to the natural environment's degradation and pollution" (World Bank, 1991). On the other hand, awareness, gradually grew of many grassroots success stories of women fighting to conserve local resources such as those described in *"Power to Change"* (Women's feature Service, 1994). This then led to women being viewed as major local assets to be harnessed in the interests of better environmental management (Braidotti *et al.*, 1994).

The problem of this new approach – *Women being seen as 'assets to be harnessed in the interests of better environmental management* – is that it is not always honoured in practice. Firstly, projects intentions can be subverted, leaving environmental management to community level institutions. The most cited examples, are the *projects promoted by the Aga Khan Programme in Northern Pakistan.* These projects do not guarantee women's access to project resources. The aim of involving women in all stages of the project cycle often translates into demands on women to do voluntary work, without giving them a fair share of project benefits.

Secondly, compared to a gender analysis of the underlying problems, environmental projects promote a limited set of aims. The policy documents (e.g. World Bank, 1991) acknowledge that *lack of property rights* reduces women's capacity to conserve environmental resources. The 'new approach' does not address this issue..

Thirdly, investors in NRM still promote the practice of women access to credit to help them manage resources and build up assets. But this is naïve because it assumes that traditional male control over land and other assets will not extend to newly acquired natural resources. Trying to give women authority within isolated projects without taking into account their restricted property rights is almost bound to fail. We must try to find a way of strengthening women's control over natural resource management. For instance, legal changes that guarantee women independent property rights and increased political representation would go a long way in solving this problem. This can be done at the national and local levels by building up women's capacity to claim the new rights attained.

Another approach suggested for environmental projects for instance, the Aga Khan promoted projects that we have seen above, is support for collective actions by women (Agarwal, 1994). Women have more chances of exercising rights as a group than as individuals, and this has the potential to confer inalienable use rights over natural resources. Examples are given of 'wasteland development projects in India, such as the Bankora projects in west Bengal, which have successfully supported women groups' efforts of regenerating forests to improve land productivity. They also build on women's greater use rights over common property than on privatised lands.

Support of women's collective actions in addressing natural resource management problems is one instance of a general strategy to strengthen women's bargaining power in relationship with their male counter parts. This could be developed into a policy to help overcome environmental problems affecting women in the management of natural resources.

Spurred by the foregoing views, on an extensive scale; Governments, International and National donor agencies, NGOs and Private Voluntary Organizations (PVOs) should design natural resource management programmes and projects that focus on forest conservation and social forestry, soil conservation and improvement, water capture and distribution and water shed management. Even if the long-term development goal of the above projects is increased productivity, the importance of both distributional equity and resource stewardship will be enhanced.

There is also an increasing consciousness that management of natural resources takes place in an ecosystem context, in which consequences may not be measurable or even discernable during a normal project cycle. In the same way, interventions designed to improve the status of women take place in the context of a human ecology- in their household relationships, their community relationships and their relationships with the environment around them. This shows us that no single sector can be successfully isolated in any development project. Focus must be put on both inputs and outputs, which inevitably yield unexpected results felt economically, socially and environmentally.

As we mentioned earlier, gender equality and equity are matters of fundamental human rights and social justice and, a pre-condition for sustainable development. In the use, management and conservation of natural resources; women and men have different roles and responsibilities that vary greatly from region to region. Women often make their contributions to the family, community and society with an equal access to, control over and benefits from resources and resource use. This inequality often exists in a context.

Gender Integration in the Natural Resource Management

Integrating gender concerns in natural resource management has to be understood in the context of gender mainstreaming. U.N. Economic and Social Council (1997:28) observes that mainstreaming a gender perspective is a process of assessing the implications for women and men of any planned action, including legislation, policies or programmes in all areas and at all levels. Department for International Development (DFID) (2002:9) provides a more comprehensive definition,

> "A commitment that women's as well as men's concerns and experiences are integral to the design, implementation, monitoring and evaluation of all legislation, policies and programmes so that women and men benefit equally and inequality is not perpetuated. Gender mainstreaming is integral to all development decisions and interventions; it concerns the staffing, procedures and culture of the development organizations as well as their programmes: and it forms part of the responsibility of all staff"

DFID's gender manual recognizes four key steps in gender mainstreaming:

- Sex disaggregated data;
- Gender analytical information;
- Women as well as men influencing the development agenda;
- Context specific working definition of gender mainstreaming.

The following diagram illustrates these points.

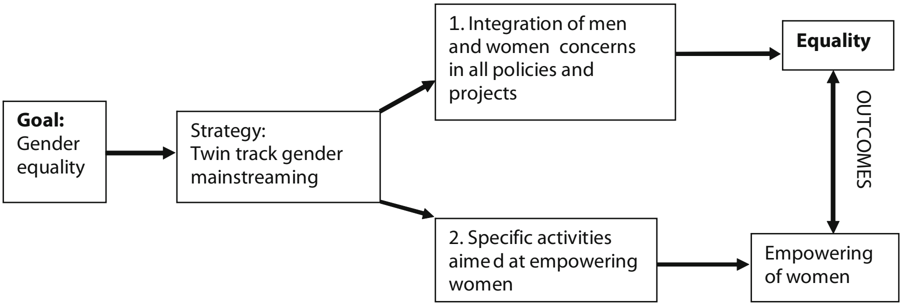

Figure 5.3: DFID Gender Mainstreaming Strategy

As illustrated in Figure 5.3, the goal of gender mainstreaming is to attain gender equality. This can happen by having a strategy that integrates the concerns of both men and women in policies and programmes. There is also a need to develop specific activities aimed at empowering women.

The Gender Analysis Frameworks

Gender analysis is a sub-set of socio-economic analysis. It reveals the connections between gender relations and the development problem to be solved. Its purpose may be two-fold: (i) to “surface” the fact that gender relations are likely to have an impact on the solution to the problem, and (ii) to indicate exactly what that impact is likely to be, and alternative courses of action. Gender issues are significant to the policy area, and play a determining role in policy outcomes.

It is extremely important to perceive that we live in societies that are permeated by gender differences and gender inequalities. There is no country in which the outcomes of public policy are equal for men and women, but the dimensions of these inequalities are often so deeply embedded that they are difficult to perceive. Gender analysis reveals these differences, and the fact that in such a social context, any gender interventions that profess to be gender-neutral will in fact reflect and probably reinforce the imbalances that exist. Gender analysis of various kinds is, therefore, required to bring these inequalities the attention of people who can make a difference, so that their decisions are taken in a manner that is sensitive to and reflects the outcome of gender analysis.

Gender Analysis Frameworks are step-by-step tools for carrying out gender analysis, which help to raise questions, analyze information, and develop strategies to increase women's and men's participation in and benefits from projects and programmes. It is the systematic way of exploring roles and responsibilities of women and men and their access to and control over resources and benefits within a particular setting, project, household or community.

Gender analysis in NRM involves looking at different impacts of development programmes and projects on women and men because women and men perform different activities in society and NRM policies and plans affect them in different ways.

Gender Analysis Frameworks refers to methods of research and planning for assessing and promoting gender issues in institutions. The frameworks were developed to address different aspects of gender equality and hence are used for different policy priorities. They are designed to explore division of labour between men and women in agriculture and in more urban settings (Harvard and Moser, 1993 Frameworks, respectively), gender mainstreaming in institutions (Levy Framework), gender differentials in the impact of projects at community level (Gender Analysis Matrix (GAM) Framework), and assessment of the contributions of interventions in all sectors to the empowerment of women (Longwe Framework) among others. The Frameworks are used to integrate gender considerations in development programmes and development activities or research. They provide qualitative and quantitative information on gender relations, creates understanding and awareness of the existing gender issues at the level of development workers, community researchers and planners. They enhance the understanding of the implications of the different development activities for both men and women.

Gender analysis recognises that:

- Women and men’s lives and, therefore, experiences, needs issues and priorities are different especially in regard to natural resource management;
- Women’s lives are not all the same; the interests that women have in common in the Management of Natural Resources may be determined by other factors such as their social position, ethnicity and the fact that they are women;
- Women’s life experiences, needs, issues and priorities are different for different ethnic groups especially in Africa where the issues of Natural Resource Management are concerned;
- The life experiences, needs, issues and priorities vary for different categories of women dependent on age, ethnicity, disability, income levels, employment status, marital status, sexual orientation and whether they have dependants;
- Different strategies in the Management of Natural Resources may be necessary to achieve equitable incomes for women and men

Figure 5.4 illustrates the different aspects of gender analysis that may be involved in designing NRM project with gender dimensions while Box 5.3 summarizes the rationale for gender analysis in NRM.

Box 5.3 Why Gender Analysis in NRM?

Several different Gender Analysis Frameworks exist today. They are step-by-step tools which help to raise questions, analyze information, and develop strategies to increase women and men's participation in forestry programmes and benefit from them.

Gender Analysis Frameworks are concerned with:

1. The development context or patterns in an area, answering the questions, "*What is getting better? What is getting worse?*"
2. Women and men's activities and roles in the forestry sectors, answering the questions, "*Who does what?*"
3. Women and men's access to and control over resources, answering the questions, "Who *has* what? Who *needs* what?", and
4. The forestry programme actions needed, answering the questions, "What *should be done to close the gaps between what women, and men need? What does development deliver?"*

Gender Analysis can be used, for example, in the following situations:

- Development of village level forest management plans to ensure that the contributions of both women and men are adequately recognized in determining access to and control over resources;
- Development, or review, of forestry policy to ensure sustainable forestry through equitable participation of all stakeholders;
- Profiling of stakeholders to develop an understanding of who the stakeholders in the forestry sector are beyond gender to other socially determined characteristics;
- Restructuring of the forestry sector to ensure equitable participation at all levels and in a diversity of functions by both women and men.
- Development of criteria for training, selection, or recruitment to ensure that women and men have equal opportunities to progress in their career and that, there are both women and men working in diversity of capacities in the sector to work with the women and men of the other stakeholder groups

Source: FAO, "Gender issues in the Zambia Forestry Action Programme" (1997)

Gender Analysis for Projects

The *gender analysis framework* has four parts in projects and is carried out in two main steps. First, information is collected for the activity profile and the access and control profile. Then this information is used in the analysis of factors and trends influencing activities, access and control, and in the project cycle analysis.

The Harvard Analytical Framework

The Harvard Analytical Framework is also called the Gender Roles Framework or Gender Analysis Framework. It was developed by the Harvard Institute for International development in collaboration with the WID office of United States Agency for International Development (USAID). This is based on the WID efficiency approach and is one of the earliest frameworks designed for gender analysis and planning for women and men. The framework is a tool to understand differences between men and women in relation to their participation. This enables project planners and policy makers to make an economic case for allocating resources to women as well as men. It is used in adopting a sustainable livelihoods approach to poverty reduction. It is also used for analysis of productive work.

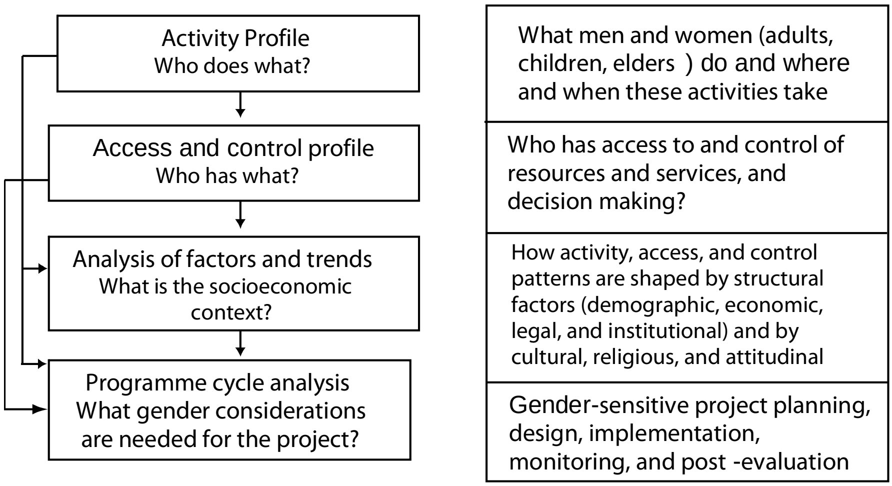

Figure 5.4: Project-Based Gender Analysis Framework

The framework emphasizes that both men and women are involved in development as actors and as beneficiaries. As such, there is economic sense in allocating resources to both. The framework helps planners to design projects that are more efficient and which improve overall productivity.

According to Overholt, *et al.*, (1984), the framework consists of four interrelated components or tools:

- Activity profile;
- Access and control profile;
- Analysis of determinant factors;
- Project cycle analysis.

Activity Profile

This component categorizes the activities undertaken viz: productive, reproductive and community, then outlines who does them, when and where. It has been adapted to reflect community activities and also to look at how and why the activities are done. This process helps to understand the gender division of labour and how it comes about. *Productive Activities* are the activities that produce goods and services which have an economic gain or monetary value. These could include, wage employment, trade, and marketing to mention just a few. Both men and women are involved in productive activities. Women’s productive work is often less valued because in most cases, there is no monitory value attached to it. *Reproductive Activities* are done for generation and maintenance of human life. They include child bearing and rearing, household work, cooking, washing clothes utensils, etc. This type of work is usually not recognized, nor is it accounted for in the Gross National Product (GNP). To a large extent, women and girls are involved in carrying out reproductive work in most parts of this world.

The Access and Control Profile

The access and control profile, identifies the resources used to carry out the work identified in the activity profile, and access to and control over their use, by gender. It indicates whether men or women have access to resources, who controls their use and who controls the benefits of a household or community use of resources. The person who controls a resource ultimately makes decisions on its use including whether it can be sold. In gender analysis, it is often found that whereas women have wide access to resources and benefits, the control of those resources largely rests with men, thus shifting gender power relations in men's favour.

Figure 5.5 is an example of a participatory assessment tool for gender analysis information on access and control of resources related to camel among the Rendile tribe in northern Kenya.

Resource - Camel	Camel Product	How Used	Access	Control	Challenge
	Milk	Sale (Cash) Food Medicinal	Women Women and men Women and men		- Market access - Training opportunities - Need for value addition - to provide income for women
	Meat	ceremonies weddings Funerals	Women and men, boys and girls		- livestock diseases - drought
	Transport	Kids Water People Food stuff Household items	Men and women		- security - drought
	Hide	carpet bedding ropes sale handicraft	Women		marketing - middle men
	Ceremonies e.g. dowry	2 camels for dowry			- difficulty to find camels
	Income	sold to traders	Women and men and boys		- market - middle men
	Medicine	milk and urine	Women boys and men		- Use of indigenous technical knowledge (ITK)

Figure 5.5: Access and Control Profile for Camel Resource among the Rendile in Kenya

Source: Ochola et al., (2008)

Analysis of Determinant Factors

A number of factors influence how the Harvard framework is used. They include but are not limited to culture/tradition, education, religion, politics, economics, environment, wars, legal, demographic trends, exposure, etc. For proper targeting and strategizing, planners need to understand these factors and the extent to which they are amenable. The purpose of identifying these influencing factors is to consider which ones affect women or men's activities or resources and how they in turn can respond to them.

The Project Cycle

The project cycle analysis examines a project or intervention in light of gender-disaggregated information and captures the different effects of the social change on men and women. Key questions are asked at each stage of the project cycle: identification, design, implementation, and evaluation.

Uses of the Framework

- Best suited for project planning, rather than programme or policy planning.
- As a gender-neutral entry point when raising gender issues with constituents resistant to considering gender relations and power dynamics.
- For baseline data collection.
- In conjunction with Moser's framework, to draw in the idea of strategic gender needs.

Strengths of the Harvard Framework

- It is practical and hands-on.
- Once the data have been collected, it gives a clear picture of who does what, when and with what resources. It makes women's role and work visible.
- It distinguishes between access to and control over resources.
- It can be easily adapted to a variety of settings and situations.
- It is relatively non-threatening, because it relies on "facts" only.

This framework is useful for collecting and organizing information that can then be used at any stage of the project cycle. It provides clear information on the gender division of labour and makes women's work visible. It makes a distinction between access and control over resources. The framework is more useful for projects than for programmes as it depends on micro-level analysis. It can be adapted and used, for example, with the Moser Framework tools for practical and strategic gender needs assessment. It can be useful as a gender neutral "entry point'' for introducing discussions on gender issues, especially where there may be resistance.

By reviewing the question of control over resources, this framework is useful as the basis for a preliminary discussion of power relationships, although this was not its original intention.

Limitations of Harvard Analytical Framework

The Harvard Analytical Framework has a perspective which is efficiency rather than equity oriented, focusing on allocating new resources in order to make a programme more efficient than addressing unequal gender relations. It tends to focus on material resources rather than on social relationships. The analysis can be carried out in a non- participatory way without the involvement of women and men from a community. In summary, the limitations are:

1) Based on WID (efficiency) rationale, which aims at increasing project/programme efficiency. It does not delineate power relations or decision-making processes. Therefore, the framework offers little guidance on how to change existing gender inequalities. It tends to result in gender-neutral or gender-specific interventions, rather than those that can transform existing gender relations;
2) Tends to oversimplify, based on a somewhat superficial, tick-the-boxes approach to data collection, ignoring complexities in the community; may result in lost opportunities for change;
3) Is basically a top-down planning tool, excluding women's and men's own analysis of their situation;
4) Ignores other underlying inequalities, such as class, race and ethnicity, encouraging an erroneous view of men and women as homogeneous categories;
5) Emphasizes separation of activities and resources based on sex or age, ignoring connections and co-operative relations across these categories. This can result in projects that may not tackle women's strategic gender needs;
6) The profile yields a somewhat static view of the community, without reference to changes over time in gender relations.

Women Empowerment Framework by Sarah Longwe

This framework was developed by Sara Hlupekile Longwe as a method of analysing development projects (Williams *et al.,* 1994). The aim of the framework is intended to help planners question what women's empowerment and equality means in practice and assess critically to what extent a development intervention is supporting this empowerment.

The framework is based on five 'levels of equality'. The extent to which they exist in social or economic life determines the level of women's empowerment. The framework also allows gender and development workers to analyse development organizations, degree of commitment to women's equality and empowerment. March *et al.,* (1999) outline the two main tools of Longwe's Framework:

Tool 1: Levels f Equality

The Longwe Framework's five 'levels of equality' indicate the extent to which women are equal with men, and have achieved empowerment. The levels of equality are:

- *Control:* This term refers to women's control over the decision making process through conscientisation and mobilisation, to achieve equality of control over the factors of production and the distribution of benefits. Equality of control means a balance of control between men and women, so that neither side dominates;
- *Participation:* The framework considers women's equal participation in the decision making process, in policy-making, planning, and administration. It is a particularly important aspect of development projects, where participation means involvement in needs-assessment, project formulation, implementation, and evaluation. Equality of participation means involving women in making the decisions by which their community will be affected, in a proportion which matches their proportion in the wider community;
- *Conscientisation:* This is a conscious understanding of the difference between sex and gender, and an awareness that gender roles are cultural and can be changed. 'Conscientisation' also involves a belief that the sexual division of labour should be fair and agreeable to both sides, and not involve the economic or political domination of one sex by the other;
- *Access:* This is defined as women's access to the factors of production on an equal basis with men; equal access to land, labour, credit, training, marketing facilities, and all public services and benefits. Longwe points out that equality of access is obtained by applying the principles of equality of opportunity, which typically entails the reform of the law and administrative practice to remove all forms of discrimination against women;
- *Welfare:* Longwe defines this as the level of women's material welfare, relative to men. Do women have access to resources such as food supply, income and, medical care?

In this Framework, the levels of equality are hierarchical. March *et al.*, (1999) suggests that if a development intervention focuses on the higher levels, there is greater likelihood that women's empowerment will be increased by the intervention. If the intervention focuses only on welfare, it is very unlikely that women will find the project empowering.

Tool 2: Level of Recognition of 'Women's Issues'

Longwe suggests that it is important to establish whether women's issues are ignored or recognised by identifying the extent to which project objectives are concerned with women's development. In this context, women's issues relate to all issues concerned with women's equality in any social or economic role, and involving any of the levels of equality. That is, an issue becomes a women's issue when it considers the relationship between men and women, rather than simply at women's traditional and subordinate sex-stereotyped gender roles (March, *et al.*, 1999). This tool assumes that women's empowerment is the concern of both women and men. March, *et al.,* (1999) describes the three levels of recognition (defined by Longwe) in project design as:

- *Negative Level:* the project makes no mention of women's issues. Experience has shown that the project is likely to be detrimental to women (i.e. women are very likely to be left worse by the project);
- *Neutral level:* Project objectives recognise women's issues, but concerns remain that the project intervention does not leave women worse off than before;
- *Positive level:* the project objectives are positively concerned with women's issues, and with improving the position of women relative to men.

Moser Framework

The Moser Framework (gender planning) was developed as a planning tradition in its own right. It takes the view that gender planning, unlike other mainstream planning, is "both technical and political in nature". It assumes conflict in the planning process. It involves transformative processes and it characterises planning as a "debate.'' There are six tools in the framework that can be used for planning at all levels from project to regional planning.

Tool 1: Gender Roles Identification/Triple Role

This tool focuses mainly on the gender division of labour. Gender roles identification involves mapping out all the activities of men and women (including girls and boys) in the household and community at large in reference to national resource management. It highlights the productive work, reproductive work, and community management roles.

Productive work: This is work that produces goods and services for consumption by the household or for income and is performed by both men and women. Women's productive work is often carried out alongside their domestic and childcare responsibilities (reproductive work) and tends to be less visible and less valued than men's productive work.

Reproductive work: This work involves the bearing and rearing of children and all the tasks associated with domestic work and the maintenance of all household members. These tasks include cooking, washing clothes, cleaning, collecting water and fuel, caring for the sick and the elderly. Women and girls are mainly responsible for this work which is usually unpaid.

Community roles: Women's activities in the community include the provision and maintenance of resources which are used by everyone, such as water, healthcare and education. These activities are undertaken as an extension of their reproductive role and are normally unpaid and are carried out in their free time. In contrast, it is mainly men who are involved in politics at the community level. This work may be paid or unpaid but can increase men's status in the community.

Tool 2: Gender Needs Assessment

The Moser Framework further assesses the gender needs of men and women in the community in reference to NRM using the gender needs assessment tool.

Moser developed this tool from the concept of women's gender interests which was first developed by Maxine Molyneux in 1984. Women have particular needs because of their *triple role* as well as their subordinate position to men in society. Triple role refers to women's productive, reproductive and community tasks. Women's needs differ from men's needs. A distinction is made between practical gender needs and strategic gender interests or needs.

Women and men have different roles and responsibilities and therefore have different interests and needs in the management of natural resources. These are called gender interests and needs, practical and strategic. Practical and strategic gender interests and needs should not be seen as separate, but rather as a continuum. By consulting women on their practical gender interests and needs, an entry point to address gender inequalities in the longer term (strategic gender interests and needs) can be created.

Practical Gender Needs: These are gender needs that women and men can easily identify, as they relate to living conditions. Women may identify safe water, food, health care, cash income, as immediate needs which they must meet while men may identify care, sex, security and money. Meeting women and men's practical gender needs is essential in order to improve living conditions, but in itself, will not change the prevailing disadvantaged (subordinate) position especially on the part of women. It may, in fact, reinforce the gender division of labour for example, education, information and possession of skills which are instrumental to natural resource management. For example, do men and women have the capacity to study environmental changes that may impact negatively on their livelihoods?

Strategic Gender Interests and or Needs: Strategic gender interests and needs are those women identify because of their subordinate position to men in their society. They relate to issues of power and control and the gender division of labour. Strategic interests and needs may include changes in the gender division of labour, that is, women to take on work not traditionally seen as women's work, men take more responsibility for child care and domestic work, legal rights, an end to domestic violence, equal wages, and women's control over their own bodies. They are not as easily identified by women themselves as their practical interests and needs; therefore, they may need specific opportunities to do so.

Tool 3: Disaggregating Control of Resources and Decision-Making Within a Household

This tool is used to find out who has control over resources within the household, who makes decisions about the use of these resources, and how they are made. It links the allocation of resources within the household with the bargaining processes.

For example, in many communities men control the productive resources such as land, the market depending on the context. For example, in Northern Nigeria, men control the market while in Lagos women control the markets. Generally, women control the local markets while men control the national, regional and global markets. Control of resources is influenced by the rules governing the decision making process in a particular community. It is, therefore, important to examine the regulations and policies and levels of control that men and women possess over particular resources. It is evident that market forces are determined by the supply and demand but the decision making process is dependent on rules imposed by the society. In that regard, women will focus on subsistence production while men will confine themselves to cash crop production.

Tool 4: Balancing of Roles

This relates to how women manage the balance between their productive, reproductive and community tasks popularly known as "the triple role". A researcher or a practitioner should ensure that a planned intervention does not increase a woman's workload in one role with consequence for her other roles.

Tool 5: WID/GAD Policy Matrix

The WID /GAD policy matrix provides a framework for identifying and evaluating the approaches that have been (or can) be used to address the triple role, and the practical and strategic gender needs of women in programmes and projects. Five different approaches can be identified:

i) *Welfare*: Earliest approach, predominant 1950-1970. Its purpose was to bring women into the development as better mothers. Women are seen as the passive beneficiaries of development. It recognises the reproductive role of women and seeks to meet Practical Gender Needs (PGNs) in that role through a top-down handout method of food aid; measures against malnutrition and family planning. It is non-challenging, and therefore still widely popular;

ii) *Equity*: The original WID approach, emerged in the 1976-85 during the UN Women's Decade, in the context of the predominant "growth with equity" development paradigm. Its purpose is to gain equity for women who are seen as active participants in development. It recognises the triple role, and seeks to meet Strategic Gender Needs (SGNs) through direct state intervention giving political and economic autonomy and reducing inequality with men. It challenges women's subordinate position. It is criticised as western feminism, is considered threatening and is unpopular with governments especially in the third world countries;

iii) *Anti-Poverty:* The second WID approach, a toned-down version of equity, adopted from 1970's onwards in the context of *Basic Needs approaches* to development. Its purpose is to ensure that poor women increase their productivity. Women's poverty is seen as a problem of underdevelopment, not of subordination. It recognises the productive role of women, and seeks to meet their practical and strategic needs to earn an income, particularly in small scale income generation projects. It is still very popular with NGOs;

iv) *Efficiency:* The third and now predominant WID approach was adopted particularly since the 1980's debt crisis. Its purpose was to ensure that development is more efficient and effective through women's economic contribution, with participation often equated with equity. It seeks to meet PGNs while relying on all the three roles and an elastic concept of women's time. Women are seen principally in terms of their capacity to compensate for declining social services by extending their working day. This is considered a very popular approach;

v) *Empowerment:* This approach seeks to empower women through greater self- reliance. Women's subordination is expressed not only in terms of male oppression but also in terms of colonial and neo-colonial oppression. It recognises the triple role and seeks to meet SGNs indirectly through bottom- up mobilisation of PGNs. It is potentially challenging, although its avoidance of western feminism makes it unpopular except with third world women NGOs.

Tool 6: Involving Women, Gender Aware Organizations and Planners in Planning

The aim of this tool is to ensure that practical and strategic gender needs are identified by women ensuring that "real needs'' as opposed to perceived needs are incorporated into the planning process.

The framework looks at the separate activities of women and men rather than how these activities interrelate. Not everyone accepts the concept of the triple role, particularly in relation to community roles. Other forms of inequality such as race and class are not addressed. It is argued by some that a strict division between practical and strategic gender needs is unhelpful as there is often a continuum from practical to strategic. Moser does not consider the strategic gender needs of men. There are arguments for and against their inclusion. In adapting Moser's work the Development Planning Unit (DPU), London University, has included men's practical and strategic needs in its framework.

Selecting a Gender Analysis Frameworks for NRM

When selecting a framework, it is important to consider that the selected framework answers some key questions. The following are some.

i) *To what extent does the framework incorporate an analysis of social relations which goes beyond issues of gender?* Gender relations are context-specific; they vary considerably depending on local setting. Relationships between people, including economic status, race, ethnicity, or disability can greatly influence the outcome of a given analysis.

ii) *How flexible are different gender frameworks?* With time and technology, other factors, gender roles and relations change. Sometimes, specific events such as conflict or economic crisis cause certain aspects to change rapidly or dramatically. A good framework must be flexible and adaptive to these changes.

iii) *Does the framework mainly analyze social roles or social relations or both?* There are gender analysis frameworks which focus primarily on gender division of labour and distribution of resources. On the other hand, a gender analysis framework which focuses on relations sees a community mainly in terms of how members relate to each other: the kind of bargains they make, what bargaining power they have and what they get in return; when they act with self-interest, when they act altruistically, and so on. The Harvard Analytical Framework can be considered as a method of gender-roles analysis; whereas the Social Relations Approach is a method of gender-relations analysis

iv) *What is the Role of Gender Framework? Does it focus on efficiency or empowerment?* Gender-analysis frameworks concentrate on certain factors in women and men's lives. The chosen focus reflects a set of values and assumptions on part of the framework's designers. When you use a framework, these values and assumptions will ultimately influence the type of development interventions you select.

The efficiency approach to women in development is based on the understanding that it is inefficient to ignore women in planning and distribution of resources. This approach lies behind the Harvard and People Oriented Planning (POP) Frameworks. Although this approach seems very sensible, there are times when it can come into conflict with wider issues of justice or women's empowerment. As a consequence, the efficiency approach has been heavily criticised as follows:

- This approach does not challenge existing gender relations but it tends to lead to gender-neutral or gender-specific policies or interventions;
- Since resources, not power, are seen as central, it can also further tip the balance of power in the favour of men. For example, further resources will be allocated to men if it is judged efficient, even if this is to the detriment of women;
- Similarly, if it does not make a project more efficient to involve women, then following the logic of the efficiency argument, you should not do so, and ignore issues of justice;
- This approach can be particularly problematic in countries where women are involved in production outside the house.

Other gender frameworks explicitly have the aim of empowerment. They emphasise the transformation of gender relations, through women's self-empowerment. (Kabira and Muthoni (Eds.), 1994).

Of course, it is perfectly possible to use the gender frameworks, or parts of them, in a way to subvert their stated goals. For example, the Moser Framework could be used to design projects which address women's practical needs only, with no attempt to support women's self-empowerment.

Implicit in each Framework is the planner's own view of his or her role, which can range from being top-down planner to the planner as facilitator only. One gender framework – the Social Relations Approach – explicitly requires the planners to examine their own institutions and understand how the institutions bring biases into the planning process. The gender-analysis frameworks are not intended to plan interventions which target men or boys, but it should be used to plan interventions, because they all have a potential impact on gender relations of both sexes.

There is an increasing awareness that gender identity traverses other identity issues, including race and class, to affect men's and women's roles in the gender division of labour. Most of the gender frameworks – except the Women's Empowerment Framework – look at the gender roles and relations of both women and men, and so could be used for projects which target men as well. Gender analysis frameworks have been designed for different purposes. These purposes may range from designing initial research, planning, monitoring an intervention and to evaluating the achievements.

Gender frameworks have sometimes been designed for use in a particular context. For instance, if you are working in emergency situations, there are two gender frameworks specifically designed for this (the People Oriented Planning Framework and the Capacities and Vulnerabilities Framework). When deciding which framework to use for any particular situation, it is important to consider what aspects are appropriate to your work, and what purpose you are trying to achieve.

In summary, a good analysis should provide:

- *Gender Awareness:* Understanding of Gender Relations and their implications for development policy and implementation;
- Analysis of the Division of Labour: Activities, Access and Control;
- *A Review of Women's Priorities:* Restraining and Driving Forces;
- Recommendations to Address Women's Practical Needs and/or Strategic Interests.

The purpose of a gender analysis is to identify the specific dimensions of each of these issues, in a given socio-economic context. A good gender analysis will provide precise information in all or most of these categories, in such a way as to be easily incorporated into programming and other decision-making processes.

A gender analysis should provide the following broad types of information:

Gender Awareness: What in general is the relative situation of women and men in the context under review?

Activities, Access and Control: What are the principal and/or most relevant features of the sexual division of labour (taking account of both productive and socially reproduction activities), and their implications for the productivity and economic sustainability of the context under review?

Women's Priorities: Restraining and Driving Forces: How can this information best be applied to the development problem to be addressed, and/or to the better attainment of specific outputs and outcomes? What are the trends and changes emerging in the sexual division of labour which could be leveraged for greater equality between women and men? Would it be feasible to support and strengthen driving forces (preferable) or minimize restraining forces?

Practical Needs and Strategic Interests: Would it be more appropriate in the given circumstances to address women's (and men's) practical gender needs, or to take a more transformatory approach and address the underlying causes of their situation, hereby responding to their strategic interests, and why? How would these approaches impact upon likely project outcomes, and on men and women in the situation under review? How would they impact on the overall social context?

Gender and Policy Implications in Natural Resource Management

The challenge for governments is to structure a response to the fundamental changes taking place at global, national and local levels and to ensure that gender concerns are not lost in the flux of changing priorities. In endeavouring to meet these challenges, it is useful to consider different types of development policies.

Isolated small women-specific agricultural and rural development programmes are not usually successful in effectively reaching and assisting large numbers of rural women. The reasons for this are many; financial support allocations are limited because most resources are channelled into mainstream development programmes or women-specific agricultural projects are poorly designed and often staffed with persons less skilled in agriculture and natural resource management. These small women-specific projects can be of some limited value. However, it is important to demonstrate the feasibility of particular types of programmes targeted at women and to provide specific skills training to them to enable them participate effectively in mainstream agricultural and natural resource management programmes.

There are different dimensions of policies that can help or hinder in the advancement of gender goals. These policies are divided into three categories depending on the extent to which they recognise and address gender issues. *Gender- blind policies* fail to distinguish between women and men. Policies are biased in favour of existing gender relations and, therefore, are likely to exclude women. *Gender-sensitive policies*: recognise that women as well as men are actors in development and that they are often constrained in a different way to men. Their needs, interests and priorities may differ and at times conflict. Gender-sensitive policies can be sub-divided into two policy types:

- *Gender-neutral* policies which use the knowledge of gender differences in a given context to target and meet the practical needs of both women and men. Gender-neutral policies do not disturb existing gender relations;
- *Gender-specific* policies use the knowledge of gender differences in a given situation to respond to the practical gender needs of either women or men. These policies do not address the existing division of resources and responsibilities;
- *Gender-redistributive* policies aim to transform the existing distribution of resources and responsibilities in order to create a more equal relationship between women and men. Women and men may be targeted or one group alone may be targeted by the intervention. Gender-redistributive policies focus mainly on strategic gender interests, but can plan to meet practical gender needs in a way which have transformative potential (provide a supportive environment for women's self empowerment). This is illustrated in the diagram below.

Gender in NRM Research

This section addresses the appropriate means of gathering and generating gender related information and undertaking research in Natural Resource Management from a gender perspective. Gender Focused NRM Research Methods takes into account the situations and realities of men and women in a given context and time. The conventional research, which is predominantly qualitative, excludes sex and gender variables. They fail to disaggregate data based on sex and fail to analyze sex disaggregated data and, hence, fail to report in a sex disaggregated format. Exclusion of sex and gender are serious omissions that leads to problems of validity in the generalizations. As a result, recommended interventions may not address needs of men and women.

Methods of data collection must involve both men and women as equal participants and capture women and men's experiences within social hierarchy. Some of the participatory methods that can be adapted to collect gender sensitive data include; Focus Group Discussions (FGDs), in-depth interviews, seasonal calendars, wealth ranking, resource mapping, observations and life histories.

When gathering information from women, one must think of the following issues:

- There may be resistance from husbands or men;
- There is need to have a woman as interviewers;
- It is critical that the venue and time will be friendly to women;

- Women may be easily distracted especially by children or their multiple roles;
- Strong women may dominate the interview;
- Women are more easily intimidated and they may not offer information freely;
- Illiterates women may understand better a diagrammatic explanation through illustrations to respond more effectively; this requires patience and skill;
- Key informants in a community are usually men and it requires deliberate effort on the part of the researcher to ensure that women are included as key informants.

Gender focused research methods represent human diversity. This is critical in carrying out research in natural resource management. Strategically planned and executed research that takes into account women and gender issues will result in thorough participatory and relevant results. Women are essential contributors to NRM. They impact on them differently with men. Gender sensitive research that takes this into account can in turn lead to a more effective NRM, which can in turn lead to a more sustainable development process, policies and programmes. An array of gender analysis tools are available (Table 5.3). Most participatory rural appraisal tools can be engendered for use in NRM research.

Table 5.3: An Overview of Participatory Tools for Gender Analysis

Issue	Specific Tool	General tool
Issues of NRM related labour, tasks and responsibilities	▪ daily activity profile ▪ seasonal calendar	Review of secondary data\ Direct observation Semi-structured Interviews individual or key informant interviews household interviews (focus) group interviews
Decision-making power	▪ decision-making matrix ▪ household budget	
Access to and control over natural resources	▪ household budget ▪ transect walk ▪ household resource flow diagram, benefits chart, mobility map,	
External factors	▪ organizational linkages diagram (Venn diagram) ▪ trend line ▪ critical incident analysis,	
Constraints, problems and opportunities	▪ problem drawing ▪ ranking and scoring matrices ▪ problem tree – objective tree,	

Summary

The sustainable management of natural resources including forests, water, land and biodiversity, requires the involvement of multiple social actors or stakeholders especially the local resources users–both men and women). All NRM initiatives in Africa require consideration of both the ecological and sociological aspects of natural resource (management) dynamics.

Chapter 5 has clarified that a sound understanding of social differences and social inequality is key to finding answers to the questions outlined in the previous chapters. This is because gender relations, like all social relations, are multi-stranded: they embody ideas, values and identities; they allocate labour between different tasks, activities and domains; they determine the distribution of resources; and they assign authority, agency and decision-making power.

Women in particular, have unequal access to information and resources, and are under-represented in decision-making. In any NRM undertaking, it is important to address the questions: Who participates in development (research) interventions, projects, programmes, and policies? How exactly? Who benefits from them? Who remains excluded or isolated? These are becoming crucial questions to be considered and integrated into intervention strategies if the aim is to support the more equitable – and sustainable – use of natural resources and the derived benefits.

Gender is more than the biological differences between men and women as it includes the ways in which those differences, whether real or perceived, have been valued, used and relied upon to classify women and men and to assign roles and expectations to them. *Gender analysis*, the process of assessing the differential impact of proposed and/or existing NRM initiatives on men and women of different characteristics, makes it possible for natural resources to be managed with an appreciation of gender differences. By carrying out gender analysis, we enhance our understanding of social processes and for responding with informed and equitable options.

Over the years, many perspectives of gender have emerged. As a response to the concerns of feminism in many other approaches such as Women In Development (WID) and eco-feminism, the Gender and Development approach (GAD) emerged as an approach that allows space to comprehensively consider other kinds of gender relations that may be significant in people's lives beyond conjugal partnerships, for example, seniority, status, co-sanguinity. In GAD, gender is seen as structuring people's interactions with and responses to environmental change or shaping their roles in Natural Resource Management. There are specific gender considerations, in particular, natural resources. The chapter has elucidated the gender perspectives with regard to land, forests, climate change, fisheries and water resources. The management of community based organizations and NRM projects are also gender dependant and a clear integration of gender is key to success.

Chapter 5 shows that gender mainstreaming is the systematic inclusion of gender concerns in all aspects of the organizations life such as programmes, policies, budgets, skills, financial and human resource systems. This can be achieved more effectively through an organization or in an NRM project and not through isolated individual efforts. Important to this process is gender analysis. Gender analysis aims to reveal the connections between gender relations and the development problem to be solved. Gender Analysis Frameworks refers to methods of research and planning for assessing and promoting gender issues in institutions. The Frameworks were developed to address different aspects of gender equality and hence are used for different policy priorities. They are designed to explore division of labour between men and women in agriculture and in more urban settings (Harvard and Moser respectively), gender mainstreaming in institutions (Levy), gender differentials in the impact of projects at community level (GAM), assessment of the contributions of interventions in all sectors to the empowerment of women (Longwe) among others. The Frameworks are used to integrate gender considerations in NRM interventions.

When selecting a Framework, it is important to consider that a selected framework answers some key questions:

i) To what extent does the Framework incorporate an analysis of social relations which goes beyond issues of gender?
ii) How flexible are different gender Frameworks?;
iii) Does the Framework mainly analyze social roles or social relations or both?; and
iv) What is the role of the gender Framework? Does it focus on efficiency or empowerment?

The chapter has also demonstrated how impacts of global changes like climate change poses differential implications to vulnerabilities and opportunities for various gender groups. Women and men are differentially impacted by climate changes due to the current power relations and their differentiated roles in these communities. Women have access to but not control over natural resources and other property rights. Additionally, women do most of the reproductive and part of the productive work, while men are only responsible for productive work. The thread that runs through the whole of this chapter is that if our society achieves sustainable management of Africa’s natural resources for development, gender must be mainstreamed in NRM in an effort to achieve the goal of gender equity and sustainable NRM.

Learning Activities

Learning Activity 5.1

After having reviewed the key gender concepts, please summarize your understanding of each using the table below. Add other concepts that are not discussed in the unit.

Gender concept	*Key characteristics and use*	*Major strength*	*Major limitations*	*Your Recommendations*

Learning Activity 5.2

1. Prepare and present summary argument why gender issue is important for sustainable management of natural resources.
2. The management of water resources must be informed by the underlying gender issues and concerns. Identify the issues relating to a specific water resource from sub-Saharan Africa and present a practical case that illustrates the roles of men and women and how gender integration can improve management of the named water resource.
3. Highlight the main gender issues and concerns in the management of a Community Based Natural Resource Management group or organization. How would the understanding of the gender issues improve the maturity and sustainability of such Community Based Organizations?

Learning Activity 5.3

Box 5.4: Gender Analysis Case Study for The Harvard Analytical Framework

The government of a rich, cacao producing country wanted to increase its exports to boost the national economy. With the help of a major international donor, access roads were built through 80% of the rural areas so cacao farmers could easily transport their crops to the market centres. This stimulated cacao production and the income of the farmers increased measurably. In this region, women do most of the agricultural work, both on cash crops and on family food stuffs. The men are responsible for decisions concerning what and where to plant, and for the marketing of crops. The men belong to cash crop cooperatives that collect cacao, sell it to international marketing boards and then distribute the revenue back to the men according to the amount brought in to the market. Women work long, hard hours in the fields using hand tools.

They are responsible for feeding the family, making sure the children eligible for school are enrolled and participate, and for all family health care needs. Before the cacao boom, a few women had small stands to sell basic items such as soap, salt and oil to community members. With the boom, every body is involved in producing more and more cacao. Four years after the road was build, there was extensive malnutrition in these cacao growing communities.

Learning Activity Question

Using the Havard analytical frame work, discuss the factors that contributed to the situation of malnutrition in the cacao growing communities.

Learning Activity 5.4

Box 5.5 Juma's Livelihood.

Juma is a small scale farmer and lives in a small village of Siloa. He has a family of three boys and four girls. He owns a 12 acre piece of land which the family lives on. His wife, Mina, of 30 years, is a house wife and takes care of the family. Her day-to- day work revolves around household chores which include preparing breakfast, cleaning and dressing the children for school, warming water for her husband to wash his face in the morning, serving him with breakfast, cleaning the utensils, sweeping the house and washing clothes for all members of the family. This work is done every morning including the weekends.

Juma's work revolves around the farm as he undertakes clearing the *shamba* (garden) for digging, planting coffee, pruning and spraying when need arises, and looking after the zero-grazing cows. He does this when Mina is busy and when children are in school. Most of his day is spent in various meetings including chief's *baraza* (community and political meetings). He is politically active and is hardly at home during the election campaigns. During this season, it is Mina and the children who carry out most of the household and farm work. Juma is commonly found at the shopping centre, mostly in the evenings discussing with his friends on various issues that affect the village, including occasionally taking a few mugs of local brew.

Juma, as the head of the household, controls the income from the farm such as the income from coffee and the cows including the milk payments. He is usually not concerned with the income from the subsistence farming unless the coffee does not sell well and the income from the livestock is low. In this case, he demands that Mina gives him most of the money she gets from the farm proceeds.

After the household chores are done, Mina walks to the farm where she would spend the rest of the morning digging, weeding, planting, harvesting and processing the harvest for storage. Her work in the farm depends on the season in the year. Juma has divided his land into cash crop, subsistence farming and grazing areas. Mina is free to use the subsistence farming area where she mainly plants maize, beans, potatoes, and other food crops; but she has to ask permission from Juma when she wants to plant something different such as bananas and trees. She is at liberty to sell some of the products if the season is good and uses the money gained to support other necessities of the family.

Mina belongs to Baraka merry-go-round women's group which meets once a month on a rotational basis. The group contributes money mainly to support the members in improving household standards as it buys anything from household utensils to a water tank depending on the needs of the members. The group also invites resource people to talk to the members on various development issues such as appropriate farming technology, improved jikos (a charcoal cooking stove), and basic facts about HIV and AIDS etc. The members value these seminars and are usually enthusiastic about them.

A typical evening in Juma's house is spent carrying on the usual household chores including cooking, serving, cleaning utensils and preparing children for bed. These activities are done by Mina and her daughters while Juma usually rests in the sitting room reading Taifa Leo or listening to the radio. The three boys spend their evening either doing their studies, visiting the neighbours or taking long walks with other boys especially during the holidays. Juma usually goes to rest in bed after the 9:00 pm news and the funeral announcements. Mina and her daughters take a little longer as they have to ensure that the kitchen is left clean and the utensils well arranged before they can go to bed.

Juma and Mina are active members of the community and participate in events that involve the villagers such as weddings, church activities and funeral preparations. During a wedding preparation for example, Mina and other women are involved in cooking for visitors, serving and entertaining. Juma and the other men slaughter and roast meat for visitors and keep them engaged in various talks. Men's main role during wedding preparations is negotiations on and decision making on how much dowry to ask for, who to spearhead the discussions and how to treat the in-laws. The discussions on dowry are usually done after the visitors have been fed and are satisfied. The dowry is normally a male issue save for little which is given to women for sodas.

Discussion Questions

i) Identify reproductive, productive and community activities in Siloa village and analyze who does them.

ii) What resources does Juma's family have?

iii) Who has access to and control of these resources?

iv) In your view, is there equity and equality in access to and control of these resources?

v) What determines who does what and who has access to and control of the resources? What can be done to address the situation?

Learning Activity 5.5

1. Development planners can use the matrix to analyze how gender position can be improved in NRM. Select that which illustrates the gender aspects shown in the matrix below.

Level of Equality	*Negative*	*Neutral*	*Positive*
Control			
Participation			
Conscientisation			
Access			
Welfare			

2. You have been exposed to various gender analysis frameworks in this chapter. Develop a tabular summary which shows 5 important frameworks including those that are not discussed above and identify:
   - Key characteristics
   - Important strength
   - Key limitations

   How best the framework can be used for NRM programmes and projects planning, monitoring and evaluation

Learning Activity 5.6

1. Identify NRM policy cases and analyse and point out aspects in which the policy is:
   - gender blind
   - gender neutral

- gender aware
- gender specific and
- Gender-redistributive

2. Discus ways in which you may improve this policy to make it responsive to gender needs in NRM

Learning Activity 5.7

1. Design a NRM research project with conscious inclusion of gender considerations for sustainable Natural Resource Management and Development. Present your plan for a gender disaggregated data collection.

Revision Questions

1. Discuss the key factors that determine the differential impact of natural resource management impacts on men and women.
2. Name and explain the tools for enhancing the gender responsive capacities of individual governments, civil societies and NGOs for effective natural resources management.
3. How does sex disaggregated data to help in developing effective gender responsive policies and actions.
4. Is it important to involve both women and men in decision -and policy -making process in order that the needs and concerns of both sexes are represented equitably.
5. Define the terms gender, *gender roles* and gender *relationships as used in NRM*. What is the main aim of gender analysis in NRM?
6. Describe the historical basis for the developments of Women In Development (WID), Women and Development (WAD, Gender in Development (GID), and Gender and Development (GAD).
7. Differentiate between gender equity and gender equality giving examples from specific NRM initiatives.
8. Explain how you would provide policies makers with gender sensitive guidelines/recommendations for sustainable management of the following natural resources or issues:
   i) Land
   ii) Forests
   iii) Fisheries
   iv) Climate change adaptation
9. Compare and contrast the main frameworks for gender analysis useful in NRM.

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Natural Resource Management in the Context of Climate Change

P.Z. Yanda, T. Yatich , Washington O. Ochola and N. Ngece

Introduction

In this chapter, an attempt has been made to synthesize the state of knowledge on climate change as well as mitigation and adaptation using Natural Resource Management (NRM) as an entry point. Climate change governance and re-orientation of national level institutions to effectively bridge local and global level mechanisms are also discussed. The existing knowledge gaps have been expressed in learning activities. This is aimed at shaping the direction of bridging scales and expanding the frontiers of climate change knowledge. Case studies presented are linked to how the frontiers of knowledge have been expanded as well as the role of communities in climate change mitigation and adaptation.

The chapter exposes the reader to the science of climate change in relation to Natural Resources Management with the aim of understanding, acquiring and applying tools, knowledge, approaches, methodologies and skills on the phenomenon of climate change and associated impacts on natural resource management. Specifically, the Chapter enables the reader to:

i) Apply tools, approaches and methodologies on climate change phenomena and natural resource management;
ii) Acquire expertise and design mitigation and adaptation programmes and projects to climate change;

iii) Advocate and create awareness on climate change at different levels through provision of information, tools and approaches; and
iv) Work with communities through organizing, information provision and capacity building on climate change and NRM to promote collective learning and action.

The learning outcomes of this chapter include *inter alia*:

- Use of the synthesis provided to understand, apply and design mitigation and adaptation measures;
- Use of the tools, approaches and methodologies to contribute and further fill the knowledge gaps on climate change impacts, vulnerability, mitigation and adaptation;
- Adoption of an inter-disciplinary approach in addressing climate change and variability impacts; and
- Creation of awareness and working with governments and other stakeholders to provide relevant tools, and methodologies for mainstreaming climate change into sectoral and development planning.

Climate Change

Climate change is the greatest challenge of our time. It has elicited action at local, national and global scales. Climate change is predicted to exacerbate the intensity and magnitude of extreme weather events like flooding, cyclones and droughts. These will negatively affect natural and social systems. Human livelihoods, especially those of nature-based economies, will be adversely affected. Changing precipitation and temperature patterns and trends will affect ecosystems' productivity and thus the availability and distribution of goods and services. Understanding, mitigating and adapting to climate change is urgent if ecosystems are to continue providing critical goods and services. This includes focusing on the improvement of the resilience and adaptive capacity of natural and human systems. An important question is, "how can this be realized?" The answer lies in the way NRM is undertaken now and in future.

Communities dependent on natural resources have had less to do with climate change and yet that is where the action lies. There have been attempts to localize global level initiatives and decisions. This lies in how Natural Resource Management is viewed and undertaken in the light of climate change responses at global, regional and national levels. It is expected that with climate change, Natural Resource Management at different levels will dynamically facilitate the design and implementation of mitigation and adaptation strategies that will enhance resilience and adaptive capacities of natural and social systems. In order to bridge global, regional, national and local level divides, climate change science is critical. Appropriate tools, approaches and methodologies are, therefore, critical in advocating for mitigation and adaptation strategies. It has been argued that the physical science basis of climate change is fairly well settled. Greenhouse gases are major contributors of climate change.

Controversies persist on precipitation and temperature patterns and trends and quantification of their impacts on natural resources. However, questions abound, for example, on how plausible the glacial melting rates in the Himalayas are, the connection between severe weather storms and climate change. As regards mitigation of climate change, an array of measures, including financing mechanisms, have been piloted and scaled up in different landscapes. Questions on environmental justice and adequacy of payments to sustain smallholders' interests have been raised. Some of the mitigation mechanisms, Reduction of Emissions from Deforestation and Degradation (REDD) are seen as excuses not to reduce emissions from industry. These controversies are likely to be addressed as the frontiers of knowledge get expanded. Universities, especially graduate students, have a role to play in addressing these knowledge gaps and controversies.

Definitions and Concepts

The Intergovernmental Panel on Climate Change (IPCC) (2007) defines *climate change* as changes in the mean and/or the variability of its properties that persists for an extended period, typically, decades or longer. It is a statistically significant decadal variation in either the mean state of the climate or in its variability. Climate variability refers to the variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forces (external variability). Another definition of climatic variability is by Zhou *et al.,* (2004) who say it refers to *Climate variability* short-term fluctuations around the mean climate state within an averaging period, typically, 30 years (Hare, 1985). In this Chapter, climate variability is treated as an integral and inherent aspect of climate change. This is because climate change is attributed to natural variability or to human activities and therefore, the need to discuss them together.

Climate change is a gradual process that builds over time while *climatic variability* are short-term fluctuations that lead to extreme events like droughts and floods. It is predicted that with climate change, there will be increased frequency, intensity and magnitude of extreme events like flooding and droughts. Climate change impact is defined as consequences of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential and residual impacts. Potential and residual impacts differently impact on natural and human systems.

There are varying definitions of *vulnerability*. Fussel and Klein (2006), define it as the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. Vulnerability, according to the IPCC definition, is an integrated measure of the expected magnitude of adverse effects to a system caused by a given level of certain external stressors (IPCC, 2007). Here, vulnerability includes an external dimension represented by the ‘exposure’ of a system to climate variations, as well as an internal dimension, which comprises its ‘sensitivity’ and its ‘adaptive capacity’ to these stressors. *Exposure* refers to the nature and degree to which a system is exposed to significant climatic variations.

It has been argued that climate change can be managed through mitigation and adaptation. In the context of climate change *mitigation* Chandler *et al*., (2002) sees it referring to human interventions to reduce the "sources" of greenhouse gases or enhance the "sinks" to remove carbon dioxide from the atmosphere. This in no way ignores what communities have done over the years to adapt to extreme climatic events. Local communities have used a wide range of strategies to deal with climatic hazards such as drought. Coping strategies are short-term responses that are utilised to face a sudden, unanticipated climatic risk while adaptation is a more long-term process that often entails some socio-economic and institutional changes to sustain livelihood security (Orindi and Eriksen, 2005). *Adaptation* is adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate, harm or exploit beneficial opportunities. Various types of adaptation can be distinguished as anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. Coping strategies, mitigation and adaptation are aimed at enhancing the resilience and the adaptive capacities of natural and social systems. *Adaptive capacity* refers to the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

In this Chapter, these concepts are used in line with the definitions presented above, but this does not in any way ignore different perspectives or dimensions that have been advanced by different stakeholders depending on contexts.

Historical Account of Climate Change

There is no doubt to the proposition that the root of climate change is global warming caused by anthropogenic emissions of carbon dioxide (CO_2), methane and other greenhouse gases (Collier *et al.*, 2008). IPCC (2007) concluded that it is more than 90% certain that the current global warming is the result of human activities, particularly related to industrial, consumption and land-use practices. Climate change is attributed to 30 percent of human-caused greenhouse gas emissions from agriculture, forestry, and other changes in land uses. Deforestation is seen as a major source of emissions. The world has warmed by an average of 0.76°C since pre-industrial times and the global average temperature is projected to increase further by 1.8°C to 4°C if no action is taken. For example, in the Arctic, average temperatures have increased at almost twice the global average rate in the past 100 years. Sea ice extent has shrunk and temperatures at the top of the permafrost layer have generally increased (IISD, 2008; IPCC, 2007d: 7–9).

Over the past century, the Earth's average surface temperature has increased by almost 0.74°C. The consequences of this alteration are starting to become more visible as climatic conditions and ecosystems begin to change. This warming trend is projected to continue, rising another 1.1°C to 6.4°C over the next 100 years (IPCC, 2007a). At present emission rates, a 2°C rise in temperature is highly probable and possibly inevitable (Stern, 2006). At this level of global average temperature increase, up to 30% of all plant and animal species will likely be at increasing risk of extinction; most corals will likely be bleached; cereal productivity in low latitudes likely to decrease and millions more people will likely experience coastal flooding (IPCC, 2007b; IISD, 2008). Natural variability of the climate will be altered leading to changing rainfall and temperature patterns and trends. These are likely to have adverse impacts on natural and human systems. Figure 6.1 illustrates the trends in global mean surface temperature based on dataset and method by Hansen *et al.*, (2006) while Figure 6.2 shows the mean surface temperature changes from the year 2000 to 2009 relative to the average temperatures from the year 1951 to 1980.

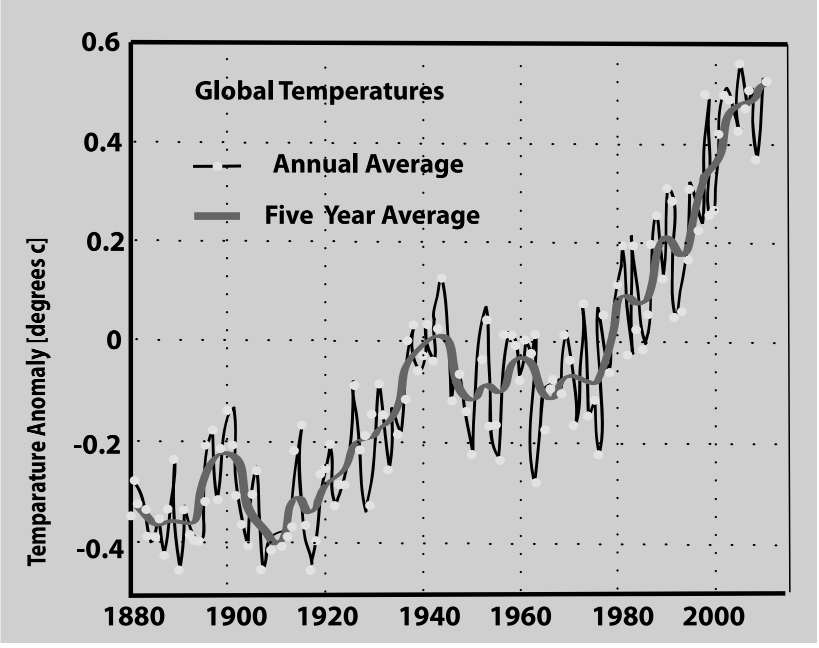

Figure 6.1: Global Mean Surface Temperature Difference Relative to the 1961–1990 Average

Source: Hansen et al., (2006)

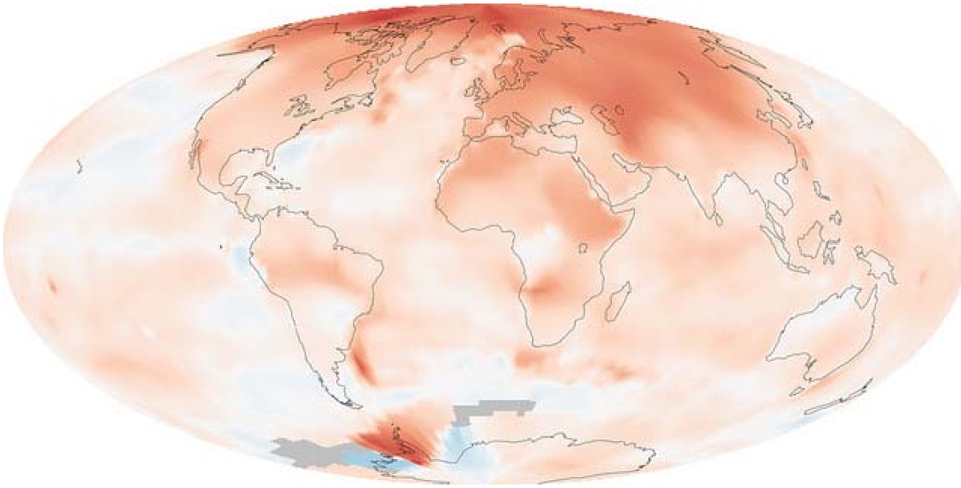

Figure 6.2: Mean Surface Temperature Change for the Period 2000 to 2009 Relative to the Average Temperatures From 1951 to 1980

Source: Hepburn and Stern (2008).

Ultimately, the increasing temperature, greenhouse gas accumulation in the global atmosphere and increasing regional concentrations of aerosol particulates are now understood to have detectable effects on the global climate system (Santer *et al.*, 1996).While these effects are evident at regional scales, they are differentiated by the technological and economic power of respective regions (Giorgi & Francisco 2000; Hulme, 2001; Mitchell & Hulme, 1999). The changing climate at global scale has been considered to be more sensitive due to numerous human activities, which are directly linked to climate. In this respect, adapting to climate variability and the effects of climate change has always been a challenge for humankind. In particular, extreme weather events have always significantly affected human societies through famines, migrations, epidemics, and in some instances, the complete disappearance of communities or civilizations (Fluet *et al*., 2009; Collier *et al.*, 2008).

The climate landscape has fundamentally changed since the Kyoto Protocol[3] in 1997. Human-induced climate change is increasingly being observed (IPCC, 2007a) and there is greater confidence in long-term climate projections suggesting that significant, and largely adverse change will take place within this century (IPCC, 2007b). In addition, the growing number of extreme weather events throughout the world in recent years has increased sensitivity to the potentially dramatic social and economic impacts of climate change for all countries. In this respect, economic analyses have raised awareness of the substantive additional technological and

3 The Kyoto Protocol (1997) is an agreement to a 5.2 % reduction in greenhouse-gas emissions by about 2010 (relative to 1990), and constant emissions thereafter. These targets relate to the annex 1 countries. These are 38 highly industrialized countries and countries undergoing the process of transition to a market economy.

financing need to prepare for these impacts (IISD, 2008). In addition, these climate change trends call for ambitious local and global mitigation and adaptation efforts to lessen and improve the local capacity of communities and ecosystems in the face of potential and dramatic changes in the global climate system and their consequent impacts on societies, economies, livelihoods and ecosystems (IISD, 2008).

Given the potential impacts of climate change and inherent natural variability, progress has been made to provide the evidence base for decision-making. There is a growing consensus on the understanding of the natural and human processes that govern climate change, and their associated socio-economic impacts. As a result, there has been increasing attention on global and regional efforts to cope and curb the increasing and projected impacts from changes (IPCC, 2007; Bosetti *et al*., 2009). Climate change challenge has become a public policy priority, and is now ranked high in the political agenda of many countries. Climate change is no longer treated as an environmental issue alone; but rather a national development agenda with links across sectors (Bosetti, *et. al*., 2009). Consequently, there have been two types of response to these changes. *First*, efforts to reduce the extent to which our climate is altered. This is known as *climate change mitigation*. The *second* is to learn to live with the inevitable changes. This is known as adaptation to climate change impacts (Reid, 2004).

The significance of climate change vulnerability has aggravated normal planning motives in the 21st century (Orindi and Murray, 2005). While impacts are projected to increase and reduce coping capacities of poor countries, there is continuous industrialisation leading to the release of Greenhouse Gases (GHGs) into the atmosphere, with subsequent changes in the Earth's temperature and weather systems (Collier *et al.,* 2008; Orindi and Murray, 2005). Already, global warming has led to changes in temperature, distribution of rainfall, frequency and intensity of extreme weather events, and sea-level rises. Eventually, many human systems are affected by these changes, particularly agriculture, water resources, industry and human health (Murray, 2005). In addition, significant disruption of existing ecosystems is expected to take place as global climate change proceeds (Murray, 2005).

Climate change is attributed to the greenhouse gas effect. According to Treut *et al*., (2007), roughly one-third of the solar energy that reaches the top of Earth's atmosphere is reflected directly back to space. The remaining two-thirds are absorbed by the surface and, to a lesser extent, by the atmosphere. To balance the absorbed incoming energy, the Earth must, on average, radiate the same amount of energy back to space. Because the Earth is much colder than the Sun, it radiates at much longer wavelengths, primarily in the infrared part of the spectrum (see Figure 6.3). Much of this thermal radiation emitted by the land and ocean is absorbed by the atmosphere, including clouds, and re-radiated back to the Earth. This is called the greenhouse effect.

Without the natural greenhouse effect, the average temperature at Earth's surface would be below the freezing point of water. Thus, Earth's natural greenhouse effect makes life, as we know it, possible. However, human activities, primarily the burning of fossil fuels and clearing of forests, have greatly intensified the natural greenhouse effect, causing global warming. Adding more of a greenhouse gas, such as carbon dioxide (CO_2), to the atmosphere, intensifies the greenhouse effect, thus warming Earth's climate.

The amount of warming depends on various feedback mechanisms. For example, as the atmosphere warms due to rising levels of greenhouse gases, its concentration of water vapour increases, further intensifying the greenhouse effect. This in turn causes more warming, which causes an additional increase in water vapour, in a self-reinforcing cycle. This water vapour feedback may be strong enough to approximately double the increase in the greenhouse effect due to the added CO_2 alone.

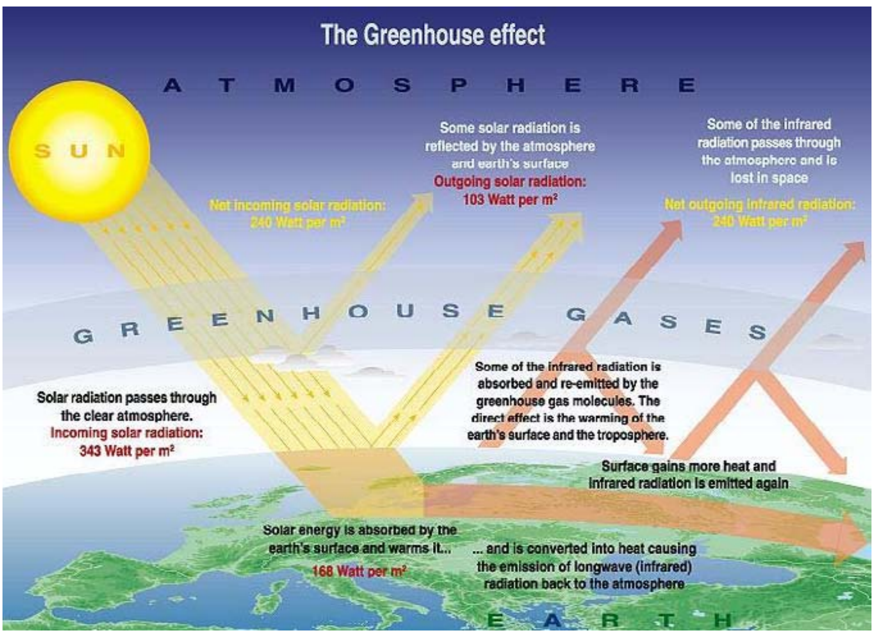

Figure 6.3: An Idealized Model of the Natural Greenhouse Effect

Source: Adapted from Treut et al., (2007) and IPCC (2007)

Additional important feedback mechanisms involve clouds. Clouds are effective at absorbing infrared radiation and therefore exert a large greenhouse effect, thus warming the Earth. Clouds are also effective at reflecting away incoming solar radiation, thus cooling the Earth. A change in almost any aspect of clouds, such as type, location, water content, cloud altitude, particle size and shape, or lifetimes, affects the degree to which clouds warm or cools the Earth. Some changes amplify warming while others diminish it. Much research is in progress to better understand how clouds change in response to climate warming, and how these changes affect climate through various feedback mechanisms (Treut *et al.*, 2007).

The Greenhouse Gas (GHS) effect causes global warming as well as affects the state of the ozone layer which shields natural and social systems from the sun's ultraviolet rays. If the sun's ultraviolet rays are not shielded, there would be potential consequences like skin cancer, cataracts, and damage to the immune system. Thinning of the ozone layer is also predicted to alter the DNA of plants and animals. The greenhouse effect is responsible not only for heating the lower atmosphere, but also for cooling the upper atmosphere. The cooling poses problems for ozone molecules, which are most unstable at low temperatures. Shindell *et al.*, (1998) argues that the build-up of greenhouse gases could chill the high atmosphere near the poles by as much as 8 to 10 degrees centigrade and that the maximum ozone loss would occur between the years 2010 and 2019. The greenhouse effect has different impacts on the different layers of the atmosphere leading to ozone depletion by influencing the interactions between ozone and Human-Created Greenhouse Gases (GHGS).

Future Projections on Climate Change

According to regional projections for Africa, warming rate and magnitude are predicted to be larger than the global average (IPCC, 2007). Climatic parameters, specifically rainfall and temperature, are predicted to vary across different ecological zones in all seasons, with drier subtropical regions warming more than the moister tropics. Annual rainfall is likely to decrease in much of Mediterranean Africa and northern Sahara, with the likelihood of a decrease in rainfall increasing as the Mediterranean coast is approached. Rainfall in southern Africa is likely to decrease in much of the winter rainfall region and on western margins. In East Africa, there is likely to be an increase in annual mean rainfall (IPCC, 2007). Such predicted changes will have varying impacts on natural and social systems. Figure 6.4 depicts predicted global warming levels with the assumption of current economic growth and greenhouse gas emissions trajectories.

Climate variations are attributed to a small number of climate patterns, such as El Nino–Southern Oscillation (ENSO), North Atlantic Oscillation (NAO), Arctic Oscillation (AO), Northern Annular Mode (NAM), Southern Annular Mode (SAM), Pacific-North American Pattern (PNA) and Pacific Decadal Oscillation (PDO). Changes in the fluctuations of these climate patterns will likely have effects on the distribution and the extent of monsoonal rains, a decrease of subtropical precipitation due to the poleward movement of the transition zone and possibly more and stronger tropical storms. The extent to which these patterns can be described accurately with today's generation of climate models is limited and remains an area of intense research, but several 20th Century changes can be viewed as alterations of these distinct climate patterns (IPCC, 2007). Ocean temperatures and teleconnections, for instance, cause temperature anomalies. The Indian Ocean Dipole (IOD), has been observed to influence South Asian monsoon as well as weather in East Africa and the western part of Indonesia. In the 'IOD+' mode, there are abnormally warm sea surface temperatures in the western Indian Ocean, with long dry seasons in Indonesia and heavy rainfall over East Africa. When the ENSO and IOD patterns coincide, which is not always the case, extreme droughts and flooding may be the result, as in the 1997/8 period. There is reason to believe that global warming effects on the western Indian Ocean have increased IOD variability and that this may have replaced the ENSO as the major driver of climate patterns over the Indian Ocean region.

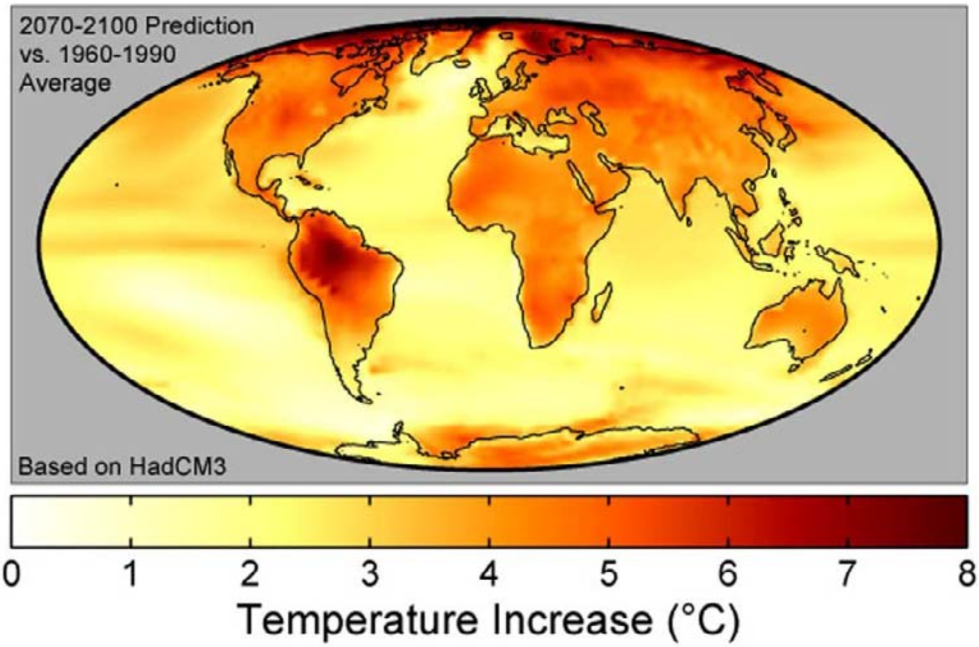

Figure 6.4: The Geographic Distribution of Surface Warming During the 21st Century Calculated by the Hadcm3 Climate Model if a Business as Usual Scenario is Assumed for Economic Growth and Greenhouse Gas Emissions. In this Figure, The Globally Averaged Warming Corresponds to 3.0 °C (5.4 °F).

Source: Hansen et al., (2006)

Box 6.1: The El Niño Phenomenon

El Niño is a warm phase of the interannual climate oscillation called El Niño Southern Oscillation (ENSO) event, an example of large-scale ocean-atmosphere interaction, and is characterized by large-scale warming of the surface tropical Pacific Ocean. El Niño events occur every 3-6 years, last 9-12 months, sometimes even up to 18 months, and have a big impact on world weather.

The major impacts of El Niño are temperature anomalies, changes in precipitation variability, floods and droughts throughout the world.

El Niño events happen irregularly and are hard to predict. However, many numerical climate models predicted the last few El Niño events successfully. El Niño forecasting is becoming more and more reliable with our improving knowledge of the phenomenon's nature, with the help of more and more powerful computers, and with the operational El Niño Southern Oscillation observation system. El Niño forecasting is especially important for tropical countries where El Niño impacts are the strongest.

Source: Stewart (2009)

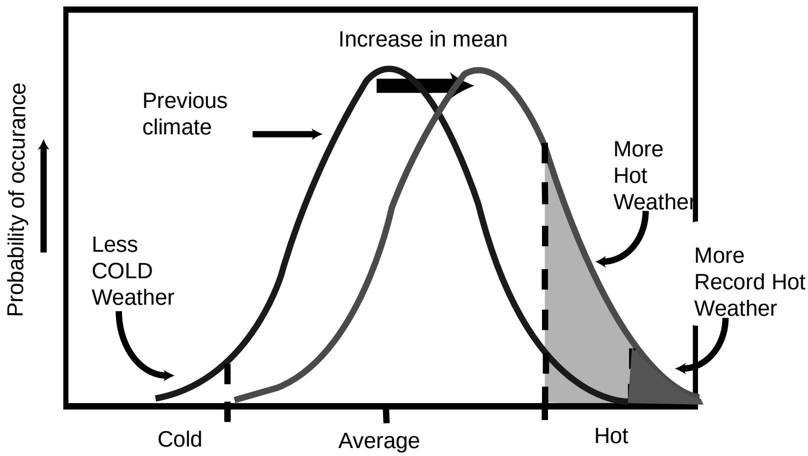

Figure 6.5: Schematic Representation of the Effect on Extreme Temperatures When the Mean Temperature Increases, for a Normal Temperature Distribution.

Source: IPCC, 2007.

The frequency and intensity of extreme weather events, such as droughts or floods is important in making decisions on natural resource management. Extreme weather events are responsible for the majority of direct climate impacts and can have disastrous effects on human health and wellbeing and on the economy. No individual extreme event can be directly attributed to climate change because there is limited knowledge (records generally date back no more than 150 years) about how extreme weather events have been in the past. In some cases, it is possible to assign the probability with which an event has been affected by climate change. Figure 6.5 illustrates how a fairly small shift could affect weather events at the upper and lower end of the Probability Distribution Function (PDF).

The recurrence of extreme weather conditions have been linked to various ocean temperature gradients and circulation patterns. The search for periodicities in extreme weather events is still poorly linked to underlying biophysical understanding. The failure to understand climatic variability of rainfall and temperature at local scales affects planning, management and preparedness.

Therefore, empirical tools to pick signals and explain rainfall variability relative to global phenomena are critical. One such approach is the ‘wavelet analysis’ that has been used to show links between climatic variability to IOD and ENSO, among other factors (Jevrejeva *et al.*, 2003; Grinsted *et al.*, 2004). Following the approach of Torrence and Compo (1998), seasonal time series of rainfall data for the Nyando and Yala River Basins were subjected to wavelet analysis to identify repetitive cycles of high rainfall, temperature or malaria incidences. Using the Continuous Wavelet Transform (CWT), evidence emerged for repetitive cycles at quasi bi-annual scale, the ENSO time series and the solar cycle.

These repetitive cycles can be correlated with rainfall anomalies to show their relationship thereby establishing rainfall behaviour. Questions, however, abound on the level of different global scale phenomena influence on rainfall behaviour, links to climate change as well as impacts on the constituents of human well-being (Roy and Duraiappah, 2003).

Changing rainfall patterns will devastate the health of ecosystems, associated services and human well-being. The availability and distribution or overlaps of different goods and services provided by different ecosystems will also be affected either positively or negatively. Increased rainfall will lead to increased productivity of both crops and pasture in arid and semi-arid environments. This will not be without impacts on human settlements, increased disease (e.g. malaria, cholera, diarrhoea etc) prevalence, and disruption of transport and communication infrastructure. East African highlands, which are seen as safe havens, are slowly becoming malaria infected with climate change and variability. The hypothesis that the re-emergence of highland malaria in East African highlands is attributable to climate change and variability is still controversial despite emerging credible evidence. Nevertheless, re-emergence of highland malaria still remains a challenge irrespective of whether it is attributed to either climatic change, variability or land use and land cover changes.

The cause of climate change is Greenhouse Gases (GHGs), particularly Carbon Dioxide (CO_2), methane, nitrous oxide, and Hydro-Fluorocarbons (HFCs), through consumption and production that have been observed to accelerate these environmental changes (Hepburn and Stern, 2008). Although Africa’s GHG emissions are negligible compared to the rest of the world (Figure 6.6), it is worst hit by the impacts of climate change due to the continent’s great reliance on natural resources. These flows of emissions accumulate into stocks of GHGs in the atmosphere. However, the rate of accumulation depends upon the Earth's ‘carbon cycle’, whereby carbon dioxide is reabsorbed into the oceans and land. Over time, the accumulated GHGs trap heat and result in global warming. As the planet warms, the climate changes, which affect human and natural systems through rising sea-levels and increased frequency and intensity of storms, floods, and droughts (Hepburn and Stern, 2008). Climate change represents a new threat and challenge to many households and social groups with limited capacity to adapt. Furthermore, household adaptive capacities are weakened by other non-climate factors (e.g. high levels of poverty, diseases, poor governance, conflicts) **(**Eriksen *et al.,* 2009) thus worsening the existing situation.

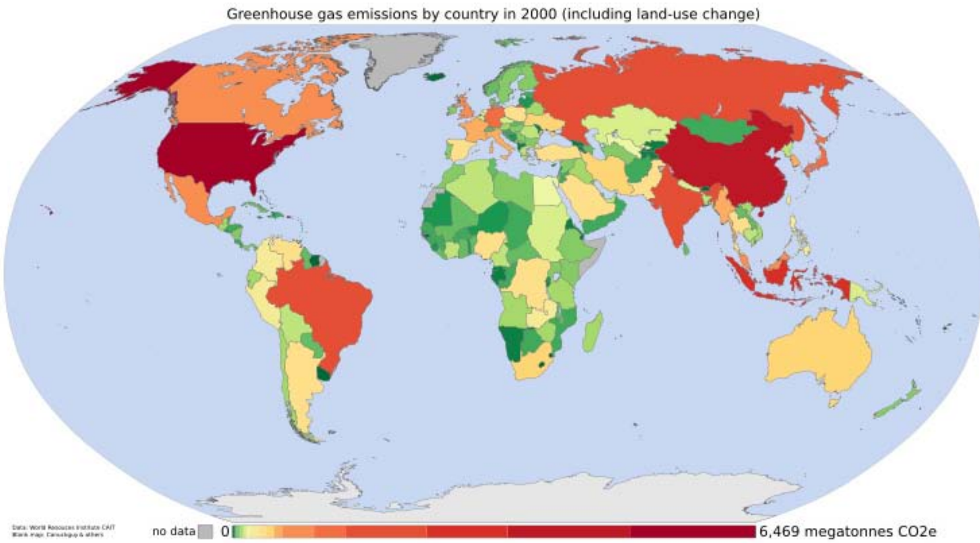

Figure 6.6: Total Green House Gas Emissions by Country in 2000 Including From Land Use Change.

Source: Hepburn and Stern (2008).

Strategic changes at the management level of natural resources will see the mainstreaming of climate change into policy development and national level planning and development. With variations in the availability, distribution and or overlaps of ecosystem goods and services, resulting tradeoffs will need to be managed with different management approaches adopted for each landscape exhibiting different characteristics. Multi-functional landscapes can be sustained through supporting multi-functionality by adopting different management approaches.

Climate Change – Ecosystem Linkages

Natural resources are inextricably linked to climate changes. This is based on the grounds that climate change affects natural resources such as land and biodiversity; and changes to natural ecosystems affect climate parameters (Mansourian *et al*., 2009; Reid *et al.,* 2004; Reid, 2004). For instance, land use changes that lead to biodiversity losses can cause increased greenhouse gas emissions. Since forests are a major store of carbon, carbon dioxide is released into the atmosphere and when forests are cut down or burnt. For instance, continuing deforestation, mainly in tropical regions, is currently thought to be responsible for annual emissions of 1.1 to 1.7 billion tonnes of carbon per year, or approximately one-fifth of human

Carbon dioxide emissions (Reid, 2004). Understanding lateral flows and sink areas at landscape level is important in any spatial planning that is aimed at adapting and mitigating to climate change. Spatial planning provides a systematic approach to developing appropriate watershed plans and involves:

i) carefully delineating the watershed;
ii) identifying critical areas within the watershed; and
iii) calibrating and validating hydrological, climatic and socio-economic models.

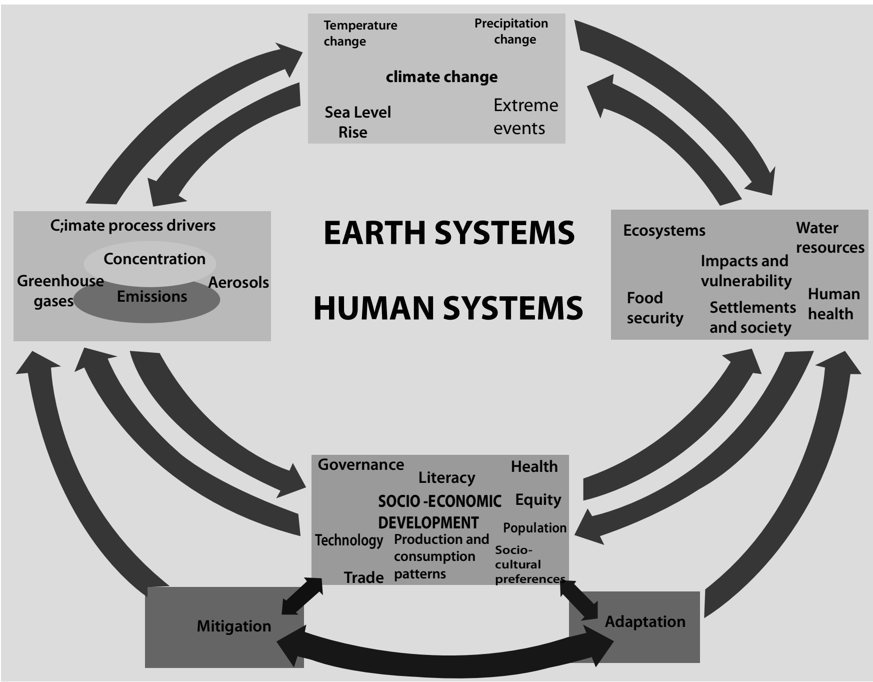

Figure 6.7: Schematic Framework Representing Anthropogenic Drivers, Impacts of and Responses to Climate Change, and their Linkages.

Source: IPCC, 2007

The climate change-ecosystems linkages are reflected in Figure 6.7. The feedback mechanisms between the different systems are either clockwise or counterclockwise. The clockwise linkages show climatic changes and impacts from socio-economic information and emissions. With increased understanding of these linkages, IPCC (2007) observes that it is possible to assess the linkages also counterclockwise, i.e. to evaluate possible development pathways and global emissions constraints that would reduce the risk of future impacts that society may wish to avoid.

Sasumua Watershed

In an ongoing study in Sasumua Watershed, 100 miles North of Nairobi and providing 20 percent of Nairobi's water demand, an integrated approach has been adopted in scoping Rewards for Ecosystem Services (RES). RES can therefore be seen as providing an integrating approach. In Sasumua watershed, the scoping adopted a modular approach encompassing catchment delineation, land use, land cover change analysis, land tenure analysis, land degradation assessments, hydrological modelling, water quality assessment, environmental auditing, socio-economic assessment and carbon stock measurements. A modular approach brings the different elements associated with a specific problem together. The rationale for adopting this approach is to reduce sediment flow and water contamination of the Sasumua Reservoir through shift from the current land uses to more appropriate land use systems. The land uses to be adopted are expected to be an income stream for communities through linking farmers to the voluntary market.

This linkage acknowledges that effective biodiversity conservation and management can lead to higher levels of carbon sequestration and hence climate change mitigation. For example, forest management activities such as increasing rotation age, low intensity harvesting, reduced impact logging, leaving woody debris, harvesting which emulates natural disturbance regimes, avoiding fragmentation, provision of buffer zones and natural fire regimes, can simultaneously provide biodiversity and climate benefits. This is also true for certain agroforestry, revegetation, grassland management and agricultural practices such as recycling and use of organic materials.

Integrated watershed management can conserve watershed biodiversity in addition to increasing water retention and availability in times of drought; decreasing the chance of flash floods and maintaining vegetation as a carbon sink (Reid, 2004).

In Africa, rural poor communities depend on natural resource base for their daily needs. Natural resources reflect those actual and potential forms of wealth supplied by nature, such as coal, oil, water, power, arable land (Peck, 1999). Natural resources, therefore, encompass the individual elements of the natural environment that provide economic and social services to human society.

Traditionally, natural resources are considered to be limited to resources providing quantifiable economic products such as industrial minerals, energy sources, timber, and agricultural land (Raymond and Smith, 1993). However, in recent decades, there has been a growing recognition that natural resources, as ecosystems, provide a larger array of services to society than merely as a source of industrial raw materials. As these services have come to be recognized, the definition of natural resources has expanded to include ecological elements and the services derived from ecosystem processes (Peck, 1999). We can therefore say that they are benefits freely provided by nature.

Provisioning and supporting ecosystem services can rightly be classified as natural resources. Regulating and cultural ecosystem services influence, in various ways, the use, nature, and patterns of provisioning and supporting services. This provides the need for an integrated approach in examining the links between climate change and natural resource management. Climate change regulation is dependent upon health of ecosystems and their associated provisioning and supporting services. This is an outcome of the different typologies of the management of natural resources, interests, norms and values at different scales.

While acknowledging the goods and services natural resources provide for community livelihoods, there is no doubt that future climate shifts will damage such resources (Hepburn and Stern, 2008). Many of the impacts will be felt in the distant future, but it is also likely that serious impacts will be felt by many people currently alive (Hepburn and Stern, 2008). Projected effects include the rising of sea levels, dramatic changes in weather patterns, accentuation of tropical disease patterns and a wide variety of accelerated biodiversity losses (Stuart and Costa, 1998). Given such trend of impacts from the changes of climatic parameters, the Intergovernmental Panel on Climate Change concluded that there is no doubt that the climate is changing and that there is 90% certainty that humans are the cause of climate change (IPCC, 2007). The IPCC also made it clear that even strong actions to reduce global greenhouse gas emissions will not prevent the climate from continuing to change for many decades to come. Thus, adaptation must be part of the response to climate change, as is mitigation (Lempriere, 2008).

The resource base of the rural poor is defined by multiple livelihood sources which are affected differently by climate change. As a result of this dependency, any impact that climate change has on natural systems threatens the livelihoods, food intake and health of poor people (Smith and Troni, 2004; Reid, 2004).When climate change and variability alters the distribution, availability and access to some of their livelihood systems, the rural communities tend to change their livelihood options. Consequently, these further degrade ecosystem integrity and enhance green house gas emissions.

Conservation of biodiversity and maintenance of ecosystem integrity may be a key objective towards improving the adaptive capacity to cope with climate change. Functionally diverse systems may be better able to adapt to climate change and climate variability than functionally impoverished systems. A larger gene pool will facilitate the emergence of genotypes that are better adapted to changed climatic conditions. As biodiversity is lost, options for change are diminished and human society becomes more vulnerable (Reid, 2004).

Climate Change Impacts and Vulnerability

Impacts of Climate Change on Natural Resources

Climate change is projected to impact broadly across ecosystems. The different ecosystems and associated ecosystem services are likely to be threatened by climate change and variability. In terms of physical and biological impacts, climate change is modifying the distribution of natural resources such as marine and freshwater species. In a warmed world, ecosystem productivity is likely to be reduced in most tropical and subtropical oceans, seas and lakes and increased in high latitudes. Increased temperatures will also affect fish physiological processes; resulting in both positive and negative effects on fisheries and aquaculture systems depending on the region and latitude (Cochrane *et al.,* 2009).

Climate change impacts are already being detected in a variety of ecosystems, particularly in southern African ecosystems, at a faster rate than anticipated. Climate change, interacting with human drivers such as deforestation and forest fires, are a threat to Africa's forest ecosystems. Changes in grasslands and marine ecosystems are also noticeable. It is estimated that, by the 2080s, the proportion of arid and semi-arid lands in Africa is likely to increase by 5-8%. Climate change impacts on Africa's ecosystems will probably have a negative effect on tourism as, according to one study, between 25% and 40% of mammal species in national parks in sub-Saharan Africa will become endangered (Boko, *et al.,* 2007).

Climate change is one of the main emerging threats facing *biodiversity*. There is evidence that climate change is already leading to losses of aquatic biodiversity. For example, in Lake Tanganyika, there is evidence of aquatic losses of about 20% with a 30% decrease in fish yields (O'Reilly *et al.*, 2003). Up to a quarter of mammal species (IPCC, 2002) are at risk of global extinction because of climate change. Climate change is expected to cause species to migrate to areas with more favourable temperature and precipitation. There is a high probability that competing, sometimes invasive species, more adapted to a new climate, will move in. Such movements could leave some protected areas with a different habitat and species assemblage than they were initially designed to protect (Mansourina *et al.*, 2009).

The effects of climate change on river ecosystems are no longer just speculation (Ormerod, 2009). Rivers and lakes have been sensitive to two indirect consequences of climate change. First, many are impaired already by other pressures with which climate interact. These include eutrophication, organic pollution, sediment release, acidification, abstraction, impoundment, urbanisation, hydropower development, flood-risk management and invasion by exotic species (Ormerod and Durance, 2009). Second, climate changes affect river and lake conditions and processes indirectly by changing the human use of river catchments, riparian zones and floodplains, possibly profoundly (Ormerod, 2009).

Water-related problems that already exist in the world are likely to worsen as a result of climate change. Intense rainfall events will increase the incidence of flooding in many areas. However, reduced runoff overall will exacerbate current water stress, reduce the quality and quantity of water available for domestic and industrial use, and limit hydropower production. Access to water in the Nile basin countries is dependent on runoff from the Ethiopian highlands and the level of Lake Victoria, both of which are sensitive to variations in rainfall. While the impact of climate change on water scarcity may be relatively minor compared to socioeconomic changes such as increased demand, land cover change and economic growth strategies, it may have international consequences and become a source of conflict (Eriksen *et al.*, 2008).

Sea level rise represents another threat to the region through saltwater intrusion and coastal erosion, although these effects will only be felt toward the end of the 21st century. Some of these climatic changes may have devastating effects where they add to existing stresses such as water scarcity and climatic variations such as decadal drying events. In addition, uncertainty regarding the direction and magnitude of changes in precipitation, river flows and lake levels in particular represents a challenge for adaptation to climate change **(**Eriksen *et al*, 2008).

Climate change and biodiversity loss are both major environmental concerns, yet the links between them often go unrecognised. Not only does the science of climate change and biodiversity share similar characteristics, but climate change both affects, and are affected by biodiversity. Diversity confers far greater resilience on natural systems, thus reducing their vulnerability – and the vulnerability of the people that depend upon them – to climate change. Yet climate adaptation and mitigation strategies that are blind to biodiversity can undermine this natural and social resilience. Ignoring the links between biodiversity and climate risks exacerbates the problems associated with climate change and represents a missed opportunity for maximising co-benefits (Roe, 2006).

Climate change is likely to have a number of impacts on biodiversity – from ecosystem to species level. The most obvious impact is the effect that flooding, sea level rise and temperature changes will have on ecosystem boundaries, allowing some ecosystems to expand into new areas, while others diminish in size. As well as shifting ecosystem boundaries, these changes will also cause changes in natural habitat – an outcome which will have a knock-on effect on species survival. A growing body of research indicates that, as a result, climate change may lead to a sharp increase in extinction rates. In addition, literature shows that for many species, climate change poses a greater threat to their survival than the destruction of their natural habitat (Reid, 2004).

The impact that floods, sea level rise and changes in climate are likely to have on natural habitats means that some protected areas may no longer be appropriate for the species they were designed to conserve (Reid, 2004). Global warming is also causing shifts in the reproductive cycles and growing seasons of certain species. For example, higher temperatures have led to an increase in the number of eggs laid by the spruce budworm, already one of the most devastating pests in North America's boreal forests. However, the impacts of climate change on biodiversity will vary from region to region. The most rapid changes in climate are expected in the far north and south of the planet, and in mountainous regions. These are also the regions where species often have no alternative habitats to which they can migrate in order to survive.

Other vulnerable ecosystems and species include small populations or those restricted to small areas such as coral reefs. Coral reefs have already shown devastating losses as a result of increased water temperatures (Reid, 2004; Glynn, 1993; Brown, 1997a; Wilkinson, 2000). "*Bleaching*" describes the loss of symbiotic algae by the coral or other host. Most of the pigments in the usually colourful corals depend on the presence of these plant cells. The living tissue of coral animals without algae is translucent, so the white calcium carbonate skeleton shows through, producing a bleached appearance. Bleaching is a general stress response that can be induced in both the field and the laboratory by high or low temperatures, intense light, changes in salinity, or by other physical or chemical stresses. Bleaching is the extreme case of natural variation in algal population density that occurs in many corals (Fitt *et al.,* 2000 & 2001).

Three types of *bleaching mechanisms* are associated with high temperature and/or light: "animal stress bleaching," "algal-stress bleaching," and "physiological bleaching" (Fitt *et al.,* 2001). Although all are important to understanding climate-coral interactions, two are particularly relevant to present concerns: algal-stress bleaching, an acute response to impairment of photosynthesis by high temperature coupled with high light levels; and physiological bleaching, which reflects depleted reserves, reduced tissue biomass, and less capacity to house algae as a result of the added energy demands of sustained above-normal temperatures. A rising baseline in warm-season sea-surface temperatures on coral reefs (Fitt *et al.,* 2001; Lough, 2001) suggests that physiological bleaching is at least partly to blame in some bleaching events. Such chronic temperature stress may also underlie some less obvious causes of reef decline, such as low rates of sexual reproduction (Mendes and Woodley, 2002). Box 6.2 explains these relationships by analogy with drought in terrestrial forests.

Box 6.2: A Coral Reef – Terrestrial Forest Analogy

Forests and reefs are very different, but both are complex ecosystems and both share enough similarities that the response of forests to severe drought can serve as a useful analogy for understanding coral reef stress responses. Trees are the main photosynthesizers in a forest and provide the structural complexity that modifies the environment and creates many habitats on which other organisms depend. Similarly, corals and marine algae - the calcareous algae, as well as the more familiar seaweeds - are the photosynthesizers that create the reef's structural and ecological complexity. Reefs, like tropical rainforests, grow in nutrient-poor conditions and have high biodiversity. Under severe drought, photosynthesis of many trees is interrupted when they lose their leaves, and some or most of them may die. Other forest organisms will then die or migrate elsewhere. Most forests can recover with the return of suitable weather conditions. Some trees will regrow leaves, but the energy lost during the drought may make them vulnerable to disease and less likely to bear fruit (reproduce) in the short term. Recovery time depends on factors like the original state of the forest, the extent of damage, resistance to disease, and whether seeds for new growth are available in the soil or by wind or animal transport from nearby forests. The nature of some forests may change permanently if a different ecosystem (e.g., grassland) takes its place.

Coral reef ecosystems have similar responses to bleaching; stress causes corals to expel their zooxanthellae, interrupting photosynthesis. Many corals can survive mild bleaching events, just as trees can recover from the loss of leaves. However, the longer corals remain bleached, the more susceptible they become to disease and other stresses. The 1997–98 mass bleaching event included extensive regions where corals and other species suffered high losses (> 90 percent mortality). Recovery, if it occurs, will depend on how many corals survive and reproduce, and whether the geographic placement of the reefs in relation to ocean currents provides larvae from elsewhere.

The temperature threshold for bleaching is not an absolute value, but is relative to other environmental variables (especially light) and to the duration and severity of the departure from the normal temperature conditions of a reef. Bleaching due to thermal stress is not, therefore, limited to areas of normally high water temperature. However, regions where higher temperatures are the norm seem likely to be more vulnerable to increased physiological bleaching (Fitt *et al.,* 2001).

Source: Buddemeir et al., (2004)

Increasing mean annual temperatures might initially promote greater forest productivity. As temperatures continue to rise though, evaporative demand is expected to increase while soil moisture decreases, leading to an increase in the frequency and intensity of drought. These changes are expected to impact each tree species differently. Some will be able to cope; others will not. Drought-stressed forests will be more susceptible to damage from insects and disease; climate change may lead to an increase in the frequency and intensity of insect, disease and fire events (FAO, 2009). Despite forests contribution in the enhancement of resilience capacity to both human and natural systems, forest ecosystems may not be able to adapt to the rate of temperature change or the intensity of weather events and other effects such as fires or floods (IIED[4], 2009).

Finally, *land management* will increasingly be affected by climate change and its many socio-economic consequences. These include global food security, fuel security, water scarcity, population displacement and management for carbon sequestration will drive agricultural change, intensification, forestry practice, water resource development and other land-use patterns over extensive areas. Not only will the direct demands on land use and management change *per se* in areas already under production, but also the geographical distribution of land uses will change as water scarcity increasingly limits options. In particular, arid and highly populated

4 IIED International Institute for Environment and Development

areas of the world that are unable to increase water supply or agricultural production will increase their demands for food exports from other regions (Ormerod, 2009).

Climate Change Vulnerability

Africa is one of the most vulnerable continents to climate change and variability, a situation aggravated by the interaction of ‘multiple stresses’, occurring at various levels, and low adaptive capacity. Africa’s major economic sectors are vulnerable to current climate sensitivity, with huge economic impacts. Climate change vulnerability is exacerbated by existing developmental challenges such as endemic poverty, complex governance and institutional dimensions; limited access to capital, including markets, infrastructure and technology; ecosystem degradation; and complex disasters and conflicts. These in turn have contributed to Africa’s weak adaptive capacity, increasing the continent’s vulnerability to projected climate change (Boko, *et al.*, 2007).

Climate change impacts will be more pronounced in arid and semi-arid parts of the developing world. Such areas will become hotter and drier, with less predictable rainfall. These climate-induced changes will negatively affect crop yields, water availability, and range conditions. Likewise, ecosystem boundaries and species’ ranges will dramatically change, and thus, influence poor people’s livelihoods. Such communities are vulnerable partly because they live in areas prone to extreme events (e.g. flooding and droughts), and are heavily dependent on *climate sensitive sectors* such as fisheries and agriculture. In essence, such communities have little capacity to adapt to such shocks. This is partly attributed to countries limited financial, institutional and human capacity to anticipate and respond to the direct and indirect impacts of climate change (Walter and Simms, 2002; Huq *et al.*, 2003; Sperling, 2003; Tyler and Fajbar, 2009).

Climate Change Mitigation

Role of Forests in Climate Change Mitigation

Forests cover 30% of the total land surface of the world (FAO[5] 2007). Forests in the ten most forest rich countries account for two-thirds of total forest area, while 57 countries have less than 10% of their land area in forests (ibid). However, many existing forests are experiencing impacts of climate change (FAO, 2007). In the context of climate change, mitigation refers to a human intervention to reduce the "sources" of greenhouse gases or enhance the "sinks" to remove carbon dioxide from the atmosphere (Chandler *et al.*, 2002). These efforts of reducing carbon emission are mainly focused on enhancing absorption channel by conserving and

5 FAO, Food and Agriculture Organization of the United Nations

restoring forest resources. The carbon capture and storage service provided by forests is illustrated in Figure 6.8.

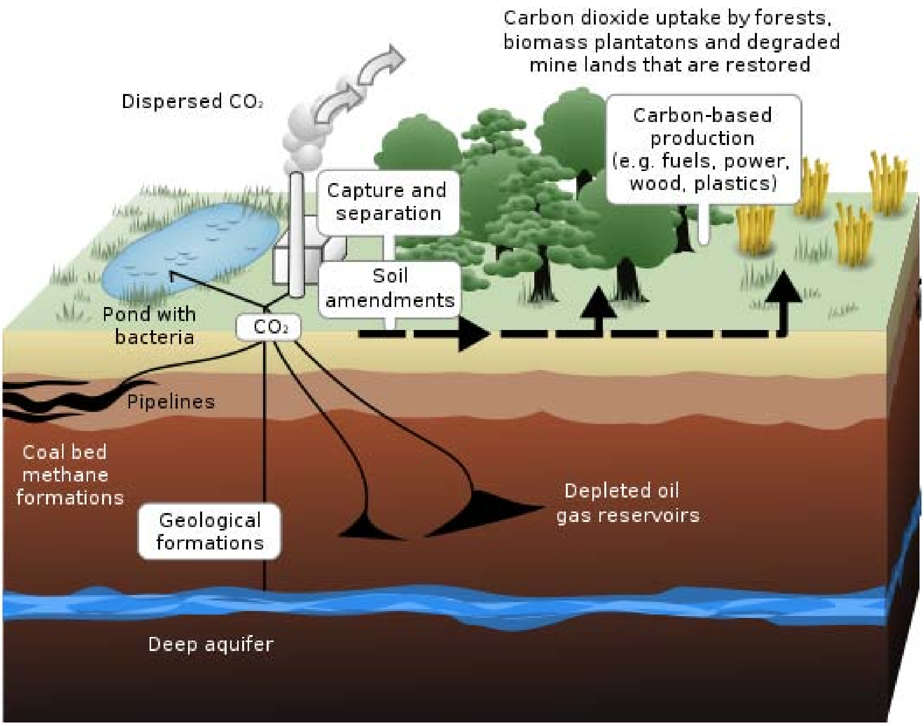

Figure 6.8: Carbon Capture and Storage (CCS) is an Approach to Mitigation. Emissions may be Sequestered from Fossil Fuel Power Plants, or Removed During Processing in Hydrogen Production. When Used on Plants, it is Known as Bio-Energy With Carbon Capture and Storage.

Source: World Bank (2010)

Mangrove forests, for example, play a vital role in climate change mitigation, but are often undervalued in many coastal communities. In addition to mitigating coastal erosion, salt spray incursion and coral siltation, they provide protection from storm surges and provide important habitats for a wide variety of bird, crab and shellfish species. Likewise, mangroves form important habitats and nurseries for numerous pelagic and coastal fish species, many of which form a vital source of protein for island communities and coastal dwellers (ibid). In relation to climate change mitigation, forests can play a role in adaptation by helping human societies to stabilise resilience capacity in adapting to climate change impacts. It is estimated that adaptive management of forests contributes to sustaining the livelihood of over two billion people worldwide (FAO, 2007).

Although ecosystems play a significant role in regulating global climate; changes in ecosystem can affect this regulatory system. Forests, for example, are both a source and sink of carbon. Carbon dioxide is fixed through photosynthesis but released into the atmosphere if forests are felled or burned (Roe, 2006). While it is apparent that forests, and sustainably managed forests in particular, can play an important role in climate change mitigation through increased uptake and storage of carbon dioxide, several important hurdles will have to be cleared before forests can fulfil their potential. These challenges range from developing effective forest carbon sequestration rules to compliance requirements and market considerations (Siry *et al.*, 2009). Another important issue is that of permanence. While carbon may be stored for decades in forests and wood products, eventually it will be released. Although it is possible to develop large forest projects which in due time will allow tree mortality and harvest to be offset by regeneration and growth, resulting in a steady state, non-declining carbon pool, this may not be a very efficient approach to land use management (Siry *et al.*, 2009).

Although the Kyoto Protocol[6] clearly recognizes the role that forests and forest management play in reducing Carbon dioxide emissions; it also places several restrictions on how this can be achieved. These restrictions are related to the principles of baseline, permanence, additionality and leakage. The Protocol also requires that forest carbon capture projects demonstrate additionality. A carbon emission reduction is additional only when it was developed exclusively for the purpose of climate change mitigation. Projects implemented under business as usual or required by other laws and regulations are not considered additional. Determining what are usual management practices in the real world often are quite difficult (Siry *et al.*, 2009). Further, the Protocol assumes and requires that carbon emission reductions are permanent. This reflects that carbon dioxide is removed from the atmosphere forever. As has already been pointed out, forest carbon sequestration by its very nature is temporary (Siry *et al.*, 2009). Another question is how carbon should be valued and how harvesting and wood product manufacturing should be treated. Carbon can be stored in wood products for many years, but many carbon schemes do not consider tree harvests nor do they allow credit for carbon stored in forest products. The answer to this question is critical for managed forests and the role they may assume in climate change mitigation (Siry *et al.,* 2009). All these requirements may seem reasonable at first, but in practice, they effectively remove managed forests from climate mitigation efforts.

While managed forests will continue to sequester carbon and provide certain storage benefits, their true potential to increase carbon sequestration above the current, natural (without extra management effort) levels may never be realized (Siry *et al*., 2009). Furthermore, assessing how much deforestation is being "avoided" can be a complex and controversial endeavour, which relates to social and economic aspects of a particular region. Often, government policies induce

6 The Kyoto Protocol (1997) is an agreement to a 5.2 % reduction in greenhouse-gas emissions by about 2010 (relative to 1990), and constant emissions thereafter. These targets relate to the annex 1 countries made up of 38 highly industrialized countries and countries undergoing transition to a market economy

pressure on standing forests by specifically encouraging forest utilisation. Some countries view conservation as patrimonial and an affront against a nation's sovereignty. As such, there has been some negative bias among potential funders against the idea of resource "lock-ups", although several programmes have combined conservation with sustainable utilisation and other economic activities (Stuart and Costa, 1998).

Recently, the World Agroforestry Centre (ICRAF) established that over 1 billion hectares of agricultural land globally or 43% have more than 10% tree cover, and these areas are home to almost a third of the 1.8 billion people who live on agricultural land. It further states that some 0.6 billion hectares of agricultural land have more than 20% tree cover, and 160 million hectares more than 50% (ICRAF, 2009). Agroforestry carbon sequestration potential is higher than those of different land uses (Figure 6.9).

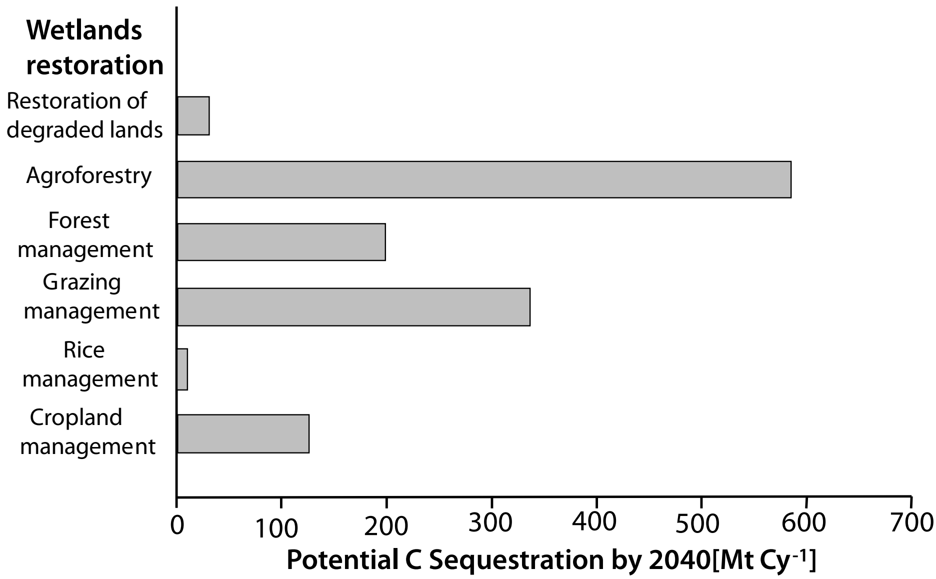

Figure 6.9: Carbon Sequestration Potential of Different Land Use and Management Options

Source: ICRAF, 2009

Carbon Trade

Modalities for rewarding farmers to adopt specific land uses to enhance the production of environmental services are service specific, but with influence on the quality or quantity of other environmental services. The planting of trees for global benefits in the long run provides watershed as well as biodiversity. Deforestation not only leads to increased sedimentation and water contamination of reservoirs for urban water supply, but also leads to habitat loss. Farmers continue to degrade agricultural landscapes because they do not see the reason for conserving or planting trees.

The shift toward payment or reward mechanisms is premised on the potential of market-based approaches to induce behavioural change among ecosystem stewards toward achieving the twin goals of poverty reduction and ecosystem conservation. Experience from Latin America and Southeast Asia has shown that poor farmers living adjacent to forested ecosystems, if recognized and appropriately rewarded, are likely to adopt land uses that have positive effects on ecosystem services available to the larger society. Market-based approaches are widely viewed as having the potential to defray conservation costs, meet social objectives and match the demand of environmental services with the short-term demands of land users within pastoral and agricultural landscapes. Two of the main ways that reward schemes vary are in terms of conditionality and voluntarism: reward mechanisms differ in terms of the explicitness of conditionality and the voluntary nature of the agreement on the part of ecosystem stewards and ecosystem service beneficiaries.

Payment modalities are being worked out for carbon trade. This will be based on carbon sequestration (deriving from the net absorption of carbon dioxide in planted trees) or by protecting carbon stocks – which would otherwise be emitted – in natural forests. In Africa, carbon trading is still incipient, but there are cases that can provide useful lessons and experiences for the design and implementation of payment schemes for carbon sequestered. The Uganda Ecotrust case of paying farmers for planting trees provide useful lessons and experiences in carbon trade and payment for environmental services (PES) (Box 6.3).

Box 6.3: Tree Planting as an Income Stream as Well as Mitigating Strategy for Climate Change

The Conservation Trust of Uganda (Ecotrust) has been implementing a 'Trees for Global Benefits Programme' in South Western Uganda. About 300 farmers are contracted to plant trees whose technical specifications have been formulated. The farmers have entered into contracts with Ecotrust, the Project Developer, to plant, care and get rewarded 4USD per tonne of carbon sequestered based on the *Plan Vivo standard*. The contract has been entered for 25 years with frequent verification. There has been engagement with buyers from Europe which want to offset carbon dioxide emitted in their production system. Farmers attest to the benefits that accrue to them by participating in the programme. A mixed system has been introduced after undertaking carbon accounting for agroforestry systems. This will see more poor farmers joining the programme in 2010 and engaging more buyers. This case is being replicated in Ulugurus Mountains (Tanzania) and Mt. Kenya East (Kenya).

Source: Byamukama, 2004; Ochieng; et al., 2007

If providers of ecosystem services can be fairly rewarded, there is good chance of reducing tropical deforestation and mitigating greenhouse gas production. These ideas are being implemented in pioneering efforts around the world. The challenge ahead is to replicate, scale up, and sustain these pioneering efforts. This requires major advances in the scientific understanding of natural capital, as well as in the design and implementation of finance mechanisms and supporting policies and institutions (Bond *et al.,* 2009). Accordingly, international cooperation to assist developing countries in preventing deforestation through carbon trading is now regarded as one essential vehicle for mitigating the impacts of global warming (Stern, 2006; Hall, 2008). While no panacea, it is increasingly seen as one viable policy option if appropriately conceived and implemented. Yet, neither should Payment for Ecosystem Services (PES), such as the Reduced Emission from Deforestation and Degradation (REDD) be viewed as a plain success. Many problems must be overcome if its potential is to be realised (Hall, 2008). Decisions taken at the 2007 Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Bali (COP 13) reopened the possibility for REDD to become part of a post-2012 global climate regime. Consequently, a number of developed-country governments and international development agencies have forged high-level partnerships and allocated substantial new funds to help prepare countries for participation in a REDD regime, including support for capacity-building, pilot demonstration activities, and other policies and measures to achieve reduced forest emissions (Bond *et al*., 2009).

While debate grows over the international architecture of a REDD mechanism and negotiations continue in various UNFCCC fora, more attention has been focused on how performance-based payments and other approaches to REDD would operate at national and local levels; the priorities for up-front investment to strengthen country capacity to implement REDD; and how REDD mechanisms can be designed to maximise co-benefits for forest-dependent communities and biodiversity conservation (Bond *et al.,* 2009). In developing appropriate management strategies involving forests, managers are increasingly expected to consider a wide range of issues and indicators, including the impacts of their actions on the greenhouse gas balance (Larsson *et al*., 2007). For instance, appropriately designed CBFM[7] policy can provide means to sustain and strengthen community livelihoods and at the same time avoid deforestation, restore forest cover and density, provide carbon mitigation and create rural assets.

Channelling carbon investment funds into CBFM projects can make both development and conservation economically viable and attractive for the local communities to maintain biodiversity and integrity of nature (Singh, 2008). Forest conservation for carbon sequestration purposes can be either direct or indirect. Direct interventions essentially require the "locking up" of threatened land resources into untouchable preserves. Indirect interventions comprise a far wider range of possibilities, including increasing agricultural productivity (thus lowering the need for cyclical slash and burn cropping), the development of agroforestry to meet fuel wood needs, and the opening of markets for indigenous forest products (Singh, 2008).

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7 CBFM, Community Based Forest Management

Existing literature indicates that forests sequester store large amounts of carbon in biomass and soils. Management practices, including afforestation, reforestation, and harvest, can substantially influence carbon sequestration potential of the land. Therefore, forest mitigation strategies may involve eliminating forest land conversions (especially in the case of tropical deforestation), postponing harvests, reducing burning or increasing carbon uptake through intensified forest management and conversion of agricultural land to forestry (Alig, 2003). Appropriate management approaches are currently in place and technologies are moderately available (Siry *et al.,* 2009). It is widely acknowledged that CBFM micro-planning exercise at the decentralized and site-specific level calls for involving the indigenous communities and their prescriptions for managing and restoring forests. It can simultaneously be used to overcome proximate threats of fragmentation and degradation and at the same time manage forests in such a way that the resilience and resistance of forests to climate change is enhanced. By protecting and restoring biodiversity, providing connectivity, mimicking nature in plantations and controlling man-made fires, CBFM is an effective way of managing forests during climate change (Singh, 2008). In addition, there are other mechanisms that can be useful in minimising carbon emission through proper management of forests. The suppression of forest fires is one option to reduce unnecessary carbon emissions. Along with the crucial need to address the policy causes, a combination of ground-based practices of fire prevention and control has great potential for reducing the frequency and extent of forest fires (Stuart and Costa, 1998).

Bio-fuel Production and Biodiversity

In recent years, biofuels have rapidly emerged as a major issue for agricultural development, energy policy, and natural resource management. Growing demand for biofuels is being driven by recent high oil prices, energy security concerns, and global climate change. In Africa, there is growing interest from foreign private investors in establishing biofuel projects. In Tanzania, biofuel production has the potential to provide a substitute for costly oil imports (currently US$ 1.3-1.6 billion per year, 25% of total foreign exchange earnings). Biofuels also have the potential to provide a new source of agricultural income and economic growth in rural areas, and a source of improvements in local infrastructure and broader development. Although many biofuel investments involve large plantations, biofuel production can also be carried out by smallholder farmers as well as through ‘out-grower’ or local contracted farmer arrangements (IIASA[8], 2009; Keeney and Nanninga, 2008; Sulle and Nelson, 2009).

For African countries, bio-fuel investment is leading to growing interest from Western and Asian private investors in biofuel projects, as well as growing support from bilateral and multilateral donors for incorporating biofuels into government

8 IIASA - International Institute for Applied Systems Analysis

policies and development plans. For countries in Africa which are non-oil producers, biofuel production has the potential to provide at least a partial substitute for costly oil imports, which are one of the major uses of foreign exchange and sources of inflation in African economies. Biofuel crops such as oils (palm, coconut, jatropha, sunflower) may provide important new opportunities for improving the returns from agriculture, including on relatively unproductive or infertile lands (Sulle and Nelson, 2009).

External interest in biofuel production in African countries is driven largely by the low cost of land and labour in rural Africa (Cotula *et al*., 2008). Investors are targeting many areas of land which are perceived as being ‘unused’ or ‘marginal’ in terms of their productivity and agricultural potential. With interest in allocating such areas for increasing biofuel, the security of land tenure and access or use rights on the part of local resident communities across rural African landscapes is potentially at risk (Sulle and Nelson, 2009).

The spread of biofuels in different parts of the world has also raised concerns from civil society organizations, local communities and other parties. This concern has been attributed to the fact that the environmental impact of biofuel plantations could involve water scarcity and deforestation, particularly in coastal areas (Sulle and Nelson, 2009). Considerable concern has been expressed about the impacts of biofuel development in terms of environment and biodiversity outcomes, food security locally and nationally, and local access and rights over land (Kamanga, 2008; Gordon-Maclean *et al.*, 2008). Some of the actual and potential agronomic and ecological threats include impacts on the soil and water. For example, biofuel plantations that involve the clearing of areas with high levels of biodiversity, or that replace natural habitats such as *Miombo* woodlands; large biofuel plantations that can block wildlife migratory routes in parts of the country, especially in areas surrounding or near to wildlife conservation areas (Sulle and Nelson, 2009).

The reduction in global biodiversity has emerged as one of the greatest environmental threats of the 21st century due to climate change and climate change mitigation strategies like the use of bio energy for reducing carbon emission. Urban and subsistence agricultural developments have traditionally been primary drivers of encroachment on important, biodiversity-sustaining ecosystems. But a new agricultural trend, the use of plant biomass to provide liquid fuels, is exacerbating agriculture’s impact on biodiversity. These fuels, called biofuels, are changing land-use patterns in many regions around the world, including some of the most diverse and sensitive regions on the planet (Keeney and Nanninga, 2008).

The rst pathway for biodiversity loss is habitat loss following land conversion for crop production, for example, from forest or grassland. As the CBD (2008) notes, many current biofuel crops are well suited for tropical areas. This increases the economic incentives in countries with biofuel production potential to convert natural ecosystems into feedstock plantations (e.g. oil palm), causing a loss of wild biodiversity in these areas. While oil palm plantations do not need much fertilizer or pesticide, even on poor soils, their expansion can lead to loss of rainforests (FAO, 2008). Although loss of natural habitats through land conversion for biofuel feedstock production has been reported in some countries (Curran *et al.*, 2004; Soyka and Engel, 2007), the data and analysis needed to assess its extent and consequences are still lacking. Nelson and Robertson (2008) as cited in FAO (2008) examined how rising commodity prices caused by increased biofuel demand could induce land-use change and intensi cation in Brazil, and found that agricultural expansion driven by higher prices could endanger areas rich in bird species diversity (FAO, 2008).

The second major pathway is loss of agro biodiversity, induced by intensi cation on croplands, in the form of crop genetic uniformity. Most biofuel feedstock plantations are based on a single species. There are also concerns about low levels of genetic diversity in grasses used as feedstocks, such as sugar cane, which increases the susceptibility of these crops to new pests and diseases. Conversely, the reverse is true for a crop such as jatropha, which possesses an extremely high degree of genetic diversity, most of which is unimproved, resulting in a broad range of genetic characteristics that undermine its commercial value (FAO, 2008).

When forests or grasslands are converted to farmland, be it to produce biofuel feed stocks or to produce other crops displaced by feedstock production, carbon stored in the soil is released into the atmosphere. The effects can be so great that they negate the benefits of biofuels, and lead to a net increase in greenhouse gas emissions when replacing fossil fuels (FAO, 2008). Biofuel production can affect habitat for biodiversity. For instance, habitat is lost when natural landscapes are converted into energy-crop plantations or peatlands are drained. In some instances, however, biofuel crops can have a positive impact, for instance, when they are used to restore degraded lands. In order to ensure an environmentally sustainable biofuel production, it is important that good agricultural practices be observed, and measures to ensure sustainability be applied consistently to all crops. Moreover, national policies will need to recognise the international consequences of biofuel development (FAO, 2008).

A difference can be made between direct and indirect *impacts of biofuels* on biodiversity. However, there exists much vagueness with regard to the boundary line between direct and indirect impacts. In relation to impacts on biodiversity: indirect impacts mostly refer to saving species by climate change mitigation (e.g. biofuels decrease carbon emissions and thus reduce climate change, and climate change therefore has a reduced consequential impact on biodiversity); whereas direct impacts refer to interferences in ecosystems (e.g. the direct removal of existing high biodiversity value forests for palm oil plantations). From this point of view, the impacts described here mainly reflect direct effects. Although indirect impacts certainly deserve attention, there has already been an emphasis in the current debate on indirect impacts while direct impacts have received less consideration (Biemans *et al.*, 2008).

Until recently, many policy-makers assumed that the replacement of fossil fuels with fuels generated from biomass would have significant and positive climate-change effects by generating lower levels of the greenhouse gases that contribute to global warming. *Bioenergy crops* can reduce or offset greenhouse gas emissions by directly removing carbon dioxide from the air as they grow and storing it in crop biomass and soil. In addition to biofuels, many of these crops generate co-products such as protein for animal feed, thus saving on energy that would have been used to make feed by other means (FAO, 2008).

Despite these potential benefits, however, scientific studies have revealed that different biofuels vary widely in their greenhouse gas balances when compared with petrol. Depending on the methods used to produce the feedstock and process the fuel, some crops can even generate more greenhouse gases than do fossil fuels. For example, nitrous oxide, a greenhouse gas with a global- warming potential around 300 times greater than that of carbon dioxide, is released from nitrogen fertilizers. Moreover, greenhouse gases are emitted at other stages in the production of bioenergy crops and biofuels: in producing the fertilizers, pesticides and fuel used in farming, during chemical processing, transport and distribution, up to final use (FAO, 2008).

Good practices aim to apply available knowledge to address the sustainability dimensions of on-farm biofuel feedstock production, harvesting and processing. This aim applies to natural-resource management issues such as land, soil, water and biodiversity as well as to the life-cycle analysis used to estimate greenhouse gas emissions and determine whether a specific biofuel is more climate-change friendly than a fossil fuel. In practical terms, soil, water and crop protection; energy and water management; nutrient and agrochemical management; biodiversity and landscape conservation; harvesting, processing and distribution all count among the areas where good practices are needed to address sustainable bioenergy development (FAO, 2008).

Conservation agriculture is one practice that sets out to achieve sustainable and profitable agriculture for farmers and rural people by employing minimum soil disturbance, permanent organic soil cover and diversified crop rotations. In the context of the current focus on carbon storage and on technologies that reduce energy intensity, it seems especially appropriate. The approach also proves responsive to situations where labour is scarce and there is a need to conserve soil moisture and fertility. Interventions such as mechanical soil tillage are reduced to a minimum, and inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in amounts that do not disrupt biological processes. Conservation agriculture has been shown to be effective across a variety of agro-ecological zones and farming systems. Good farming practices, coupled with good forestry practices, could greatly reduce the environmental costs associated with the possible promotion of sustainable intensification at forest margins. Approaches based on agro-silvo-pasture-livestock integration could be considered also when bioenergy crops form part of the mix (FAO, 2008).

Although the multiple and diverse environmental impacts of *bioenergy development* do not differ substantively from those of other forms of agriculture, the question remains of how they can best be assessed and re ected in eld activities. Existing environmental impact-assessment techniques and strategic environmental assessments offer a good starting point for analysing the biophysical factors. There also exists a wealth of technical knowledge drawn from agricultural development during the past 60 years. New contributions from the bioenergy context include analytical frameworks for bioenergy and food security and analytical frameworks for bioenergy impact analysis for bioenergy impact analysis (FAO, 2009); work on the aggregate environmental impacts, including soil acidi cation, excessive fertilizer use, biodiversity loss, air pollution and pesticide toxicity (Zah *et al*., 2007). Also, work on social and environmental sustainability criteria, including limits on deforestation, competition with food production, adverse impacts on biodiversity, soil erosion and nutrient leaching (FAO, 2008).

Climate Change Coping Strategies and Adaptation

Farmers have minimised or spread risks by managing a mix of crops; crop varieties and sites; staggering the sowing/planting of crops; and adjusting land and crop management to suit the prevailing conditions (Blench, 2003; Eyzaguirre and Iwanaga; 1996; Tengberg *et al.,* 1998; van Oosterhout, 1996). Pastoralists have also developed useful strategies including: transhumance (strategic movement of livestock to manage pasture and water resources); distributing stock among relatives and friends in various places to minimise the risk of losing all animals if a drought strikes one particular area; and the opportunistic cultivation of food and cash crops to meet some of their needs (Paavola, 2004; Orindi and Eriksen, 2005).

Implications of Climate Change Response on Natural Resources

Adaptation to climate change is concerned “with adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC, 2007). Given the current extreme impacts of climate change, adaptation to environmental variability has been undertaken (to varying degrees of success) by people for millennia. Farmers’ adaptation to their environment, livelihood diversification and coping strategies to deal with the overall variability of their social and natural environment are well documented (Grist, 2008).

Throughout the world, adaptation to the effects of climate change has become increasingly evident. Several researches have raised awareness of the challenges that climate changes process poses, particularly for poor developing countries (Tyler and Fajbar, 2009). This awareness has resulted in increased commitment to support for adaptation at the global and international level (ibid).

In addition, available studies have identified the most vulnerable countries and regions; adaptive capacity has been assessed and improved; and national action programmes have been initiated in many countries. Despite these achievements, climate change adaptation has not been adequately integrated into planning and policy in key natural resource management sectors (ibid)

Currently, a number of innovative responses are already taking place at the local level to tackle the dual agendas of poverty alleviation and resource sustainability. These responses provide a base on which to enhance resilience to future impacts of climate change, and are in many cases already responding to climate variability. Positive local efforts include strengthening production systems, building economic assets, improving access to markets and information, diversifying to less climate-sensitive livelihoods, reducing disaster risks through local planning and preparation, and building foundations for all of these initiatives through more effective institutions of local governance and resource management (ibid)

Technical approaches to Strengthening production systems are widely recognized as necessary but not sufficient to enhance resource sustainability and equity (Sayer and Campbell, 2004). Attention to more equitable tenure arrangements and access to productive resources is essential for sustainability and for poverty reduction. Ultimately, *community-based resource management institutions* (water, forests, rangelands) strive for more participatory and locally responsive planning, and aim to be inclusive of the voices of the poor and marginal groups. As well, innovative approaches to co-management have supported more equitable tenure arrangements, and addressed conflicts between different pastoral and sedentary groups (Tyler and Fajbar, 2009).

Local adaptation strategies have adopted integrated planning at the local level, across sectors and with attention to livelihoods as well as resource sustainability. Integrated management strategies that employ ecosystem and landscape approaches has been one step towards these frameworks and practices that recognize the interdependencies of land and water resources, and the need to consider these resources more holistically (ibid)

Also, the concept of sustainable adaptation has emerged from an awareness that adaptation can have unintended negative effects both on peoples and on the environment and that there is a need to qualify exactly what types of adaptation are desirable (Eriksen, 2009). The environmental sustainability aspect emphasises that adaptation needs not endanger the environmental or economic integrity, neither for other groups at present or for future generations. Therefore, mitigation of greenhouse gases becomes an important part of sustainable adaptation criteria. In high emission societies in particular, adaptation to climate change needs to take place in a way that does not increase emissions and hence aggravate the vulnerability of others. Increased use of air conditioning as a response to rising temperatures may not be a sustainable form of adaptation, for example. From focusing on local level development type measures, sustainable adaptation has come to have global significance (Eriksen, 2009).

Forests conservation depict a significant link between biodiversity and climate change, as they represent a defence against atmospheric Carbon dioxide built up as well as a repository of the genetic heritage of the world's flora and fauna. From this perspective, reforestation of degraded forests is a remedy to solve climate change problem. Several studies have demonstrated increased tolerance to environmental extremes and greater temporal stability and recovery potential as species richness increases. Species richness enhances stability by redundancy provided by multispecies membership in critical functional groups (Singh, 2008).

A functional group with more diverse membership can maintain its role in the ecosystem despite fluctuations in its member species. With interest in availability of a wide diversity of resources within their resource catchments, indigenous people also contribute to restoration of biodiversity in depleted landscapes. Where a stake is created for them as is done in CBFM, their detailed knowledge of succession and habitat preferences of different species greatly contributes to such a process (Singh, 2008). If biodiversity is maintained, long-term viability increases in case of global climate change because out of a multitude of native species, at least some individuals may respond better than the others (ibid).

Role of Forests in Climate Change Adaptation

Forests also serve as a source of resilience by absorbing harmful carbon dioxide emissions, providing resources to local populations, and through forest-landscape design to protect communities from increasingly erratic weather. Hence, it is acknowledged that forests have substantial contributions to national and global mitigation portfolios designed to reduce the rate of Carbon dioxide (CO_2) increases in the global atmosphere (Larsson *et al.*, 2007). The reduced GHG concentration would prevent dangerous anthropogenic interference with the climate system within a time frame sufficient enough to allow ecosystems to adapt naturally to climate change, to ensure that the food production is not threatened and economic development proceeds in a sustainable manner. Although, there is no legal requirement that carbon dioxide be stabilized at this acceptable level;, bringing the concentration as close as possible to the pre-industrial level is what the society must aim at in the long run (Pandey, 2002; Singh, 2008). Since carbon (C) emissions from deforestation and degradation account for about 20% of global anthropogenic emissions; deforestation has been accounted as the single largest source of land-use change emissions, resulting in extreme carbon emissions. Estimated net annual decline in the forest area globally in the 1990s was 9.4 million hectares (Mha), representing the difference between the annual deforestation of 14.6 Mha and the annual afforestation of 5.2Mha (FAO, 2001; Singh, 2008). Hence, the Stern Review (2006) reinforces the finding that forest conservation, afforestation, reforestation and sustainable forest management can provide up to 25% of the emission reductions needed to effectively combat climate change. The Review concludes that curbing deforestation has the potential to offer significant emission reductions fairly quickly in a highly cost-effective manner (Singh, 2008).

Apart from Carbon sequestration, agroforestry can increase smallholders' income as well as provide other ecosystem services including inter alia fodder, fruit and nuts, gums, resins, medicines and reduced sediment flow. Agroforestry also helps to prevent soil erosion, restore soil fertility, provide shade, and sequester carbon as well as offsetting some of the effects of climatic change. Agroforestry also diversifies farmers' sources of income especially in the case of extreme events like droughts and floods. Different innovative market-based approaches are being explored to facilitate carbon trading as an alternative income stream for smallholder farmers. This is commonly referred to as payments for environmental services.

Community Adaptation to Climate Change

Whilst mitigation is important and should be addressed, the potentially devastating impacts of climate change on natural resources, livelihoods and economies in Africa make adaptation to the adverse effects of climate change, a top priority for the region. Adaptation is an immediate as well as on-going long term challenge. The needs for adaptation are overwhelming and adequate resources and science basis is needed through policy reforms and improved planning by integrating climate change into their development planning (climate proofing development), NAPAs and community engagement. The implementation of national level adaptation plans including NAPAs, should integrate:

- Promotion of technologies for the implementation of adaptation actions at local level, including natural resource conservation systems;
- Support of the development and implementation of regional medium and long term adaptation strategies and activities;
- Addressing of the concerns of all vulnerable groups, whose adaptive capacity is low, particularly women, the elderly, physically challenged and children who are particularly affected by the impacts of climate change;
- Infrastructure investment through the use of climate change proofed technologies;
- Development of Climate related Disaster Risk Reduction and management as an adaptation tool which should be emphasized in the negotiations;
- The protection of ecosystems including trans-boundary ecosystems, which are particularly vulnerable such as the coastal, marine, wetlands and fresh water ecosystems.

Adaptation challenge for Africa paired with a growing acknowledgement that successful adaptive practice must take into account local practices and engage with local institutions (Agrawal and Perrin 2009). There is also potential of indigenous knowledge (which is often transmitted orally at very local scales and not formally documented) for adaptation.

The impact of climate change is going to affect the poorest communities the most, so the focus is shifting to formalising Community-Based Adaptation to climate change. Even with the best of intentions and lots of resources made available by the international community towards adaptation to climate change, it will only trickle down to the poorest and most vulnerable (UNFCCC, 2007). There is a clear distinction between adaptation to climate change and adaptation to climate variation. *Climate variability refers* to the variations in the mean climate statistics, while *climate change* refers to long-term significant change in average weather, including climate variability. Any adaptation measures to each of them must incorporate this distinction. Effective knowledge management is critical to community based adaptation (Ochieng, 2009).

For Africa, community based adaptation is critical. Building on the recognition of the need for a bottom-up approach, some more recent programmes/projects have started to employ a more local-level strategy to climate-change adaptation. The approach focuses on enhancing the capacity of communities and organizations to link local adaptive capacity to climate change to local interventions, by including climate-change risks as part of the initial assessment process to define development work at community level. community based adaptation builds on the practice of starting the process of local intervention by asking people what their problems are, and what exactly they need help with. There is need to understand the role of enhancing local capacity as a means to deal with climate change, as the starting point for an "innovative adaptive community".

Climate Change Governance

Africa has hitherto made little contribution to the stock of greenhouse gases in the atmosphere. Data for per capita emissions of carbon dioxide, excluding land-use change, indicate that in most African countries, emissions are less than 0.5 tonnes per capita. This is equivalent to one-twentieth that of the United Kingdom (Collier *et al.*, 2008). Surprisingly, sub-Saharan Africa, with 11% of the world's population, accounts for just 3.6% of world emissions of Carbon dioxide, reflecting low levels of income and of energy consumption (ibid). Although current estimates indicate variations between countries, there is evidence to show that most developing countries will become significant polluters in the near future. Some of the developing countries already contributing to greenhouse gas emissions include Brazil, India, Indonesia, China, South Korea, South Africa and Mexico. This has been due to scientific and economic evolutions taking place to compete with developed countries. These countries have experienced phenomenal economic growth, which has been matched by a rise in aggregate GHG emissions (IISD, 2008). For instance, China is reported to have surpassed the United States in total emissions in 2006 (Netherlands Environmental Assessment Agency, 2007; IISD, 2008). In addition, China alone is close to surpassing the USA in terms of emission rates and was projected to be responsible for almost 40% of global increases in emissions between 2004 and 2030 (IEA 2007: 81; IIED 2008). Overall, Brazil, India, Indonesia, China, South Korea, South Africa and Mexico in 2005 had Carbon dioxide emissions equivalent to over 90% of the top five Annex I emitters (see Table 6.1) (IISD, 2008). By 2012, if current trends continue, developing countries as a whole will overtake the OECD[9] (mainly developed countries) as global emitters of carbon dioxide, with China and India contributing the lion's share.

Table 6.1: Major Developing Country Emitters and Annex I Five Biggest Carbon Dioxide Emitters by 2005

SN	Country	Carbon Emissions (Million tonnes)	Carbon Emission Per Capita (Million tonnes /Carbon dioxide/ Population	(Gross National Income (GNI) per Capita
	USA*	5,816.96	19.61	43740
	China	5,059.87	3.88	1740
	Japan*	1,214.19	9.50	38980
	Germany*	813.48	9.87	34580
	Canada*	548.59	17.00	32600
	United kingdom*	529.89	8.80	37600
	India	1,147.46	1.05	720
	South Korea*	448.92	9.30	15830
	Mexico	389.42	3.70	7310
	Indonesia	340.98	1.55	1280
	South Africa	330.34	7.04	4960
	Brazil	329.28	1.77	3460
	THE WORLD	**27,136.00**	4.22	6,987

*Note: Annex 1 countries marked with an asterix, **

Source: IEA, 2007a:48–57; World Bank, 2007: 288–289.

However, compared with many Annex I parties, the major developing countries emitters are still developing, with significantly lower economic indicators and commensurately lower GHG emissions per capita (see Table 6.1). Moreover, much of the rest of the developing world is still in the same position in relation to the OECD countries as they were when Kyoto Protocol was negotiated. Notwithstanding, the world will be much different again in 2012, after three more years of economic growth. In this respect, an effective post-2012 regime will require flexibility to be able to account for such changes (IISD, 2008).

While it is recognized that Annex I Parties have a responsibility to support developing countries with their adaptation efforts, the basis upon which this support is provided (assistance or compensation; voluntarily or compulsory) and the level of funding to be provided is a matter of considerable discussion. For example, as of September 2007, the United States had not contributed funding to either the Least Developed Countries Fund or the Special Climate Change Fund. In contrast,

[9] Organization for Economic Co-operation and Development (OECD).

contributions to either or both of these funds had been received from 18 other developed countries, as listed in Annex 1 (GEF, 2007b; IISD, 2008).

Although actions and discussions to date under the UNFCCC have focused on technology transfer, this has proven to be a controversial topic. The controversy stems from the differing perceptions of what drives technology transfer; developing countries have called on developed countries to increase financial and technical support, focusing on the removal of Intellectual Property Rights (IPR) and the creation of a new fund to buy patents. Developed countries have argued that the intellectual property does not belong to governments, but to the private sector and have pointed to the need for incentives for private companies that own the technologies (IISD, 2008).

Multilateral development banks (MDBs) also contribute financially, with the World Bank (2006) reporting that over the five year period to 2005, the World Bank Group (WBG), the African Development Bank, the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB) and the Inter- American Development Bank invested over US$17 billion in projects that directly or indirectly contribute to lowering carbon emissions in the developing countries. The EIB has invested close to US$30 billion in similar projects in the EU, European Free Trade Association and the EU accession countries. The World Bank notes that this is still a small portion of the overall resources required for clean energy.

The Stern Review (2006 estimates that the costs of reducing GHG emissions to avoid the worst impacts of climate change can be limited to around 1% of global GDP each year. Without action, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year and estimates of damage could rise to 20% of GDP or more if a wider range of risks and impacts is taken into account (IISD, 2008). In the absence of mitigation and adaptation efforts, the economic damage caused by climate change will potentially be in the trillions of dollars per year. In the near term, a temperature rise of 2°C to 3°C (as is expected to take place within the next 50 years) is projected to result in a permanent economic loss of up to 3% of global GDP (Stern, 2006). Planned adaptation measures can reduce these costs. The scale of investment required to undertake these measures, however, is highly uncertain. This uncertainty reflects existing limitations in our knowledge of the type, magnitude and timing of climatic changes and their consequent impacts, as well as the long time horizons involved. However, some initial estimates provide an indication of the expected scale of financing that could be needed:

- The UNFCCC has estimated that in 2030, between US$49 and $171 billion dollars in additional investment and financial flows will be needed globally for adaptation; of this amount, US$28 to $67 billion will be needed by non-Annex I Parties (UNFCCC, 2007a).

- The estimated additional cost of climate-proofing new infrastructure and buildings in OECD countries could be between US$15 and $150 billion per year (or 0.05 to 0.5 per cent of GDP; Stern, 2006).
- The World Bank (2006a) has estimated that approximately 20 to 40% of activities financed by Official Development Assistance (ODA) and concessional finance are sensitive to climate risks and that the annual cost of addressing this risk would be US$1 to $8 billion.
- Additionally, the Bank has estimated that between US$9 and $41 billion will be needed annually to "climate proof" new investments globally (World Bank, 2006a; IISD, 2008).
- Oxfam has estimated that US$50 billion per year will be required each year to assist developing countries with their efforts to adapt to climate change (Oxfam, 2007a).
- The cost of adaptation priority activities identified in 16 of the first 17 National Adaptation Programmes of Action submitted by LDCs to the UNFCCC amounts to US$292 million (UNFCCC, 2007a; IISD, 2008).

Although these estimates are generally derived from basic calculations and make a number of assumptions, they suggest that tens of billions of dollars in additional funding will be required each year to help countries prepare for and respond to unavoidable impacts of climate change. These funds will need to be provided through a combination of national and local government expenditures (in developed and developing countries), private sector investments, and the transfer of funds from developed to developing countries (IISD, 2008).

Tirpak and Adams (2007) report that there is a considerable gap between current public funding and projected financing requirements for energy technology. While most of this gap may be filled by private capital, public funding, particularly grants, will be needed to reduce the risks associated with the introduction of new technologies and to encourage developing countries to implement more environmentally friendly, but more costly options (IISD, 2008).

The increasing sustainable energy investments and growing international technology cooperation to deal with climate change are laudable. Yet there is much work to do. In practical terms, very little transfer of hard technologies has taken place and technology cooperation agreements to date have not yielded substantial results (Ott, 2007; Murphy *et al.,* 2005; Republic of South Africa, 2006 in IISD, 2008) – certainly not enough to kick-start the deep reductions needed to stabilize Carbon Dioxide emissions at a safe level. Much remains to be done to promote the development and diffusion of climate-friendly technologies and an effective post-2012 agreement will need to include provisions to stimulate technology in developed and developing countries, far beyond what has taken place to date (IISD, 2008).

Climate Change Governance at National levels

Climate change and variability is cross-sectoral and dynamic. The gradual shifts associated with climatic change and variability requires dynamic processes that engages all sectors, gender and underpinned by policies, legislation and institutional arrangements. The design and implementation of payments for carbon sequestration needs clarity on land and tree tenure, gender, and their influence on use of accrued benefits at household or community level. Addressing climate change and variability, therefore, requires institutional adaptation that includes sector-based planning, integration and mainstreaming, decentralization and devolution. Such approach must consider cross scale linkages. Many countries in Africa are already developing National Adaptation Plans of Action (NAPAs) (See Box 6.4 for an excerpt from Mozambique NAPA). NAPAs seek to provide a basic framework for communicating "the urgent and immediate adaptation needs of the country. NAPAs are intended to be action-oriented, country-driven, and widely endorsed.

Box 6.4: Summary of The Mozambique National Adaptation Plan of Action (NAPA)

About 55% of Mozambique is considered to be vulnerable to climate change. The extreme weather events affecting Mozambique include floods, droughts and cyclones and occur throughout the country. According to the Mozambican Initial Communication to the UNFCCC, the effects of climate change are as follows:

- Increase of the mean air temperature by between 1.8 and 3.2ºC;
- Reduction of rainfall by 2 to 9%;
- Increase of the solar radiation from 2 to 3%, and;
- Increase of the evapo-transpiration by between 9 to 13%.

Various sectors of the Mozambican economy are vulnerable to the effects of climate change, therefore, there was a need to adopt measures in order to lessen the impacts of climate change. The NAPA process involved a number of government and non governmental agencies. The Ministry for Coordination of Environmental Affairs (MICOA) coordinated the process of developing the NAPA and implementation of the UNFCCC.

The NAPA document focuses on the following main adaptation issues:

- Strengthening the early warning system,
- Strengthening the capacity of the local communities who mostly depend on agriculture to deal with the effects of climate change,
- Reducing the impacts of climate change such as coastal zones erosion and water resources management to respond to the effects of climate change.

NAPA is one of the strongest ways for mainstreaming adaptation into National Policies and strategies; however, the process should be as participatory as possible.The other institutions involved in climate change adaptation include:

- National Disaster Management Institute (NDMI)
- National Meteorological Institute (INAM)
- National Directorate of Water (DNA)
- Technical Secretariat for Food Security and Nutrition (SETSAM)
- Ministry of Agriculture (MINAG)
- Red Cross-Mozambique (CVM)

The NAPA identifies key sectors to increase resilience and sustain adaptation measures (agriculture, water, energy and health. The NAPA also recognizes international organizations such as the World Food Programme (WFP), United Nations Development Programme (UNDP), and United Nations Environment Programme (UNEP).

The risks faced by Mozambique due to climate change and disaster related phenomena do not differ from other countries located in the tropical region. However, the Mozambican level of poverty, and therefore the capacity of the country to deal with the effects of climate change/vulnerability, makes the country more vulnerable. Coordination at national level, particularly among the most vulnerable sectors of the economy, including the capacity of sharing information is crucial to increase the resilience. Approaches which can demonstrate that sustainable development, proper natural resource management and long term disaster mitigation are equivalent to adaptation to climate change should be strengthened and brought into national policies and translated to local level.

Source: Bambaige (2007).

Institutional adaptation to climate change

Current institutional architecture does not match the dynamism of climate change and variability. Developing countries lack strategic policy formulation to deal with emerging threats of climate change and food crises. Existing policies and laws are sectoral, some outdated and duplicative in nature. Despite these weaknesses, it is worth noting that policy domains steer government interventions, influence markets and market transactions, concern the immediate needs and decisions of consumers, and have important impact on the behaviour of interested and affected groups within different policy domains.

The pursuit of a vertical policy approach limits linkages across different policy domains. Addressing, promoting and balancing feedbacks across the different domains would be the best planning approach. Integration and mainstreaming of different innovations, including those aimed at adapting and mitigating climate change in the face of differing mandates of the different sectors, is a challenge. The existing opportunities for underpinning climate change and variability at the national level include:

i) *Formulation of cross-sectoral policies and laws:* what happens in the agricultural sector affects other agriculture related sectors like forestry, wetlands, water, fisheries, livestock, energy, trade and wildlife. Framing climate change interventions across sectors will not only promote uptake, but provide a platform for addressing some of the policy constraints. A cross-sectoral policy framework provides opportunities for reducing potential negative effects of one policy domain on the others and promotes spinoffs. This ensures that what happens in each sector is informed by what is happening in other sectors and lessons and experiences are shared across different policy domains. Cross-sectoral planning as opposed to sectoral planning facilitates proper allocation of meagre resources, sharing of lessons and experiences, identification and replication of best bets across sectors. However, advocating for cross-sectoral policy formulation and implementation frameworks is complicated by different mandates of policy domains, power relations, conflicts and rivalries between different sectors and perceived level of influence between and among different policy domains.

ii) *Decentralization and devolution:* Decentralization finds expression in numerous policy and legal instruments. In East Africa, the tendency is to move away from more or less exclusive state competencies to stronger management responsibilities and property rights in local governments and communities. Unfortunately, provisions in law for decentralization are often not implemented and hence, disconnects between what the laws say ('the spirit of the law') and the common practice. In Mali, for example, the Forestry Code of 1995 advocates for sustainable access, use and management of native tree species by communities to achieve social, economic, cultural and ecological objectives. In contrast, the government uses permits and license to control access, use and management of native tree species (Yatich *et al.*, 2008). Such a scenario is replicated across East Africa and is likely to disincentivize farmers. It is worsened by land resource tenure, which is vested in the state. In Uganda, for instance, environmental management has been devolved to lower levels of government. However, the implementation of decentralized natural resource management faces a challenge of limited capacities and resources in the districts. It is no wonder that many of the decentralized functions have not been carried out.

iii) *Nested and subsidiarity relative to sector-based policy domains*: Multi-layered governance systems are complicated by feedback mechanism between different levels. Ellinor Ostrom (1990), cited by Marshall (2007), observed that collective action problems faced by larger groups are decomposable into smaller problems that can be handled by subunits of the larger group. Such smaller groups can be nested as part of larger inclusive organizational units. Smaller groups, argues Marshall (2007), become part of an inclusive system without giving up their autonomy. Multi-layered governance systems provide opportunities and disincentives for nesting climate change interventions in the different sectors as well as promoting cross-sector work. Multi-layered governance systems with links with 'informal' institutional frameworks at different levels will also act as platforms for building consensus and buy-in for the adoption of adaptation and mitigation measures. Such platforms are expected to be smaller than different layers of governance. Within a larger complex system, nested units can function and capitalize on benefits of the multi-layered system. Nesting allows for decentralized decision making (Ostrom *et al.*, 1999), enhanced access to local knowledge, and increased likelihood of informal infrastructures. Nesting also has its challenges. Young (2002), identified two problems with nested systems: assigning governance tasks across the different levels and dealing with cross-level interactions or ‘vertical interplay’ arising from any assignment. These weaknesses can be addressed by the ‘principle of subsidiarity’ which argues that any particular task should be decentralized to the lowest level of governance with the capacity to implement satisfactorily (Marshall, 2007).

iv) *Integration and mainstreaming of climate change:* Different integration and mainstreaming modes have been discussed in Yatich *et al., (*2008). With regards to climate change, understanding the advantages and disadvantages of each of these modes and the entry points would be useful in taking the right decisions as illustrated in Figure 6.10:

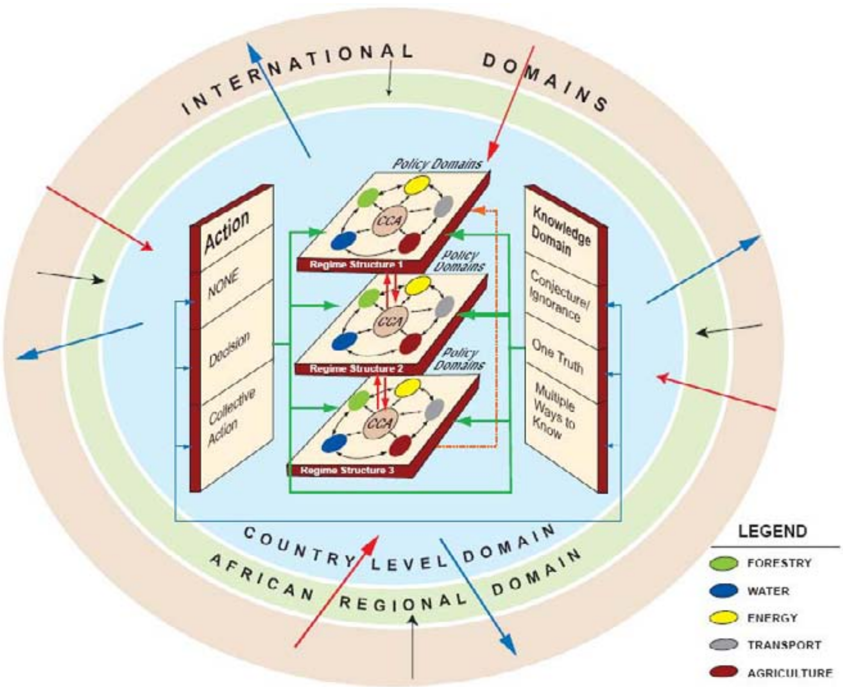

Figure 6.10: Relationships Between Different Domains and How Nested Climate Change Adaptation (CCA) Could be Addressed Through Interactions Between Action Institutions and Knowledge Systems

Source: Yatich et al., (2008)

The *national level sub-unit* is charged with policy formulation and implementation facilitation. Lower level sub-units are mainly responsible for translating policy provisions into actions with lessons and experiences feeding into the national level policy formulation sub-unit. In the case of climate change, national level lessons and experiences feed into regional and international level negotiations and decisions. Policy, plans, projects and programmes implementation at different regime structure levels are often not informed by research undertaken by different organizations at different levels. Implementation of policies, plans, projects and programmes is also affected by complexities associated with multilevel governance systems (Figure 6.10). Regional-level initiatives influence and are shaped by what is happening at the national-level domain. Discussions at the international level on several policy areas and collective learning and action initiatives influence what is happening at the national and country-level domains. International level negotiations and collective action are also influenced by what is happening at the regional and national levels. Climate change adaptation or any other large-scale environmental problems are then nested in the different levels of governance providing opportunities of learning lessons across different levels.

Climate Change Scenarios

Climate change and its impacts on NRM and human well-being are uncertain. Addressing them requires an understanding of future plausible trends and implications. Climate change as the main socio-economic driver of environmental change is global in scope and inherently unpredictable. Given the uncertainties, future social, economic and environmental implications of climate change can only be roughly approximated at regional and local scales. Scenarios, providing alternative images of how the future might unfold, can act as an integration tool in the assessment of future environmental and social changes with respect to NRM at different scales. Scenarios are not predictions, but form a tool for imagining alternative worlds that could result given differences in a few key factors. Many NRM-based climate change scenarios have been developed for describing contrasting, hypothetical futures, spanning a range of plausible but critical uncertainties in future trends. Current work on climate change scenarios are informed by the IPCC Special Report on Emission Scenarios (SRES) for climate change (Grubler *et al.*, 2007; IPCC, 2007).

Scenario analysis offers a way to consider long-range climate futures in light of uncertainties and to examine the requisite NRM for adaptation or mitigation measures. Scenarios are possible sets of future events which, unlike projections of trends in human affairs, may be legitimate over the short term, but not as time horizons expand over months and years to decades and generations (Gallopin *et al.*, 1997). Scenarios are indispensable tools for NRM that focus on large-scale, long-term interactions between humans, ecosystems and biophysical processes. The use of scenario building in climate change management offers two advantages:

i) They provide a coherent framework for analysis of how various issues or sectors impinge on one another and interact with climate change; and
ii) They serve as tools to foster creativity, stimulate discussion, and focus attention on specific climate change adaptation and mitigation measures of interest for policy and practice and for opening up a constructive analysis of future climate change challenges.

Börjeson *et al., (*2006) distinguish three main classes of the goals of scenarios:

i) predictive, i.e. exploration of probable futures;
ii) explorative, i.e. exploration of possible futures; and
iii) normative, i.e. exploration of preferable futures.

Predictive scenarios make an attempt to predict what is going to happen in the future with close link to the concepts of probability and likelihood.

Explorative scenarios are often used in a high uncertainty environment or when the mechanisms underlying climate changes are unknown. Normative scenarios are by definition backcasting scenarios, i.e. start from a desired future climate situation and explore the various pathways to reach this target. They answer to the question ''How can a specific target be reached?''

Over the years, several methods for developing and analysing scenarios have been defined and developed. According to (Börjeson *et al.*, 2006), they depend on the scenario goal, on the scale of analysis, characteristics of the systems under study and the degree of stakeholders' involvement. Alcamo (2008), distinguishes modelling methods from narrative methods. Modelling methods use mathematical models either as central tool to quantify consequences of each investigated scenario or to check the consistency of predeveloped narrative scenarios. Narrative methods provide qualitative description of pathways of the future development through the collection of expert's knowledge and are mainly used when data or models are missing. By so doing, narrative methods allow incorporating the views of several different experts and describing a complex system in well-written storylines that are easily understandable for stakeholders (Alcamo, 2008). Several scenario building exercises have adopted both methods to maximize on international coherence and complementarity (IPCC, 2009; MA, 2005; Ochola *et al.*, 2006; UNEP, 2007).

Because projections of climate change depend heavily upon future human activity, climate models are run against scenarios. There are several climate change scenarios at global, regional and local levels, each making different assumptions for future greenhouse gas pollution, land-use and other driving forces. Assumptions about future technological development as well as the future economic development are thus made for each scenario. Box 6.5 summarises the four main scenarios presented in IPCC: Special Report on Emission Scenarios (SRES. A detailed generic scenario building procedure is presented in Chapter 6 as used in NRM research.

Box 6.5: The IPCC Scenarios

The *Special Report on Emissions Scenarios* (SRES) was a report prepared by the Intergovernmental Panel on Climate Change (IPCC) on future emissions using Global Circulation Models (GCM) to develop climate change scenarios. Four different narrative storylines were developed to describe consistently the relationships between emission driving forces and their evolution and add context for the scenario quantification. Each storyline represents different demographic, social, economic, technological, and environmental developments, which may be viewed positively by some people and negatively by others.

A1 The A1 scenarios are of a more integrated world. The A1 family of scenarios is characterized by: ▪ Rapid economic growth. ▪ A global population that reaches 9 billion in 2050 and then gradually declines. ▪ The quick spread of new and efficient technologies. ▪ A convergent world - income and way of life converge between regions. Extensive social and cultural interactions worldwide.	**A2** The A2 scenarios are of a more divided world. The A2 family of scenarios is characterized by: ▪ A world of independently operating, self-reliant nations. ▪ Continuously increasing population. ▪ Regionally oriented economic development. ▪ Slower and more fragmented technological changes and improvements to per capita income.
B1 The B1 scenarios are of a world more integrated, and more ecologically friendly. The B1 scenarios are characterized by: ▪ Rapid economic growth as in A1, but with rapid changes towards a service and information economy. ▪ Population rising to 9 billion in 2050 and then declining as in A1. ▪ Reductions in material intensity and the introduction of clean and resource efficient technologies. ▪ An emphasis on global solutions to economic, social and environmental stability.	**B2** The B2 scenarios are of a world more divided, but more ecologically friendly. The B2 scenarios are characterized by: ▪ Continuously increasing population, but at a slower rate than in A2. ▪ Emphasis on local rather than global solutions to economic, social and environmental stability. ▪ Intermediate levels of economic development. ▪ Less rapid and more fragmented technological change than in A1 and B1.

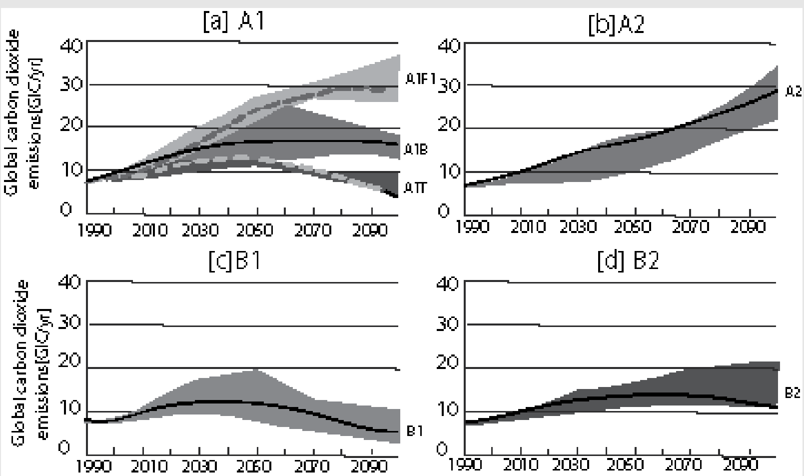

Figure 6.11: Total Global Annual CO_2 Emissions from all Sources (Energy, Industry, and Land-Use Change) from 1990 to 2100 (in Gigatonnes of Carbon (Gtc/Yr)) for the Four IPCC Scenarios.

Source: IPCC (2007) and Grubler et al., (2007).

Summary

Generally, forest carbon sequestration is one of the key approaches to reducing atmospheric carbon concentrations. For example, Enkvist *et al., (*2007) estimated that forestry projects such as protecting, planting and replanting forests constitute as much as 25% of the total global abatement potential at a cost up to €40 per ton. It is a safe, environmentally acceptable, and cost-effective way to capture and store substantial amounts of atmospheric carbon. Mainly, trees continuously remove carbon dioxide from the atmosphere by the photosynthesis process and store carbon in their biomass. Therefore, forestry can help mitigate climate change through afforestation, reforestation, avoided deforestation, silvicultural change, biofuels and carbon storage in wood products. The Kyoto Protocol recognized the role that forests can have in mitigating climate change (Siry *et al*., 2009). With climate change riding high on the political and economic agenda, more and more attention is being paid to different mechanisms for offsetting, reducing and preventing carbon releases into the atmosphere. Yet the so-called “avoided deforestation” or “reduced emissions from deforestation and degradation” (REDD) projects are underway in the establishment of framework for their implementation in various countries (Roe *et al.,* 2007).

The growing market for carbon offers create opportunities for linking greenhouse gas mitigation with conservation of forests and biodiversity, and the generation of local livelihoods. For these combined objectives to be achieved, strong governance is needed along with institutions that ensure poor people win, rather than lose out, from the new challenges posed by climate change. Therefore, the new generation of carbon funds must address the need for a sustained reduction in carbon emissions, while also building good governance and strengthening the resilience and adaptive capacity of ecosystems and local communities in the face of increased vulnerability to climate change (Roe *et al.,* 2007). To tackle climate change effectively, we need to “join the dots” between biodiversity loss, local livelihoods and land use changes such as deforestation. There is a strong need for credible standards that link curbing emissions with forest conservation to ensure they provide robust carbon benefits while incorporating biodiversity conservation and benefits to local communities. Conservation-based strategies that address carbon emissions, which include afforestation, reforestation and curbing deforestation, must be made robust (Roe *et al.,* 2007).

Performance payments, whether market-based or fund-based, will be an important element of national and sub-national carbon mitigation strategies, such as the REDD mechanisms. However, if certain up-front conditions are not met, it is unlikely that Payment for Ecosystem Services (PES) will be an effective instrument for REDD. These up-front conditions include economic, institutional, informational and cultural conditions (Wunder, 2008b). In these cases, investments in improved governance structures or other enabling policies and measures are more effective (Bond *et al.,* 2009). Hence, a PES approach to REDD requires effective and equitable governance frameworks and systems, such as clarity of land rights and functioning monitoring to enable the enforcement of conditionality and quid pro quo payments. However, in many areas where deforestation and degradation are at their highest, governance is weak and is an underlying cause of deforestation and forest degradation. Importantly, governance can vary considerably across a single country (e.g., Brazil) (Bond *et al.*, 2009). This suggests that REDD interventions will need to be paced and sequenced in accordance with capacity-building achievements, and thus the level of urgency for the forest governance.

Learning Activities

Learning Activity 6.1

1. Conduct a literature review from relevant reports and publications on the following scenario building processes and develop a synthesis of the underlying scenarios. For each scenario process identify the following:

- The scenario nomenclature and any archetypes;
- Scenario framework;
- Key assumptions under each scenario;
- Key driving forces;
- Qualitative and quantitative trends in key drivers and climate change parameters;

2. Key lessons, opportunities, challenges and implication for NRM policy and action or practice.

Learning Activity 6.2

Using an example show the patterns and trends of crop productivity (during the 1980-2005 period) and rainfall of levels of productivity of a particular crop, for instance maize, show the pattern and trends of both rainfall and the crop productivity

Learning Activity 6.3

Discuss the impacts of climate change on different sectors of nature-based economies

Learning Activity 6.4

Using illustrations, discuss the linkages and implications between climate change and different ecosystems.

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Natural Resource Project Planning and Management

W. O. Ochola and D. Nyariki

Introduction

Natural Resource Management is clearly a systematic undertaking with a set of activities and tasks programmed to contribute to meeting a desirable outcome. The success of a project is based on how well the project team manages the time and resources designated for the undertaking (project). A large proportion of projects fail because the efforts to achieve the desired outcomes are poorly defined and managed. This chapter on Natural Resource Management Project Planning and Management presents the broad, overarching strategies, framework and cases providing a hands-on account of the full project cycle as related to NRM projects and programmes by putting a community perspective—on new developments in project design, implementation and assessment.

The new face of project management especially for community based NRM initiatives is cognizant of the holistic context including human, social, natural, physical and financial assets and processes that underpin programme and project management strategies. Project *initiation*, design, implementation, reporting, communication and evaluation are presented using local concepts, cases and frameworks. Since monitoring, evaluation, reporting and improvement are integral components of NRM programmes and projects, the chapter presents details and approaches to assess the impact, appropriateness, effectiveness, efficiency and legacy of NMR policies and programmes and a process to promote accountability by all stakeholders.

A series of narrative illustrations, cases, guiding questions and NRM problems and other essential references are provided for guidance on specific approaches and tools for Project Planning and Management. This is done in ways that are compatible with the broad approach of integrated community based NRM. Learning activities, additional reading and hand's on resources are also provided to guide implementation of projects targeting redress of problems of NRM at community and other scales. The overall objective of the chapter is to expose the reader to the concepts, principles and application of project planning and management in natural resources development and more specifically to:

- Explain the overarching definitions, concepts, framework and approaches in the development and management of NRM programmes and projects;
- Guide the development and implementation of project-level NRM plans;
- Reinforce, review and refine natural resource management and investment strategies and practices to ensure that adaptive management occurs as part of continuous performance management process;
- Enable readers to design, implement and assess NRM projects with a result orientation;

The chapter is intended to facilitate the reader to be able to:

- Describe key concepts, elements, tools, frameworks, approaches and processes of NRM project planning and management;
- Discuss the elements of NRM project proposals and write fundable proposals for NRM projects;
- Apply relevant tools and frameworks for effective management of NRM projects;
- Formulate plans for monitoring and evaluation of NRM projects and apply monitoring and evaluation tools in development and implementation of NRM projects and programmes;
- Systematically document and communicate processes and results of NRM projects;
- Demonstrate professionalism in project management and appreciate the contribution of project management essentials such as planning, community participation, Monitoring and Evaluation, learning and reporting, teamwork and budget management in sustainable NRM.

Project Planning

As a crucial part of Project Management, Project Planning relates to the use of schedules to plan and subsequently report progress within the project environment. The key to a successful project is in the planning. Creating a Project Plan is the first thing to do when undertaking any NRM project. Often Project Planning is ignored in favour of getting on with the work. However, many projects fail to realize the value of a Project Plan in saving time, resources and addressing many implementation constraints. This section looks at practical approaches to NRM project planning.

The Concept of Planning

It is often said that, 'failing to plan is planning to fail' (Blackman, 2003) Thus, planning is the key to the success of a project. But what exactly is *planning*? When we think of planning, we are faced with multiple definitions, even without including specific areas of planning - such as physical planning, economic planning, regional planning, etc. However, our definition should be in line with the commonly accepted uses and meanings of *planning*.

One good definition is that 'planning is the process of preparing a set of decisions for action in the future directed at achieving goals by preferable means' (Cleland & Gareis, 2006). This definition includes seven different elements. Planning is substantially and in most cases, also formally and legally a process of preparing a set of decisions to be approved and executed by some other organs. It is important to emphasize the difference between *planning* and *decision making and policymaking* in general. While planning is a kind of decision making and policymaking, its specific characteristic in this respect is its dealing with *a set* of decisions, that is, a matrix of interdependent and sequential series of systematically related decisions.

Planning primarily involves making a set *of decisions for action* and is not directed at other objectives, such as pure knowledge, development of its planners, and so on. So planning is *execution*-oriented. The actions in planning are taken *in the future*. This is perhaps the most important characteristic of planning, introducing the elements of prediction and uncertainty and conditioning all aspects, problems, and features of planning. Planning is *directed at achieving goals*. The planning process cannot operate unless it has more or less defined goals to the achievement of which its recommendations for action in the future are directed. These goals are achieved *by preferable means*: The very nature of planning, as a process for rational shaping of the future according to our desires, depends on the *means-ends* relationship, which is basic to the planning process. The planning process is directed at suggesting the preferable means for achieving our goals; i.e., at selecting on the basis of rational processes – including, for example, collection of information, utilization of knowledge, and systematic and integrative data processing – the preferable means for achieving the desired goals. A variety of Project Planning activities are normally carried out to ensure all elements of NRM Project Management are scoped, planned and executed in an integrated way. Figure 7.1 illustrates the group activities involved in comprehensive Project Planning.

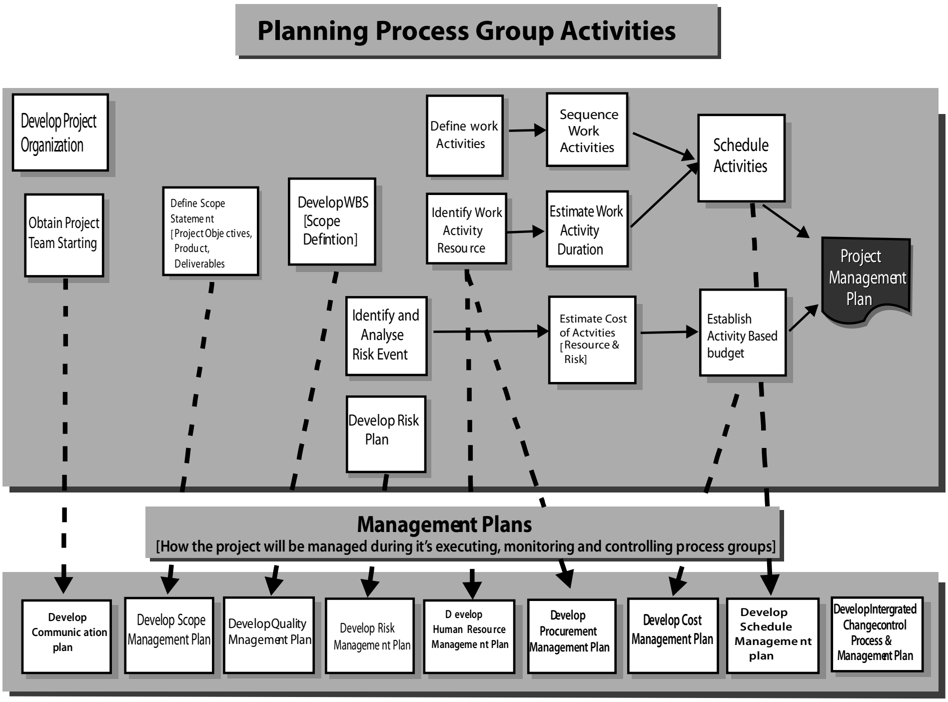

Figure 7.1: Interaction Between Activities in Planning for Various Project Management Plans Development

Source: USDVA, 2003

Natural Resource Use Planning

Natural resource (use) planning may be defined as a process involving progressive preparation and analysis of natural-resource-based projects. The process includes all work necessary to bring the project to the point at which a careful review can be undertaken, and, if found to be good enough, execution started. Natural Resource Use Planning needs detailed *feasibility studies* which should define the *objectives* of the project clearly. It should address the question of whether alternative ways to achieve the same goals may be preferable, and this will enable planners to leave out poor alternatives. Detailed planning takes time, often a year or two or longer for complex natural-resource-based projects. It may also be quite expensive; planning may cost up to 10% of the total project investment. Careful planning increases a project's efficiency and helps ensure its smooth implementation, so that the additional time and money required will be returned many times over by the increased return from the investment. Hasty and superficial planning will often lead to projects that fall behind schedule, have lower returns, and waste (scarce) resources. This is why we need to plan.

Planning the use of natural resources requires a series of decisions about measurement and analysis. For illustration purposes, in the case of rangeland resources, the measurements are used in three main stages. *The first stage* is estimating attributes: biomass, cover, density, abundance, frequency, height, and number of species and others. *The second stage* is interpretation. This requires calculating and summarising the raw data so that the relationships between the attributes within the plant community or ecosystem become clear. For example, the percentage species composition, usually calculated from data on mass or cover, gives a measure of relative importance of species that is not readily seen in the field data. Other second-stage (or second-order) characteristics include relative dominance, pattern of species and exclusiveness to a stand or community (fidelity). *The third stage* - synthesis involves applying the summarized data to comparisons among plant communities, pastures, sites and ecosystems (Nyariki *et al.*, 2005).

To plan for natural resource utilization, a resource inventory must be carried out. Resource inventory includes survey and measurement of vegetation, animal populations, geography, etc. The evaluation of resources includes assessing their condition in relation to potential, improvement or deterioration, and sociological aspects (Figure 7.2).

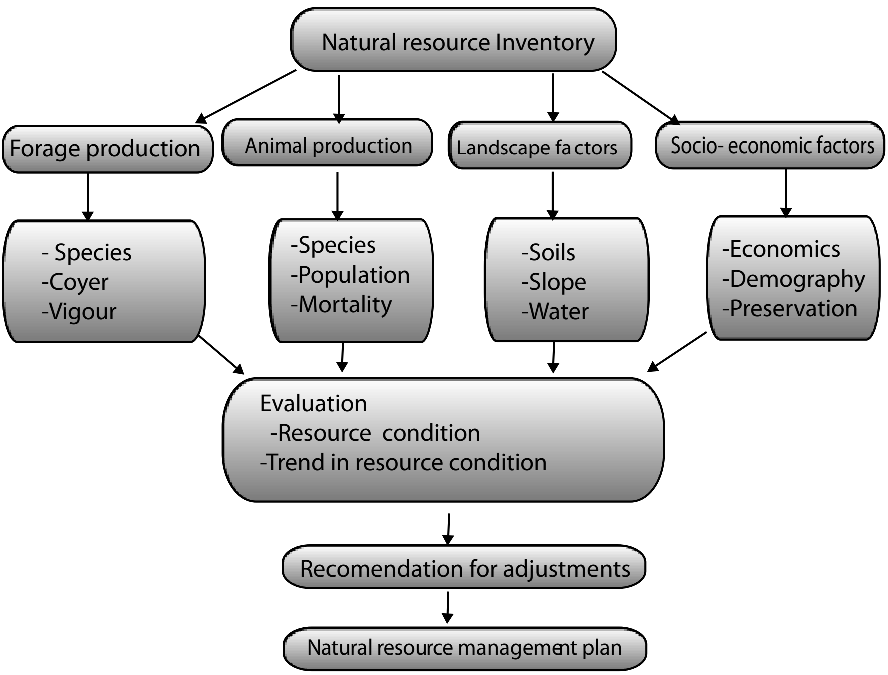

Figure 7.2: Natural Resource Inventory and Planning

Source: Gonsalves et al., 2005

Project Cycle

The literature on Project Management distinguishes stages in what is generally known as *project cycle*, also sometimes described as *project spiral*. This is the sequence in which a project is planned and executed (Neefjes, 2000). It can be divided in many ways. Some of these ways are listed below (Figure 7.3):

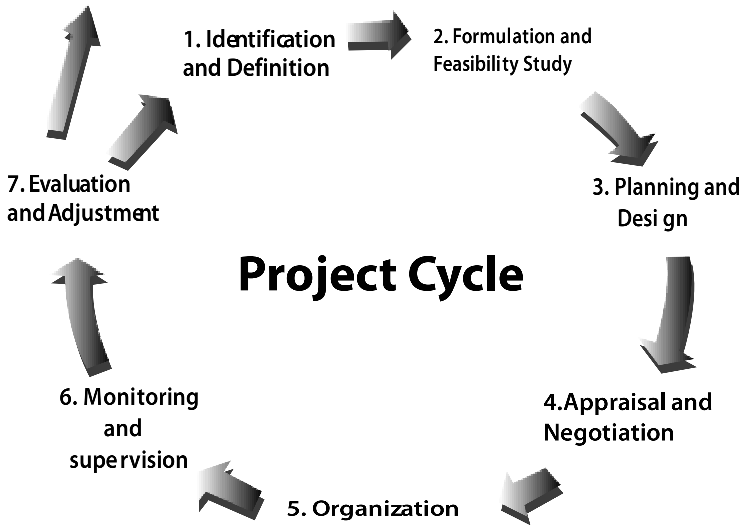

Figure 7.3: The Project Cycle

Source: Neefjes, 2000

The first stage of an NRM project, initiation, determines the nature and scope of the development. It is imperative that this stage is managed well lest it becomes unlikely that the project will be successful in meeting the Natural Resource Management goals of the community and stakeholders. It is important to understand NRM context and to make sure that all necessary controls are incorporated into the project design. Any deficiencies should be reported and a timely recommendation should be made to fix them.

The initiation stage should include a cohesive plan that encompasses the following areas:

- Study analyzing the stakeholder needs in measurable goals;
- Review of the current NRM practices and operations;
- Conceptual design of the project operations, its products and services;
- Services, resources, equipment and contracting requirements including an assessment of 'long-term desires;
- Financial analysis of the costs and benefits including a budget;
- Stakeholder analysis, including NRM asset users, and any conflicts therein;
- Project charter including costs, tasks, deliverables, and schedule.

Project Identification: This stage involves identifying potential projects from various sources, usually leaders; technical specialists; proposals to extend existing programmes; development banks intended to encourage domestic industries; project implementing agencies; sector surveys, etc.

Project Formulation, Preparation and Feasibility Studies: the first step in this stage, is a feasibility study leading to increasingly detailed feasibility studies—depending on the complexity of the project. Financial and economic analyses are done here so that whether or not the project should be rejected is known early. Preparation should be made and planned to avoid delays and resource wastage. The project may be prepared by a purpose-selected team given sufficient time and resources and/or a technical assistance agency. A report is then written and presented to the financier of the project.

Project Design: This is where the engineering aspects are considered. The structural details of the project are examined at this stage. As a project manager, you will need to gather the necessary team. You may have to borrow resources from other departments, or use all or part of your own staff. You can build a team and determine the design if the purpose, schedule, and budget for the project are clear.

Project Appraisal: This stage enables a re-examination of the soundness of the Project Plan before the investment is made or a new plan developed. Appraisal is made on the basis of technical, economic, financial and administrative considerations. After the specialists have assessed that the project is as good as presented in the preparation report, they recommend it for implementation.

Project Selection and Negotiation: In cases where there are many projects to choose from, a project is selected on the basis of cost/benefit ratios. Negotiation is done with financiers on modalities of funding the project.

Project Activation and Coordination: This refers to the organization of the project. At this stage, lines of authority are established. At this stage, it is indicated who is responsible for what. By its very nature, a project demands consistent management. Committees don't work well if they're overly democratic; so as a project manager you must be responsible for coordinating the efforts of everyone on the team.

Project Implementation: This is where the actual investment and operation starts. Implementation has three phases—the investment period, the development period and full development period. Project implementation must be flexible as it is a process of refinement. A realistic Project Plan is more likely to be implemented successfully.

Project Monitoring and Supervision: This is one of the most important in Project Cycle Management (PCM). It involves checking the activities, personnel and resources as implementation continues. This enables implementers to compare achievements with the original plan. If implementation is not going as per plan adjustments can be made. The project schedule and budget will succeed only if you are able to spot emerging problems and promptly correct them; delegating work to others or creating a control system isn't enough. You also need to track the indicators that tell you whether the project is on schedule and within budget and if the purpose is being achieved at each step along the way. If you find that problems are developing, you will need to take action promptly to correct them. If your team is falling behind schedule, you must accelerate the pace of work. If they're exceeding the budget, the costs and expenses must be brought under control and further variances eliminated or reduced. This is possible only if you can follow upon discovered problems before they get out of hand. Otherwise, if the discovered problems arise from shortfalls in planning, or the implementation factors and or environmental factors have changed adversely the Project Plan may need revision.

Project Completion: This is a stage where all intended investments are completed. Even if a project is well-managed and kept on schedule most of the time period, if that last step isn't taken, the deadline won't be met. Even well-run projects sometimes prove difficult to close out. That final report, the last conclusion, and the commitment to paper often prove to be the hardest parts of the entire project.

Project Diffusion: At this stage, a decision is made on whether to expand the project, sustain the project or wind up.

Project Evaluation and Review: This is the last phase of the project cycle but is not limited to completed projects only; it should be a continuous process. The primary criterion for evaluation is the extent to which the project objectives are met. Evaluation gives recommendations on improvement. After evaluation the project completion review or report (PCR) is written.

Considerations in Project Formulation and Design

Various aspects must be considered in the formulation and design of effective natural-resource-based projects. These aspects (or factors) together determine how successful a proposed investment project will be. The formulation and design of projects would normally involve information, technical, institutional, organizational, managerial, social, commercial, financial, and economic analyses. The various types and issues to be considered under each analysis is provided below.

Information Analysis:	Provide a preliminary understanding of the priorities and establish possible inter-linkages between the previous activities and the ongoing and on-coming activities. Show the relationship of proposed projects to the broad national development and its replicability. This ensures complementarities of activities and avoid duplication and enables the preliminary identification of potential project beneficiaries and collaborators. Identifies possible funding agencies and/organizations
Technical Analysis:	Project inputs (supplies) and outputs (production) of real goods and services. Technical analysis is essential and the project framework must be defined clearly enough to permit the analysis to be thorough and precise. The other aspects of project analysis can only proceed in light of the technical analysis. In natural resource management, issues of location, site,

	training and technology are among the aspects considered here.
Institutional Analysis.	Both local and national aspects. The questions to ask include whether the institutional setting is appropriate. The socio-cultural patterns and institutions of those the project will serve must be considered. Does the project design take into account the customs and culture of the farmers, pastoralists and other natural resource users who will participate? Will the project involve disruption of the ways in which these natural resource users are living or accustomed to working? If it does, what provisions are made to help them shift to new patterns and livelihoods?
Organizational Analysis:	Questions to be answered include whether the organization is such that lines of authority will be clear. Are authority and responsibility properly linked? Does the organizational design encourage delegation of authority, or do too many people report directly to the project manager? Does the proposed organization take proper account of the customs and organizational procedures common in the country or region?
Managerial Analysis:	The ability of available staff to judge whether they can administer such large-scale public activities as a complex water project or an extension service. If not available, there may be need to train more staff or outsource locally or globally.
Social Analysis:	The social-cultural patterns and practices of the clientele a project will serve. Social-cultural implications of proposed investments must be examined. Projects that benefit affirmative-action considerations should be favoured. Consideration should be made to determine whether a proposed project is responsive to national objectives. The adverse effects a project may have on particular groups in particular regions should be considered. Also, the effects on the society as a whole, e.g., possibilities of furthering other objectives like rural healthcare and education, should be considered.
Commercial Analysis:	Commercial aspects include arrangements for marketing output resulting from the project, e.g., market outlets and prices, financing arrangements and processing facilities if required. On the input side, there should be proper arrangement of securing inputs at the right time, right place, and right price.
Financial Analysis:	Financial effects of a proposed project on each of its various participants, e.g., local communities (farmers, pastoralists and other natural resource owners), firms, corporations, etc. A separate budget must be prepared for each. Things to be included in the budget could be incremental benefits, credit requirements, credit terms, expected change in income and whether participants need incentives to participate in the project. The financial contribution of the local population should be indicated. The analysis should be such that project activities will continue even after (external) donors have left. Project cost should be kept to a minimum.
Economic Analysis:	How the NRM project will contribute to the economy's development. By contrast, economic analysis considers society as a whole while financial analysis focuses on individual participants.

NRM Project/Programme Direction: The Goals and Objectives

Project Goals

Project goal(s) should come from and be closely associated with the stakeholders' overall strategic goals. These are captured at initial phases of project formulation. In NRM projects, we should think about for instance, three to five major accomplishments that must be reached to attain each overall change in society/environment/economy. Goals are an overall status to be reached through continued implementation of the project or programme. Goals should be described such that the stakeholders can assess whether they have been attained or not. The goal should establish clear direction for the implementers and portray that direction to others. In Box 7.1 the case of a regional community managed Disaster Risk Reduction Project is presented to illustrate project hierarchy with goal, purpose and objectives.

Project Objectives

These are the "sub-goals", or specific objectives, that need to be accomplished systematically in order to reach the intended goal. In developing Project Objective, planners need to know how the Project/Programme Process will be carried out and then identify specific milestones, or objectives, in carrying out the process. This approach is somewhat like the reverse of thinking about goals and associated objectives. Objectives should be worded such that one can rather easily discern if it has been achieved or not. They should specify who is going to do what to whom, when and how much. The key to writing good project objectives is to focus on the benefits that the project will yield. Project objectives are nothing more than a clear description of these positive changes that will accrue. Good project objectives should satisfy the SMARTA criteria. That is, they should be Specific, Measurable, Achievable, Relevant, Time-framed and Agreed.

Box 7.1: The Case of Regional Community Managed Disaster Risk Reduction Project

Background

The horn of Africa is prone to disasters caused by both natural and man-made hazards. Global climatic change has increased frequency and severity of hydro-meteorological hazards like drought and floods. The hazards trigger resource based conflicts and outbreaks of both human and livestock diseases. Basic service delivery to these areas is inadequate because of poor infrastructure. Women, children and people living with HIV/AIDS are more vulnerable and disproportionately at risk in poor communities. National and international agencies respond more to emergency relief because it is easier to appeal for assistance. Relief fails to link the development process. It does not protect livelihoods during emergencies; facilitate quick recovery or future preparedness. It emphasizes involvement of vulnerable communities in risk assessment, identification of risk reduction measures and their implementation. The African Union Disaster Risk Reduction (AUDRR) strategy (AUDRR, 2004) exists but there is need to shift from disaster response to disaster reduction at all levels of governance, functional and sustainable organizational structures at all levels. The AU DRR strategy also points out that disaster risk reduction efforts should be multi-disciplinary and multi-sectoral. Effective design and implementation of disaster risk reduction requires institutional collaboration between various stakeholder interests and assignment of roles, responsibilities, and coordination of activities. Orientation to disaster risk reduction as a sustainable mechanism for disaster risk management has not officially caught on in Kenya, Uganda and Ethiopia.

The Project

The regional capacity building for effective participation in disaster/risk reduction processes will improve governance for Disaster/Risk Reduction (DRR) in Ethiopia, Kenya and Uganda. The project targets nongovernmental development agencies, local governm

ent structures and vulnerable communities.

Project Goal

The project goal is to contribute to disaster resilience among pastoralist and agro-pastoralist communities in Northern Kenya, South Eastern Ethiopia and Uganda's Karamoja, Teso and Northern region.

Project Purpose

To improve effectiveness of disaster/risk reduction efforts of Cordaid partners and their collaborators in Kenya, Ethiopia and Uganda.

Specific Objects

Enhance participation of Cordaid partners and other community organizations in Disaster Management and Disaster/Risk Reduction decision making at Woreda district level

Establish a Disaster/Risk Reduction lobby, advocacy and learning network in Kenya, Ethiopia and Uganda to influence regional decision makers

Build capacity of Cordaid partners' staff communities and others agencies; and

Establish and strengthen six model learning community centres across the region where community managed DRR concepts and innovations are tested and adapted.

Project Partners

Cordaid: Funding agency

Implementing partners of Cordaid: Includes international and local non-governmental organization and faith based organizations in Ethiopia, Kenya and Uganda; and

IIRR: Implementing partner

Planning for Project Scope

At Project Planning stage, project managers and teams must bring together the complete understanding of the project's requirements with a deep understanding of all the elements that are required to implement a successful NRM project. In brief, this is the centerpiece for the requisite Project Management skills as it all counts for nothing unless it leads to a successful project. The three main elements of project planning: planning, estimating and resourcing are normally viewed as separate issues, but they need to be conducted in parallel as they directly affect each other. *Planning* is the definition of work to be done, including resource requirements, dependencies and timing. *Estimating* is the calculation of the amount of time and effort that will be required per type of resource for each part of the work to be done. *Resourcing* is the allocation of actual resources (usually the project's workforce) to the plan.

The availability of resources will always be limited. Resources may be required in greater quantities than are available or different activities will have competing demands on time and other resources. It may be necessary to make compromises or move work between different potential resources to make best use of the resources available. As these practical adjustments are made, there will inevitably be an impact on the duration and timing of tasks. It may also affect the project's predicted costs. It is good practice to design a detailed implementation plan before the start of every project or project phase. Before the start of each phase, the initial high-level planning needs to be expanded into fully detailed plans with the chosen depth of detail (REF). This is true even where the original plan was created at a detailed level, it should now be reviewed and revised to take account of the current starting position and any changed circumstances.

Approaches to Project Planning

Although there are many approaches to Project Planning, this book explains the activity, process, deliverable, outcome and milestone-focused planning approaches. An activity-focused planning assumes the basic purpose of a plan. The plan tells you what things to do, in other words the various activities that are required and are often broken down and structured into categories for ease of understanding. A *process focused* plan is a variant of an activity-focused plan and tells the story of each process within the project rather than present it in a disjointed way divided up into phases. It is however difficult to show project phases (stages) clearly hence this approach is not popular with project managers and donors. This leads the need to be based on deliverables by focusing not on doing tasks but on delivering the results - hence the project plan could be expressed as deliverables and sub-deliverables - the *deliverable-focused* plan.

Unfortunately, deliverable focus in practice often emphasizes the reports and documents that are to be created and diverts attention from the true desired outcome of the work. The project might appear successful because training materials were produced ignoring whether or not that training had the desired effect on the workforce. It is better not to focus on work done, nor the reports produced, but achieving the desired *outcome* in the most beneficial manner and hence the need for an *outcome-focused plan*. There is also a need to have in plan critical checkpoints indicating the completion of a significant achievement, deliverable, stage of work etc. These "milestones" are inserted into the plan as control points for management and reporting. They often represent important review points or interdependencies in the plan. Table 7.1 compares the various types of project plans.

Table 7.1: Summary of Viewpoints About Different Types of Project Plans

	Strengths	**Weaknesses**
Activity focused	It's what many people are familiar with - instructions that tell them what they have to do	Can seem like a lot of work is done without creating any tangible, measurable result
Process focused	Very good at explaining how things are done	Loses the staged view of the overall project
Deliverable focused	Focuses attention on delivering the deliverable	Might focus attention on trivial or artificial outputs instead of the major focus of the work
Outcome focused	Focuses attention on what really counts	Can seem esoteric and can be hard to measure that the outcome has been satisfactorily achieved.
Milestone focused	Presents a simple picture focusing on critical information.	In reality focus is on deliverables or outcomes as described above. Will not normally focus attention on the path or effort to attain each milestone.

Since NRM is complex and multi-scale, it is prudent to hold all these differing views and criteria in a multi-dimensional model of the project. A good NRM project plan will, nevertheless, be organized so that the major activities, workstreams, deliverables and outcomes are all apparent to the reader whichever main structure has been chosen. After the initiation stage, the project is designed. The results of the design stage should include a project design that satisfies the resource users, sponsors and sustainable development requirements, functions as it was intended, can be implemented within quality standards, and can be executed within time and budget constraints.

Formulating and Designing a Land-Based NRM Project

This section attempts to illustrate how NRM projects with land as the major component could be formulated and designed. What entails a land-based project plan, such as livestock plan? Before a planner collects data for, say, a livestock plan, he should first have an idea about the levels and sources of finances. It is after determining the level and method of disbursement of finances that one can prepare a good NRM plan such as that related to a livestock production project in terms of when and how it could be started. The site of the project with respect to land area and hence herd size, and the type of infrastructure required will be determined by the level of finances and the modalities of disbursement. The planner should also understand the kind of data and information he requires. There would be several components of a livestock project using grazing lands (rangelands) as the major natural resource base, including, but not limited to:

- National and local objectives and/or policies
- Beneficiaries' needs, objectives, occupation and culture
- Natural and physical resource inventory, including land-use and land tenure, climate (rainfall amount/distribution and temperatures), soils, topography, vegetation, water (rain water, and ground and underground water), animals (domestic and wildlife), and physical infrastructure, among others
- Factors influencing land use patterns
- Possible effects on the ecosystem (environmental impact)

For example, a proposed livestock production project next to an important river and its catchment would affect other users of the river by way of, say, reduction of the volume of water and/or its pollution, and even declining volume of fish catch. There should be a clear indication in the project plan regarding what should be done within the riverine system to reduce or remove potential adverse effects on others; and if the adverse effect cannot be avoided, what parties are likely to be affected and what levels of compensation to be effected should be known. Figure 7.4 illustrates a design of a livestock ranch and location of water point.

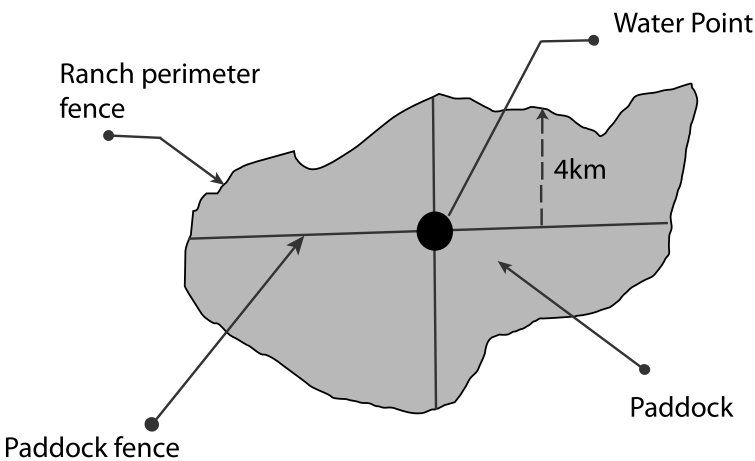

Figure 7.4: Distribution of Water Points in a Livestock Project – Ranch

Source: Nyariki et al., 2005

Generally, a NRM project is likely to succeed if it is flexible, specific, clear, technically feasible and economically viable. A project plan should be flexible so that it can be adapted to prevailing and changing conditions during implementation stages. Finally, the economic viability is often considered particularly for projects that may be for the general good of society without necessarily being implemented for any direct and immediate economic return. If a project is being implemented to derive direct economic benefits, a specific investment programme should be in place, showing projected amounts of money to be spent on natural resources, physical infrastructure, etc. If the project is involving livestock, as in our example, herd projections are often carried out. For a more in-depth illustration of herd projections, see Nyariki *et al., (*2005).) Furthermore, and more importantly, there should be an indication of profitability. The criterion for determining profitability is mainly based on cost-benefit-ratio (CBR), net-present-value (NPV), or internal-Rate-of-Return (IRR) (George, 1979; Gittinger, 1982; Munasinghe, 1993).

Project Management in Natural Resources

Projects and Programmes

Project management, though considered a full-fledged discipline, is a growing field of knowledge. It has been practiced since early civilization. Until 1900 projects were generally managed by creative architects and engineers. The application of the systemic project management tools and techniques to complex projects is useful in NRM. As a discipline, Project Management developed from different fields of application including construction, engineering and defense. The two forefathers of Project Management are Henry Gantt, often referred to as "father of planning and control techniques", who is famously known for his use of the Gantt chart as a Project Management tool, and Henry Fayol for his creation of the 5 management functions (planning, organizing, leading, staffing, and controlling), which form the basis for the body of knowledge associated with Project and Programme Management.

But what is a *project*? There are many ways to define a project. According to Thomsett (1990) the definition varies from one organization to another. In some cases, the word is used loosely to describe any task, exceptional or recurring. However, among the many definitions, there are two comprehensible and generally accepted definitions advanced by Gittinger (1982).

One, a Project is an investment activity in which financial resources are expended to create capital assets that produce benefits over an extended period of time. In some projects, however, costs are incurred for production expenses or maintenance from which benefits can normally be expected quickly, usually about a year. Projects form a clear and distinct portion of a larger, less precisely identified programme. The whole programme might possibly be analyzed as single project, rather small, close to the minimum size that is economically, technically, and administratively feasible. *Two,* a project is an activity for which money is spent in expectation of returns and which logically lends itself to planning, financing, and implementing as a unit. It is a specific activity, with a specific starting point and a specific ending point, intended to accomplish specific objectives. It will have a well-defined sequence of investment and production activities, and a specific group of benefits, that we can identify, quantify, and usually in agricultural or natural-resource-based projects, determine a money value for.

A project involves investigating, compiling, arranging, and reporting information outside the range of the usual activities. Project activities involved in project phases are related to one another and to a desired end result. Project goals and deadlines are specific. Projects have singular goals that will be either reached or missed, with clear starting points and completion dates.

Projects are further distinguished by the way in which they must operate under three main constraints of result, budget (cost), and time (schedule). To a degree, all NRM project management functions operate within these constraints. These constraints, while common to all organizations and recognized by every manger; are not encountered consistently all at the same time in all cases. However, projects succeed or fail on the basis of the three constraints. The completion of a specific, defined task or a series of tasks is the primary driving force behind a project. Thus, a project is targeted to the idea of a finite, one-time result. A project also operates within a given budget. A project team operates with a degree of independence in terms of both control and money. Finally, projects have specific starting points and finishing/completion points. A well-organized project is based on careful controls over completion phases, which involve the use of each team member's time. These NRM project considerations are reflected in the conventional "*Project Management Triangle*" illustrated in Figure 7.5.

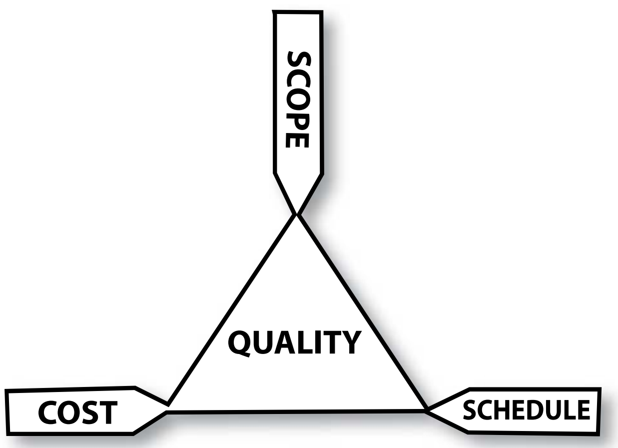

Figure 7.5: The Project Management Triangle

Source: Harold, 2003

Like any human undertaking, projects need to be performed and delivered under certain constraints. Traditionally, these constraints have been listed as "scope," "time (schedule)," and "cost". Systematic project management in community based NRM requires the provision of tools and techniques that enable the project team (not just the project manager) to organize their work to meet the three main project constraints.

Project and Programme Management

Programme Management is the process of managing multiple interdependent projects that lead towards an improvement in Natural Resource Management at national, regional, or community level. *Project management* is a carefully planned and organized effort to accomplish a specific (and usually) one-time objective, for example, development of NRM value chains. Figure 7.6 illustrates the key project management areas namely the management of time, cost, risk, procurement, communications, human resources, quality, scope and integration. Most of these aspects of project management are described in detail in this chapter.

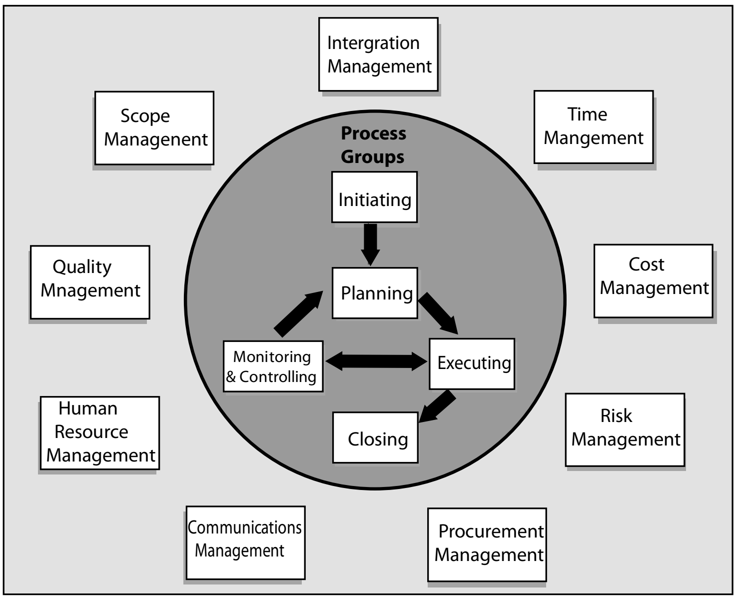

Figure 7.6: The Core Elements of NRMProject Management

Source: USDVA (2003)

Project management includes developing a project plan, which includes defining and confirming the project goals and objectives, identifying tasks and how goals will be achieved, quantifying the resources needed, and determining budgets and timelines for completion. It also includes managing the implementation of the project plan, along with operating regular 'controls' to ensure that there is accurate and objective information on 'performance' relative to the plan, and the mechanisms to implement recovery actions where necessary. Projects usually follow major phases or stages (with various titles for these), including feasibility, definition, project planning, implementation, evaluation and support/maintenance

Programme Planning is usually of a broader scope than Project Planning. NRM projects *deliver outputs* while NRM programmes *create outcomes*. A project might deliver a new market for environmental goods and services. By combining many projects with other deliverables and changes, NRM programmes might deliver increased income and food security to communities. Programme Management is concerned with doing the right projects, whereas Project Management is about doing projects right. Successful projects deliver on time, to budget and to specification. The key factors that propel NRM projects to success are summarized in Box 7.2.

Box 7.2: Key Factors in Project Management

Alignment: The programme must support a higher level strategy, vision, goals and objectives.

Assurance: Verification and validation of the project, ensuring adherence to standards and alignment with the vision.

Finances: Tracking the basic costs together with wider costs of administering the programme.

Governance: The structure, process, and procedure to control operations and changes to performance objectives.

Improvement: Constant direction of project management efforts to increasing project quality and delivery of outputs, outcomes and impacts through in-built learning,

Infrastructure: Allocation of resources influences the cost and success of the programme/project. Infrastructure might cover offices, equipment and other assets.

Integration: Optimizing performance across the programme value chain, functionally and technically.

Management: Ensuring that there are regular reviews, there is accountability, and that management of projects, stakeholders and suppliers is in place.

Planning: Developing the plan bringing together the information on projects, resources, timescales, monitoring and control

Source: Cleland and Gareis, 2006.

A NRM programme is different from a *project*, in that a project is unique and is of definite duration. A programme is ongoing and is implemented within a community or organization to consistently achieve specific results in the long run. A project is designed to deliver an output or a deliverable and its success will be in terms of delivering the right output at the right time and to the right cost. Programme management includes management of projects which, together, improve the well-being of social and biophysical systems. A programme's success will be measured in terms of benefits. Benefits are the measures of improvement social, economic and environmental conditions and might include increased income, increased profits, decreased costs, reduced wastage or environmental damage, more satisfied communities.

In the course of achieving required results, environmental and NRM programmes, project managers and teams are required to understand related constraints and determine the processes required to achieve results based on resources allocated. Improvement of processes is a continuous operation that very much contrasts a programme from a project. There is an inherent desirability to change the predetermined scope of a project. Programmes often have to react to changes in strategy and changes in the environment, economy and society at local, national, regional and global levels.

Principles of NRM Project Management

All community-based projects take place in socio-economic and environmental context. A project is a temporary endeavour to create a unique product or service, Projects thus have definite beginning and a definite end and produces predetermined deliverables within an often changeable time frame and budget. This requires significant resource planning and management effort which warrants a structured management approach and set of management tools. It is therefore necessary to follow certain principles (Box 7.3).

Box 7.3: The Principles of NRM Project Management

1. Both resource users and team must be committed to the project
2. Measures of success must be pre determined.
3. Planning - first plan, and then implement.
4. There must be a single point of responsibility for both the client and the project manager
5. Control procedures must be established before implementation commences.
6. Trade-off - Scope, time, cost and quality must be mutually consistent and attainable.
7. "Management" must provide an informed, supportive and relational development environment for effective project management.

Project Management Approaches

There are several approaches that can be taken to managing NRM project activities including the traditional, process-based and critical chain approaches. These approaches are variously characterized by interactive, incremental, and phased execution procedures. Regardless of the approach employed, careful consideration needs to be given to clarify surrounding project objectives, goals, and importantly, the roles and responsibilities of all participants and stakeholders.

The Traditional Approach

A traditional phased approach identifies a sequence of steps to be completed. In the "traditional approach", we can distinguish 5 components of a project (4 stages plus control) in the development of a project:

Typical development phases of a project (Figure 7.7) include:

- Project initiation stage;
- Project planning and design stage;

- Project execution or implementation stage;
- Project monitoring and controlling systems;
- Project completion stage.

Not all NRM projects will go through every stage as projects can be terminated before they reach completion. Some projects don't have planning and/or monitoring stages. Some projects will go through steps planning, execution and monitoring multiple times.

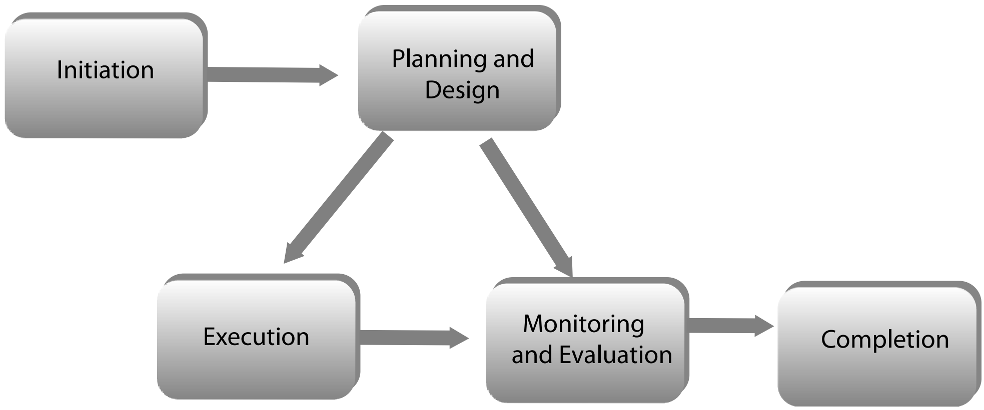

Figure 7.7: Traditional Project Management Approach

Source: Blackman, 2003

Critical Chain Project Management Approach

NRM projects like other conventional project undertakings can also be managed using the Critical Chain Project Management (CCPM) which is a method of planning and managing projects that puts more emphasis on the resources required to execute project tasks. It is an application of the Theory of Constraints (TOC) to projects (Alexander & Sheedy, 2005). TOC aims to increase the rate of throughput (or completion rates) of projects in a community or organization. To exploit the constraint, tasks on the critical chain are given priority over all other activities. Finally, projects are planned and managed to ensure that the critical chain tasks are ready to start as soon as the needed resources are available, subordinating all other resources to the critical chain. The application of Project Evaluation and Review Technique (PERT) and the Critical Path Method (CPM) is central to this approach. The application of PERT/CMP is discussed under Project Scheduling and Time Management.

Process-Based Management (PBM) Approach

The use of the Process-Based Management (PBM) technique further explains the developments in the growing group of project management approaches. Focusing on the processes before, during and after an NRM project, PBM encourages learning and institutional change in the project. Process-Based Management (PBM) technique is an ensemble of activities of planning and monitoring the performance of a process (Kohlbacher, 2010). It is the application of knowledge, skills, tools, techniques and systems to define, visualize, measure, control, report and improve processes with the goal to meet natural resource user-needs and it involves the use of a repeatable process to improve on the outcome of the project. The management of NRM projects through PBM focuses on the mindset and actions within the project. It embraces the philosophy that project operations are aligned with and supported by the community, organizational or national goals, missions, visions and values (Kohlbacher, 2010; Thom, 2009). Essentially the process forms the basis upon which project implementation decisions are made and actions are taken. Its orientation is largely biased towards achieving a vision rather than targeting specific project activities and tasks.

Based on the community or organizational vision, the project strategy, structure and resource requirements are set. It assumes that a clear vision of an NRM project defines its strategy, structure and resources required to achieve success. The tasks and activities are merely set to achieve the project vision. Many NRM projects focus on performance such as natural resource resilience, project budgets, costs, and capacity development. The PBM technique adds these performance measures but in an operational manner (Thom, 2009). As the project is implemented over time, the process measures take centre stage.

Results-Based Management (RBM) Approach

Results-Based Management (RBM) is a life-cycle approach to the management of natural resources that integrates strategy, people, resources, processes and measurements to improve decision-making, transparency, and accountability (Alexander & Sheedy, 2005). For effective NRM project management, the approach focuses on achieving outcomes, implementing performance measurement, learning and changing, and reporting performance. Figure 7.8 illustrates the basic approach to the use of RBM in project management.

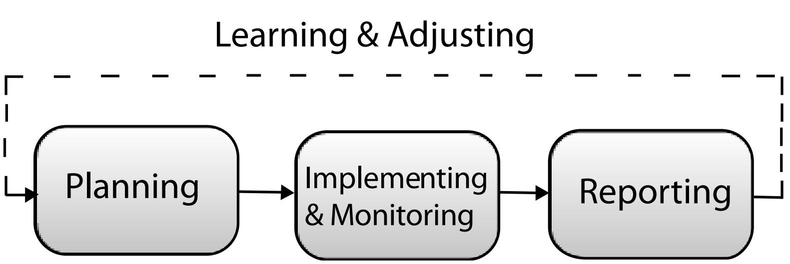

Figure 7.8: Basic Representation of the Use of RBM in NRM Project Management.

Source: Thorn, 2009

According to (Kousholt, 2007), the use of RBM approach to NRM projects:

- Ensures clear and logical design that ties resources and activities to expected results;
- Allows a systematic description of clear roles and responsibilities for the main partners involved in delivering the programme, policy or initiative;
- Enables the making of sound judgments on how to improve performance on an ongoing basis;
- Promotes and shows accountability and benefits to communities and other project partners; and,
- Ensures that reliable and timely information is available to senior executives in the department, central agencies and other key stakeholders.

Frameworks for NRM Project Design and Management

As overarching guidelines for framing and underpinning NRM Project Management, frameworks help to focus the design, planning, implementation and evaluation of projects. Frameworks act as broad and generic blueprints for overall project management. Many frameworks are in use for management of NRM projects in Africa. They are conceptual models to overall project layout. Any framework for project management must of necessity adhere to key principles:

- Maximising investment return, especially in relation to demonstrable, positive and strategic NRM outcomes;
- Recognising that it is more cost-effective to prevent damage than to repair it;
- A project/programme architecture that addresses strategic NRM concerns in an integrated manner and that is sufficiently flexible to accommodate community ownership;
- Identifying, protecting and rehabilitating high value NRM assets;
- Enable project managers to address areas of high and emerging demand for NRM action (such as climate change and urban and peri-urban issues); and
- The establishment of decision-making processes and structures that are informed by the best available scientific and socio-economic information and advice, and that provide for the timely review of this information and advice.

This section discusses selected frameworks that are in use for NRM Project Management including the logical framework and the results-based framework.

The Logical Framework

The Logical Framework Approach

In NRM projects, a logical framework (also known as logic model) identifies the linkages between the activities and the achievement of its outcomes. It succinctly clarifies the set of activities that make up a policy, programme or initiative and the sequence of outcomes that are expected to flow from these activities. As such, a logic model serves as a "roadmap", showing the chain of results connecting activities to the final outcomes and, thus, identifying the steps that would demonstrate progress toward their achievement. The logic model serves as a tool with multiple uses[1]:

- Clarify for NRM project partners the linkages between activities, outputs and the expected outcomes of the NRM project initiative. In so doing, it will serve to clarify and distinguish the expected immediate, intermediate and ultimate outcomes;
- Communicate externally about the rationale, activities and expected results of the policy, programme or initiative;
- Test whether the NRM project or initiative "makes sense" from a logical perspective; and
- Provide the fundamental backdrop on which the performance measurement and evaluation strategies are based (i.e., determining what would constitute success).

In designing NRM project logical frameworks, it is recommended to follow a methodical, interactive and inclusive work with knowledgeable personnel in the area. In order to develop a logic model, it is necessary to identify each of the following components:

- *Activities*: What are the key activities that staff are engaged in under the NRM project or initiative? That is, what are the key activities intended to contribute to the achievement of the outcomes (as opposed to the administrative activities necessarily undertaken to provide the infrastructure for the policy, programme or initiative)
- *Outputs:* What are the outputs of the key activities. That is, what demonstrates that the activities have been undertaken? Outputs are the products or services generated by the activities and they provide evidence that the activity did occur.
- *Immediate Outcomes: W*hat are the short-term outcomes that stem from the activities and outputs? Outcomes in a logic model typically have an action word associated with them (e.g., "increased", "improved") and represent the consequences of the activities and outputs.
- *Intermediate Outcomes*: What are the next links in the chain of outcomes that occur, flowing from the activities and outputs and occurring after the immediate outcomes have been achieved? These outcomes could be considered to be medium-term.

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1 Note that the logic model can also be used in designing research projects (Chapter 9) and policy formulation initiatives (chapter 8)

- *Final Outcomes*: What are the final outcomes of the NRM project or initiative, or, why are these activities being engaged in? These are generally outcomes that take a longer time period to be realized, re subject to influences beyond the policy, programme or initiative itself, and can also be at a more strategic level.

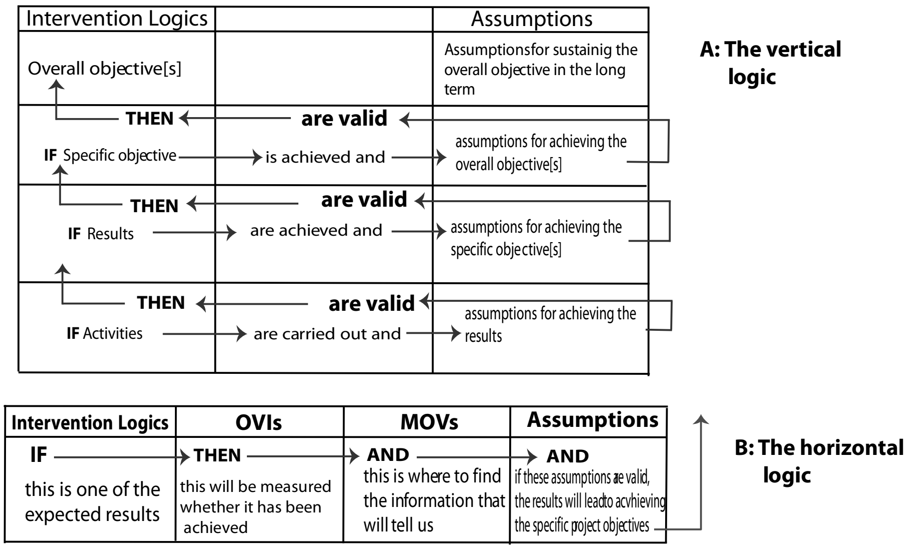


Figure 7.9: Completing the Logical Framework Matrix Using (A) Vertical and (B) Horizontal Logic

In brief, the Logic Framework represents a diagram of the NRM project or initiative theory, i.e. how a set of activities is expected to lead to the intended outcomes. There are several different styles of Logic Framework presentation, and each organization or project team should use the format most appropriate for both their internal and external audience. Flexibility is paramount, as long as the core components of the Logic Model are presented (i.e., activities, outputs and outcomes). Figure 7.9 shows the typical flow of arguments that guide the completion of a logical framework. Some organizations or projects may choose to present their logic model in a table while others use a flow chart style. Table 7.2 gives an explanation of the elements of a logical framework using the "four-by-four" matrix style.

The Logical Framework Matrix functions on two dimensions – vertical and horizontal (Figure 7.9).

It connects the levels of the matrix – activities, results, specific objective, and overall objective(s) ensuring that:

- Successful completion of the activities should lead to delivery of the expected results;

- The successful delivery of the expected results should lead to achievement of the specific project
- objective;
- Achievement of the Specific Project Objective should contribute to the overall objective.

If the NRM project has good causality, the vertical logic is desirable. The vertical logic to correct logical inconsistencies when formulating an NRM project and writing the project proposal. The horizontal logic of the matrix considers how to determine the status of activities, results, achieving the Specific Project Objective and contributing to the overall objective by listing the indicators and means of verification, and the assumptions overarching the project implementation

Table 7.2: Explanation of the Elements of a Typical NRM Project Logical Framework

LOGICAL FRAMEWORK				
	Intervention Logic	**Objectively verifiable indicators of achievement**	**Sources and means of verification**	**Assumptions**
Overall Objectives	What are the overall broader objectives to which the Project will contribute?	What are the Key Indicators related to the overall objectives?	What are the sources of information for these indicators?	
Specific Objective	What specific objective is the Project intended to achieve to contribute to the overall objectives?	Which Indicators clearly show that the objective of the Project has been achieved?	What are the sources of information that exist or can be collected? What are the methods required to get this information?	Which factors and conditions outside the Beneficiary's responsibility are necessary to achieve that objective? (external conditions) Which risks should be taken into consideration?
Expected results	The results are the outputs envisaged to achieve the specific objective. What are the expected results? (enumerate them)	What are the indicators to measure whether and to what extent the project achieves the expected results?	What are the sources of information for these indicators?	What external conditions must be met to obtain the expected results on schedule?

Activities	What are the key activities to be carried out and in what sequence in order to produce the expected results? (group the activities by result)	Means: What are the means required to implement these activities, e. g. personnel, equipment, training, studies, supplies, operational facilities, etc.	What are the sources of information about project progress?	What pre-conditions are required before the project starts?
			Costs What are the Action Costs? How are they classified? (breakdown in the Budget for the Action)	What conditions outside the Beneficiary's Direct Controls have to be met for the implementation of the planned activities?

Source IFAD, 2002

NRM Project Assumptions

The success of any NRM project depends on critical externalities and project context factors. These are external factors outside the control of the project, but which are critical for the achievement of its objective. Assumptions should be stated in terms of the desired situation such as *"The budget allocations are made available in a timely manner", "local institutions collaborate in planning activities", "suitable staff are identified and recruited and or trained on time", and "New laboratory building is operational according to requirements and on schedule".*

Results-Based Framework (RBF)

According to Thom (2009) the preparation and use of a Results-Based Framework (RMF) is guided by five key principles:

- *Action-oriented* - to ensure information needed by managers and other stakeholders is available when it is required for key decisions;
- *Credibility* - to ensure professional standards are adhered to and commitments for monitoring, evaluation and reporting are realistic.
- *Focused and Concise* - to ensure its immediate implementation by managers and delivery partners;
- *Shared Ownership* - to meet the needs of all stakeholders and ensure information needs and accountability requirements of (all) managers are met;
- *Transparency* - to ensure all stakeholders understand what results are expected;
- *Utility* - to ensure managers can use the RBF to explain their policies, programmes or initiatives institute sound performance measurement and evaluation activities.

Over the years, the application of RBF in Project Management, including NRM, has been streamlined into three core components (project profile, expected results and monitoring and evaluation):

Programme Profile: description of the policy, programme or initiative including the context and need, stakeholders and beneficiaries, and resource allocations (See Table 7.3 for elements of a project profile);

Table 7.3: Project Profile Information Requirements

Section	**Key Elements**
1.1 Context	▪ Clearly state and demonstrate the need for the NRM project, policy or initiative. o For new NRM projects or initiatives, reference the evidence and policy that supports the NRM project. o For NRM projects or initiatives that are seeking renewal of authority, explain why the issue remains important and the progress that has been made to date. o Cite research studies, needs assessments, detailed demographic studies, etc. to support analysis. ▪ Explain why there is a legitimate and necessary role for government in this NRM project area or activity.
1.2 Objectives	▪ Clearly state objectives of the NRM project, policy or initiative. ▪ Describe how the objectives link to the department's strategic outcomes as identified in its NRM project Activity Architecture.
1.3 Key Stake-holders and Beneficiaries	▪ List all key stakeholders including delivery partners and project beneficiaries. ▪ When information is available, identify targets in terms of reach to project beneficiaries. When no targets are available, explain why and how and when targets, if any, will be developed.
1.4 Resources	▪ Summarize (in a table) annual resources allocated to the department and each delivery partner including salaries, O&M, transfers to partners and capital costs. ▪ Specify estimated costs for ongoing performance measurement and evaluation activities.

Expected Results: description and illustration (i.e., Logic Model) of how the activities of a policy, programme or initiative are expected to lead to the required economic, social and or environmental change, accountabilities, and the critical assumptions on which the programme, policy or initiative is based. Table 7.4 shows the information for this section of the RBF.

Table 7.4: Expected Results Information Requirements

Section	Key Elements
2.1 Expected Results	▪ Identify results expected at various stages of NRM project, policy or initiative delivery and specify anticipated timeframes for the achievement of results. ▪ Identify internal and external factors that may influence the ability of a NRM project, policy or initiative to achieve results. Reference to your RBF is acceptable but must be noted.
2.2 Logic Model	▪ Provide a Logic Model including, if necessary, explanatory text for the NRM project, policy or initiative ensuring that there is a logical flow of activities to outputs to outcomes of the NRM project. ▪ In the logic model, link final outcomes to the department's strategic outcomes as specified in its NRM project Activity Architecture.
2.3 Accountabilities	▪ Identify the roles and responsibilities (i.e., duties, obligations and authorities) of the department and its delivery partners. ▪ Specify performance targets, reporting responsibilities and any operating constraints of the department or its partners that may impact the department's ability to deliver the NRM project or report on performance. ▪ For collaborative arrangements (i.e., NRM projects or initiatives managed or delivered jointly by partners), outline how this relationship will be managed including how decision-making will take place.

Monitoring and Evaluation (M&E): detailed roadmap for ongoing performance measurement and evaluation activities that will support effective programme management and accountability. The M&E plan represents the NRM project's strategy to monitor performance and demonstrate results. It enables partners to establish the necessary systems and processes to collect and analyze data and information so that programme performance can be optimized. The associated evaluation studies and assessments generate accurate, objective and evidenced-based information to help managers make sound project management decisions, demonstrate success, show ongoing relevance and develop more cost-effective alternatives to service delivery (IFAD, 2007). Table 7.5 presents the key information for the M&E component of an RBF

Table 7.5: Monitoring and Evaluation Plan Information Requirements

Section	Key Elements
3.1 Performance Measurement Plan	▪ Outline the overall performance measurement strategy including four to five key performance issues and provide a rationale as to why this strategy is proposed. The performance measurement strategy should outline what current systems (i.e. information systems as well as operational systems) are in place to support monitoring and how, when and by whom performance will be reviewed and adjustments made. ▪ For each key performance issue, identify the associated indicators/ measures and performance targets. ▪ Outline provisions to ensure data integrity. ▪ Provide estimated costs for performance measurement activities by year. ▪ List all performance reporting commitments on the part of the department and all delivery partners. The purpose of a report should be clearly stated with an emphasis on how the report will be used to improve performance.
3.2 Evaluation Plan	▪ Outline the overall evaluation strategy and provide a rationale as to why this strategy is proposed. o Formative evaluations should be used judiciously – primarily in instances where questions arise as to the delivery of the NRM project. They may address specific delivery issues or focus on the quality of performance information and reporting systems. Where "full" formative evaluations are undertaken, outputs, early results, validation of NRM project logic, and the likelihood of long-term results achievement must be assessed. o For summative evaluations, identify all known evaluation issues this includes success, relevance, cost-effectiveness, and any issues identified in past evaluation studies. ▪ Identify how and when the Expenditure Review Committee's questions will be incorporated into evaluation activities. Present an overall approach to evaluation (i.e., evaluation framework) including: data sources, proposed methodologies, and responsibilities for data collection. ▪ Provide estimated costs for evaluation activities. ▪ List all reporting requirements associated with the evaluation strategy including dates for development of the evaluation framework and completion of evaluation studies.

Box 7.4 Illustrates an example of the table of contents of a RBF for Project Management and M&E while Figure 7.10 illustrates the result chain, an illustration of logical flow of NRM project results in relation to inputs, process, outputs and outcomes. The measurement of project efficiency and effectiveness is controlled by

the result chain levels and determines the aspects of the project results that the project partners have control over.

Box 7.4: Typical Integrated RBM Framework Table of Contents

1.0 Introduction	3.4 Accountabilities
1.1 Background	4.0 Risk Assessment and Management Summary
1.2 Level of Integration	4.1 Key Risks
1.3 Overall Risk Assessment	4.2 Existing Mitigating Measures
2.0 Programme Profile	4.3 Incremental Strategies
2.1 Context	5.0 Monitoring, Evaluation and Auditing
2.2 Objectives	5.1 Monitoring Plan
2.3 Stakeholders and Beneficiaries	5.1.1 Performance
2.4 Resources	5.1.2 Risk
3.0 Expected Results	5.2 Evaluation Plan
3.1 Expected Results	5.3 Internal and Recipient Auditing
3.2 Key Risk Areas	5.4 Reporting Commitments
3.3 Logic Model	

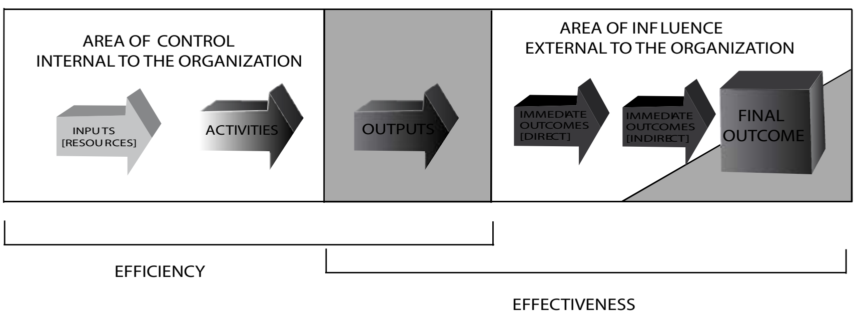


Figure 7.10: A Classical Results Chain for NRM Project Result Logical Flow

Source: Adapted from IFAD (2007)

Outcome Mapping (OM)

Outcome Mapping (OM) is an M&E tool developed by IDRC that focuses on the following key words (Carden and Smutylo, 2001):

- *Behavioural Change*: Outcomes are defined as changes in the behaviour, relationships, activities, or actions of the people, groups, and organizations with whom a programme works directly. These outcomes can be logically linked to a programme's activities, although they are not necessarily directly caused by them.

- *Boundary Partners*: Those individuals, groups, and organizations with whom the programme interacts directly and with whom the programme anticipates opportunities for influence. Most activities will involve multiple outcomes because they have multiple boundary partners.
- *Contributions*: By using OM, a Project is not claiming the achievement of development impacts; rather, the focus is on its contributions to outcomes. These outcomes, in turn, enhance the possibility of development impacts - but the relationship is not necessarily a direct one of cause and effect.

The focus of OM is on people assessment of the NRM project impact (defined as changes in state - for example, reforestation, improved water quality, improved people participation, policy relevance, reduced degradation, improved access to clean water, poverty alleviation, or reduced conflict) and toward changes in the behaviours, relationships, actions or activities of the people, groups, and organizations with whom a development programme works directly. This shift significantly alters the way a project understands its goals and assesses its performance and results. OM establishes a vision of the human, social, and environmental betterment to which the project hopes to contribute and then focuses monitoring and evaluation on factors and actors within that project's direct sphere of influence. The project's contributions to development are planned and assessed based on its influence on the partners with whom it is working to effect change.

The three stages of OM (Figure 7.11) including *(1) Intentional Design, (2) Outcome and Performance Monitoring (3) Evaluation Planning* are based on the principles of participation; and purpose include those implementing the NRM project in the design and data collection so as to encourage ownership and use of findings. Outcome is intended to be used as a consciousness-raising, consensus-building, and empowerment tool for those working directly in the development programme. OM introduces M&E considerations at the planning stage of a programme.

Developing NRM Project Proposal

Many graduate students, beginning researchers and project managers do not fully understand what a Research Proposal means, nor do they understand its importance. An NRM project is only as a good as the proposal. An ill-conceived proposal dooms the project even if the idea is original and the NRM problem it addresses is real and urgent. An NRM proposal is intended to persuade stakeholders, including funders to governments to support the initiative. Generally, a Project Proposal should contain all the key elements involved in the NRM undertaking with sufficient information needed to evaluate the proposed project. Regardless of your project idea or NRM issue, all project proposals must address some questions: What you plan to accomplish?, why you want to do it and how you are going to do it?. The quality of the proposal depends not only on the quality of the proposed project, but also on the quality of Proposal Writing. This section focuses on Proposal Writing rather than on the development of NRM project ideas.

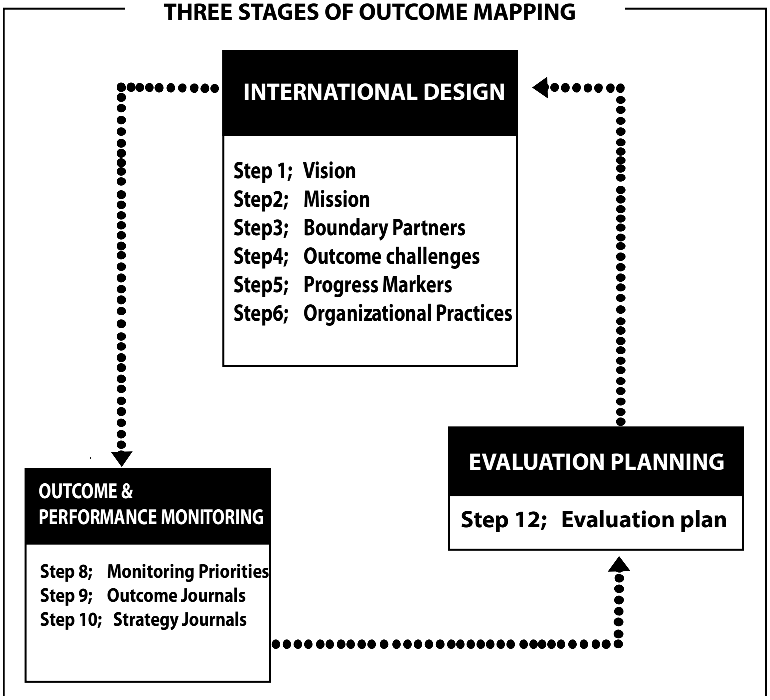


Figure 7.11: The Steps of Outcome Mapping

Source: Carden and Smutylo (2001)

The Concept Note

Writing or developing the project concept note is often the *first act* of transforming a creative or worthwhile NRM idea into a reality. It is one of the three key components to beginning a funded NRM project design. *The other two* key components are developing the budget and mobilizing the funds. The *Concept Note,* sometimes called a prospectus, preliminary proposal, or pre-proposal, is a useful tool for several purposes. It helps to clarify and organize ideas in a written form and provides the basis for a funding search. Often the writing and review of a formal proposal is a lengthy process. The concept note therefore can save time and effort for both the development partners and grant writer in the event that an idea is not considered timely or fundable. It is essentially the foundation or cornerstone of funded NRM projects. Generally, a Concept Note describes the idea, the need for the project, how it is to be implemented, and a budget. Box 7.5 presents a typical format of a Concept Note although different donor agencies have different guidelines.

Box 7.5: Typical Format of a Project Concept Note

Project Title

Background/Problem/Need

A presentation of the importance of the project, its timeliness and innovativeness, as well as the relevance and applicability of the project to priorities of the community, donor, country or other regional or global goals. It should be accompanied by supporting statistical data which may be included in this section, but must be brief.

Goals and Objectives

The overall goal of the project should be stated succinctly, and the objectives should be listed briefly and clearly sequenced in a prioritized and logical order.

Methodology, Operations, or Procedures

Should be related directly to the objectives and should focus on the most significant points giving indications of having been thought through the scope of the study and having anticipated most reasonable questions or objections. It describes how the project will be conducted.

Resources and Personnel Available

List in this section the significant facilities and equipment available or needed for the project, plus information on key personnel and their previous relevant experience.

Budget

This is one of the three most important parts of the process. Include project activities and associated specific costs. Any cost-sharing contributions, if any, and indirect costs should be itemized.

Key Words (and Abbreviations and Acronyms)

The general definitional or descriptive words that fit the NRM project idea. These key words, while not often required in a concept paper, can be useful when the investigator begins searching for funding agency matches. They also help the grant writer gain clearer definition about the subject in mind.

The Project Proposal

A Proposal is a written statement of, and proposed solution to, an NRM problem. It must present a persuasive argument for the project case. Needs assessment or problem statement forms the basis for the development of the Project and the request for project funding and thus it is a critical component of a proposal. A successful Proposal makes it evident that the project writers have done their homework well.

The construction of a Proposal must address the needs of the reader - or more precisely, reviewers, screeners, and selection committees. Attractive proposals are those that exhibit freshness and originality, clarity of objectives and methodology, feasibility, necessity or at least desirability of the work, impact within and perhaps outside NRM sphere, potential for capacity building and sustainability, innovation in methodology, significance as well as self-promotion (Molfese *et al.*, 2002). An NRM Project Proposal is different in many ways from a Research Proposal (See

Chapter 9). A review by Porter (2004) revealed that reviewers often classify well written project proposal as one with these qualities:

- A document that is neat, well organized and easy to read;
- Responsiveness to the programme announcement, with specific references showing how the proposed project will achieve programme goals and objectives;
- Fresh insight into an important problem;
- Writing that communicates the enthusiasm and commitment of the researcher;
- Evidence that the PI knows the field;
- Convincing preliminary data; and
- A feasible work plan that is supported by an appropriate budget.

A project design focuses on the assessment and analysis required to determine the most effective and efficient means to achieve a desired change in a specific target group. However, the designer must be able to communicate that design in a clear, concise manner to reviewers, donors and other stakeholders who need to participate, approve or fund it. Therefore, a proposal must document and summarize the overall project rationale and design. A Project Design differs from Proposal Writing as follows:

Project Design	**Proposal Writing**
▪ Participatory process to identify problems/needs and to strategize solutions ▪ Involves a team and includes multiple stakeholders ▪ Idea-driven, creative process ▪ Language and format determined by design team ▪ Detailed Logframe or Results Framework with ▪ M&E Plan and workplan ▪ Basic schedules and budgets developed ▪ One project design can facilitate the development of one or several proposals	▪ Documents the results of a design process ▪ Written by a few staff members ▪ Emphasizes clear, concise communication ▪ Language and format determined by donor ▪ Basic Logframe/Results Framework, including M&E plan or PMP ▪ Includes workplan ▪ Detailed budgets with narratives, other compliance documents

Figure 7.12 shows the place of proposal writing in the overall NRM project design cycle while Box 7.6 gives a general project proposal format. Note that different donor agencies' calls for proposals and NRM organization may have different guidelines and sequencing of the elements of a project proposal.

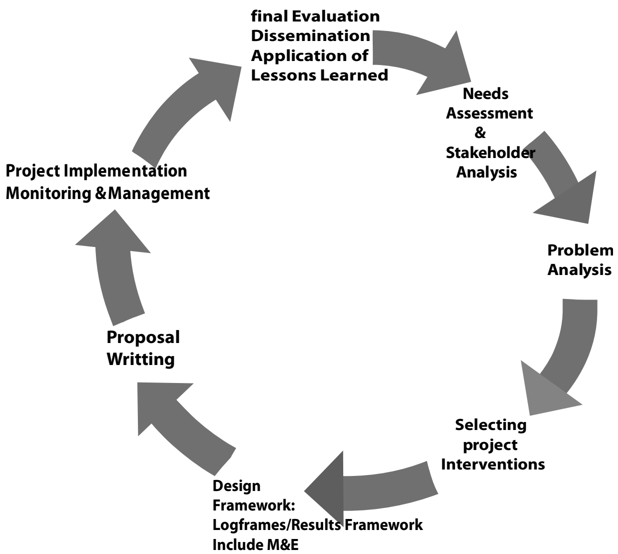


Figure 7.12: Place of Proposal Writing in the Overall Project Design Cycle

Source: Molfese, Karp & Siegel, 2002.

Box 7.6: The Basic Elements of a Project Proposal

Title Page: A title page should appear at the beginning of the proposal and should indicate the project title, the name of the lead organization (and potential partners, if any), the place and date of project preparation and the name of the donor agency to which the proposal is addressed.

Project Title: The project title should be short, concise, and preferably refer to a certain key project result or the leading project activity.

Contents Page: For project proposals that are longer than 10 pages it is helpful to include a table of contents at the start or end of the document. The contents page enables readers to quickly find relevant parts of the document.

Abstract/Summary: Many readers lack the time needed to read the whole project proposal. It is therefore useful to insert a short project summary - an abstract. The abstract should include the problem statement; the project's objectives; implementing organizations; key project activities; and the total project budget. Theoretically, the abstract should be compiled after the relevant items already exist in their long form.

Context: This part of the project describes the social, economic, political and cultural background from which the project is initiated. It should contain relevant data from research carried out in the project planning and needs assessment phase or collected from other sources. Considerations should be taken of the need for a balance between the length of this item and the size of the overall project proposal. Large amounts of relevant data should be placed in the annexes.

Project Justification: A rationale should be provided for the project. Due to its importance usually this section is divided into four or more sub-sections: (1) *problem statement* which provides a description of the specific problem(s) the project is trying to solve, in order to "make a case" for the project; (2) *priority needs* of the target group that have arisen as a direct negative impact of the problem should be prioritized with an explanation as to how this decision was reached; (3) t*he proposed approach (type of intervention)* as a strategy chosen for solving the problem and precisely how it will lead to improvement in NRM or community livelihood; and (4) *the implementing organization* including the priorities and capabilities of your organization by referring to its capacity and previous project record.

Project Aims/Project Goal "Project Purpose: Often one major "goal" is declared and then broken down into various objectives with well established hierarchy between objectives

Project goal (or overall objective) which is a general aim that should explain what the core problem is and why the project is important, i.e. what the long-term benefits to the target group are.

Project objectives which should address the core problem in terms of the benefits to be received by the project beneficiaries or target group as a direct result of the project

Project results which describe the services or products to be delivered to the intended beneficiaries. This is what the project management is promising to deliver. The results are more detailed than the objectives and the goal, and should be possible to measure through the use of objective indicators.

Target group: The proposal should define the target group and show how it will benefit from the project. The project should provide a detailed description of the size and characteristics of the target groups, and especially of direct project beneficiaries.

Project implementation: The implementation plan should describe activities and resource allocation in detail as required including who is going to implement the project's activities, as well as when and where. The implementation plan may be divided into two key elements: the activity plan and the resource plan.

Budget: An itemised summary of a project's expected income and expenses over a specified period of time. This varies widely across sectors, projects and development partner guidelines

Monitoring and evaluation: A clear monitoring and evaluation strategy and plan should be presented including the how and when the project management team will conduct activities to monitor the project's progress; which methods will be used to monitor and evaluate; and who will do the evaluation.

Reporting: Depending on the donor or organization, the schedule of project progress and financial report could be set in the project proposal.

Management and personnel: A brief description of the project personnel, the individual roles each one has assumed, and the communication mechanisms that exist between them. All the additional information (such as CVs) should be attached to the annexes.

Annexes: The annexes should include all the information that is important, but is too large to be included in the text of the proposal. This may include: analysis related to the general context; policy documents and strategic papers; information on the implementing organizations; additional information on the project management structure and personnel (curriculum vitae for the members of the project team); maps of the location of the target area; and project management procedures and forms (organizational charts, forms, etc).

Project Scheduling and Time Management

Time management is a critically important requirement for the success of any NRM project. Success in meeting project schedule requires adherence to project schedules and budget. The most common cause of blown project budgets is lack of Schedule

Management. A number of techniques and software systems are available commercially for managing project schedules or timeline. This section of the chapter presents some important fundamentals of using the Project Evaluation and Review Technique (PERT) for project scheduling.

Project Evaluation and Review Technique (PERT)

The Project Evaluation and Review Technique (PERT) is a method to analyze tasks involved in completing a project, especially the time needed to complete each task, and identifying the minimum time needed to complete the entire project. PERT aims at simplifying the planning and scheduling of large and complex projects. Initially developed by Bill Pocock and Gordon Perhson of the U.S. Navy Special Projects Office in 1957, PERT is increasingly in use in scheduling NRM projects at all levels. It is an event-oriented technique rather than start- and completion-oriented tool. It is useful in NRM projects where time, rather than cost, is the major factor. It is applicable in very small to large-scale, complex, non-routine NRM and development research projects.

It is important to note that:

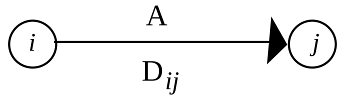
- A PERT chart (network diagram) is a tool that facilitates decision making and is an event and activity illustration of connectivity between activities
- Two consecutive events in a PERT chart are linked by activities, which are conventionally represented as arrows (see the diagram above).
- The events are presented in a logical sequence and no activity can commence until its immediately preceding event is completed.
- The project planner decides which milestones should be PERT events and also decides their “proper” sequence.

PERT is valuable to manage where multiple tasks are going simultaneously to reduce the redundancy. A *PERT event*: is a point that marks the start or completion of one or more tasks. It consumes no time, and uses no resources. It marks the completion of one or more tasks, and is not “reached” until *all* of the activities leading to that event have been completed. A *predecessor event*: an event (or events) that immediately precedes some other event without any other events intervening. It may be the consequence of more than one activity. A *successor event*: an event (or events) that immediately follows some other event without any other events intervening. It may be the consequence of more than one activity. A *PERT activity*: is the actual performance of a task. It consumes time, it requires resources (such as labour, materials, space, machinery), and it can be understood as representing the time, effort, and resources required to move from one event to another. A PERT activity cannot be completed until the event preceding it has occurred.

Using PERT to Determine NRM Project Critical Path Method (CPM)

Like all other projects, NRM projects are bound by time and resources, The *Critical Path* is the longest possible continuous pathway taken from the initial event to the terminal event. It determines the total calendar time required for the project; and, therefore, any time delays along the critical path will delay the entire project. A *Critical Activity* has total float equal to zero and falls in the critical path, meaning any delay in a critical activity will automatically delay the whole project.

In order for the network diagram to display the precedence relationships between project activities, it is constructed using two basic elements, an event represented by a node and an activity denoted by an arrow. An activity has both a tail (i) and head (j) events. In a network diagram the duration of the activity (*Dij*) is plotted below the arrow while its label (A) is placed above the arrow. This is illustrated in the schema below.



An example of a simple network diagram with activities and events.

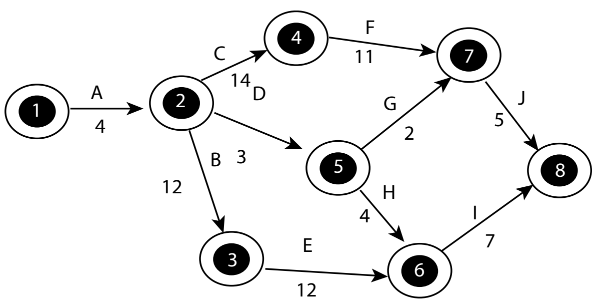


Figure 7.13: A Network Diagram Representing an Eight Event Project

The project can be further represented in a table describing each activity, its preceding activity(ies), duration and partner responsible (Table 7.6).

Table 7.6: Schedule and Description of Activities in a Wetlands Product Value Chain Project.

Activity Label	Activity Description	Preceding Activity (ies)	Duration (Weeks)	Partner Responsible
A	Project scoping and wetlands reconnaissance	-	4	Partner 1 (Community Water User Group)
B	Inception planning meeting	A	12	All Partners
C	Wetlands community sensitization	A	14	Partner 1 and Partner 2 (Local CBO)

D	Participatory wetlands resources appraisal	A	3	All Partners
E	Wetlands resources utilization and value chain survey	B	12	Partner 3 (Sokoine University)
F	Stakeholder wetlands product value chain analysis and benefits assessment	C	11	Partner 3
G	Health and livelihoods systems design	D	2	Partner 3 and Partner 4 (Ministry of Health)
H	Participatory project review	D	4	All Partners
I	Community takeover and exit strategy design	E.H	7	All Partners
J	Project reporting	F,G	5	Partner 3

Using the above project information, it is possible to determine the Critical Path of the community based wetlands product value chain project. There are three generic steps to doing this.

Step 1: Forward Pass

This step involves the computation of the Earliest Start Times (EST) and we proceed from the first event to the last using the expression below which is interpreted as the longest path to the current node, i.e. The highest sum of the EST at the tail (i) and duration between the activity tail (i) and head (j). For the first event this value is zero.

$$ES_i = \max\{ES_i + D_{ij}\}$$

From the example on wetlands products value chain project,

$$ES_1 = 0$$

$$ES_2 = 0 + 4 = 4$$

Step 2: Backward Pass

The Critical Path Method (CPM) algorithm in step 2 follows the exact opposite of step 1. From the last event to the first, we obtain the Latest Completion Times (LCT). using the expression below which is interpreted as the shortest path to the current node, i.e. The lowest difference between the LC time at the head (j) and duration between the activity head (j) and tail (i). For the event this value is the ES at this node.

$$LC_i = \min\{LC_j - D_{ij}\}$$

From the example on wetlands products value chain project,

$$LC_8 = ES_8 = 35$$

$$LC_5 = \min\{LC_6 - D_{56}, \quad LC_7 - D_{57}\} = \min\{30-2, 28-4\} = 24$$

Step 3: Determination of Critical Activities

In order to complete the process the critical activities are identified. A critical activity is one for which:

$$ES_i = LC_j$$

$$ES_j = LC_j$$

$$ES_j - ES_i = LC_j - LC_i - D_{ij}$$

Following the two steps and the conventional representation of the processes results in shapes, △ for ES and □ for LC, the network diagram is improved to show Critical Path Method (CPM) computations and activities as follows. Figure 7.14 shows the final network diagram with critical activities identified for the community based wetlands product value chain project. In this project, the crucial activities are A, B, E and I while the project is expected to take 35 weeks.

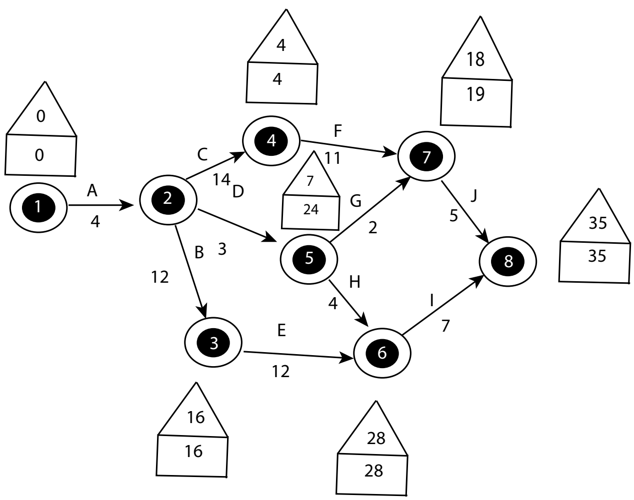


Figure 7.14: Final Network Diagram for the Community Based Wetlands Product Value Chain Project.

*(**Note** The CPM Activities Marked)*

Using standard computer software, project managers can determine Critical Paths and other time and resource scheduling aspects of NRM projects. Figure 7.15 illustrates the outputs from Microsoft Project 2003 showing the Gantt Chart and Project network diagram from the fore-running case.

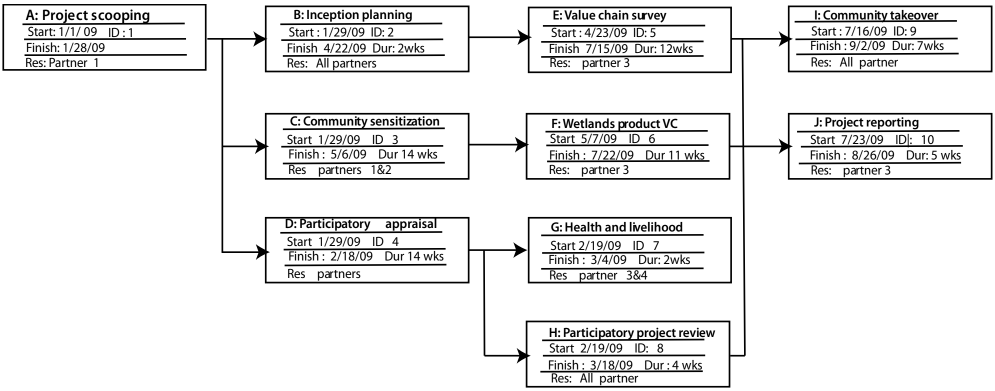


Figure 7.15: Network Diagram Generated from Microsoft Project 2003 Software for the Community Based Wetlands Product Value Chain Project.

This depiction shows the logic behind the sequencing. It also helps us to calculate the "Critical Path" – i.e. which path through the work network takes the longest and therefore defines the elapsed time that will be taken. Figure 7.16 illustrates a screen shot from Microsoft Office Project.

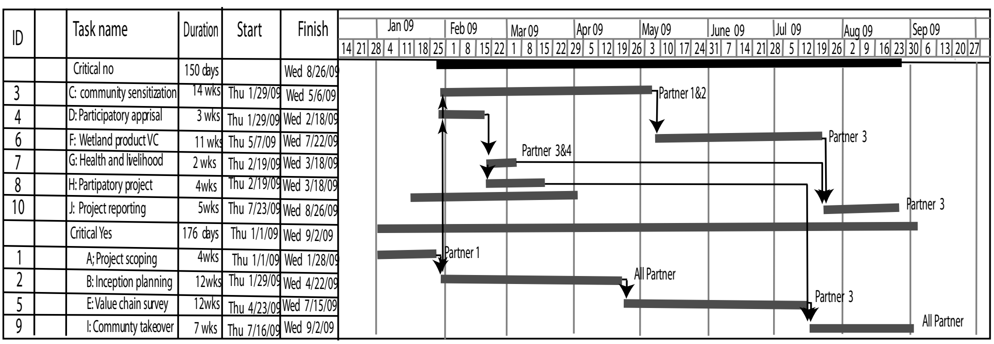


Figure 7.16: Network Diagram Project Schedule with Gantt Chart Generated from Microsoft Project 2003 Software for the Community Based Wetlands Product Value Chain Project

Stakeholder Participation in NRM Projects

This section blends the two main issues on the community participation agenda: (1) *bio-geographic and community priorities for action* and (2) *mechanisms to ensure broad stakeholder participation*. In NRM projects, stakeholder participation must be viewed as an essential component in ensuring sustainable resource management. The section examines the rationale for emphasizing stakeholder participation, describes principles for stakeholder participation, proposes mechanisms to ensure broad stakeholder participation, and lastly addresses practical issues of framing these mechanisms in NREM projects through a case study and learning activity.

Rationale and Definition of Stakeholder Participation

Stakeholders are the individuals, groups, or institutions that have an interest or stake in the outcome of an NRM project. The term also applies to those potentially affected by a project. They include resource users, governments, implementing agencies, project executing agencies, donors, and other groups in the civil society and private sector. Stakeholders are generally classified into three groups:

- *Primary stakeholders*: people or groups who are ultimately impacted either positively (beneficiaries) or negatively (victims) depending on the type of project;
- *Secondary stakeholders*: people or groups who have a role in the decision-making process without being directly affected by the outcome and may include funding organizations, implementing agencies, NGOs;
- *Key stakeholders*. Those who can significantly influence a project, or who are critical to the success of a project;
- *Peripheral (or Tertiary) Stakeholders*. Those directly or indirectly affected positively or negatively without opportunity for feedback from them.

It is particularly necessary to conduct a stakeholder analysis to identify the type of stakeholder, their relative degree of influence and role in the project while laying out the principle strategies for incorporating stakeholder participation throughout the project cycle including those targeting disadvantaged populations in and around project sites. According to Abbot and Guijt (1998), there can be different degrees of participation, such as:

- *Manipulation*: false participation, where “participation” is contrived as a means to indoctrinate;
- *Information*: stakeholders are merely informed about a project or activity that will affect them;
- *Consultation*: where stakeholders answer questions and have a voice in a project or activity;
- *Implementation*: stakeholders form groups to implement projects and activities;
- *Consensus-building*: where stakeholders interact and analyze problems and solutions of a project together;
- *Decision-making*: stakeholders make collective decisions;
- *Partnership*: working together as equals towards a mutual goal;
- *Self-management*: stakeholders take initiative and ownership.

In NRM project, the ultimate goal is obviously to reach a level of participation or benefit at the higher end of this scale. Achieving any NRM project goal will require fully incorporating stakeholders' views on the objectives and how they are to be achieved. If people are to be agents of change and not just beneficiaries of goods and services, participation is mandatory (Guijt, Alevaroes & Saldores, 1998). Best practices show that the most successful Resource Management Projects are those where the project objectives correspond to the needs of primary and secondary stakeholders, and where stakeholders are regularly involved in decision-making at all stages of the project cycle (Blaikie, 2006). Participation can also help reduce the risk of failure, though it is not a guarantee of success. If appropriately managed, stakeholder participation improves the performance and impact of projects by:

- Addressing the social and economic needs of affected people and their interests in sustainable livelihoods;
- Building effective partnerships among executing agencies and stakeholders;
- Building local capacities and abilities to manage their own development;
- Enhancing ownership and accountability for project outcomes by state and vulnerable populations dependent on natural resources, thereby increasing sustainability;
- Improving the status and empowerment of vulnerable groups such as women the poor, minorities, etc;
- Making effective use of knowledge, skills, and experience of all stakeholders in the design, implementation, monitoring, and evaluation of project activities.

Principles of Good Practice in Stakeholder Participation in NRM Projects

A number of principles for stakeholder participation should be borne in mind in the design, implementation and monitoring and evaluation of NRM projects:

- Creating venues and mechanisms to promote cooperation among stakeholders over the long-term is essential for managing natural resource conflicts;
- Gender and social equity in access to and control of natural resources is the ultimate measure of the sustainability of community-based land management efforts;
- Natural resource users are essential to address key NRM concerns at the farm, forest, and pasture community levels, while intercommunity networks address multi-community concerns at a larger scale. This ensures strong local groups;
- With adequate policy support, communities become more effective custodians of natural resources.

Strategies for Community Participation

A number of mechanisms can be applied to ensure effective stakeholder participation in NRM projects regardless of the type of resource in question.

Participation should be emphasized throughout the project preparation and design phase, as well as through implementation, monitoring, and evaluation:

- Community organization to help local residents identify, analyze, and solve issues through common goals and plans;
- Sustainable livelihood approaches to ensure projects have direct implication to food and income security of the stakeholders;
- Incentivization schemes especially for primary stakeholders to capture interest and reduce political or economic risk. Projects must be designed to provide appropriate incentives to motivate active participation;
- Coalition building involving a range of stakeholders in identifying key issues and seeking ways to convene parties for collaborative analysis and action;
- Collaborative and participatory research and other forms of joint fact-finding into the decision-making process is a key feature of project including during needs assessments, stakeholder analysis, conflict analyses and participatory monitoring and evaluation. A range of participatory methodologies (such as Participatory Rural Appraisal (PRA)[2] can be used to enhance primary stakeholder participation in analyzing community issues, assessing community needs, programme planning, and evaluation of programme impact;
- Consensus-building strategies including strategic planning meetings, workshops, seminars, cross visits, and many other mechanisms should be used to bring parties together;
- Training and capacity building to catalyze stakeholder participation. Capacity building should also target capacity of stakeholders to participate in the project.

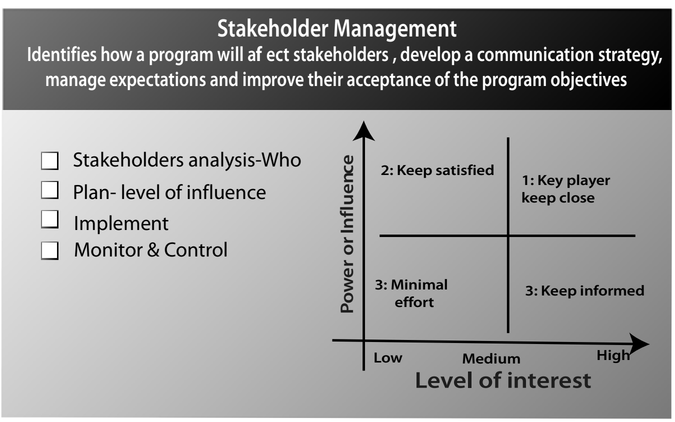


Figure 7.17: Typical Stakeholder Management Framework

Source: Adapted from Grimble (1998)

[2] See chapter 9 for details on PRA

Box 7.7: Sample Stakeholder Table for a Natural Nesource Management Project

Stakeholder group	Nature of interest	Potential research impact	Relative importance of interest	Importance of group*	Influence of group**
Primary stakeholders					
Female-headed households	Improved food security	High	High	High	Low
Male-headed, surplus producing households	Improved income	Medium	Medium	Low	High
Secondary stakeholders					
Collaborating (NAR) research bodies	Sustaining programmes of research and funding	High	High	Medium	Medium
Ministry of Agriculture	Increasing production via 'progressive farmers'	Low	High	Medium	Low

Source: Adapted from ODA, 1995

** Indicates importance to the natural resource project/programme leader.*

*** Indicates importance and representation within local/national power structures and institutions.*

Figure 7.17 illustrates general strategies for dealing with different types of stakeholders based on their level of influence and interest in the NRM project while Box 7.7 shows a sample stakeholder table.

NRM Project Implementation

Implementing NRM projects and programmes consists of the processes used to complete the work defined in the Project Management Plan to accomplish the goals. The implementation process involves coordinating people and resources, as well as integrating and performing the activities of the project in accordance with the Project Management Plan. The deliverables are produced as outputs from the processes performed as defined in the project management plan. Figure 7.18 illustrates this process.

NRM project implementation borrows heavily from the Monitoring, Evaluation, Reporting and Improvement (MERI) Framework. The use of MERI framework in project implementation is underpinned by five key principles:

i) Effective NRM depends on meaningful and efficient partnership arrangements and evaluations that are recognised by stakeholders as being well informed, relevant and timely, and are clearly and concisely presented;
ii) Establishing and fostering a constructive partnership among all partners in NRM: local governments, regions, communities, industries and other relevant stakeholders, is essential both for generating evaluation recommendations and for ensuring their uptake and ownership;

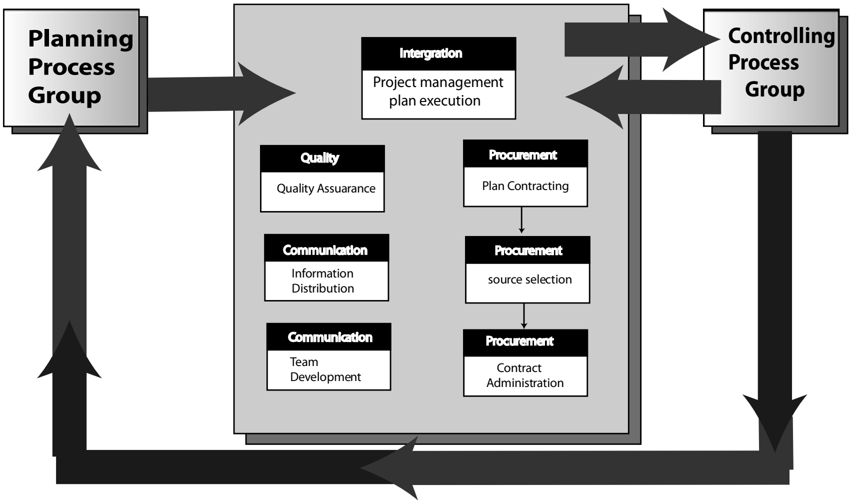


Figure 7.18: Project Execution Plan

Source: Usdva (2003)

iii) Establishing effective evaluation methods and feedback loops from evaluation to policy makers, operational staff and the community is essential if evaluation lessons are to be learned, recommendations adopted and the required changes and programme improvements made;

iv) Evaluation of NRM programmes and projects should incorporate assessment of multiple lines of quantitative and qualitative evidence about both the state and trend of identified NRM assets and key aspects of programme performance which describe the causal links between what a programme has achieved and how the achievements were accomplished;

v) NRM interventions encompass a range of temporal scales (up to 50 years or more), and institutional and spatial scales. Assessment of performance of NRM interventions should acknowledge this range of scales and use logic-based approaches to measuring and reporting.

An open communication approach illustrated in the continuous model in Figure 7.19 is imperative for application of MERI Framework in NRM project M&E. It is typically a continuous cycle of participation and communication rather than a single evaluation event. MERI promotes learning and adaptive management in response to progressive monitoring and evaluation, which enables improvement in programme/project design and achievement of desired outcomes.

Figure 7.19: MERI Continuous Participation and Communication Processes

Source: Commonwealth Of Australia, 2009.

NRM Project Monitoring and Evaluation

Defining Monitoring and Evaluation

Monitoring and evaluation are important aspects of NRM Project Management. The two terms differ on what, how and why questions concerning NRM project elements.

Monitoring is focused on daily Project Management issues. By monitoring we try to assess whether activities are implemented effectively and efficiently. Evaluation addresses strategic questions: “So what?”(impact and sustainability) and “Why?” (relevance). Monitoring is one of the components of the modern Project Management. First of all, it is expected to generate useful information for project manager: Where are bottlenecks? How are we doing towards our objectives? Are expenses under control? We can say that utility is the primary feature of properly organized monitoring system. Evaluation serves different audiences, like sponsors, assistance recipients and a wider public, who are potentially interested in results of the investment made in natural resource management projects. Table 7.7 summarizes the key differences between monitoring and evaluation in the context of natural resource management projects.

Table 7.7: Differences Between Monitoring and Evaluation

Characteristics	Evaluation	Monitoring
Subject:	usually focused on strategic aspects of NRM projects	addresses operational project management issues
Character:	incidental, flexible subject & methods	continuous, regular, systematic
Primary client:	stakeholders and external audience	project management (communities could also be involved in monitoring)
Approach:	objectivity, transparency	utility
Methodology:	rigorous research methodologies, sophisticated tools	rapid appraisal methods (could also mention other methods)
Primary focus:	focus on relevance, outcomes, impact and sustainability	focus on operational efficiency and effectiveness. Also use of inputs and timely completion of tasks
Objectives:	to check outcomes / impact, verify developmental hypothesis	to identify and resolve implementation problems
	to document successes and lessons learned	to assess progress towards objectives

Both monitoring and evaluation refer to the same logical framework that organizes the programme as a whole. Monitoring system utilizes some of the results, outcomes and impact indicators to observe project progress towards its final objectives. A well organized monitoring system creates a solid base for proper design of final evaluation. Evaluation, even if expected at the end of a project, influences its current implementation. Inevitable assessment by an independent, external expert puts significant pressure on the project partners. Sometimes monitoring faces important implementation issues, which can’t be properly explained by simplified research methodologies and within limited time and budget resources.

Typically, NRM project M&E targets the constant tracking and regular assessment of sustainability, project quality, capacity improvement, financial management and project impact. The learning activity that follows, will guide you in designing a project M&E strategy

Rationale of Monitoring and Evaluation

M&E as an important aspect of sustainable NRM especially must be inbuilt in project design and bolstered with effective stakeholder involvement, learning and communication. Effective M&E strategies ensure continued project relevance to the original cause so as to promote transfer of technologies and NRM project goals. This may be, for instance, control, reduce or prevent anthropogenic emissions of greenhouse gases that improve the efficiency and productivity of agriculture, forestry and other land use while supporting adaptation to the adverse effects of climate change and availing widespread opportunities for increasing carbon sequestration and adaptation exist in agriculture, forestry and other land us, hence, the landscape approach to climate change mitigation and adaptation[3]. M&E also ensures project quality such as strengthening capacity and processes for assessment of NRM technologies and stakeholder involvement. M&E is critical to assuring project sustainability by offering opportunity and institutional structures for learning and project improvement beyond the project time-frame. Monitoring and Evaluation M&E includes:

- Measuring the ongoing NRM project activities (*where we are*);
- Monitoring the project variables (cost, effort, ...) against the project management plan and the project performance baseline (*where we should be*);
- Identify corrective actions to properly address issues and risks (*How can we get on track;*
- Influencing the factors that could circumvent integrated change control so only approved changes are implemented.

In multi-phase NRM projects, the M&E process also provides feedback between project phases, in order to implement preventive and or corrective actions to bring the project into compliance with the Project Management Plan.

A variety of tools and frameworks are available for use in operationalizing M&E. The most prominent ones include Result Based Framework (RBF) and Outcome Mapping (OM). When augmented with appropriate knowledge management strategies, these tools will ensure the effective and efficient management of the project and its components towards the continuous renewal of project partners' knowledge base. The knowledge systems used are meant to create and strengthen supportive structures for learning, facilitation of partners to participate in the project, use of ICT tools, appropriate communication and strong emphasis on teamwork and diffusion of knowledge. Through the knowledge management, NRM projects can improve the flows of knowledge among partners, target groups and other NRM stakeholders. For optimum project improvement, the Knowledge management strategy should include, *inter alia*:

- Creation of knowledge databases (best practices, expertise directories, NRM technologies, NRM learning tools and approaches, land use and beneficiary profiles, emerging developments, institutional processes, policy and legislative developments);
- NRM knowledge mapping;

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[3] This was the overall objective of a project on “Up-scaling of conservation agriculture in Eastern and Southern Africa Region” designed by the Common Market for Eastern and Southern Africa (COMESA) through its Africa Climate Change Knowledge Network of 2010.

- Multi-stakeholder approaches to the formation of NRM knowledge teams;
- Active management of NRM knowledge processes;
- Development of NRM project knowledge centres of excellence and knowledge webs.

The application of ICT and networks of NRM practitioners, communities of practice who collaborate across and beyond the project's functional and geographic boundaries and the design and use of collaborative technologies - intranets or groupware for rapid information access, but also to aid effective project communications. Box 7.8 summarizes some key questions asked in an NRM M&E process.

Box 7.8: Key Questions Asked in a Project M&E Process

Monitoring and evaluation plans are normally developed at various levels, consistent with programme and project delivery models, to address questions under five key categories.

Appropriateness

- To what extent is the programme aligned with the needs of the intended beneficiaries?
- To what extent is the programme compliant with recognised best practice processes in the field—e.g. the type, level and context of investment and associated activities?

Impact

- In what ways and to what extent has the programme or initiative contributed to changing asset condition and management practices and institutions?
- What, if any, unanticipated positive or negative changes or other outcomes have resulted?
- To what extent were the changes directly or indirectly produced by the programme interventions?

Effectiveness

- To what extent have the planned activities and outputs been achieved?
- Are current activities the best way to maximise impact or are there other strategies that might be more effective?
- To what extent is the programme attaining, or expected to attain, its objectives efficiently and in a way that is sustainable?

Efficiency

- To what extent has the programme attained the highest value out of available resources?
- How could resources be used more productively and efficiently?
- What could be done differently to improve implementation, and thereby maximise impact, at an acceptable and sustainable cost?

Legacy/sustainability

- Will the programme or project impacts continue over time and after the programme ceases?
- How should the legacy be managed and by whom?

To inform future approaches to management and investment, for each of the above questions it will be important to ask why the change has or has not occurred.

Participatory Monitoring and Evaluation: The Community Perspective

Participatory Monitoring and Evaluation (PM&E) is an extension of Participatory Rural Appraisal (PRA) (Egerton University PRA Programme, 2002) and involves the adaptation of participatory tools combined with more conventional statistical approaches specifically to measure the impact of NRM interventions and projects on a community's social, environmental and economic status. The approach consists of a flexible methodology that can be adapted to local conditions. The approach acknowledges local people, or project stakeholders as experts by emphasizing the involvement of project participants and community members in assessing project impact – and by recognizing that 'local people are capable of identifying and measuring their own indicators of change' (Catley, 1999). All the definitions of NRM outputs, outcomes and impacts in NRM projects involve the concept of change, which can be positive or negative. Consistent with this, a project level PM&E endeavours to answer the following three key questions (Watson, 2008):

- What changes have there been in the community since the start of the NRM project?
- Which of these changes are attributable to the project?
- What difference have these changes made to people's lives?

In contrast to many traditional project M&E approaches, PM&E aims to measure the real impact of a project on the lives of the project participants. Most evaluations tend to focus on measuring aspects of project implementation, such as the delivery of inputs and services, the construction of project infrastructure, the number of trainings carried out or the number of people trained. PM&E tries to go a step further by investigating if and to what extent these project activities actually benefited the intended recipients, and if these benefits can be attributed to the project activities. The use of participatory methods in PM&E allows impact to be measured against qualitative indicators, such as changes in dignity, status, and well being, or changes in the level of community participation throughout the implementation of a given project. The use of participatory ranking and scoring methods enables these types of qualitative indicators, often based on opinions or perceptions to be presented numerically.

Comparative scoring and ranking methods can be used in PM&E to assess project attribution, by comparing both the project and non-project factors that contributed to any assessed change. This is particularly useful where the use of a control group is unethical or impractical, which is often the case in the context of humanitarian assistance projects. Comparative scoring methods used in PM&E can also be used to develop a retrospective baseline against which to measure impact. Again the lack of baseline data is a common feature of humanitarian assistance projects, particularly those being implemented in an emergency setting. The PM&E approach emphasizes the standardization and repetition of participatory methods, helping to improve the reliability of the information, but ideally leaving enough scope for the open-ended and flexible inquiry typical of PRA. In this respect PM&E tries to find a balance between systematic methods and the richness of qualitative inquiry. In summary, a systematic, well designed PM&E can assist communities and their NRM partners to measure impact using their own indicators and their own methods. It can also overcome the weaknesses inherent in many externally-driven monitoring and evaluation systems which emphasize the measurement of process and delivery, over results and impact.

Managing NRM Projects for Impact

Investments in NRM in ESA are increasing and the overall management of stakeholder processes, project resources and other aspects of the project is a keystone of NRM projects if impact and accountability are to be demonstrated. Project designs that promote a high level of community participation can in their very design lead to enhanced awareness and knowledge and better management of the processes and practices in the projects. To manage NRM projects for impact, a clear understanding of how this is done is imperative and has been the objective of this chapter in general and is the objective of this section in particular. Operating across multiple jurisdictions and scales, the NRM projects is necessarily and undeniably complex. It is this complexity and risk of fallacy of attribution that demands and logical impact orientation. The project must have coordinated effort to improve the condition of the most valued and most vulnerable environments, people and natural resources in sub-Saharan Africa. Tracking and demonstrating that a project has been managed for impact is thus both tricky and necessary. The task of assessing and tracking the progress of investments in NRM activities is an enduring challenge.

This is because:

- NRM outcomes need to be achieved at a range of spatial scales;
- Multiple interacting factors affect the health of NRM assets;
- The condition of NRM assets can be highly variable naturally;
- There can be long time lags between management actions and a detectable difference in the condition of NRM assets;
- The social context in which NRM operates can often mean there are different views on what constitutes success;

- Climatic impacts can dwarf resource management impacts;
- Developing cost-effective indicators presents a challenge.

These elements of uncertainty and risk require NRM programme design, including monitoring and evaluation plans, to include rigorous risk assessments and logical mapping. Different guidelines and frameworks have been developed for implementing the project impact management. These guidelines must adopt a fundamental function of enhancing understanding of the framework(s) therein so that it can be practically implemented with a reasonable degree of flexibility to accommodate differences in NRM jurisdictional capacity. An understanding of the logical framework approach is important in demonstrating how this can be presented.

NRM assets, goods and services are intrinsic to NRM projects while changes in the social, environmental, financial and political conditions of the people are paramount but may take longer than the project lifespan to achieve. Both the intrinsic and utilitarian values that people place on the environment and the many resources and opportunities it provides for human consumption and wellbeing must be addressed in the Project Management Scheme. An NRM asset-based approach is most amenable to targeting and measuring outcomes in terms of conservation, repair and replenishment of natural resources and improvements in human wellbeing. This therefore demands the construction of a Logic or Theory of Change to guide action for improving, verifying and measuring the condition to be changed. M&E and other performance measurement frameworks help to develop measurement tools and indicators to monitor and assess change in the asset (capital, social, financial, natural) over time; the relative effectiveness, efficiency and appropriateness of the NRM project and the extent of change or impact from the project activities.

Programme/Project Impact Logic

The impact logic lays the foundation for learning about which strategies have the most impact and adaptation in response to that information. It provides a Theory of Change that can be tested. It also helps to determine what and when to evaluate so that resources can be used effectively and efficiently. A Logic Model assists in developing appropriate process and outcome measures.

The NRM Project Logic comprises a hierarchy of expected NRM outcomes at different temporal scales. The Logic provides the basis for informing decision making at various scales, including community based, national policy making and regional project management. The generic NRM outcome hierarchy in Table 7.8 provides an illustration of the type of outcomes that could be expected at each level of the hierarchy. It is important to understand the distinction between an outcome and a target. An outcome refers to the results achieved at the defined levels of the outcomes hierarchy in the programme logic. A target is a specified objective that indicates the number, timing and location of that which is to be realised for a policy, programme or activity.

Table 7.8: Generic NRM Outcome Hierarchy

	Outcome hierarchy	Outcome Description	Associated Target
Aspirational programme goal	Vision for the asset	Statement of the overall vision for the state of the asset in 50 years. This statement helps guide Programme Planning and provides a context for setting other targets	No targets at this level
Longer term outcome	Improvements in the state of the asset	Expected outcomes relating to the condition of the biophysical, institutional and social assets as a result of intervention	Usually longer-term targets at a broad geographic level
Intermediate outcome	Aggregate changes in how the asset is managed and affected	Changes in management practices resulting in impact on asset condition across a region A reduction in pressures on and threats to the asset	Intermediate targets (e.g. percentage of land protected or managed in a certain way over five years)
	Practice and attitude change	Adoption of best practice or sustainable management practices Enhanced knowledge, aspirations, skills, attitudes and/or confidence Institutional and organizational change, as reflected in corporate policy, business practices, laws and infrastructure	Immediate and intermediate targets (e.g. percentage of land/resource managers or communities that adopt sustainable management practices)
Immediate Activities and outcomes	Biophysical outputs	Deliverables that are related to immediate on-ground results as set out in investment plans and funding agreements	Output targets (e.g. number of hectares of land re-vegetated or enhanced)
	Non-biophysical outputs	Deliverables that are related to immediate social, institutional, cultural or economic results as set out in investment plans and funding agreements	Output targets (e.g. number of community plans, number of participants in training workshops, or number of incentives projects funded)
Foundational activities	Project activities	Activities that largely concern the development of NRM strategies and investment plans. These include:	Output targets (e.g. number of community workshops conducted or number of

		conducting baseline assessments and analysing programme evaluation results building skills and developing knowledge base developing institutional frameworks, plans and strategies undertaking community consultation consulting and/or commissioning scientific research	educational resources developed)

Source: Carden and Smutylo, 2001

Together with the knowledge of available resources, science and data, this type of hierarchy assists in defining and reality-testing the change that is expected at each level and the extent of change that is anticipated. The next step would be to develop implementation strategies to effect the desired change. In many instances, significant changes in some NRM assets will not be seen for many years. Intermediate outcomes – both biophysical improvement and improvement of the social and institutional capacity to manage natural resources sustainably – also need to be identified to assess progress towards longer-term outcomes.

Under the MERI Framework, four key concepts are critical:

- An *integrated approach* to NRM project investment and design, the planning process, evaluation and adaptive programme/project management involving stakeholders across jurisdictions of scale and scope;
- An *asset-based approach* to M&E that promotes target setting for the key asset classes that contribute to sustainable NRM;
- Monitoring *project/programme performance* in addition to the state of and change over time in the condition of assets; and
- Reporting with an emphasis on *outcomes and impacts*, including at an intermediate outcome stage.

NRM Project Budgeting

NRM projects, like other development projects consume resources (including financial) resources. Successful project management demands prudent budgetary plans and management. It is good project management practice to design definitive budget schedule for each project period as well as a cumulative budget schedule for all years or periods, and a budget narrative giving justification for key cost elements. The discussions in this section are supplementary to the specific instructions often provided as guidelines pertaining to budgetary and financial management different donors.

In a project proposal, a budget is the key element especially for NRM projects soliciting grants. An effective proposal budget outlines the proposed NRM project in fiscal terms and helps determine how the project will be executed. Looking at the budget details one is able to determine whether a proposed NRM project has been carefully planned and may ultimately be feasible. The budget should be *complete*; that is, it should include all the costs of any personnel, supplies, and activities required by the project. The budget should also be *reasonable*; that is, it should be based upon actual costs as much as possible all based upon available price information. Table 7.9 is a sample budget template showing the common budget items in projects.

Table 7.9: Sample Project Budget Template

Budget Item	Unit Description	No. of Units	Unit rate (USD)	Costs (USD)
Personnel Cost				
1. Human Resources				
1.1 Salaries/wages (gross amounts, local staff)				
1.3 Per diems for field trips/travel				
Subtotal Human Resources				
2. Travel and Perdiem				
2.1. International travel				
2.2 Local transportation				
2.3 Participation in stakeholders' meetings				
Subtotal Travel				
3. Equipment and supplies				
3.1 Purchase or rent of vehicles				
3.2 Furniture, computer equipment				
3.3 Machines, tools…				
3.4 Spare parts/equipment for machines, tools				
3.5 Other (please specify)				
Subtotal Equipment and supplies				
4. Local office				
4.1 Vehicle costs				
4.2 Office rent				
4.3 Consumables - office supplies				
4.4 Other services (tel/fax, electricity/heating, maintenance)				

Subtotal Local office				
5. Other costs, services				
5.1 Publications				
5.2 Studies, research				
5.3 Auditing costs				
5.4 Evaluation costs				
5.5 Translation, interpreters				
5.6 Financial services (bank guarantee costs etc.)				
5.7 Costs of conferences/seminars				
5.8 Visibility actions				
Subtotal Other costs, services				
6. Other				
Subtotal Other				
7. Subtotal eligible direct costs of the Action (1-6)				
8. Contingency reserve (% of 7, subtotal)				
9. Total eligible direct costs of the Action (7+ 8)				

NRM Project Sustainability

Over the years, the definition of sustainability and Natural Resource Management and Development literature has varied widely and broadened in scope. The concept arose in response to Economic Growth Models that characterized development approaches in the past three decades. Many projects did not adequately address social inequalities and led to environmental degradation. The concept gained wider use after the World Commission on Environment and Development published *Our common future* (Brundtland, 1987).

Sustainability Defined

Project Sustainability refers to ability of the Project concerned to ensure *that the institutions created and or supported through the project and the benefits realized therefrom are maintained and continued after the completion of the Project.*

The assessment of NRM project sustainability entails determining "whether the results of the project will be sustained in the medium or even longer term without continued external assistance". According to IFAD (2006), there are several aspects of project sustainability:

- Economic and financial sustainability – resilience against economic shocks, financial viability, reduced household vulnerability and increased capacity to cope with risk/shocks;
- Environmental sustainability – projects' positive contributions to soil and water preservation and management, resilience to external environmental shocks;
- Institutional sustainability – institutional support, policy implementation, staffing, recurrent budgets;
- Ownership – whether or not communities, local government and households accept and own the outcomes of the project in ways that are sustainable;
- Political sustainability – government commitment, an enabling policy environment, stakeholder interests, strong lobby groups and political influence/pressure;
- Social sustainability – social support and acceptability, community commitment, social cohesion;
- Technical sustainability – technical soundness, appropriate solutions, technical training for operations and maintenance, access to and cost of spare parts and repairs;
- Sustainable Corporate Social Responsibility (CSR) activities.

The scale at which sustainability is evaluated is crucial. At the field level, the sustainability of NRM projects is likely to be assessed in terms of viable resource use systems and the satisfaction of basic social and economic needs of the community. Conversely, sustainability at the regional or national level often places greater emphasis on a population's adaptability to a changing natural environment factors contributing to (or constraining) social equity, and the coherence of national policy frameworks.

NRM project participants and partner institutions play crucial role in its success. It is, therefore, important to consider their perspective on the meaning of the term. At the local level, community members and CBO partners consider sustainability to mean new NRM initiatives would remain viable and benefits from them would be stable. In designing projects, a comprehensive sustainability strategy should be included. According to TANGO (2008), ensuring project sustainability requires consideration of four essential dimensions (Figure 7.20).

In addition to the initial design, the way an NRM project is implemented can have considerable influence on its long-term sustainability; for instance, by fostering participatory approaches, remaining flexible in the face of inevitable setbacks, and strengthening capacity of stakeholders to plan and manage future actions. Also building capacity of local institutions to take charge of the project.

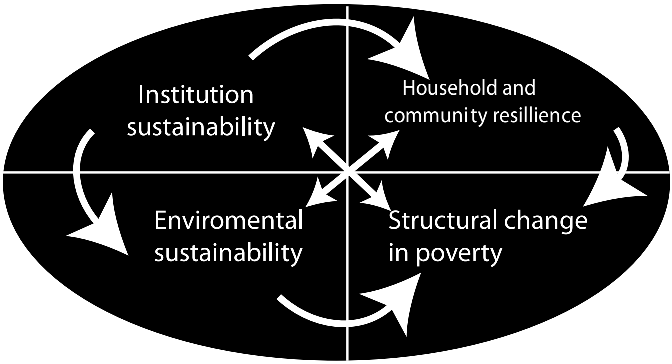


Figure 7.20: Essential Dimensions of NRM Project Sustainability

Source: TANGO, 2008.

NRM project designs must identify hazards and risks that threaten the continued stream of benefits to households and communities, and the inclusion of risk management strategy. Several factors are known to determine sustainability. According to IFAD (2007), the factors that are directly related to implementation and falls within project control include:

- Project objectives must be clear, must account for important assumptions, and should not be overambitious;
- Projects need to build systematic, institutional, economic, social and risk analysis and risk mitigation strategies into the design and implementation programmes;
- NRM project management must be able to provide or arrange for the provision of consistent implementation support to institutional partners;
- A clear exit strategy must be planned and agreed on by key partners during the design phase and used as a reference point (benchmark) throughout project implementation.

There are also a range of external factors that may compromise the sustainability of NRM projects. They include external policies and institutional contexts that may have direct or indirect influence on project implementation, but are typically outside project control. For instance, the sustainability of a carbon project is likely to be compromised by results of international negotiations on climate change and carbon trade regimes. Many NRM projects use different strategies to deal with such externalities:

- Systematic identification, analysis and *response to* risks in ways that ensure continuation of NRM project benefits after completion of the project;
- Strengthening the capacity of individuals, households, communities and formal and informal institutions that will help them cope with future shocks;

- Making efforts to cause 'no harm' to the environment while meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

Factors Constraining NRM Project Sustainability

There is evidence from literature on NRM projects and case studies that the likelihood of future sustainability of NRM projects is constrained by conspicuous absence of one or more key enabling factors. At the same time, there are a number of factors that function as constraints on project sustainability.

- Overambitious objectives that are poorly adapted to the livelihood context of a particular country;
- Insufficient attention paid in the project design phase to creating effective linkages among different sectors;
- No unifying framework for analysing the impact of resource investments on risk/shock management;
- Underinvestment in institutional strengthening and capacity development;
- Preoccupation with achievement of major outputs and general neglect for fostering sustainable processes among community stakeholders;
- Insufficient priority given to the promotion of community participation, collaboration and collective decision-making;
- Persistent lack of access to inputs and markets to the detriment of technical and economic/financial sustainability;
- Insufficient technical and implementation support, coupled with short project time frames;
- General lack of environmental analysis in assessments of institutional sustainability and household food and livelihood security;
- Lack of an in-country institutional presence capable of advocating for needed policy change;
- Lack of a systematic approach to arranging or providing incentives and ongoing technical support for governmental and non-governmental partners responsible for sustaining activities (infrastructure maintenance, NRM, etc.);
- Limited capacity-building for enabling communities to acquire the ongoing financing needed to sustainably maintain programme improvements;
- M&E systems incapable of measuring programme impact, partner performance and institutional learning;
- Inadequate attention given to the formulation of viable exit strategies.

NRM Project Risk Management

What is Risk? 'A future event (or series of events) with a probability of occurrence and the potential for causing damage or loss on project objectives. The purpose of risk management in NRM projects is to identify potential problems before they occur so that risk-handling activities may be planned and invoked as needed across the life of the project. Risk management is a continuous, forward-looking process that is an important part of business and technical management processes. Risk management should address issues that could endanger achievement of critical objectives. In designing a risk management strategy, a continuous risk management approach is applied to effectively anticipate and mitigate the risks that have critical impact on the project. Effective risk management includes early and aggressive risk identification through the collaboration and involvement of relevant stakeholders. Risk management considers: (1) defining a risk management strategy; (2) identifying and analyzing risks; and (3) handling identified risks, including the implementation of risk management plan and risk M&E. Figure 7.21 summarizes the basic project risk management framework.

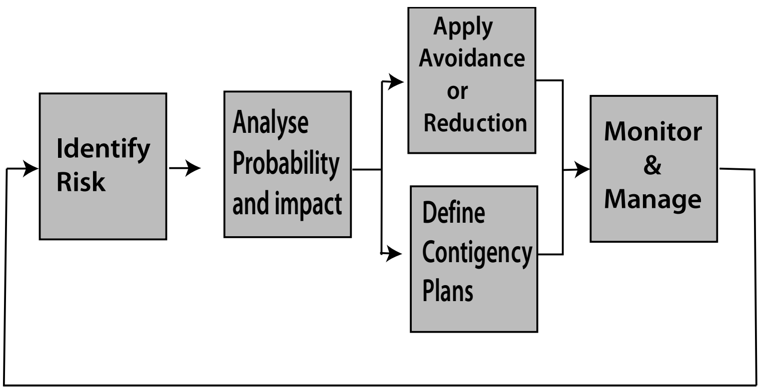


Figure 7.21: Basic Project Risk Management Framework

Source: Alexander And Sheedy, 2005

In NRM projects, risk management includes the following activities (Alexander and Sheedy, 2005):

- *Planning how risk management will be held in the particular project:* Plan should include risk management tasks, responsibilities, activities and budget;
- *Assigning a risk officer:* a team member other than a project manager who is responsible for foreseeing potential project problems. Typical characteristic of risk officer is a healthy scepticism;
- *Maintaining live project risk database:* Each risk should have the following attributes: opening date, title, short description, probability and importance. Optionally a risk may have an assigned person responsible for its resolution and a date by which the risk must be resolved;
- *Creating anonymous risk reporting channel:* Each team member should have possibility to report risk that he foresees in the project;

- *Preparing mitigation plans for risks that are chosen to be mitigated:* The purpose of the mitigation plan is to describe how this particular risk will be handled – what, when, by who and how will it be done to avoid it or minimize consequences if it becomes a liability;
- Summarizing planned and faced risks, effectiveness of mitigation activities, and effort spent for the risk management.

Project Exit Strategy

At or towards the completion of NRM projects, it is better to make provisions of "safe" exit. In order to ensure sustainability of projects, we must find ways of complementing its technical components with appropriate project exit strategies. The timing and manner in which NRM project activities are concluded depends on a range of factors. An 'exit' may take many forms: moving into a second phase of a project; terminating stakeholder engagement assistance under a specific project or its component; or ending the project altogether.

An exit strategy should include possible indicators or 'triggers' for exit and must be linked to NRM project design and specific project goals and objectives; systems for measuring progress; and identification of capacities to be built and left behind after the project ends (Blackman, 2003). Ultimately, the focus is on sustainability rather than on exiting for exit's sake. Answers to a number of key NRM project implementation questions may serve as the basis for initial formulation of exit strategies.

How can projects be best designed from the initial planning stage so as to facilitate eventual phase-out?

- How will project partners determine whether their contribution has contributed to a community's resilience and furthered its NRM capacity?
- How can the gains made during project be consolidated and continued after the project?
- These questions should be applied not only to projects as a whole, but also to specific activities within projects as they are phased in or out.

Linking Exit Strategies to Project Sustainability

Exits strategy refers to a specific plan describing how the project will withdraw from a region or population while ensuring that the achievement of NRM goals is not jeopardized (TANGO International, 2008). It is explicitly linked to sustainability in that it also considers means of ensuring further progress towards these goals after the end of an agency's technical and financial support (IFAD, 2009). The principle goal of an exit strategy is to ensure the sustainability of project impacts and activities (Cascio, 2007). The possible strategies that may be included in an NRM project exit strategy include increased ability of communities to take initiative, community control and management of resources and resource mobilization and networking strategy. In order to qualify as a strategy, the exit or graduation strategy must contain the following:

- A timeline (flexible to a degree) specifying when these benchmarks will be reached and when the assessments will be conducted;
- Clear action steps to reach benchmarks and identification of those responsible for taking these steps;
- Measures to periodically assess progress towards meeting the exit criteria and possible modification of the plan based on any unforeseen difficulty in reaching the benchmarks;
- Specific and measurable benchmarks for assessing progress towards meeting these criteria;
- Specific criteria for graduation and/or exit;

According to Cascio (2007) and IFAD (2009), exit strategies may be ‘phase-out’, ‘phase-over’ or ‘phase-down’ depending on the context. The ‘phase-over’ strategy seeks to transfer the full responsibility for NRM project activities to other organizations, governmental entities, community groups or individuals. The ‘phase-out’ exit strategy involves the withdrawal of project resources, but without transferring responsibility or ownership to another group. ‘Phase-down’ exit strategies refer to the gradual reduction of project inputs or resources, often prior to a ‘phase-over’ or ‘phase-out’ strategy.

Summary

This chapter has exposed you to the concepts, principles, principles, tools, frameworks and application of project planning and management in natural resources development. Due to the dynamic, integrated and complex nature of NRM, careful planning and management is necessary in order to deliver on any objectives. Like any human undertaking, NRM projects are planned and delivered under certain constraints, chiefly: scope, time and resources. Project management is a carefully planned and orchestrated effort to accomplish a specific NRM undertaking guided by some principles, tools, approaches and frameworks.

Planning is the key to the success of a NRM projects and is the process of preparing a set of decisions for action in the future directed at achieving sustainability. It involves clear steps and decisions on: project identification, formulation, design, appraisal, selection, coordination, implementation, monitoring and evaluation, completion and exit. Project planners can use deliverable, outcome and milestone-focused planning approaches.

As blue prints, frameworks, like the Logical Framework, Results-Based Framework and Outcome Mapping help structure project design, execution and control as a roadmap for ongoing performance measurement and evaluation activities that will support effective project management and accountability. The design of project culminates in the concept note and project proposals as documents to narrate the transformation of creative or worthwhile NRM ideas into a reality. A Proposal is a written expression of, and proposed solution to, an NRM problem. It must present a persuasive argument for the project case. Executing NRM projects and programmes involves coordinating people and resources, as well as integrating and performing the activities of the project in accordance with the project management plan. The primary, secondary and key stakeholders should be involved in project design, planning, execution and evaluation at levels of participation based on their level of influence and interest in the NRM project.

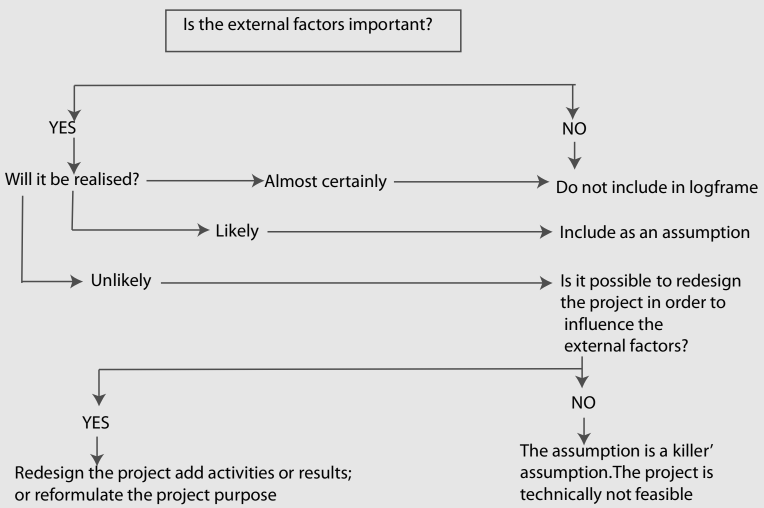
Monitoring and Evaluation (M&E) as an important aspect of sustainable NRM is especially inbuilt in project design and bolstered by effective stakeholder involvement, learning and communication. Monitoring is focused on daily project management issues while evaluation addresses strategic project questions. An assessment of NRM project sustainability entails determining whether the results of the project will be sustained in the medium or even longer term and may be seen in economic, financial, environmental, institutional, political, social or technical terms. In addition to the initial design, the way an NRM project is implemented can have considerable influence on its sustainability.

The formulation of project exit strategy demands addressing project design at the initial planning stage so as to facilitate eventual phase-out, determining partners' resilience and NRM capacity, and consolidating gains made in the project through well structured institutions and capacity building. As a plan describing how the project will withdraw from a region or community, it is explicitly linked to sustainability. A project may be 'phased-out', 'phased-over' or 'phased-down' depending on the project context.

Learning Activities

Learning Activity 7.1

Working in groups of individuals with diverse disciplinary backgrounds, identify a 1 year community based NRM project and deliberate on its main features. Use the Logical Framework Approach to design the project. Use the following schema to formulate the project assumptions ensuring the avoid "killer assumptions"



Learning Activity 7.2

Conduct a literature review on a comparative analysis of approaches and frameworks for Project Planning, Design Management and M&E. Summarize your findings using the template below and discuss with your peers in order to consolidate wider views on as many approaches as possible.

Approach	Strengths	Weaknesses	Application in NRM Projects

Learning Activity 7.3

Using the template below, develop a comprehensive M&E strategy for an NRM project of your choice. Begin by first breaking down the M&E objectives into specific M&E issues and then complete the matrix. You may add as many M&E issues as needed and rows to fit new issues and sub-issues.

Objective/Activity/ Output	Timeframe (years)					Methodology	Responsibility	Beneficiary/ Information Use
	1	2	3	4	5			
Project relevance and effectiveness								
Project quality								
Stakeholder participation								
Financial management efficiency								
Project sustainability								
Impact evaluation								

Learning Activity 7.4

For a named NRM project design the project outcome hierarchy with details of project logic using the template in Table 7.9.

Learning Activity 7.5

Using the sample budget template in Table 7.10, develop a comprehensive budget for a specific NRM project of your choice. Remember to provide a detailed budgetary note for each line item. You can break the budget items into more specific sub-items based on activity or expenditure lines.

Learning Activity 7.6

Identify from your country or local community two natural resource management projects each representing either a sustainable or failed project. Using the criteria presented in this section, analyze the projects for their inherent sustainability features, constraining factors and how the project design succeeded or failed in addressing sustainability.

Learning Activity 7.7

Using the generic template below, design a risk management plan for any community based NRM project of your choice indicating clearly the risks (both internal and external), possible impacts of project, management response and M&E indicators for measuring the performance of the risk management plan.

Risk	Possible Impact on Project	Risk Response/ Strategy	Risk M&E Indicators

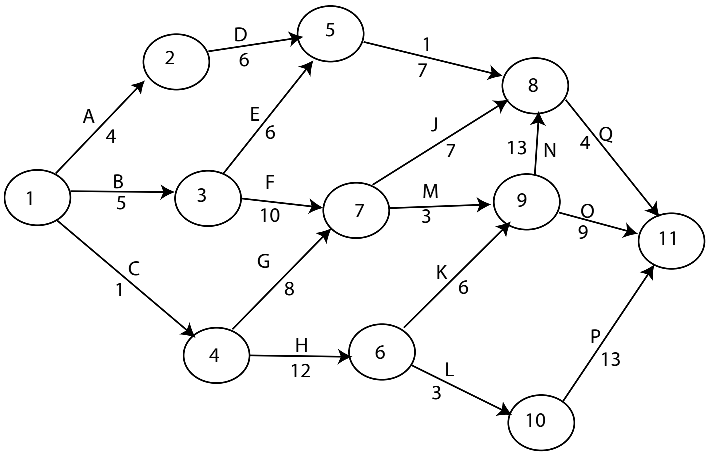
Revision Questions

1. Trace the history of project management, highlighting the major milestones and application to various disciplines. How does project management contribute to the success of NRM projects?
2. Differentiate, giving examples from NRM, between project and programme.
3. Compare and contrast the main approaches to project planning. For a specified NRM project, which of the approaches would you use and why?
4. Identify a unique natural resource management problem. Conduct a comprehensive situation analysis, formulate a plan for solving the problem through a project showing a logical flow from activities to project goal.
5. The logical framework approach is often criticized for some weaknesses in application to complex systems like natural resources. Mention these weaknesses and describe how you would address them in managing a specific NRM project.
6. Project design, monitoring and evaluation, management of risks and exit strategies are important in project sustainability. What is the contribution of each of these elements to sustainability?
7. How would you ensure appropriate stakeholder participation in an NRM project?

Additional Project Design Problems

Problem 1: The following is a PERT chart (network) diagram of a community dam construction and aquaculture project. By allocating project activity descriptions, use the diagram to:

a) Develop the project time schedule
b) Determine the project critical path and considerations for reducing project duration without affecting project resource requirements



c) Use any version of Microsoft Project (or any other project management software) to validate your answers to (a) and (b) above. By trying different time schedule, experiment with the software changes occurring to the project design under different time, cost and partner assumptions to find out the result of crashing and change of activity schedules.

Problem 2: The Shinyanga Case

The region of Shinyanga that lies on the southern side of Lake Victoria in north western Tanzania is home to the Wasukuma who are agro-pastoralists. It represents approximately 5.4% of the total land area in Tanzania. Over 80% of the population in Shinyanaga own livestock for daily household sustenance and income generation. The population of the area has more than doubled from 1.4 million in 1980 to 3.1 million in 2008. As a consequence, the numbers of livestock have similarly doubled, representing 20% of the total livestock in Tanzania on 5.4% of its total land area. This situation has exposed Shinyanga to the risk of environmental degradation occasioned by overgrazing. The natural forests and vegetation cover in the area have also been lost due to bush fires, area expansion for cash crops and attempts to eradicate the tsetse fly. The loss of indigenous woodlands and land cover has resulted in wood fuel scarcity, loss of biodiversity and water shortage in wells. This degradation is compounded by the fact that the land in this region is primarily owned by the Government and therefore there is little incentive for the population to invest in land conservation and regeneration. Massive environmental degradation in Shinyanga has caused severe hunger, conflicts and increased poverty.

a) By first developing a project logframe, design a community based integrated land management project in response to the problems highlighted in the above case. Select appropriate sub-headings for your project from the any proposal guide or format to complete your design:
b) Design a Project Evaluation Framework to be used to assess the success of the project (in A above) based on the following evaluation areas
   i) Innovative elements
   ii) Impacts on natural resource base
   iii) Impacts on livelihood of the users
   iv) Other impacts
   v) General success factors
   vi) Technology success factors
   vii) Institutional success factors
   viii) Problems remaining to be resolved

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Policy and Governance in Natural Resource Management

D. Nyariki, P. Sanginga, Y. Yemshaw and W. Kakuru

Introduction

Natural Resource Management (NRM) is a relatively new and expanding thrust in policy research on African development. This is because of the importance of natural resources in African development and the increasing rates of degradation of natural resources. Several scholars have concluded that if natural resources are to be protected against the risk of destruction, it is essential that governments devise a range of policy instruments that can influence behaviour for the adoption of technology innovations and institutions that promote sustainable management of natural resources to alleviate poverty (Shiferaw *et al*., 2008; Egulu and Ebanyat 2000). Policies and institutions of governance influence how people use and manage natural resources, and subsequently affect the condition of natural resource systems.

This chapter is about NRM policy and governance. It is concerned with decisions made by governments and related stakeholders and the approaches these entities use to effect desirable changes in the utilization and management of natural resources. While special emphasis is placed on natural resource policies, the chapter also addresses the general nature, principles, development and analysis of policy within the social, economic, environmental and political contexts.

From a policy point of view, NRM is the management of land, water, soil, plants and animals, to provide a satisfactory amount and mix of social values (consumptive and non-consumptive) for people living, while protecting these values and use options for future generations. A natural resource management policy specifies certain principles regarding the use of a society's natural resources which it is felt, will contribute to the achievement of some of the objectives of that society. A NRM policy provides orientation for the choice and execution of activities which affect natural resources both publicly and privately owned. Government NRM policy profoundly influences the way in which private organizations and individuals can utilize their natural resources and carry out their programmes and activities (Birkland, 2005).

Without a clearly enunciated NRM policy, within the government, it is difficult and uncertain to know if there is an appropriate body of legislation, if an appropriately structured agency or agencies exist, and if they are carrying out adequate programmes. The public institution in charge of NRM faces the hazards of inconsistencies and illogical variations in its work programmes from year to year. Coupled with this, is the risk of taking too many *ad hoc* decisions that can be contradictory and create confusion within the institution and, above all, pose perils to the public. Furthermore, NRM policy has wider impacts on situations related to natural resources and activities such as rural community development, agricultural policy, urbanisation, environmental management, the existence of facilities for recreation, water supply, and many others.

The chapter addresses four key aspects of NRM policy and governance: The *first* section defines the key concepts and elements of policy and governance in the context of natural resources management. The chapter then focuses on policy processes in NRM, with particular attention to international, regional and national policy instruments in NRM. Section four discusses the frameworks, processes and tools for policy formulation and policy analysis in NRM. Section five outlines the different characteristics of decentralized governance of NRM, participatory policy development and formulation of local policies. The chapter concludes with a section on linking NRM research to policy and presents some guiding principles for influencing policy change in NRM.

The objectives of this chapter are to:

i) Introduce the concepts of public policy and governance as they relate to NRM;
ii) Describe the principles, processes, frameworks and tools for policy formulation, implementation, analysis and evaluation in relation to NRM;
iii) Describe the national, regional and international instruments for formulation and implementation of NRM policies at different levels;
iv) Discuss the processes and tools of participatory policy development and decentralized governance of natural resources;

v) Understand the complexity of NRM policies and provide guiding principles for linking research to policy.

After reading this chapter, readers will be able to:

i) Acquire knowledge, tools and skills to navigate through complex, dynamic and difficult terrain of formulating, analysing, implementing, evaluating and influencing NRM policies.
ii) Become conversant with the international, regional and national NRM policies and their instruments, and advocate their integration into local and national policies.
iii) Better understand the SWOT analyses paradigms and the SWOT analysis matrix for linking NRM research and knowledge to policy and practice.
iv) Acquire skills and knowledge and tools for promoting decentralized governance of natural resources and facilitating community and local stakeholder participation in NRM policy-making and implementation.

Concepts and Elements of Policy and Governance in NRM

Policy

There is no agreed definition of *policy*. It may, therefore, mean different things to different people as reality is in the subjective perception of the partisan beholder. For some, policy is typically a course of "action" adopted for the sake of expediency; a course of action adopted and pursued by government, private sector organizations and groups, or individuals according to the social and economic objectives that it is desired to achieve. It is thus the way in which a government uses its institutional and legal means to carry out its programme of activities aimed at achieving its chosen objectives including the identification of different alternatives such as programmes or spending priorities, and choosing among them on the basis of the impact they will have. Simply put, policy is a definite course of action to guide present and future decisions (Torjman, 2005). Policies are decisions taken by those with the mandate to do so on particular issues or resources, with indications of the strategies and means of implementing the decisions. Those decisions are usually expressed in official statements and codified in formal documents subject to the vision, mission, goals and objectives of the decision-makers with regard to their stakeholders. They are executed by the relevant arm(s) of government bureaucracy that bears the mandate (Opio-Odongo and Woodsworth, 2004).

Policies provide rules by which individuals or groups of individuals in a society are expected to wisely use the physical environment within society's beliefs, values, and ideas. Some of the rules may restrict individuals' values or provide incentives to modify their beliefs for the greater good. For example, to promote sustainable use of the rangelands (physical environment) a cattle owner may find rules in a policy restricting him/her from overstocking (rule of behaviour) although his/her desire to show that he/she is an important person in the community (value?) is that he/she should have a lot of cattle. Policies are important to guide behaviour based on competing beliefs, values and ideas among individuals in society on one hand, and the principles of sustainable development on the other. By allowing each individual to have only a limited number of heads of cattle, the range can be shared, and overgrazing of the range is avoided.

Policy is composed of goals and methods adopted by governments in order to influence certain outcomes - economic, environmental, political, etc. Generally, policy implies state-specific interventions such as, water policy, environmental policy, research policy, land reform policy, irrigation policy, or wildlife policy. It could be in the form of written or spoken statements aimed at solving particular problems.

Policy should be differentiated from *law*. Policy is a deliberate plan of action to guide decisions and achieve rational outcomes. It may apply to government, private sector organizations, groups and individuals; and may include presidential/ executive orders, corporate policies and parliamentary rules. While law, e.g. a law requiring payment of taxes on the use of a natural resource or on pollution due to the activities of a private entity *compels* or *prohibits* certain actions or behaviour, policy merely guides actions towards the most desirable outcome(s) (Fischer *et al.*, 2006, Torjman, 2005). It should, however, be noted that laws and policies must not necessarily be both compatible and synergetic.

Other categorizations of policy also exist, such as *distributive* and *constituent* policies. Distributive policies extend goods and services (as well as their costs) to members of an organization. Examples are government policies that impact spending on environmental welfare, public education, roads and public safety. Constituent policies are those that create executive power entities or deal with laws. They also deal with fiscal issues in some circumstances.

Governance

Like the word policy, governance has also been defined in different ways. The World Bank defines governance as the exercise of political authority and the legal use of institutional resources to manage society's problems and affairs (World Bank, 1998). Governance has also been used to describe the proper functioning of institutions and their acceptance by the public. This definition considers, amongst others; the capacity of the government to effectively formulate and implement sound policies and the respect of citizens and the state of the institutions that govern economic and social interactions among them. Institutions refers generally to the set of instruments through which people, living in a state and believing in common core values, govern themselves and includes policy, laws, rules and regulations as well as custom (North, 1990). Governance refers to the processes through which these institutions are implemented. Governance invariably relies on interaction between the state, civil society and the private sector, although the relative roles of these sectors differ depending on the priorities and values of a given social system (Weiss, 2000). For example, the extent of public participation in decision making is often a reflection of this.

For the purpose of this chapter, governance can be defined as the interventions and institutions aiming at changes in NRM-related incentives, knowledge, institutions, decision-making and behaviours of people and organizations in the management of natural resources. NRM governance refers to the set of regulatory processes, mechanisms and organizations through which political actors influence NRM actions and outcomes. Governance is not the sole purview of the state through government, but rather emerges from the interactions of many actors, including community organizations, civil society organizations, the private sector and businesses, but also “international” and “transnational” institutions. It can be formally institutionalized or expressed through subtle norms of interaction or even more indirectly by influencing the agendas and shaping the contexts in which actors contest decisions and determine access to resources. Governance involves the structures and processes by which societies share power, shapes individual and collective actions. According to Dietz *et al., (*2003), NRM governance requires multi-stakeholder participatory processes at different levels, which facilitate broad community participation to devise locally appropriate rules, sanctions, and conflict resolution processes. NRM governance, therefore, means creating conditions, structures, processes and institutions for social coordination and collective action by which people in societies make decisions and share power, providing a vision and direction for sustainability (Folke *et al.,* 2005, Lemos and Agrawal, 2006).

Elements of Public Policy

Types and Categories of Policies

Two major policy categories are recognized. These are *public* and *private* policy. Public policy affects ‘all of us’– the public. It involves governments and is the main interest of this book. Private policy is that which involves private entities and includes company or even family policy. Public policy seeks to achieve a desired goal that is considered to be in the best interests of most, if not all, members of a society. Some of these goals may be to achieve clean water, improved environment health, conserve biodiversity, protect water towers, mitigate climate change, protect wildlife, improve food security, and provide employment. The impact of public policy is directed at entire populations, groups, regions or sectors.

Based on their effects, policies might be classified both as *macro-economic* and *sectoral*, or *regulative* and *developmental* policies. *Macro-economic policies* are policies or policy changes that governments make to stabilize the economy or to maintain stability and or continue growth. Sectoral policies affect particular sectors, for example, environment and natural resources, agriculture, health and education. Sectoral policies are in two forms. One is the productive sector policies such as those related to, land, water, wildlife, arid and semi-arid lands, forests, agriculture and livestock, fisheries, wildlife, and tourism, which are examples of natural resources. The second form is the social sector policies, including health, education, culture and sports which are not expected to provide material or tangible returns.

Regulative policies are mainly in the form of *laws* and *acts* of parliament and *sessional papers*. Regulative policies limit the discretion of individuals and agencies, or otherwise compel certain types of behaviour. These policies are best applied in situations where proactive behaviour (for example, use of 'green' technologies) can be easily defined and adverse behaviour (such as environmental pollution and land degradation) can be easily regulated or punished through fines or sanctions. For example, limits and or controls in the use of non-degradable materials and in carbon emissions can be defined.

Developmental policies are in forms such as those contained in government development plans and strategy papers. The Millennium Development Goals (MDGs) and Poverty Reduction Strategy Papers (PRSPs) are examples. Some of the developmental policies may be wholly or partially aimed at addressing issues associated with natural resources while others may have less to do with natural resource management.

Elements of Public Policies

Policy consists of three main elements: *objectives* or goals, *instruments* for achieving those objectives, and *rules* for operating those instruments (Colman and Young, 1989). It is formulated in terms of several simultaneous objectives; it involves several instruments which are applied according to specific rules. These rules are devised in order to achieve the objectives. It is the way the rules are set in order to operate those instruments that will determine whether the objectives will be met or not (i.e., success of the policy).

Policy Objectives

An explicit statement of policy objectives aids in decision-making at the higher governmental levels. It provides a guide for the sub-units of government institutions tasked with NRM to support decision-making on resource allocation through the planning and budgeting offices. Without an understanding of governmental NRM policy, private organizations and the public in general are prone to misunderstandings, misinterpretations, conflicts, and a climate of uncertainty that will surely have an adverse effect on the development and achievement of governmental programmes as well as those of the private sector.

Instruments of Policy

Instruments of policy are the different means adopted by policy makers to influence policy outcome. They are ways of tackling a problem or setting an objective. It is therefore important to identify policy instruments by which a given situation could be improved. In the case of natural resource policy, the instruments would influence outcomes at several levels. These would include local, national, regional and international levels.

Similarly, instruments would be implemented at these different levels. For example, a policy instrument may aim at protecting a water catchment affecting a local community (local-level), and would thus require a part of or a whole community to participate (i.e. local institutions will be called upon to support and be involved in the process), with an expected result of improved water availability. The policy instrument in this case would be legislation against cultivating too close to water catchments, or legislation for the repossession by the government of a strip of land surrounding certain water masses – some form of land reform measure – or enforcing the building of conservation structures by the affected communities to protect these areas. A similar instrument that would be regarded as being national-level is that implemented through an act of parliament in a country declaring a certain natural resource area as a conservation area. This could be a national park or a forest reserve. International- or region-level instruments are those contained in international or regional agreements, conventions and/or protocols, which involve resources that are of common interest to, or the utilization of and with the impact felt across regions and nations, and must be implemented and enforced by the concerted efforts of nations.

Sometimes those concerned with policy are confronted with a situation commonly referred to as the ‘single instrument trap’, a belief that only one way (instrument) can be used to tackle a problem or set an objective. To prevent getting caught in this trap, it is useful to search systematically for alternative instruments. The search can be assisted by grouping the possible instruments into broad categories as shown in the preceding paragraphs.

Rules of Policy

A policy rule is the exact means by which a policy instrument is applied. It is precisely how, where and when an instrument functions. It is about the process by which an instrument is put in effect. The rule of policy influences the impacts of the instrument. A basic rule of policy is that there must be as many (or more) instruments as there are objectives, that is, where there is a single objective of policy, at least one instrument would be required. Box 8.1 provides a specific example of Uganda’s Water policy for agricultural production to illustrate the objectives, instruments and rules of policy.

Box 8.1: Uganda's Water Policy for Agricultural Production—Objectives, Instruments, and Rules:

Overview of Uganda's water resources:

- Dependence on rain-fed agriculture and gender affects food security and financial benefits
- Un-even distribution of water resources
- Surface water resources are seasonal and ground water potential is often limited
- Dams and valley tanks have insufficient inflow or have too small storage capacities
- Water scarcity limits livestock production, promotes nomadism, spreads diseases, and leads to overgrazing and land degradation

Policy goal:

- To manage and develop water resources of Uganda in an integrated and sustainable manner so as to secure and provide water of adequate quantity and quality for all social and economic needs for the present and future generations with the full-participation of all stake-holders.

Policy objective:

- To promote development of water supply for agricultural production in order to modernize agriculture and mitigate the effects of climatic variations.

Specific objectives:

- Promoting proper water resource assessment and planning for agricultural production
- Increasing the capacity of the farmers to access and use of water for crop, fisheries and livestock production
- Promoting appropriate water harvesting technologies for irrigation and livestock development
- Promoting the participation of farmers and the private sector in the planning, financing, development and management of irrigation and livestock water supply systems
- Promoting and supporting, where appropriate, the development of adequate and reliable livestock water supply

Key policy aspects addressed by the policy:

- Support to vulnerable groups
- Sustainability of water use
- Preservation and protection of the environment
- Private sector involvement and user participation
- Water use efficiency
- International obligation in the use of the waters shared across national boundaries

Policy instruments and rules:

1. Instrument: Water resource assessment and planning

Rules:

- Preparation of guidelines for improved design of dams and valley tanks
- Development of dams and valley tanks in the dry pastoral areas
- Aqua-culture development programme—to promote development of fisheries at farm level

- Formulation of action plan and strategy for development of irrigation covering review and assessment of technical feasibility
- Water resources assessment, review of irrigation potential

2. Management and sustainability aspects

Rules:

- Sustainable management of the environment
- Increase water use efficiency and productivity
- Formulation of by-laws governing use of government-funded resources by all the users

3. Financing, investment subsidies and user charges

Rules:

- Commercial agricultural development credit scheme
- Providing investment subsidies to vulnerable groups

4. Capacity building

Rules:

- Institutional capacity building programme
- User training programmes

5. Technology choice

Rules:

- Appropriate, selected and disseminated to vulnerable groups
- Small scale irrigation development programmes

6. Environmental and public health aspects

Rules:

- Carrying out detailed Environmental Impact Analysis of all projects before implementation
- Setting guidelines and standards for water quality

Policy Processes in Natural Resource Management

Who Determines NRM Policy?

Policy making is a complex process that involves many stakeholders with different interests (Figure 8.1). The main participants in the determination and execution of NRM policy include governmental authorities or bodies (cabinet, ministries, parliaments), civil society organizations (NGOs, interest groups, political parties, mass media), private sectors, donors (multilateral and bilateral technical and financial institutions, and advisory units) (Bratton, 1990), who play different roles in the different stages of policy making. These are briefly discussed below.

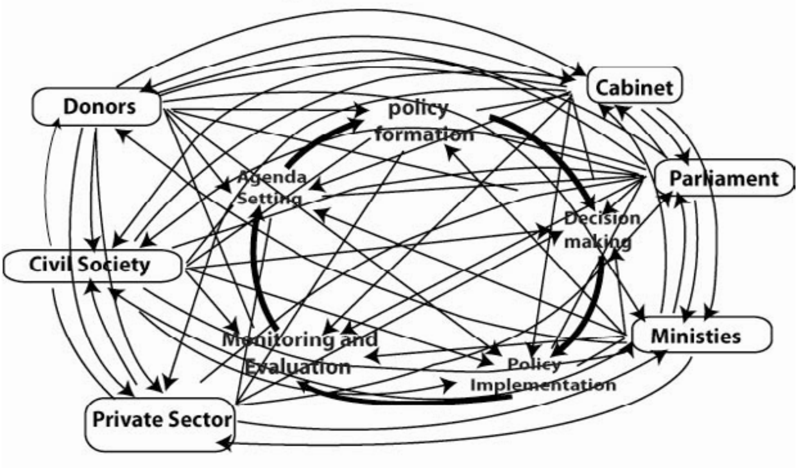

Figure 8.1: Policy Formulation Processes are Complex and Involve Multiple Stakeholders

Source: Adapted from http://www.odi.org.uk/events/2006/12/07/413-workshop-handout.pdf; accessed 18 October 2010

Governmental Authorities or Bodies

Government authorities have the most prominent and visible role in natural resource policymaking. These include not only the institutions of the executive branch of government, but also active and powerful parliamentary institutions with lawmaking and funding functions that have a strong influence on NRM policy. A governmental NRM authority, such as the Ministry of Environment, will be limited, to a certain extent, in its policy formulation and execution by basic legislation of a broader nature directly or indirectly related to natural resources. Other governmental agencies with NRM related responsibilities can also influence policy. Needless to say, officials at high levels in the government authority can play major roles.

Civil society organizations include interest or pressure groups, community organizations, non-governmental organizations and other pressure groups that are consulted and express opinions on the multitude of possible policy issues and actions and try to persuade their representatives and government bodies to accept their views. These groups may be temporary, organized in response to some current or transitory dispute. Most of the NRM policy conflicts which have occurred in recent years have been clashes between groups more interested in the non-consumptive NRM values with groups more dedicated to the consumptive NRM values. The effectiveness of an interest group in influencing NRM policy decisions depends upon several factors—the group's attitude, skills, knowledge, interest, its power, and its access. The role of communities and the processes of eliciting the participation of communities in shaping, influencing and making policies are discussed in detail in the section entitled *Governance and Community Institutions* *for Natural Resources Management*. Some of the most influential interest or pressure groups in civil society organizations include:

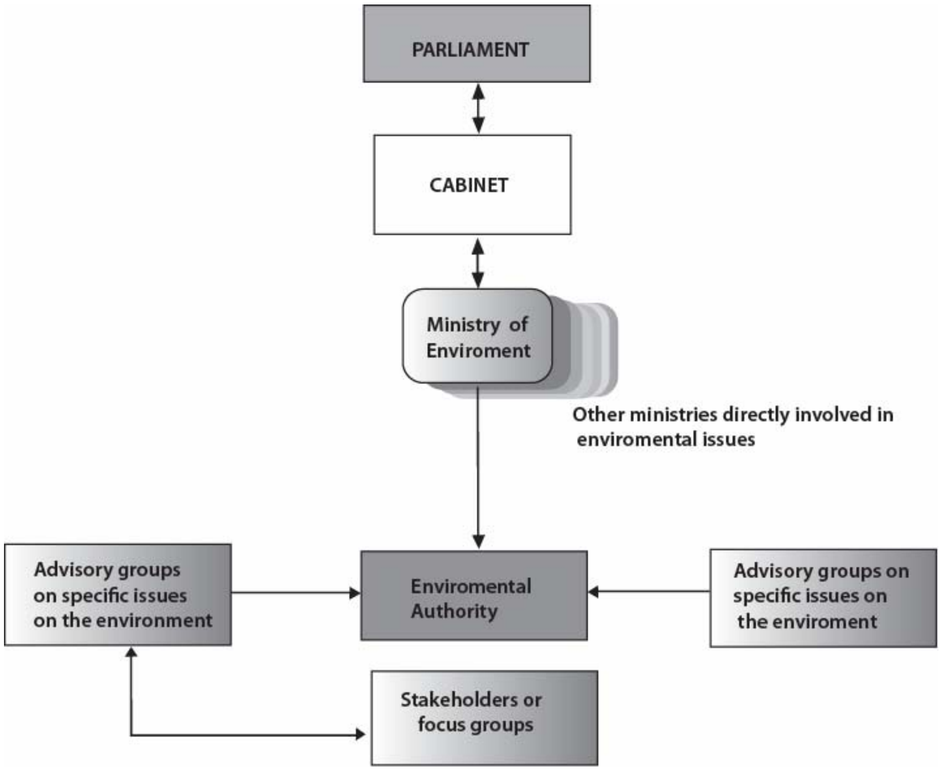

Figure 8.2: Policy Formulation by Government Authorities

Source: Adapted from Nkambwe and Chenje, 2006

Political parties: When political parties exist, are able, and motivated, they may express opinions and exert pressure regarding NRM policy issues. Their effect is similar to that of interest groups although political parties are usually established with much broader aims than simply for NRM policy. However, there has been a tendency for persons interested in ecological issues and the prevention of environmental pollution to band together in political parties or to make these issues prominent in the platforms of existing political parties.

Mass media: Newspapers, magazines, radio and television are the principal means of mass communication which are used by all the participants in policy questions to publicize their views and try to convince government authorities and the public of the validity and correctness of their positions. In addition, the proprietors and managers of these mass media may have their own personal views that can be pushed effectively as they control the channels of communication.

Multilateral and bilateral technical and financial institutions

Donors can influence national NRM policy, especially in the less developed countries such as those in Africa. These countries are recipients of technical and financial assistance under bilateral or multilateral means such as the World Bank, International Monetary Fund (IMF), and European Union (EU). The influence may be through expert advice and information to a recipient government or, as is often the case in bilateral assistance, through actions such as technical or financial assistance dependent upon the acceptance of recommended policy.

Advisory units

Regardless of the socio-economic and political conditions under which a country operates, it is useful to establish an advisory board for the government at an appropriate level. Members of the board should not be part of the government but representatives of different public segments of the natural resources and related sectors. The aim of such a body is to make known the opinions and will of the public in NRM policy development as well as obtaining specialized knowledge that may not be available within the government. The advisory board should have access to the information compiled by the policy analysis unit of the NRM authority as well as information from other sources. The advisory board would have the responsibility of expressing opinions and making recommendations on issues of government policy.

Policy Formulation

NRM Policy Framework

Policy development or policy formulation is a decision-making process that helps address identified goals, problems or concerns. The political ecology framework posit that understanding NRM policy will require detailed understanding of a range of political, economic, socio-cultural and environmental (technical) factors. These different factors can be summarized by the ‘context, evidence, links’ framework for policy analysis (Figure 8.3) developed by Crew and Young (2002), which recognizes the importance of external factors such as international interests and donor policies in shaping NRM policies. But to be appropriate to NRM policy, this framework should include a very explicit and specific consideration of the environmental and ecological factors.

In this Chapter, we distinguish two major factors: the technical and political components. The technical environment consists of the ecological and economic factors, state of knowledge, and operational or administrative practicability. The political environment includes policies in other related sectors, legislation, governmental priorities and commitments, social and cultural influences, and policies of private owners (Birkland, 2005; Dias and Begg, 1994).

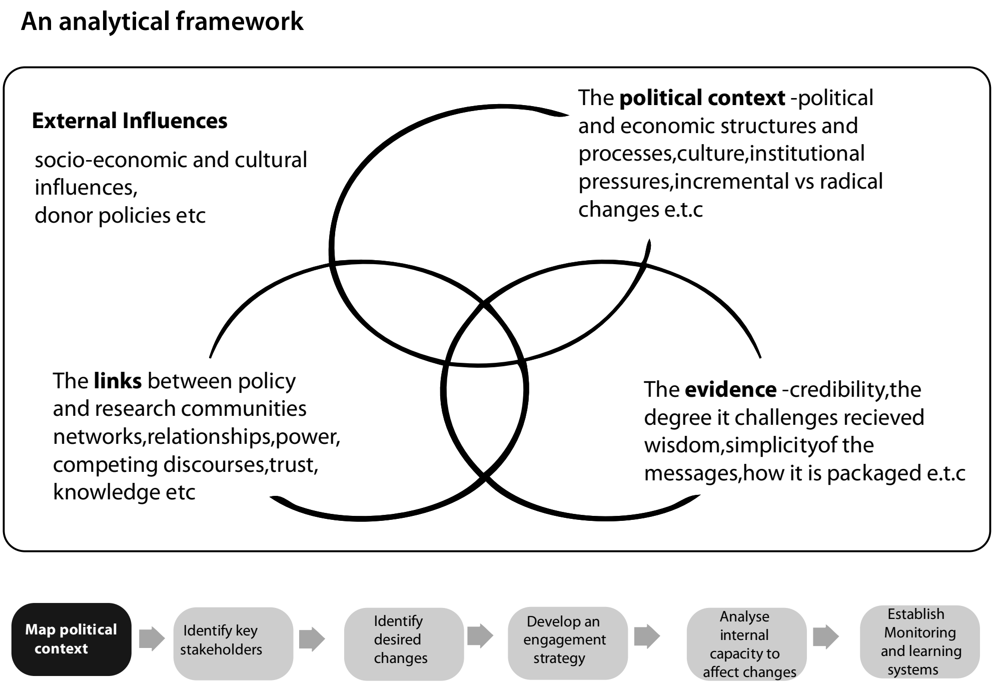

Figure 8.3: The 'Context, Evidence, Links' Framework

Source: Court et al., 2004

Technical Environment

Ecological Factors

The objectives and programmes of a NRM policy must be physically and biologically attainable. To ensure this, ecological factors such as climate, soils, water, vegetation types, growth rates and regenerative capacity, among others, must be considered in defining and executing a NRM policy.

Economic Factors

The relative importance of natural resources in the national economy of a country will have an influence on its NRM policy. Policy makers need to see the cost of inaction in terms of lost employment and potential of stimulating the development of rural communities. If NRM related industries are important, a basic objective of a NRM policy may be to assure the provision of adequate supplies of raw material of appropriate quantities and qualities.

Other economic factors affecting the NRM policy may be world market conditions for agricultural and mineral products, results of feasibility studies for natural resource development projects, and the availability of domestic and international capital for investment in natural resource programmes.

Social and Cultural Influences

In arriving at decisions when formulating and executing a NRM policy, one must consider the social and cultural acceptability of the decisions by individuals and groups within the country. These factors include customs and traditions, the type of land ownership and the rural infrastructure. Whatever decisions are taken, one must consider their social and cultural acceptability. Rarely will they be acceptable to everyone. The existence of possible conflicts does not mean that the controversial decision should be avoided. However, policy makers should recognize the potential dispute and include it in their evaluation of merits and demerits of the question.

State of Knowledge and Skills

In formulating a NRM policy, one must consider if the required knowledge, research findings and experiences are available to permit carrying out the policy. An important question is whether adequate technology is available for the necessary actions to be successfully carried out. It is also important to consider operational or administrative practicability, as objectives of a NRM policy must be operationally and administratively achievable. The objective must also be tested against the implementing organizations' ability (staff, material, equipment and funds). A proposed objective which cannot be practically achieved is best not included in a policy.

Political Environment

Policies in Other Related Sectors

NRM policy cannot be formulated in isolation. It should be an integral part and in synergy with overall government policy and those of other sectors of the national economy, especially those dependent on the use of land and other natural resources. NRM policy must be consistent with the objectives and programmes of other governmental policies such as those related to agriculture, agrarian reform, land settlement, rural development, taxation, foreign trade, housing, transportation, sale of state land, prevention of environmental pollution, land-use planning, state land, etc.

Legislation

NRM policy formulation and execution must be in compliance with the constitutional framework of the country and existing national laws and regulations. If NRM policy decisions conflict with current legislation, there are two courses open: modify the NRM policy decisions to comply with existing laws and regulations, or take steps to modify prevailing legislation so that the policy decision may be acceptable. The interpretation of the constitution and of existing and proposed legislation by the judicial branch of a government may also have an influence on policy.

Government Priorities and Commitments

A government will always have objectives of varying importance and priority in its overall national policy that will have an effect on natural resources. As examples, government objectives and programmes of high priority may be to favour certain regions of the country, to establish human settlements on its public lands, to provide jobs to the unemployed or to enhance the security of its national frontiers in natural resource conflict areas. If it is a signatory to international conventions, adherence of a government to international treaties may impose certain obligations on its NRM policy.

Policies of Private Owners

Natural resources may be owned or controlled by individuals, corporations, institutions, cooperatives and other associations of various types. The objectives and activities of the policies of these owners must be taken into consideration in the formulation of government NRM policy. The desirable situation would be that these policies provide ideas, experience and evidence of value in the formulation and execution of official policy and that they do not conflict with it.

Policy Evolution

A policy at any moment is an expression of a number of decisions that were taken based on the existing environment at the time of formulation. But the policy environment is mutable and dynamic with a set of influences and criteria. The details and contents of these categories of influences have undergone changes in the past and will undoubtedly undergo changes in the future. The main issues that must be confronted in formulating a policy will also change as time passes. Policy formulation and implementation can be regarded as an incremental process whereby policy is added to, revised and evolves over time.

Policy Nesting: Relation between national laws and international treaties

Policies may exist in hierarchies where narrowly focused policies are nested within and linked to a series of progressively broader policies (Figure 8.4). This nested arrangement can exist across many levels of government, both within a country and internationally and has the very important element of streamlining objectives of policies directed at a particular issue. Though national laws create and protect the rights of a state’s citizens, there are several international hazards that such citizens are bound to face that can not be controlled by national laws. This may require solemn agreements across borders to encounter such hazards. International treaties reinforce national laws to control hazards that affect different states such as depletion of the ozone layer and emission of greenhouse gases.

The implementation of international treaties at times depends on the effect of the national laws. Although an international treaty creates obligations to the parties in terms of execution, where it is not self-executing, it may require an implementing legislation in the form of national laws of state parties. An obligation of the parties is to move their parliaments to enact laws that enforce and implement international treaties.

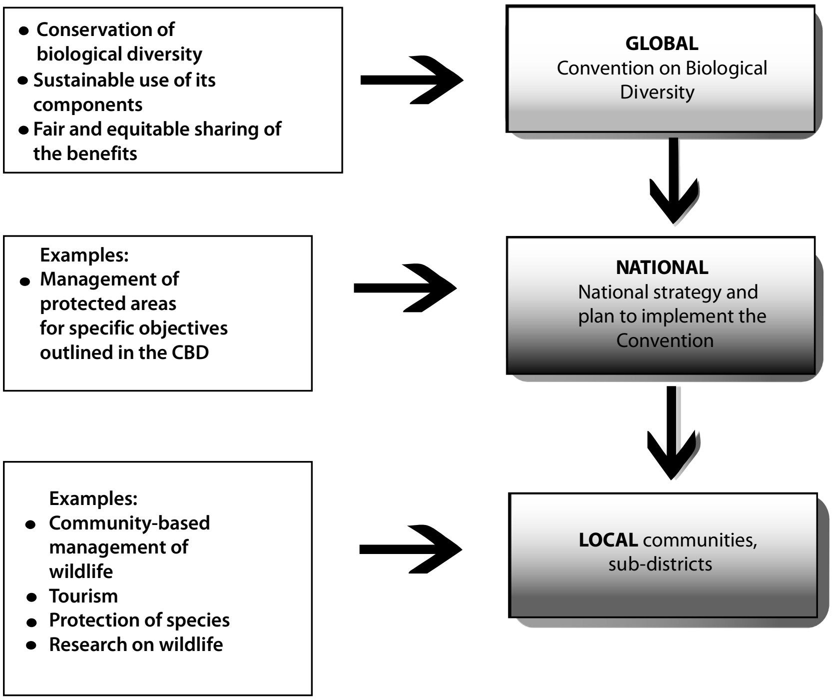

Figure 8.4: Hierarchies of Nested Policies

Source: Adapted from Nkambwe and Chenje, 2006.

However, policies at these different levels may be complementary or may be contradictory or conflicting, resulting into policy failures, defensive routines and implementation failures.

International and Regional NRM Policy Instruments

A number of related NRM legal instruments have been developed for managing the environment and natural resources. These have received commitment from a number of countries and it is expected that they will go a long way in contributing to sustainable management and utilization of natural resources. This section summarises the key legal NRM international and regional instruments, their origins, objectives and provisions relevant to NRM.

The Convention on Biological Diversity (CBD). The United Nations Conference on Development (UNCED) or the Earth Summit held in 1992 in Rio de Janeiro, Brazil identified major environmental strategies and challenges through the 1990s and beyond. One of these strategies was the Convention on Biological Diversity (CBD). The others included Agenda 21 Programme of Action for Sustainable Development, the UN Convention on Climate Change and the Statement of Forest Principles. The CBD acts very much as an overarching structure to which a number of other NRM related instruments, with their own more precise focus, can and must relate and contribute. The CBD defines biological diversity as 'the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, including diversity within species, between species and of ecosystems'. The world community's growing commitment to sustainable development inspired this convention. It represents a dramatic step forward in the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources. The CBD's broad formulations include articles on conserving biodiversity and using biodiversity in a way that generates its survival.

The Ramsar Convention on Wetlands. The convention on wetlands is an intergovernmental treaty adopted on 2nd February 1971 in the Iranian City of Ramsar, on the southern shore of the Caspian Sea. This convention is popularly known as the '*Ramsar Convention*'. Ramsar is the first of the modern global intergovernmental treaties on conservation and wise use of natural resources. The official name of the treaty – The Convention on Wetlands of International Importance especially as Waterfowl Habitat – reflects its original emphasis on the conservation and wise use of wetlands primarily to provide habitat for the water birds. Over the years, however, the convention has broadened its scope to cover all aspects of wetland conservation and wise use, recognizing wetlands as ecosystems that are extremely important for biodiversity conservation and for the well being of human communities.

The convention entered into force in 1975 and as of 2005, it had 146 contracting parties in all parts of the world. One of the commitments of contracting parties is to designate at least one wetland that meets defined criteria for inclusion on the list of Wetlands of International Importance (Ramsar List) and to promote its conservation, including, where appropriate, its wise use. The key criteria for including wetlands on the Ramsar list consider the wetland's significance in terms of ecology, botany, zoology, limnology, or hydrology. The Contracting Parties have adopted specific criteria and guidelines for identifying sites that qualify for inclusion in the List of Wetlands of International Importance. As of August 2005, Contracting Parties had designated 1,462 Ramsar sites, with a total surface area of more than 125 million hectares.

The African-Eurasian Waterbird Agreement (AEWA). Early in 1993, the Bonn Convection Secretariat, in co-operation with the Dutch Government's Ministry of

Agriculture, Nature Management and Fisheries, took up the initiative following further amendment to the agreement. The African component was given more weight and the name was changed to African-Eurasian Water bird Agreement (AEWA). The first consultative meeting of range states of AEWA was held in Nairobi in June 1994. The management strongly supported the concluding of AEWA, and that consensus could be achieved on almost all matters of substance. In June 1995, the final negotiation movement was held in the Netherlands. At this meeting sixty-four range states and the European Union were represented. Several intergovernmental and non-governmental organizations attended the negotiation meeting as observers.

The Nile Water Treaties. The Nile water treaties have been the subject of many studies and comments (see Okidi 1982 and 1994) and have recently been subject to intensive media coverage and diplomatic negotiations. The 1929 Nile Waters Agreement was an Exchange of Notes between Great Britain (acting for Sudan and her East African dependencies) and Egypt in regard to the use of the waters of the Nile. The purpose was to guarantee and facilitate an increase in the volume of water reaching Egypt. *Inter alia*, the Agreement provided as follows: *"Save with the previous agreement of the Egyptian Government, no irrigation or power works, or measures are to be constructed or taken on the River Nile or its branches, or on the lakes from which it flows in the Sudan or in countries under British administration, which would, in such a manner as to entail prejudice to the interests of Egypt, either reduce the quantities of water arriving in Egypt or modify the date of its arrival, or lower its level."*

Thus, this Agreement expressed recognition by Great Britain, of Egypt's "natural and historic rights in the waters of the Nile". This 1929 Egyptian-British treaty was revised in 1959, but it still retained clauses barring the Nile Basin countries from using the waters for large-scale irrigation and other projects without permission from Egypt. The 1959 Agreement was only bilateral (Egypt-Sudan) and did not include any of the other riparian countries of the Nile (Ethiopia, Uganda, Kenya, Tanzania, Rwanda, Burundi and DR Congo). It portioned out all of the Nile's waters between the two downstream countries: 92.3% for Egypt and 7.7% for Sudan. The Treaty also gives Egypt the right to monitor the Nile flow in the upstream countries, and the right to veto any construction projects that would affect her interests adversely. The 1929 and 1959 Nile treaties have been the subject of numerous studies and diplomatic initiatives over the last three decades. The Nile riparian countries have questioned the legitimacy and relevance of these treaties. For example, Ethiopia, from which about 80 percent of the water comes, was not even consulted and no amount of water was even allocated for future usage by any upstream country except Sudan. In May 2010, the Nile Basin States signed the Agreement on the Nile River Basin Cooperative Framework for a period of one year - until May 2011.

Definition of Key Terms of International Instruments

To formalize ways of working together and implementing various decisions, it is usually deemed important to have relevant sovereign states or international organizations enter into some form of documented or non-documented statements (instruments). The instruments provide appropriate guidelines on the mode of operation and clarify rights and obligations. To this end, a number of terminologies are used to define different types of instruments. These include among others, agreements, charters, conventions, declarations, exchange of notes, memoranda of understanding, *modus vivendi*, and protocols. This topic gives an overview of definitions for some key categories of instruments, based on the United Nations system. The topic also outlines some processes required to be fulfilled by the relevant agreeing parties and some of the common NRM international instruments.

Terminologies used for reference to international instruments vary from state to state, region to region and instrument to instrument, and are at times used synonymously as generic terms or in some instances as specific terminologies. In some cases, the terminologies reflect some characteristics, the scope and functions of the different instruments, though they are sometimes used interchangeably. They also give an indication of the desired objectives and technical matters handled.

Agreements. The term '*agreement'* can also have a generic and specific meaning. In the generic sense, it is used to define treaties as '*international agreements'* with certain characteristics. The Vienna Convention uses the terminology to refer to instruments which do not meet its definition of 'treaty', for example, instruments not in written form. As a particular term, the word agreement is usually used to refer to less formal instruments and deal with a narrower range of subject-matter than 'treaties'. It is also most often used to refer to instruments of a technical or administrative character, which are signed by the representatives of government departments, but are not subject to ratification. Typical *agreements* deal with matters of economic, cultural, scientific and technical cooperation.

Charters. Charters are formal and solemn instruments, such as the constituent treaty of an international organization.

Conventions. The term 'convention' can be used in the generic and specific sense. The generic meaning refers to instruments whether general or particular which act as sources of law, apart from international customary rules and general principles of international law for judicial decisions and the teachings of the most highly qualified publicists. As a specific term, *conventions* refer to formal multilateral treaties with a broad number of parties, normally open for participation by the international community as a whole, or by a large number of states. Usually the instruments negotiated under the auspices of an international organization are called *conventions* (e.g. Convention on Biological Diversity of 1992). Some examples of NRM instruments include those where the United Nations Framework Convention for Climate Change (UNFCCC) established a framework for the development of binding greenhouse gas emission limits.

Declarations. This is a term used for various international instruments that are not necessarily legally binding. The term is often deliberately chosen to indicate that the parties do not intend to create binding obligations but merely want to declare certain aspirations, which may later have binding effects. A popular example in the NRM sector is the 1992 Rio Declaration (see chapter 1 on Agenda 21). However, it should be noted that *declarations* though not initially intended to have binding obligations and force can lay a basis for the generation of binding obligations in the form of other instruments.

Protocols. Protocols are reserved for agreements less formal than those referred to as treaties or conventions, which gives more clarity and details to an instrument. A *protocol* can therefore be simply defined as an instrument that supplements a previous treaty or international agreement. One example is the Kyoto Protocol (see chapter 6, climate change) that contains the specific provisions and regulations later agreed upon.

Processes for International Treaties, Agreements and Protocols

International instruments normally have formal processes required to be fulfilled before being recognized for implementation. The processes vary depending on the urgency of the instruments and the circumstances under which the instruments are being handled.

Processes for international instruments are guided by the Vienna Convention of the Law on Treaties (1969). Below are the highlights of the common processes that most international instruments go through. The processes are not presented in any sequential order of occurrence but are discussed in an alphabetical sequence.

Acceptance and Approval. 'Acceptance' or 'approval' refers to part of the process where relevant parties express the consent to be bound by the international instrument in question.

Accession. 'Accession' is a term used to refer to the act whereby a state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states. It usually occurs after the treaty has entered into force.

Adoption. 'Adoption' refers to the formal act by which the form and content of a proposed treaty text are established. It normally involves expression of the consent of the states participating in the treaty-making process. In some cases, the instruments are adopted during special sessions of International Conference of Party (COP) that are convened for a special purpose of setting up the instrument.

Amendment. The term 'amendment' refers to the formal alteration of provisions affecting all the parties to a particular instrument.

Authentication. 'Authentication' is the procedure whereby the text of an instrument is established as genuine and definitive. Once a treaty has been authenticated, states cannot unilaterally change its provisions.

Definitive Signature. The term ‘definitive signature’ refers to a less rigorous process used to establish consent of the state to be bound by the instrument where there is no need for ratification, acceptance or approval.

Deposit. This is an act of placing in custody of the finalized written instruments which have been concluded, as formal evidence of consent to be bound. The depository must accept all notifications and documents related to the relevant instruments, examine whether all formal requirements are met, deposit them, register them and notify all relevant acts to the parties concerned.

Entry into Force. This refers to the date on which the provisions of the relevant instrument take effect. Where the treaty does not specify a date, there is a presumption that the treaty is intended to come into force as soon as all the negotiating states have consented to be bound by the instrument.

Exchange of Letters/Notes. This is a procedure where states express their consent to be bound by having documents signed by the representative of the other party.

Modification. The term ‘modification’ refers to the variation of certain provisions only as between particular parties of a treaty, while in their relation to the other parties the original treaty provisions remain applicable.

Notification. ‘Notification’ refers to a formality through which a state or an international organization communicates certain facts or events of legal importance.

Provisional application of a treaty that has entered into force. This refers to a situation when a state undertakes to give effect to the instrument obligations provisionally, although its domestic procedures for ratification/accession have not yet been completed.

Provisional application of a treaty that has not entered into force. Provisional application of a treaty that has not entered into force may occur when a state notifies that it would give effect to the legal obligations specified in that instrument provisionally.

Ratification. Ratification defines the international act whereby a state indicates its consent to be bound by an international instrument, if the parties intended to show their consent by such an act. In the case of bilateral treaties, ratification is usually accomplished by exchanging the requisite instruments, while in the case of multilateral treaties the usual procedure is for the depositary to collect the ratifications of all states, keeping all parties informed of the situation. The institution of ratification grants states the necessary time-frame to seek the required approval for the treaty on the domestic level and to enact the necessary legislation to give domestic effect to that treaty.

Registration and Publication. This refers to the process of having international instruments entered into by contracting parties registered with the relevant Secretariats and published. Registration promotes transparency and the availability of texts of treaties to the public.

Revision. The term ‘revision’ refers to an overriding adoption of the instrument to changed circumstances.

Signature subject to Ratification, Acceptance or Approval. This refers to a situation where the signature does not establish the consent to be bound, but is used as a means of authentication and expresses the willingness of the signatory state to continue the treaty-making process. The signature qualifies the signatory state to proceed to ratification, acceptance or approval. It also creates an obligation to refrain, in good faith, from acts that would defeat the object and the purpose of the treaty.

Suspension and Termination. If a party has materially violated or breached its treaty obligations, the other parties may invoke this breach as a ground for temporarily suspending their obligations to that party under the treaty. A material breach may also be invoked as a ground for permanently terminating the treaty itself. A treaty breach does not automatically suspend or terminate treaty relations, however. The issue must be presented to an international tribunal or arbiter (usually specified in the treaty itself) to legally establish that a sufficiently serious breach has in fact occurred.

Withdrawal. International instruments are not necessarily permanently binding upon the signatory parties. As obligations in international law are traditionally viewed as arising only from the consent of states, many treaties expressly allow a state to withdraw as long as it follows certain procedures of notification.

Execution and Implementation of International Instruments

International instruments differ in scope and substance. Nevertheless, they tend to be formulated through a similar process that moves through recognizable stages. These stages include pre-negotiation, negotiation, adoption and signature, ratification and accession, and entry into force. One of the most significant processes is negotiation, whose guidelines are documented in different reports (Kanie, N. 2004; Simoneli, 2005; UNEP, 2007). As already noted, an instrument becomes a treaty only when it has a binding force to ensure its implementation and execution. At the national level only instruments with binding capacity are recognized as legal laws. It is important to note that neither national laws nor international treaties can create legal obligations between relevant parties unless with binding capacity that drives all parties to the cause of the instrument.

Policy analysts appreciate that though the international instruments may seem to vary by title, they basically have the same rules that guide their implementation and have evolved from experiences of different parties and are usually regarded as descriptions for international customary law. Customary International Law results from a general and consistent practice of states followed by them from a sense of legal obligation. Customary International Law relies on the feeling that, if the usage is departed from, some form of sanction probably falls on, or at any rate ought to, fall on the transgressor.

International instruments can therefore be loosely compared to *contracts*, since both are means of willing parties assuming obligations among themselves, and a party to either that fails to live up to their obligations can be held liable under international law for that breach. However, the central principle of treaty law is expressed in the *maxim pacta sunt servanda*—'pacts must be respected'. The sanctions are fairly loose to the extent that commitment to implementation mainly relies on the principle of *free consent* and *utmost good faith*. This sets a big challenge for instances of NRM, where lack of commitment to the implementation of a treaty has a big impact on the livelihoods of some communities, for example, the case of the United Nations Framework Convention for Climate Change (UNFCCC) and the attendant Kyoto Protocol. And where *utmost good faith* is not abided by, as in the case of Kyoto Protocol where some countries' refusal has not attracted any form of sanctions.

In terms of enforcement, international instruments may be seen as 'self-executing', in that merely becoming a party puts the treaty and all of its obligations in action. Other treaties may be non-self-executing and require 'implementing legislation'—a change in the domestic law of a state party that will direct or enable it to fulfil treaty obligations. An example of NRM related instruments that catalyzed processes of domestic laws in the sector were the Rio Declaration and the Convention of Biological Diversity (CBD). If a treaty requires implementing legislation, a state may be in default of its obligations by the failure of its legislature to pass the necessary domestic laws.

The negotiation process helps different actors to establish positions on how the relevant instruments will be put into action. Negotiation is normally carried out by having decision-makers assembling a delegation or "negotiating team." Different team members may focus on different issues. It may also be very important for someone to be responsible for obtaining important documents from the Secretariat, drafting text, taking notes during sessions, developing new positions, and communicating with government officials back in country or within the negotiating process.

Frameworks, Processes and Tools for NRM Policy Development

NRM Policy Cycle

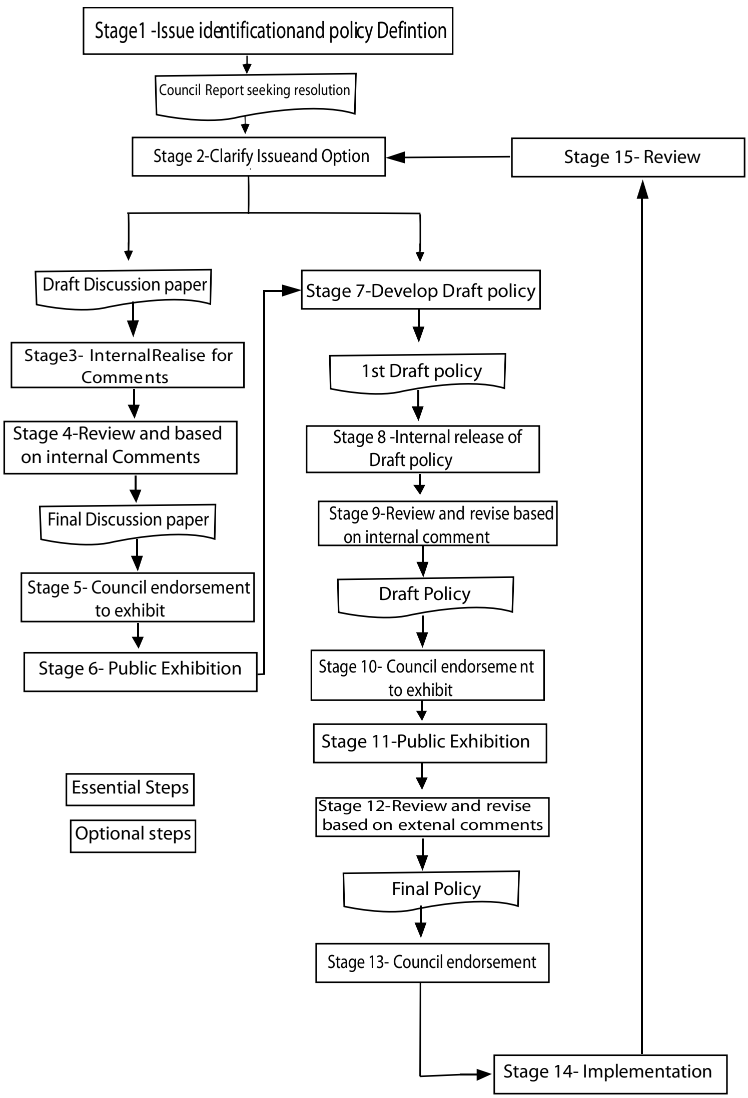

Figure 8.5: The Policy Development Stages

Source: Ranganathan et al., 2008.

Policy Cycle is a tool used for analyzing the development of a policy item in a stages-approach. The stages of a policy cycle mainly consist of agenda setting (problem identification), decision-making, policy analysis and evaluation, policy formulation, and policy implementation (see Fischer *et al.*, (2006) and Torjman, 2005, Source: Court *et al.*, 2004). Policy cycles are typically characterized as adopting a classical approach. Cyclical models are, however, criticized as unresponsive and unrealistic as opposed to systematic and more complex models. Any policy development process comprise of several steps. These steps are iterative and can be more complex as illustrated in figure 8.5 above.

1. Selecting the Objective and Setting the Agenda

At its core, policy development involves the selection and estimation of desired objectives. Three key factors act as an aid to assess decisions in developing public policy. One is the *potential effectiveness* – how well the policy will meet the stated goals. The second is *efficiency* – how well resources are likely to be utilized in achieving goals and in implementing the policy. The third is *consistency* – which refers to the extent to which the alignment of decisions with the broader objectives, goals and strategies of government and society is achieved.

The first step in policy formulation is determining the desired objectives. Public policy is shaped by and must be consistent with those values. Within this context, the selection of the objectives typically derives from the priorities that depict societal values. They are often set at a political level. A policy direction can be given from a presidential speech at the opening of a new parliament session or finance minister's budget or speech. It may also be a departmental pronouncement on government intention on environmental or natural resource protection. As we have already mentioned, policy may derive as well from obligations such as international conventions, agreements or protocols, like nations' agreement to the UN Convention to Combat Desertification (UNCCD), or the Convention on Biodiversity, or the Convention on Climate Change, in which each country's policies are formulated according to or are aligned with the agreement (Munasinghe, 1993). Through their signatures, nations commit themselves to bring policies, legislation and practice in line with these agreements.

It is often difficult to formulate policy objectives, even with clear political intentions, without considering the citizens. It is therefore important to engage citizens especially in policies that directly affect them. While governments are responsible for the formulation of policy, we must recognize the need to involve potential stakeholders in discussing the potential options to ensure their voices are heard in policy formulation. Policy dialogue thus provides members of a community with the opportunity to be involved. They are afforded the chance to talk directly to government officials on issues of concern and how the government should best be involved in addressing those issues.

2. Identifying Appropriate Pathways or Policy Formulation

A policy may target or be intended for an entire population, specific households, groups with certain concerns, or a specific region of a country. The selected target is then linked to the overall objective. The overall objective may embody in itself a direct or indirect statement of who will or should be affected by the policy action or measure. This task should be tied to the next phase or step of setting up the possible route or pathway to reach the objective. The identification of the selected target derives from the selected pathway. In some cases, the target group may be already identified because of a legislative or political commitment, e.g. provision of free primary education, in turn enhancing or improving the education of the youth and assisting parents to increase their disposable income by taking away their obligation to pay fees, and to engage in other economic activities. One useful tool to identify appropriate pathways for policy formulation is scenario building/modelling (Box 8.2).

Box 8.2: Exploring the Future Using Scenarios

"Thinking about the future requires thinking in alternatives"

Scenarios are indispensable strategic planning tools for NRM policy formulation that focuses on long-term interactions between development and environment. A scenario can be defined as a consistent and plausible picture of a possible future reality that informs the main issues of a policy debate. Scenarios are creative stories about the future, "plausible futures, each an example of what might happen under particular assumptions" (Millennium Ecosystem Assessment (MA, 2005). Scenarios methods are being applied in a wide variety of purposes in NRM at the local, national, regional and global levels with notable examples such as the Africa Environment Outlook, AEO-2 (UNEP, 2006), Fourth Global Environment Outlook, GEO-4 (UNEP, 2007), Millennium Ecosystems Assessment (MA, 2005) and the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2007). Figure 8.6 shows some tools for addressing uncertainity and complexity scenerios which can incorporate explorations and projections, and are especially suitable for addressing the high uncertainity and complexity typical of socio-ecological systems.

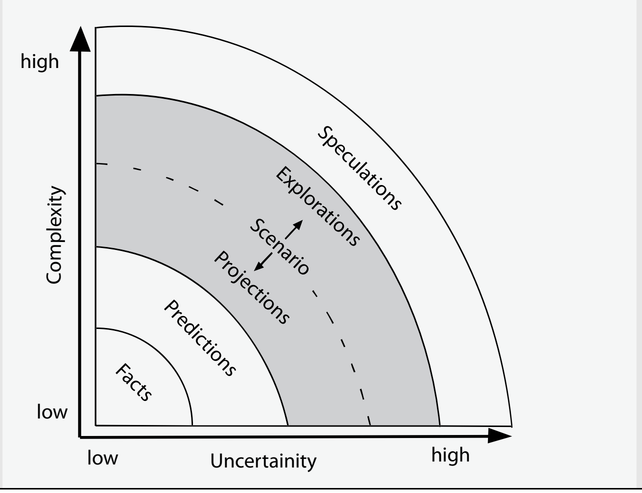

Figure 8.6: Tools for addressing future uncertainty and complexity scenarios.

Source: Ranganathan et al., (2008).

3. Determining the Pathway or Decision Making

This refers to finding the best means by which to reach the objectives by selecting from a range of options. This process is relatively easy where options are limited. It may, however, prove difficult where a policy objective can be achieved through many possible pathways; since it is often difficult to agree on a specific pathway. An example is poverty reduction alongside restoration of degraded environments or reducing the degradation of the environment. A lot of debate has been raging on how to reduce or eradicate poverty without damaging the environment or further degrading natural resources. In fact, it is now strongly believed that poverty is a cause and a consequence of environmental degradation; in other words, there exists a feedback relationship between poverty and the environment (Ekbom and Bojo, 1999, Reardon and Vosti 1995). The specific results of the associated measures will vary depending on the route/pathway selected to achieve the objective. One, two or several pathways might be selected but each is used at different stages. Pathways are equivalent to instruments of policy.

4. Designing the Intervention for Policy Implementation

Formulating policy typically requires considerable design work after identifying the objectives, targets and pathways. For example, in tackling poverty through payment for ecosystem services, we are faced with several questions related to the appropriate design, including policy targets, cost and finances, political factors, and even environmental considerations. Policy targets already identified must at this point be explored in more detail, going beyond the general description of generic nature. At the design stage, a decision must be made to determine precisely for whom these measures are intended and how many individuals and households this selection of targets would affect. In short, policy decisions always consider trade-offs and who might lose or who might gain some advantage, right or resource. So we look at regions or single groups of certain households with certain characteristics and balance these with the interest of other groups or regions.

5. Implementing the Policy

Policies are formulated so that they can be implemented and their impacts assessed. Clear implementation plans are crucial to the effectiveness, efficiency and consistency of policy. Thus, a policy may be excellent but difficult to implement due to inadequate resource allocation, or because some of its aspects are inconsistent with the objectives and measures that are being proposed by the rest of the policies. The question of cost is a key element in the policy process. The design of any policy initiative must be costed to establish how much is required to support the proposed plans. An amount of money deemed excessive or prohibitive in, for example, improving a difficult physical environment, may mean abandoning the plans. One solution would be to stagger the cost over time. The allocation of resources is also often influenced by the politics of the day. Some governments may place emphasis on natural resource and environmental management while others may not.

6. Monitoring, Evaluating and Assessing Impact

Ideally, all policies and programmes must be assessed and corrected as implementation continues, i.e., on an ongoing basis. There is need for continuous feedback, in other words, a clear M&E system must be stipulated in policy. This offers an opportunity for learning as the policy is being implemented—to determine whether what was proposed is workable and to closely monitor the implementation, with a view to improving on the policy. The issue of environmental effects by any policy is increasingly being given attention. There is hardly any country in the world these days without a policy on assessing the impact of any major plans, including the use of natural resources, leading to the preparation of an Environmental Impact Assessment (EIA) report (Munasinghe, 1993).

Tools for Policy Analysis in NRM

Policy analysis is the process through which we identify and evaluate alternative policies or programmes that are intended to solve certain problems that affect us. It is a means of determining which of the various or alternative policies will achieve a given set of goals most effectively. There are six generally agreed or expected steps as illustrated in Figure 8.7. The framework also provides some useful tools for each of the six steps. An in-depth discussion of these steps is provided by Ellis (1992), Fischer *et al., (*2006) and Torjman (2005).

Mapping the Policy Context and Assembly of Information

The specification of objectives for a country's NRM policy should be based upon adequate knowledge of the situation of natural resources. A weakness often encountered in NRM policy formulation is the lack of required information to make rational choices on objectives. The more information available, the better the decisions on the objectives. In many cases, objectives have been copied from other policies or simply consist of conventionally accepted generalities or stereotypes. The objectives of a policy suitable to a given country should be based upon specific information on natural resources backed by a breadth of general information.

The starting point for policy formulation is the analysis of existing NRM policies. Even in countries with a long NRM history, NRM policy is not always succinctly defined but has to be deduced from a host of legislative and administrative measures taken individually and over a period of years or even centuries. In countries without a tradition of natural resource stewardship, there may be no NRM policy as such, but there are bound to be laws and customs affecting the use of land and the exploitation of NRM products and services, which must not be ignored.

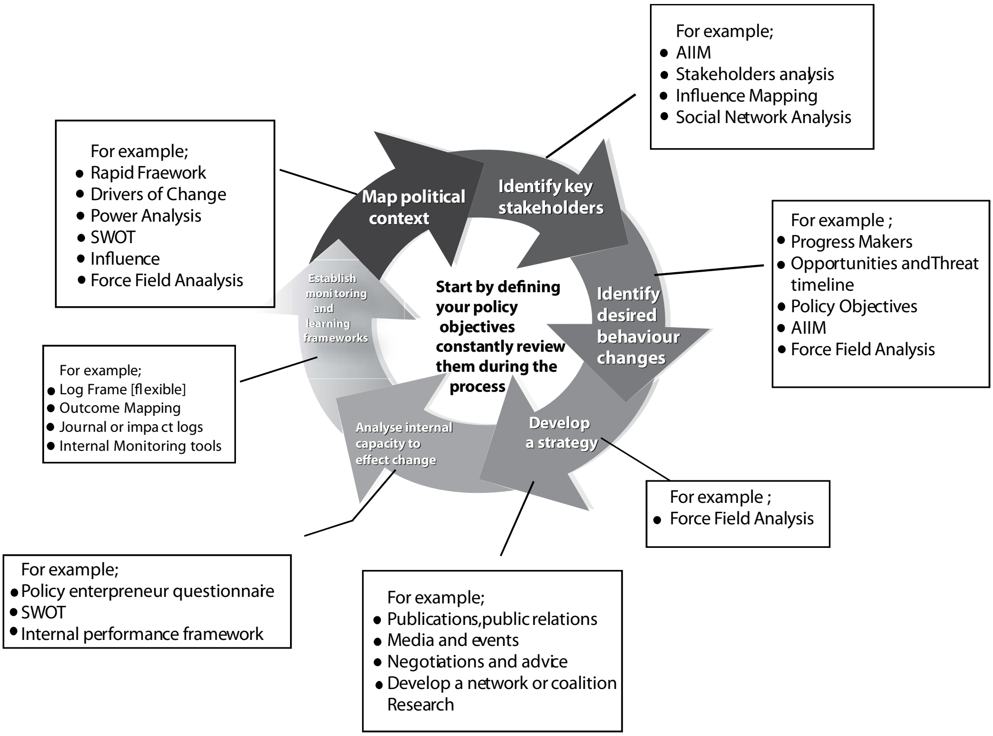

Figure 8.7: The RAPID Framework for Policy Analysis

Source: http://www.odi.org.uk/events/2006/12/07/413-workshop-handout.pdf accessed 18 October 2010

The political ecology framework discussed in Chapter 4, the ecosystem approach and the INRM concepts as well as aspects of gender analysis and climate change discussed in earlier chapters provide very useful frameworks for mapping the NRM policy context. Of paramount importance is a good knowledge of the natural resources of the country or community. This information should consist of estimates of NRM types, land area, location, composition, quantity, quality, growth and rain. This should also include data on utilisation and consumption of NRM products and services by different categories of stakeholders for different uses. The socio-economic information about rural populations, patterns of rural land distribution, and data on factors which influence land productivity, like climate, topography, soils and demographic information (present population and its geographic distribution, labour force, trends or expected changes in population and labour force, and per capita income), should also be collected and analyzed to inform policy. Some useful tools to help in this analysis include Geographic Information System (GIS) of land use systems, participatory tools, drivers and trends analysis, baseline data, demographic and household tools, etc.

Analysis of Options and the Process of Consultation (Stakeholder Analysis)

Before options can be analyzed and advantages and disadvantages of each considered, the options must be clearly identified. The analysis of options should take into account not only the relevant facts concerning the forests, laws, and customs, but also the views of all interested parties because government decisions on NRM policy are almost bound to affect many interests not all directly concerned with natural resources.

The effectiveness of consultation with non-governmental interests depends essentially on two factors: first, there must be organizations representing these various interests; second, there must be provision for bringing the leading representatives of these organizations together for joint discussions with government. Some countries have established some frameworks and mechanisms for stakeholder consultations. It is always possible to ascertain the views of a wide range of stakeholders if policies are to be realistic and acceptable.

In some cases, governments may decide to leave policy making to the experts or advisory boards (CoE) to provide advice to inform government decisions made without consulting the public or their elected representatives. Such policies often fail when success requires behaviour change throughout society. Effective interventions for problems of climate change require changes in the beliefs and behaviours of a large majority of the population, supported by complementary changes in education, incentives, and institutions. Decisions once taken by experts are now seen to affect multiple stakeholders, the public at large, and future generations. People are often suspicious of experts and their evidence, believing - often with just cause—that those with power and authority routinely manipulate the policy process for ideological, political, or pecuniary purposes. When citizens are unable to assess the reliability of evidence about complex issues on their own, and are frequently excluded from the policy process, their non-compliance and active resistance grow.

Definition of Objectives (Desired Behavioural Changes)

As already mentioned, a broad definition of objectives is essential before even the facts of the situation. A common mistake is to list a series of objectives without any consideration of priorities, of mutual compatibility or of the resources that are needed for their implementation. The purpose of a society in establishing policies about what its members do is to try and assure that their actions will contribute as much as possible toward some ends which society deems desirable. A policy is thus a means to some end or ends, and its effectiveness can only be judged in terms of those ends. However, many of the ends toward which policies are aimed, are desirable only because they in turn become means toward the achievements of other ends.

Table 8.1: Design Criteria for Selecting Policies

Criteria	Factors to consider
Political viability	Does the decision maker have the political capital to undertake a major initiative? Does the public understand the issue and support action to address it? What is the range of interests that would be affected?
Legal authority	Is the legal framework for adopting and carrying out the policy in place? If so, does the decision maker have authority or would it be necessary to build a partnership with another government body that has authority?
Economic viability	Is the policy cost-effective for society as a whole? For those who must change their behaviour?
Effectiveness	Does the policy force action that is capable of modifying the direct and indirect drivers of ecosystem change? Is it possible to set an incentive such as a tax credit at the appropriate level to change behaviour? Can the results of the policy be measured and used for accountability and to change course as appropriate?
Equity	Is the outcome fair to all stakeholders? If there are "losers" under the policy, how will they be compensated?
Institutional capacity	Is adequate capacity and funding in government and other participating groups available to implement the policy? If the policy requires working across scales and/or sectors, is there a mechanism to do so, or can one be created?

Source: Ranganhatan et al., 2008.

Objective Structuring (Strategy Development)

Objective structuring is a systematic and logical procedure for analyzing or deciding on the more specific objectives of a NRM policy. An objective structure defines and relates the objectives of a policy, carrying their definitions to specificity necessary for purposes of legislative and action programmes. To be operationally useful, objective definition must conform to the Specific, Measurable, Accurate, Realistic and Time-scaled (SMART) criteria. Formulation of objectives should include setting targets whose accomplishment can be checked or tested against established standards. Targets are essential since they constitute the guidelines to deciding on legislation, organizational structure and action programmes, and subsequently provide measures to determine their effectiveness.

Table 8.2: Examples of Selected Policy Options and Tools in NRM

Policy options and tools	**Potential value for sustaining Ecosystem services**	**Challenges in design and implementation**
National and sub-national policies		
Mainstream ecosystem services into economic and development planning	Addresses indirect drivers over the longer term by including ecosystem services in poverty reduction strategies, national economic and development plans, or country assistance strategies	Overcoming separate agency mandates, integrating different skills and perspectives, aligning with other policies such as financial and economic incentives
Include investments in ecosystem services in government budgeting	Makes the crucial link between policies focused on ecosystem services and providing funds to carry them out	Improving ability to value and integrate ecosystem services in cost-benefit analysis and identifying specific investments to sustain them
Establish protected areas	Helps protect ecosystems and their associated services from drivers of over exploitation and conversion	Incorporating goal of sustaining ecosystem services into site selection, linking biodiversity conservation and sustaining ecosystem service goals including local communities, taking a landscape approach that recognizes drivers of change outside the protected area, and ensuring financial sustainability
Economic and fiscal incentives		
Use tax deductions and credits to encourage investment in and purchase of ecosystem services	Provides economic incentive to manage ecosystems in ways that sustain services	Avoiding equity problems or protecting one service at the expense of others
Establish fees for use of resources or services	Reduces waste of resource	Avoiding equity issues, where those with lower incomes are less able to pay and balancing number of users
Use taxes or other public funds to pay for the maintenance of regulating and cultural services	Creates economic incentive to supply services that do not normally have a market value depending still on emerging market infrastructure such as quantification, verification, and monitoring tools. Informing public about use of funds to provide	Maintaining one service at the expense of others, avoiding creating equity issues such as loss of harvest rights or ineligibility because of lack of tenure

	accountability	
Fund valuation of ecosystem services and research into improving valuation methods	Increases societal awareness of the value of ecosystem services and strengthens cost benefit analysis for public decisions	Dealing with techniques for valuing ecosystem services that are still in their infancy discrediting ecosystem service approach by overestimating values
Set limits and establish trading systems for use of ecosystems and their services	Achieves more cost-effective improvements in ecosystem services than conventional regulatory approaches	Ensuring limit is stringent enough to provide an incentive to participate Allocating permits or credits in cases of unclear property rights keeping transaction costs manageable, especially for non-point sources
Sector policies		
Include ecosystem services in sector policies and strategic environmental assessments	Goes beyond addressing impacts of economic development to look at dependence on services Broadens scale of analysis	Dealing with limited experience of public sector using Ecosystem Services Approach in decision processes and limited information on ecosystem services
Set targets to encourage use of renewable energy	Provides incentive to replace fossil fuels with renewable sources	Using land to produce renewable energy sources such as biofuels can lead to soil erosion and degradation of ecosystem services such as water quality
Require Ecosystem Management Best Practices in granting licenses or concessions	Creates incentives for managing ecosystems in ways that sustain ecosystem services	Defining and enforcing best practice standards
Use zoning or easements to keep land available for priority ecosystem services	Provides way to maintain priority ecosystem services.	Needing legal framework in place and fair political process to apply zoning
Establish certification schemes that encourage best management practices	Provides those growing or harvesting timber, fish, or crops a way to learn about best management practices and to demonstrate use of the practices	Ensuring development of transparent, scientifically valid standards and their adoption Paying transaction costs that may limit participation informing consumers
Introduce education or extension programmes on good practices	Provides knowledge to those maintaining ecosystem services	Providing economic incentives for participation
Governance and Institutions		
Clarify or strengthen local	Ensures involvement of stakeholders who may	Identifying who represents the community, clarifying the

community rights to use and manage ecosystem services	depend on ecosystem services for their immediate livelihood and well-being	role of traditional authorities, ensuring that women and the poor are included
Develop and use private and public sector indicators for ecosystem services	Provides information about the state of ecosystem services and show where practices need to be changed	Obtaining funding to develop ecosystem indicators and continued funding to disseminate and use data on regular basis
Establish processes to work across levels of government, from local to national	Shifts focus to boundaries of ecosystem services rather than boundaries of government jurisdictions, uses complementary authorities, skills, and resources of different levels of government	Requiring transaction costs and time for building partnerships
Ensure public access to information and participation	Allows the public to hold public and private actors accountable for their actions in relation to ecosystem services	Requiring investment in building the capacity of individuals, civil society, and government to produce, analyze, disseminate, and use information and to engage effectively in decision making.

Source: Adapted from Ranganathan et al., 2008.

In the objective structure, a *goal* is the overall or long-range objective of a policy. A goal will not usually be totally achievable by any single effort but may require the combination of many (legislation and action programmes) over extended periods of time. This category of objectives may also be called long-range or development objectives. These objectives can be broken into a series of *immediate objectives,* each of which will fit within and contribute to achieving the stipulated goal. Chapter 7 (NRM project management and evaluation) provides more insights on the logic model and hierarchy of objectives.

Tools for Policy Implementation

Policy implementation requires a mix of policy tools—mandatory and voluntary, juridical, financial and market based, and internal and external to the NRM sector (Table 8.2). The tools are applied having in mind, at least, their interrelationships, and, whenever possible, the overall concept of the policy tools mix, that is the optimum combination of the various tools (Adamowicz and Veeman, 1998).

The purpose of comparative evaluation alternative policies is to determine which policy should be adopted by applying each of the decision criteria (efficiency, cost political acceptability, equity, environmental wellbeing) to each alternative including the no-action alternative. These criteria are the measurable dimensions of the objectives, and are used to compare how close different proposed policy alternatives will come to meeting the goals of solving the problem. Examples of criteria are:

- *Effectiveness*: how much of an improvement will this alternative produce?
- *Cost*: how much will it cost using this alternative?
- *Technical*: is the equipment and know-how available to use the alternatives
- *Political*: is this alternative politically acceptable?
- *Administrative*: is it administratively operable?
- *Environmental*: what impact (negative or positive) will the alternative policy have on the environment (natural resources)?
- *Social*: What are the policy's impacts on the social systems within which it operates (impacts on different categories of people, gender impacts; impacts on community relations, empowerment and participation processes, etc.)

A number of evaluation designs are available for adoption. The designs are an application of accepted *social science research methods* to public programmes. They are principles to guide the planning and execution of policy evaluation. They include the following:

- *Before-and-After evaluation:* Policy is evaluated for the changes it has produced since its implementation, all other factors being constant
- *With-and-Without evaluation:* Policy is evaluated for producing changes in the target population, compared to another population without the policy

- *After-Only evaluation:* The extent to which the policy goals were achieved, compared to the situation before the policy was implemented
- *Time-Series evaluation:* Changes produced by the policy are tracked over a long time period

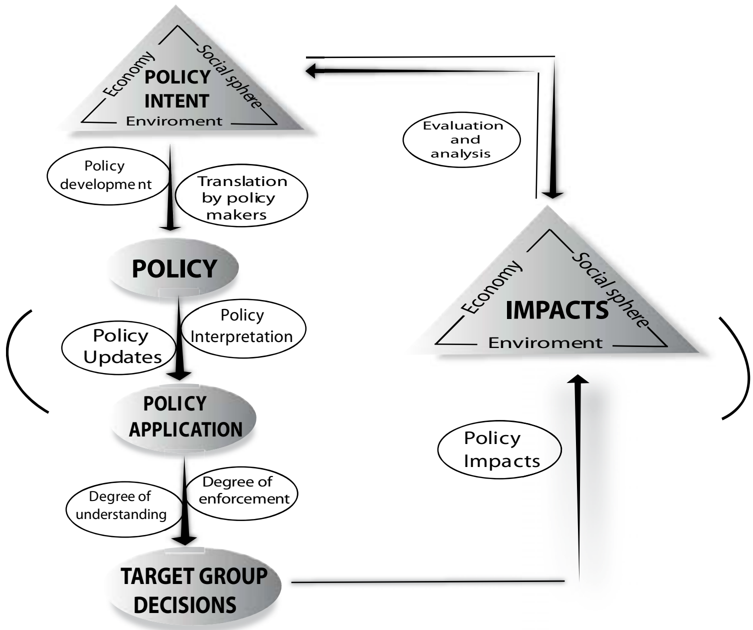

Figure 8.8: Framework for Assessing the Impacts of NRM Policy

Source: *Nkambwe and Chenje, 2006*

The Figure 8.8 shows that the expected outcomes, expectations and objectives of the policy should guide the evaluation process by comparing actual performance with what was expected. The evaluation should also focus on changes and challenges in the implementation process and the reasons why the original expectations were not met. Policy performance evaluation could also be used to retrace what should have been expected with the original inputs and level of effort.

Chapter 7 presents *other approaches* for monitoring and evaluation and impact assessment of NRM projects. Many of these approaches are relevant for evaluating the impacts of policies and can therefore be contextualized to focus on the policy outcomes.

Environmental Impact Assessment

Environmental Impact assessment (EIA) concerns a policy's impacts on natural systems, including ecosystems, land, air and water. It also includes the environmental impacts of products and services; energy, material and water use; greenhouse gas and other emissions; effluents and waste generation; impacts on biodiversity; use of hazardous materials; recycling, pollution, waste reduction and other environmental programmes; environmental expenditures; and fines and penalties for non-compliance. Opio-Odongo and Woodsworth (2006), provides some guidelines on policy analysis for integrated environmental assessment and reporting. EIA ensures that environmental aspects are addressed and potential problems are foreseen at the appropriate stage of the implementation of policy alternatives. EIA is a tool used to determine the social, economic and environmental impacts of major developments in order to determine the necessary mitigation measures. The general aim of EIA is to ensure that NRM policies are sustainable and do not detrimentally affect the natural environment and communities' lives (SAIEA, 2005 cited in Nkambwe and Chenje, 2006). The specific aims of the assessment are to:

i) Understand the consequences or impacts of the proposed development on the environment;
ii) Identify ways in which the development can be improved, and ways to minimize negative impacts and enhance its benefits; and
iii) Provide this information to decision-makers.

Economic Models for Impact Assessment

EIA concerns a policy's impacts, both direct and indirect, on the economic resources of its stakeholders and on economic systems at the local, national, and global levels. From an Environmental Evaluation point of view, it is increasingly being recommended that in the implementation of policy objectives, particularly those involving large public investments, an EIA should be carried out and linked with the Cost-Benefit Analysis (CBA). EIA is also used to determine the long term costs and benefits of a proposed policy alternative, and then the Net-Present-Value (NPV), Cost-Benefit-Ration (CBR) or Internal-Rate-of-Return (IRR) is calculated, using an appropriate discount rate. Risk analysis to minimize any possible losses, rather than pursue the riskier maximum possible gains, is an important aspect considered as well. Good examples on wildlife policy, impact and risk analysis are given by Bojo (1996), Munasinghe (1993), Ndirima *et al., (*2003) and Nyariki *et al., (*2007). Additionally, an implementation analysis is carried out to determine the factors that will make the policy alternative easier to implement.

One important framework for EIA is *Partial Equilibrium Analysis (PEA)*. The analysis of policy impacts or effects is ordinarily an economic tool used to compare the costs and benefits of implementing a policy. The analysis is done through what is referred to as PEA. It means that the effects of policy actions are examined only in the markets which are directly affected. Supply and Demand Curves are used to depict the price effects of policies, assuming the existence of a (perfect) market (Colman and Young, 1989). Producer and consumer surplus are used to measure the welfare effects on participants in the market. (For more on how Policy Impact Analysis (PIA) is done through PEA, see Colman and Young (1989), Ellis (1992) and Fischer *et al., (*2006).)

Social Impact Assessment

Political analysis is carried out on the basis of political acceptability. This helps to identify the important elements to be considered for each proposed policy, for example, which actors will favour or oppose it, and why (based on their beliefs and motivations). What reasons do they have and how effective will they be in supporting or opposing the policy? An interesting approach for Social Impact Assessment is Outcomes Mapping (for details see Earl *et al*., 2006). Outcome mapping is especially useful for policies and projects where success depends on behavioural or social change. Outcome mapping can complement other NRM evaluation methods that focus on the biophysical and more tangible NRM parameters such as soil fertility, water quality, or erosion. Changes in the state of resources and well-being of intended beneficiaries may not take the form anticipated; and they may be influenced by the actions of stakeholders who remain beyond the reach of the programme. Policies interact with each other and the causes of change usually cannot be isolated. It is therefore difficult to attribute change to specific policies or policy components and to compare results across different sites or communities. Outcome mapping links implementation to outcomes, so it is well suited to the complex and long-term nature of NRM policies and programmes, where different outcomes are not easily or usefully separated. Outcomes Mapping (OM) allows the programme to measure results within its sphere of influence, to obtain useful feedback that can help improve performance and to take credit for its contribution to outcomes rather than for the outcomes themselves.

Another tool is the After-Action Review (AAR) to help policy-makers, communities and other stakeholders reflect, analyse and learn by talking, thinking, sharing and capturing the lessons learned about the formulation and implementation of policies before they are forgotten. AAR is usually facilitated using the following six questions: (i) What was supposed to happen? Why? (ii) What actually happened? Why? (iii) What is the difference? Why? (iv) What went well? Why? (v) What could have gone better? Why? (vi) What lessons can we learn? Sanginga *et al., (*2010) used the AAR to track and document the impacts of local NRM policies in Uganda to find answers to questions such as: What happens after policy and project intervention? Does the policy translate into better management of natural resources? Who benefits and who loses, and in what ways? What are the conditions for sustainability of NRM policies and programmes?

Policy Failures and Policy Resistance: Intended and Unintended Effects of Policy

Policies to promote sustainable management of natural resources often fail or worsen the problems they are intended to solve. At times, NRM policies do not only fail to solve the persistent problems, but are in fact causing them. When policies fail to have the intended effect, it is usually due to a number of factors that can be grouped into two: (i) theory failure and (ii) implementation failure:

i). *Theory failure:* Theory failure suggests that the policy was implemented as intended but failed to have the desired effect. It is observed that policy often fail in NRM because actors and ecosystems are:

- *Constantly changing.* Heraclitus said, "All is change." Change occurs at many time scales, and these different scales sometimes interact;
- *Tightly coupled.* The actors in a system interact strongly with one another and with the natural world. Everything is connected to everything else. "You can't do just one thing.";
- *Governed by feedback.* Because of the tight couplings among actors, our actions feed back on themselves. Our decisions alter the state of the world, causing changes in nature and triggering others to act, thus giving rise to a new situation, which then influences our next decisions;
- *Nonlinear.* Effect is rarely proportional to cause, and what happens locally in a system (near the current operating point) often does not apply in distant regions (other states of the system);
- *History-dependent.* Many actions are irreversible: you can't unscramble an egg (the second law of thermodynamics). Stocks and flows (accumulations) and long time delays often mean doing and undoing have fundamentally different time constants;
- *Self-organizing.* The dynamics of systems arise spontaneously from their internal structure. Often, small, random perturbations are amplified and moulded by the feedback structure, generating patterns in space and time;
- *Adaptive and evolving.* The capabilities and behaviours of the agents in complex systems change over time. Evolution leads to selection and proliferation of some agents while others become extinct. People adapt in response to experience, learning new ways to achieve their goals in the face of obstacles;
- *Characterized by trade-offs.* Time delays in feedback channels mean the long-run response of a system to an intervention is often different from its short-run response. Low-leverage policies often generate transitory improvement before the problem grows worse, whereas high-leverage policies often cause worse-before-better behaviour;
- *Counterintuitive.* In complex systems, cause and effect are distant in time and space, whereas we tend to look for causes near the events we seek to explain. Our attention is drawn to the symptoms of difficulty rather than the underlying cause. High-leverage policies are often not obvious;
- *Policy resistant.* The complexity of the systems in which we are embedded overwhelms our ability to understand them. The result: many seemingly obvious solutions to problems fail or actually worsen the situation;
- *Dynamic complexity*: the often counterintuitive behaviour of complex systems that arises from the interactions of the agents over time.

ii) *Implementation failure:* Implementation failure implies that the policy was not implemented as planned. Imperfect implementation can hinder learning as well, because the managers evaluating the outcomes of their decisions may not know the ways in which those decisions were distorted, delayed, or derailed altogether by other actors in the system. Implementation failure often results from:

- *Time delays:* Time delays in implementation processes are common and particularly troublesome. More problematic, the short- and long-run impacts of our policies are often different (using fertilizers give short term gains in productivity, but may cause water pollution over time). Delays also create instability and fluctuations that confound our ability to implement policies and see their impacts;
- *Policy resistance:* the tendency for interventions to be defeated by the system's response to the intervention itself. Policy resistance arises when we do not understand the full range of feedbacks surrounding - and created by - our decisions. Ignoring the feedbacks in which we are embedded leads to policy resistance as we persistently react to the symptoms of difficulty, intervening at low leverage points and triggering delayed and distant effects;
- *Defensive routines:* Defensive routines often yield Groupthink, as members of a group mutually reinforce their current beliefs, suppress dissent, and seal themselves off from those with different views or possible disconfirming evidence. Even if a team were united in recommending the proper course of action, the implementation of their decisions is often distorted by asymmetric information, private agendas, and game playing by agents throughout a system. We use defensive routines to save face, make untested inferences seem like facts, and advocate our positions while appearing to be neutral.

Governance and Community Institutions for Natural Resources Management

Previous sections have dealt with public policy. Ostrom (1992), cautions against single governmental units to solve the collective action problem of coordinating work against degradation of natural resources because of the complexity and the diversity of actors involved. Ostrom proposes a polycentric approach, where key management decisions should be made as close as possible to the scene of events and the actors involved. A critical component of NRM policy formulation and implementation is therefore strengthening the institutions of governance that translate policy into action at different levels, particularly at the local level where management actions take place.

One big area of NRM policy concerns decentralized governance and devolution of NRM responsibilities to lower levels of governments. Most governments in the region have devolved some levels of authority over some natural resources to some local authorities. NRM practitioners are advocating for the devolution of greater authority or control over these resources to local communities. Effective environmental management driven by local initiatives and participation should provide the key to reducing rural poverty, as well as conserving the natural resource base (Murphree, 2004).

There has been a growing backlash against top-down approaches to environmental management throughout the world because of the tendency to prioritise and solely appreciate professional and scientific 'expert' knowledge (Cook and Kothari, 2001). This lends the approach a potentially exclusive and paternalistic nature, which can be alienating to local people and their internal resource management schemes. As such, there has been a growing acceptance of bottom-up approaches that both characteristically appreciate and incorporate local people and their local knowledge, skills, needs and experiences.

Characteristics of NRM Governance

As defined under "Elements of Public Policy" governance has some attributes that are frequently considered to be part of "good" governance: participation, representation, deliberation, accountability, empowerment, social justice, and organizational features such as being multilayered and polycentric (Table 8.3).

Table 8.3: Characteristics of Good Governance and their Meaning

Characteristics of Good Governance	**Definition**	**Interpretation**
Participation	"All men and women should have a voice in decision-making, either directly or through legitimate intermediate institutions that represent their interests. Such broad participation is built on freedom of association and speech, as well as capacities to participate constructively"	The act of involving people, regardless of gender, to voice their interests in the decision-making processes. This involvement can be direct or indirect, e.g. the public participating through institutions that articulate their interests
Transparency	"Transparency is built on the free flow of information. Processes, institutions and information are directly accessible to those concerned with them, and enough information is provided to understand and monitor them"	The full release of information and providing stakeholders with free access to institutions, operations and information
Responsiveness	"Institutions and processes try to serve all stakeholders"	Institutions and operations answer the requests of stakeholders

Consensus Orientation	"Good governance mediates differing interests to reach a broad consensus on what is in the best interest of the group and, where possible, on policies and procedures"	Arbitration of the clash of interests in order to establish agreements based on the optimal interests of stakeholders
Equity	"All men and women have opportunities to improve or maintain their well-being"	The act of providing people, irrespective of gender or other factors of possible discrimination, with equal chances to foster the quality of their welfare
Effectiveness and Efficiency	"Processes and institutions produce results that meet needs while making the best use of resources"	Achievement of optimal use of resources while serving stakeholders
Accountability	"Decision-makers in government, the private sector and civil society organizations are accountable to the public, as well as to institutional stakeholders. This accountability differs depending on the organization and whether the decision is internal or external to an organization"	Managers and decision-makers are held liable to the community
Strategic Vision	"Leaders and the public have a broad and long-term perspective on good governance and human development, along with a sense of what is needed for such development. There is also an understanding of the historical, cultural and social complexities in which that perspective is grounded"	Managers and the public have a long-term view with regard to governance and are aware of contextual obstacles related to history, culture and society
Rule of Law	"Legal frameworks should be fair and enforced impartially, particularly the laws on human rights"	The act of justly and objectively putting laws in place

Source: GDRC, 2004

Public participation often broadens the range of interests and issues that need to be considered, because different stakeholders assign different values to different ecosystem services and risks. Deliberation is a process of open communication, discussion, and reflection among actors who have alternative political viewpoints and understandings. When it works well, deliberation makes it possible to learn about the views and motivations of others even when their positions remain fixed.

Governance includes all aspects of rules and regulations that determine what and how people use the resource base. There are many, but fundamental from onset is, the rights people have to accessing or controlling the resources—property rights. The information arising from this analysis will come into play in considering appropriate interventions for NRM and governance.

Participatory Governance in NRM

In recent years, there have been significant shifts in the paradigms of NRM from centralized top-down approaches to more decentralized, participatory and community based Natural Resources Management, adaptive or collaborative management approaches (Folke *et al.,* 2005, Barrow *et al.*, 2000, Agrawal and Ostrom, 2001). These are often promoted as a multi-stakeholder partnership between local communities and government structures. It is essentially based on the devolution of responsibilities, authority and rights for environmental governance from central government or higher units to local communities or lower government structures.

With recent decentralization efforts and the mainstreaming of participatory approaches in policy and development, considerable attention is now given to devolving decision-making to the lowest level, and to refining participatory techniques by creating more inclusive spaces for hearing the voices of all (Scoones and Thompson, 2003, Ribot, 2002). However, there is concern that despite decentralization policy, it is only limited to the extent that policy makers seek the participation of local stakeholders in designing and formulating NRM policies. Yet, it is recognized that rural communities and local stakeholders would be more likely to see policies as addressing their own needs and constraints and more likely to implement them, if they had participated in their formulation (Nkonya *et al.*, 2005).

Participatory Governance focuses on deepening democratic engagement through the participation of citizens in the processes of governance and policy-making with the state. The idea is that citizens should play a more direct role in public decision-making or at least engage more deeply with political issues. Government officials and the state should also be responsive to this kind of engagement. Recent decentralisation efforts in many African countries have shown promising improvement in the participation of local people and other stakeholders in the policy decision-making process. However to be effective, decentralisation must be based on effective and sustainable local institutions for engaging local communities directly in the articulation of their policy needs, and in the analysis, design and implementation of policies and innovations.

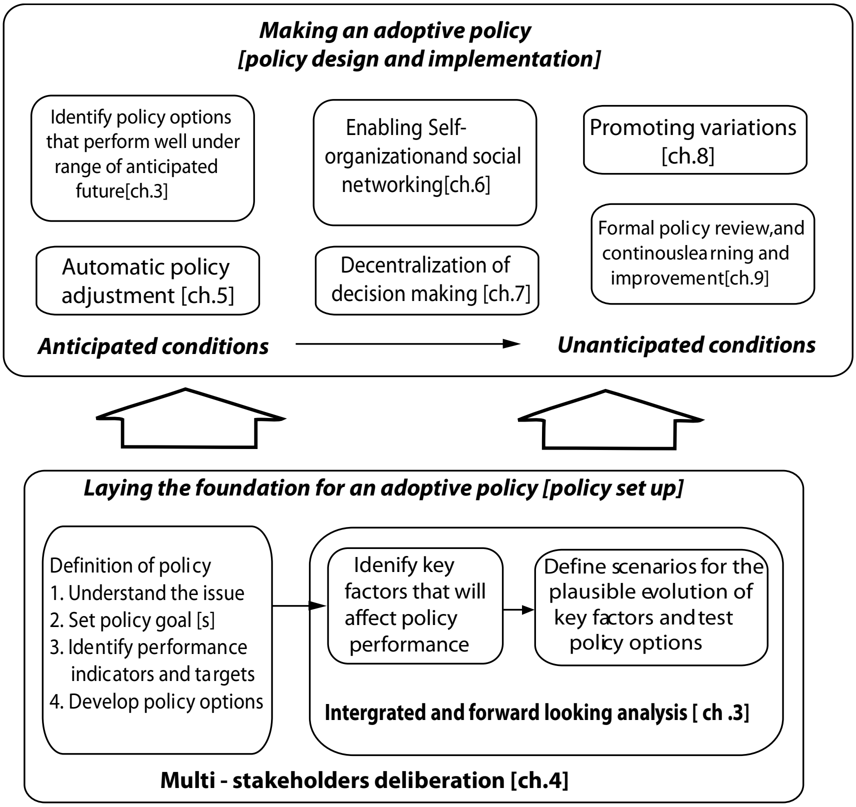

Figure 8.9: Framework for Participatory Policy Design and Implementation in NRM

Source: Adapted from Swanson and Bhadwal (2009)

This framework is similar to the policy cycle discussed earlier (Figure 8.5), but it introduces the importance of multi-stakeholder deliberations, decentralized decision-making and scenarios building as critical for participatory governance and policy making in NRM. Participatory or responsive governance is based on the following seven tools (see Swanson and Bhadwal, 2009):

i) *Integrated and forward-looking analysis:* By identifying key factors that affect policy performance and identifying scenarios for how these factors might evolve in the future, policies can be made robust to a range of anticipated conditions, and indicators developed to help trigger important policy adjustments when needed. This section is further developed in Chapter 6 that provides some insights on scenarios building;
ii) *Multi-stakeholder deliberation:* A collective and collaborative public effort to examine an issue from different points of view prior to taking a decision. Deliberative processes strengthen policy design by building recognition of common values, shared commitment and emerging issues, and by providing a comprehensive understanding of causal relationships;

iii) *Automatic policy adjustment:* Some of the inherent variability in socio-economic and ecological conditions can be anticipated, and monitoring of key indicators can help trigger important policy adjustments to keep the policy functioning well;

iv) *Enabling self-organization and social networking:* Ensuring that policies do not undermine existing social capital; creating forums that enable social networking; facilitating the sharing of good practices and removing barriers to self-organization all strengthen the ability of stakeholders to respond to unanticipated events in a variety of innovative ways;

v) *Decentralization of decision-making:* Decentralizing authority and responsibility for decision-making to the lowest effective and accountable unit of governance, whether existing or newly created, can increase the capacity of a policy to perform successfully when confronted with unforeseen events;

vi) *Promoting variation:* Given the complexity of most policy settings, implementing a variety of policies to address the same issue increases the likelihood of achieving desired outcomes. Diversity of responses also forms a common risk-management approach, facilitating the ability to perform efficiently in the face of unanticipated conditions;

vii) *Formal policy review and continuous learning:* Regular review, even when the policy is performing well, and the use of well-designed pilots throughout the life of the policy to test assumptions related to performance, can help address emerging issues and trigger important policy adjustments.

By-laws and Local Policies

Previous sections of this book indicate that NRM practices are shaped by a range of both national and international policies, but also by local institutions and governance mechanisms. In many African countries, most NRM policies were inherited from the colonial administration. These were repressive, centralized and typically top-down and failed to provide appropriate incentives for community-based NRM.

Recent decentralization efforts have led to increased attention to the role of local institutions and decentralized governance of natural resources. It is widely recognized that communities are more efficient than state structures in the management of natural resources (Agrawal and Gibson, 1999, Ostrom, 2000). It is argued that rural communities and local stakeholders would be more likely to see policies as addressing their own needs and constraints and more likely to implement them, if they had participated in their formulation (Nkonya, 2006). This however is mostly handicapped by lack of education, knowledge and skills at the local level. Therefore, a good NRM policy should aim to build communities that are empowered to formulate their own local policies and regulations, develop, adapt and mobilize collective action and local innovations that have helped them better manage their natural resources and even increase resource productivity (Fabricius *et* *al.,* 2007). The understanding of bylaws as local laws, defined and created at the local level, is becoming more important as many countries in Sub-Saharan Africa pursue the course of political decentralization and shift policy focus to the active role of local communities in managing their resources (Olowu, 2003; Campbell and Shackleton, 2001).

By-laws are at the core of many governance structures that frame the access, use, and conflict resolution around natural resources across Africa. The understanding of bylaws often varies by country and is affected by the policy and institutional context and legal frameworks in each country. In general, the term *by-law* has three distinct meanings: (i) a body of laws and customs of a village, town, or city – *by-law as local law*; (ii) a law or rule derived from a national law enacted at a local level – *by-law as secondary law;* and (iii) a law or rule governing the internal affairs of an organization, association, or business corporation – *by-law as an organizational rule (*Markelova and Swallow, 2009).

i) *By-law as local law:* by-laws are negotiated rules, social norms and agreed behaviours that exist within communities to prevent and manage conflicts (Sanginga *et al.,* 2010). They are local community regulations, norms and sanctions for managing natural resources in a way that place community interests above those of individuals and give individuals confidence to invest in community activities, knowing that others will do so too. These may be written or unwritten. For example, in Uganda the local councils created in the process of decentralization have the authority to enact locally created regulations (Sanginga *et al.,* 2007; Nkonya *et al.,* 2008). In Tanzania, Village Councils or Village Forest Committees have been given formal authority to craft and implement local bylaws by the Forest Act of 2002 for the withdrawal of resources from their forests. In cases such as these, local bylaws for NRM become especially important as they connect the decentralized bodies with their constituents at the local level.
ii) *By-laws as secondary laws:* In legal and policy terms, by-laws are seen as secondary laws or a body of local laws and customs of a village, town or city, or rules made by lower local government councils and provide the local guidelines to be followed in implementing sectoral policies in agriculture and NRM. For instance, in Kenya by-laws are understood as either enacted by local authorities acting on behalf of central government agencies as part of the implementation of specific legislation, or by legally-constituted entities that have responsibilities consistent with the national law. For example, the Forest Act of 2005 established the Kenyan Forest Service (KFS) with the mandate to oversee the management of all indigenous state forests. It oversees the drawing of all management plans, but in many instances does so in collaboration with local communities through joint management agreements. By-laws in this case essentially serve to deconcentrate the power of central ministries. This contrasts with the devolution of actual decision-making authority (Cook, 2001). In

Zimbabwe, it falls on the Rural District Councils to formulate the conservation and land use by-laws, either unilaterally or in consultation with local communities (Mandondo, 2001).

iii) *By-law as an organizational rule: B*y-laws as the rules that guide the functioning of organizations and are important determinants of the success of resource user groups. For example, Kenya's Water Law of 2002 requires water user groups to have constitutions and by-laws. Farmers' groups, cooperatives and registered self-help groups in Kenya are required to have constitutions and bylaws before they can be formally registered.

Box 8.3: Process of Formulating Formal By-Laws in Uganda

By-laws are formulated at lower levels of decentralization (LCI and LCIII) to guide the implementation of national policies. The formal process of formulating and enacting by-laws goes through the steps below:

- Any community can initiate the process of formulating a by-law or their councillor can draft a bill seeking to formulate a by-law;
- The draft bill is introduced to council by one councillor;
- The bill is then published and distributed to all councillors by the clerk to the council;
- The bill can then be debated and approved within 14 days after publication;
- If passed, the bill is forwarded to the relevant higher council for certification of consistency with the constitution, ordinance and other laws after which it is returned;
- The bill is then forwarded through the line Minister to Attorney General for certification of consistency with parliamentary laws and constitution after which it is returned;
- The certified bill is then signed by District Chairperson to become ordinance for district bill or by-law for lower council bills.
- The ordinance or by-law is then published in the gazette, in local media or any conspicuous place.

Source: Sanginga et al., 2010

The difference between various meanings of by-laws is in the source of rules and their formality. In the legal and policy sense, the rules come from central government authorities and are usually codified into formal law. In the sociological sense, the rules emerge either from the resource users themselves or from the lowest level of empowered local authority in decentralized governance structures. These can be formal and written (approved by government authorities or project organizers) or informal and not written. However, it is important to note that in some cases, this distinction can be blurred since the origins and functions of the regulations may stem from various sources of authority. For example, in Malawi, sectoral government departments support village committees who formulate their own by-laws, as in the case of Forestry Department and Village Natural Resource Management Committees (Campbell and Shackleton, 2001). In Uganda, though local-level authorities have the authority to draft their own by-laws for resource management (and even the fiscal powers to enact them), they have to be reviewed and approved by the district councils for consistency with the Constitution and national laws and ordinances (Onyach-Olaa, 2003; Sanginga *et al*., 2007).

Functions of By-laws

Based on a review of African experiences with by-laws, Markelova and Swallow (2009), summarized the following important functions of by-laws:

- *Conservation and sustainability of natural resources:* Several examples in literature show that locally drafted rules for resource use may significantly contribute to the sustainability of forest use, halt degradation of pastures and rangelands, and prevent the overuse of forests and watersheds (Agrawal and Ostrom, 2001 and Shiferaw *et al*., 2008). This function of by-laws is especially relevant in the context of decentralization as many African governments (Uganda, Zimbabwe, South Africa) are devolving conservation activities to the local level where these rules are created and implemented.
- *Equitable use of resources:* The literature on NRM has shown that both customary institutions and national policies guiding the use of resources may be “unfair” for some elements of the community. This is why, as illustrated by several experiences with the participatory by-laws creation, newly negotiated regulations have potential to ensure more equitable access, use, and benefit-sharing from natural resources.
- *Conflict management and resolution:* With the increasing population pressures, degradation of resource base, and inherent disharmony between formal (statutory) and traditional institutions, rules and regulations regarding the use and management of resources, especially the commonly-shared ones, can settle the existing disputes and prevent future conflicts around the rights to that particular resource (Ostrom, 1992). Such rules of use and management become critical for peaceful coexistence in the situation of multiple users and uses of a resource, especially when the property rights are not clearly defined or overlap between users and uses. The conflict management function of bylaws can also tie in with their role in promoting ecological sustainability and promoting positive economic change.
- *Linking local to central government:* This role of by-laws may stretch beyond interactions with government officials to finding common ground with private sector representatives through negotiations regarding resource use rules Such interactions are important not only in their direct impact on the success of by-laws, but also as a means of community empowerment, especially in the contexts where local communities have been disenfranchised by the government authorities and otherwise precluded from decision-making.

Linking NRM Research to Policy

It is important to remember that policy processes are complex, dynamic and messy. Policymaking is inherently a political process. There are so many factors that influence each stage of the policy cycle. A number of other players also affect policy. There are also a number of constraints that will limit the extent to which evidence can affect policy. There are clear challenges here, but the consensus among researchers, policymakers and practitioners is that more evidence-based approaches to policy and practice are a positive development.

There is an increasing emphasis that has been placed on the concept of linking research to policy. Better utilization of research and evidence in development policy and practice can help save lives, reduce poverty, and improve the quality of natural resources. A better understanding of how research can contribute to pro-poor policies in NRM is important for NRM researchers and practitioners. In particular we need to know more about:

- i). how policymakers can best use research, for evidence-based policymaking;
- ii). how researchers can best use their findings in order to influence policy;
- iii). how to improve the interaction between researchers and policymakers.

As shown in Figure 8.9, making NRM policies is complex, messy and the outcomes of any policy in NRM are often the results of intense negotiations, bargains, compromises and sometimes cross-purposes and double meanings of ordinary governmental decision-making (Carden, 2009). In such complex and dynamic contexts, it is clear that research and practice can only be one of the numerous influences in policy making. Table 8.4 below presents some useful guidelines for researchers to influence policies.

Carden (2009) further distinguishes the following five policy contexts to consider when linking research to policy: i) a clear government demand; (ii) Government interest in research, but leadership absent; (iii) government interest in research, but with a capacity shortfall; (iv) a new or emerging issue activates research, but leaves policymakers uninterested; and (v) Government treats research with disinterest, or hostility. He also proposes what researchers must take into account in order to influence policy-making and implementation in NRM.

Table 8.4: How to Influence Policy and Practice in NRM

What researchers need to know	What researchers need to do	How to do it
▪ Who are the policy makers? ▪ Is there policymaker demand for new ideas? ▪ What are the sources /strength of resistance ▪ What is the policy making process? ▪ What are the opportunities and timing for input into formal process	▪ Get to know the policymakers, their agendas and their constraints ▪ Identify potential supporters and opponents ▪ Keep an eye on the horizon and prepare for opportunities in regular policy processes. ▪ Look out for and react to unexpected policy windows	▪ Work with the policymakers ▪ Seek commissions ▪ Line up research programmes with high-profile policy events ▪ Reserve resources to be able to move quickly to respond to policy windows ▪ Allow sufficient time and resources
Evidence; ▪ What is the current theory? ▪ What are the prevailing narratives? ▪ How divergent is the new evidence? ▪ What sort of evidence will convince policy makers?	▪ Establish credibility over the long term. ▪ Provide practical solutions to problems ▪ Establish legitimacy ▪ Build convincing case and clear policy options ▪ Package new ideas in familiar theory or narratives ▪ Communicate effectively	▪ Build up programme of high-quality work ▪ Action-research and pilot project to demonstrate benefits of new approaches ▪ Use participatory approaches to help with legitimacy and implementation ▪ Clear strategy for communication from the start ▪ Face-to-Face communication
Links ▪ Who are the key stake holders? ▪ What links and networks exist between them? ▪ Who are the intermediaries and do they have influence? ▪ Whose side are they on?	▪ Get to know other stakeholders. ▪ Establish legitimacy ▪ Build coalition with like-minded stakeholders ▪ Build new policy networks	▪ Partnerships between researchers, policy makers and policy end-users ▪ Identify key networkers and salesmen ▪ Use formal contacts
External influences: ▪ Who are the main international actors in the policy process? ▪ What influence do they have?	▪ Get to know the donors, their priorities and constraints ▪ Identify potential supporters, key individuals and	▪ Develop extensive background on donor policies ▪ Orient communication to suit donor priorities and language

▪ What are their aid priorities and mechanisms? ▪ What are the policies of the donor funding research?	networks ▪ Establish credibility ▪ Keep an eye on the donor policy and look out for policy windows	▪ Co-operate with donor and seek commissions contact (regularly) key individuals

Source: Adapted from Carden, 2009.

Developing Policy Briefs

Increasingly, NRM researchers are required to develop a range of communication materials to reach different stakeholder groups. One such communication product is Policy Briefs. This section focuses on practical tips and tools for writing a *policy brief,* a document designed for an audience that has some control over how research evidence might ultimately be converted into policy. A policy brief presents programme or project findings and argument into brief, compelling and easily understood points. It does not tell the audience everything they need to know - just enough to ensure they'll *want* to know more. A good policy brief should make the evidence brief and understandable, explain why the evidence is significant, and set-out evidence-informed policy options. When planning a policy brief, consider describing the following:

- *The Development Challenge:* What is the problem to be solved;
- *The Idea:* What is the solution proposed;
- *The Research:* How is the solution going to be implemented;
- *On the Ground:* Which are the findings;
- *The Impact:* What this research has changed;
- *Future Challenges:* What needs further development.

There are now numerous resources to guide in developing communication products for different policy audience. These include IDRC's toolkits for researchers in Research That Matters series (http://www.idrc.ca/ev_en.php?D=93966_201&ID2 DO_TOPIC). We suggest a simple 1:2:3:25 formula, where:

1 = a one-pager Press Release of clear and concise *take-home messages* for skimming or time-pressed decision-makers. The shorter formats increase the chances of being read. They also build capacity among researchers to express themselves with brevity. This can be in the form of Press Releases – stories in simple language highlighting the *significance* of the research and the corresponding need for action. Like a newspaper article, they can involve direct, quoted interviews with researchers. These can also be used for other promotional purposes – a webpage, for instance.

2 a two pager Policy Brief that outlines in simple terms the problem, the potential remedies, and a discussion of how to bridge the two. *Policy briefs are an opportunity for advocacy.* They are ideal, short pieces that can outline why our particular recommendation is the best one to address the problem or situation at hand.

3 = a three-pager executive summary with more details and resources for interested decision-makers and practitioners. This is usually in the form of briefing Notes – a more indepth and scientific examination of the issue, typically for an audience that already understands the science. Like an extended abstract.

25 = a twenty-five-pager technical paper or synthesis for administrators or implementers. Placing take-home messages up front respects how decision-makers tend to read research reports – reading the abstract first and the conclusions second.

Learning Activities

Learning Activity 8.1: Policy Nesting

NRM policies are always interlinked, influencing each other either positively or negatively. In your groups, develop a diagram showing the web of influence of policies on each other. Use thick lines where you think the policies conflict or complement each other.

1. Take a real issue in your own experience where one environmental policy is central and is influenced by other policies (e.g. other environmental policies, population policy, immigration policy, agricultural policy, etc.). Put the environmental policy you would like to focus on in the centre (marked "policy") and fill the other circles with other policies that influence it (and each other).
2. Draw arrows to show the direction of influence of each policy on the policy at the centre or other policies in your diagram.
3. Let each member make his/her presentation to the group with clear explanations of the web of influence of the policies discussed.
4. The group will then select which of the diagrams to present to the rest of the participants.

Learning Activity 8.2

Some Nile basin countries have signed a new Agreement on the Nile River Basin Cooperative Framework. Analyse the challenges that led to the negotiations for this new agreement, the negotiation process, the problems and threats that this new agreement presents, and the policy and governance implications for water resources management in the Nile river basin countries.

Learning Activity 8.3

1. Select any policy relevant to rangeland or dryland (natural) resource management in a developing country that you are familiar with and identify:

- The major goals of the policy that address relevant aspects of natural resources management
- The main objectives of the policy
- The key policy aspects being addressed

- The main instruments of policy being applied to achieve the objectives
- If possible, the main rules for operating the instruments of the policy
- The critical shocks or threats likely to influence the success or failure of implementing the policy, and suggest ways to deal with these shocks

2. Using your country's Strategic Development Plan, the country's policy options for long term growth strategy (i.e. Kenya's Vision 2030), provide a short critique of the policy, with emphasis placed on the following issues:

- Is it important to have the policy (i.e., why Vision 2030)?
- What are the key policy areas that are being addressed?
- Are they well articulated and inclusive; for example, is the issue of natural resource management adequately covered?
- Focussing on the aspects of the policy that address issues associated with natural resources: Is your country capable of dealing with the internal and external shocks critical to the success of the Vision; and if not, what are the possible solutions?

3. Identify and analyse the policy actors in a country of your choice.

- Which stakeholders are influential (and which are not) in setting the policy agenda? Why?
- How involved is the media? Which policy actor influences media?
- What role do international financial institutions and donors play in influencing policy?

4. In some countries in the region, legislation precedes policy, or even legislation exist without clear policy statement in a policy document. Why do you think this happens? What will be the effect of this in policy implementation?
5. Is having good policy adequate to enhance Natural Resource Management? What determines successful policy implementation?
6. If a country sets a goal of increasing forest cover, which policy tools do you recommend? Why? Analyse the merits and demerits of Kenya's current move to ban logging and legally require tree planting on privately owned land.
7. You have been invited to join a group of experts to help the Ministry of Water to develop a Climate Change and Water Policy.

- What are some of the policy options you will consider?
- What must you as an NRM expert do to ensure that communities are involved in and benefit from such policy options?
- What are some of the challenges you are likely to face in the process of developing this policy?
- How would you deal with these challenges?

8. Choose one of NRM policies for any country.

- List three pressures that contribute to this environmental issue.
- Determine three policies that could have given rise to this issue and determine the original intent of these policies – probably quite different from their actual impact on the environmental issue you chose!
- In the fourth column, write down the effects each policy has on the issue you selected.
- Consider the effects of each policy on two other key environmental issues of your choice.

9. Identify a natural resource problem, gather evidence of its existence, identify its causes, evaluate existing policies, develop new policy alternatives, and determine the best solution based on the criteria you have set. Develop a policy brief.

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Research in Natural Resource Management

P.H. Mugabe, W.O. Ochola and Y.Yemshaw

Introduction and Scope

According to Merriam-Webster (2007), *research* is the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or, practical application of such new or revised theories or laws. This chapter explores the need for requirements and nature of Natural Resources Management Research (NRMR). The evolution and current status of NRMR is discussed along with the concept of innovation as the two are intrinsically related. Research must be of benefit to society and must therefore have a clear plan and expected benefits. As demonstrated in previous chapters, NRMR involves a complexity of resource states and domains and a complexity of stakeholders and objectives all of which must be reflected in and addressed by the research methodology. Successful research depends on the management of the research process and the participation of various stakeholders, particularly the local communities who directly interface with the natural resources. Community participation is a key research component and should not only be at the baseline stage but must also be at the planning stage through to the implementation, monitoring evaluation and application stages. Interpretation and application of research findings are as good as the data collected and require an effective and efficient data management strategy. Finally, the research process, experiences and results need to be strategically and effectively communicated to all stakeholders in order to facilitate maximum learning and positive change, and increasingly to influence policy and practices for improving the management of natural resources for development purposes.

The general objective of this chapter is to present the essential elements of NRMR and to discuss the various approaches, methodologies and tools for designing, conducting, managing and communicating the NRMR findings.

At the end of the chapter, the reader should be able to:

- Articulate the principles of managing NRMR;
- Discuss the utility of various approaches, processes, methods and tools of NRMR;
- Appreciate the significance of community participation in NRMR;
- Facilitate, design and implement participatory research for NRMR;
- Demonstrate an understanding of the theoretical and practical considerations for communicating the research processes and outcomes to NRMR communities, scholars, practitioners, and policy makers.

The chapter does not, both in context and content, attempt to replace conventional research but merely presents conceptual and practical considerations and procedures for planning, implementing and reviewing research aimed at improving the science and practice of NRMR.

Conceptual Definition of Natural Resource Management Research

Natural Resource Management Research differs from conventional research partly because NRMR is about the use of resources by communities and cannot be studied by setting up controls wherein the human factor is removed. NRM is about people and how they interact with the resources and this has to be central focus of NRMR.

General Research Considerations

Henderson (2005), states that conventional research is a linear process of application of the scientific approach to problem identification and definition, hypothesis formulation, data collection and analysis, drawing conclusions and recommendations and transferring research findings and knowledge. Applying this research approach on NRMR is problematic in that it requires 'uninvolved objectivity' wherein the researcher is external to the subject or system being studied.

This conventional approach to NRMR is based on reducing and controlling variability in order to contain and avoid negative impacts (Ashby, 2003). Such uninvolved objectivity does not contribute to sustainable NRMR which, according to Kearns (2003), involves three types of communities: the social community of practice or resource users (e.g. the local community) the community of cognitive enquiry (e.g. the scientists), as well as the community of political interest (e.g. the wider society and policy makers). The search for sustainable solutions requires these communities or stakeholders to interact, share and create knowledge together through a mutual multi-stakeholder process. Ashby (2003), distinguishes between ‘Research *and* development’ (R&D) and research *for* Development (R4D). She argues that R&D derives from the concept of researchers who are in control of a pipeline for producing technological innovations: an idea goes in at one end of the pipeline, research develops a prototype, and then a fully developed product comes out, ready to be released to eager users at the other end of the pipeline.

In contrast, ‘Research *for* Development’ emphasizes the iterative and adaptive nature of innovation in complex ecosystems, which is achieved through systematic enquiry combined with learning based on action. A concept often used to refer to R4D is Action Research. With respect to NRMR, Action Research is defined as a reflective process of progressive problem solving led by individuals working with others in teams or as part of a "community of practice" to improve the way they address issues and solve problems related to social, economic and environmental aspects of natural resources.

NRM Research is thus alternatively viewed as integrated natural resources management (INRMR). This approach incorporates research on different types of natural resources into stakeholder-driven processes of adaptive management and innovation to improve livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services at community, eco-regional and global scales of intervention and impact. Adaptive management in NRMR involves continuous learning processes based on improved understanding of the social, biophysical, institutional and economic subsystems and interactions therein that define NRM systems. Such continuous learning processes should be integrated into NRM research. Adaptive management is therefore an approach to coping with the complexity of NRM and depends on the ability of resource managers and other stakeholders to receive, understand and respond to positive or negative signals in the physical and social environment and to change management responses accordingly.

Natural Resource Management Research Components

In order to appreciate what NRM Research must achieve, an understanding of the key components of INRM is essential. Five key components of INRM (adapted from Twomlow *et al.*, 2004) that must guide the research process are:

Collective Learning for Change

Researchers and resource users together define subsystems e.g., the nature of ecosystems, ecosystem goods and services; reflect and negotiate on future scenarios such as the impacts of harvest practices on forest integrity; take action such as natural resources harvesting and afforestation and; evaluate and adapt attitudes, processes, technologies and practices. ‘Uninvolved objectivity’ of researchers is thus not applicable in this learning context.

Multiple Scales of Analysis

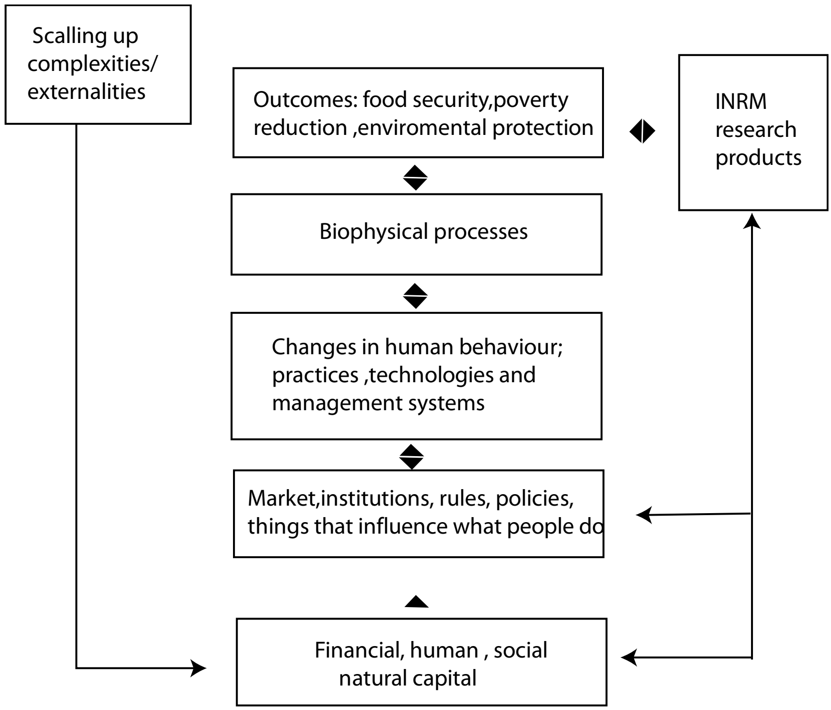

Figure 9.1: Integrated Natural Resource Management Research Furthers the Goals of Food Security, Poverty Reduction, and Environmental Protection.

Source: Hurrington et al,, 2001

The INRM attempts to integrate research efforts across spatial and temporal scales. This is because ecological and social processes take place over different time-scales ranging from minutes to decades and square meters to square kilometers. The following forest example of hierarchical organization of processes at different scale levels is given by Izac and Sanchez (2001). At the scale of a stand of trees, processes of competition between trees, nutrient uptake and impacts of human interventions, operate at about the same temporal scale of about 1 year but are influenced by factors at a higher level such as climate change and land-use change which occur over several years, to decades. At the same time, the tree-stand scale in the hierarchy is determined by processes at lower levels such as photosynthesis which occur at a time scale of days. The user-community interests at these scale levels can be the rate of growth and productivity of a tree species and, the rate of its disappearance due to disturbances. Scale is thus multileveled and hierarchical. Understanding a system, rather than just describing it, usually requires studying that system plus other systems with which it interacts. The multiple scales of analysis allow integration of INRM research products and processes to effectively inform policies, people's behaviour, Natural Resource Management practices, biophysical processes, and system outcomes that are linked in cause-and-effect relationships as shown in Figure 9.1.

Plausible Promises

The INRM needs a practical problem solving approach that delivers tangible outputs. There must be motivation for farmers to work together with researchers. This is why the researchers must invest in understanding not only the biophysical aspects of ecosystems but also the socio-economic factors that determine derivation of benefits. Often, researchers fail to articulate the link between various research activities and tangible benefits to the communities.

Scaling Out and Up

The INRM runs the risk of being criticized for producing only local solutions. INRM recognizes a difference between *scaling-out* or *horizontal* scaling, where an innovation spreads from farmer to farmer, community to community, within the same stakeholder groups; and *scaling-up* or *vertical scaling*, which is an institutional expansion from grassroots organizations to policy makers, donors, development institutions, and other stakeholders key to building an enabling environment for change. Figure 9.2 illustrates the perspectives of *scaling up* and *out* in INRM research

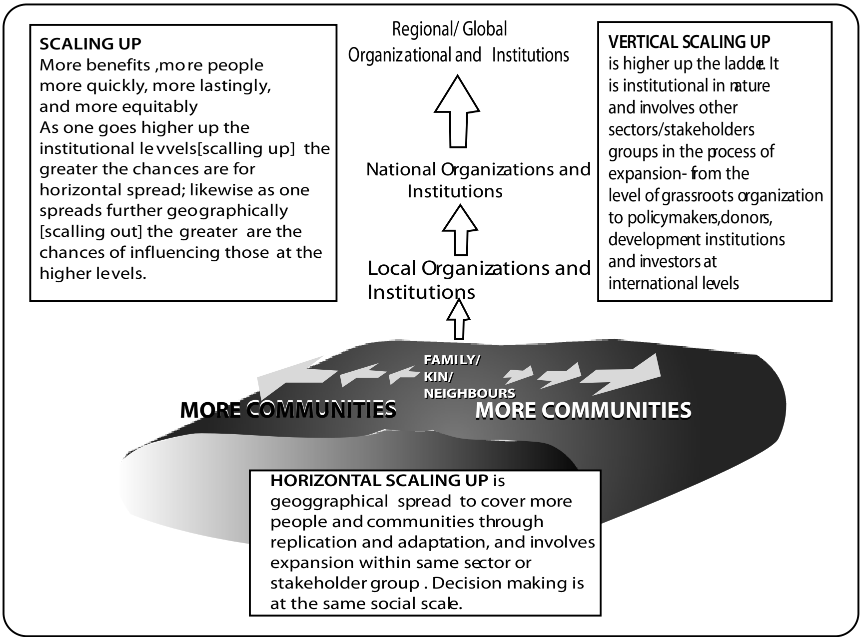

Figure 9.2: Different Perspectives on Scaling-Up and Out in INRM Research.

Source: Menter et al., 2003

Scaling-up and *scaling-out* is necessary so that more quality benefits from the research are brought to more people over a wider geographical area more quickly, more equitably. For the development of international or global public goods in particular, there needs to be *scaling-up* and *scaling-out* strategies. Thus *scaling-up* and *out* becomes part of the research process rather than a delivery mechanism for a finished product, and is more than merely achieving high levels of adoption. (Campbell *et al.,* 2005). They should be considered during the planning stage of the research.

Key Strategic Elements for *Scaling-Up* and *Out* are: (Gündel, Hancock and Anderson, 2001):

- Engaging in policy dialogue on pro-poor development so that the research process is cognizant of broader development issues related to NRM;
- Situational analysis to identify/recognise the community;
- Institutional and environmental factors enabling and constraining to *scaling-up* and *out*;
- Identifying appropriate research objectives and outputs within development processes to ensure relevance of outputs and widespread uptake;
- Identifying indicators and planning, monitoring and evaluation methods to measure impact and process of *scaling up*;
- Building networks and partnerships to increase local ownership and pathways to *scaling up*;
- Building capacity and institutional systems to be sustained and replicated;
- Developing appropriate financing mechanisms to sustain capacity for expansion and replication.

Monitoring, Evaluation and Learning

Monitoring and Evaluation (M&E) are key to research and adaptive management because they provide the real-time feedback mechanism necessary for constant improvisation, learning and performance improvement. Stakeholders should agree on plausible strategies on how research will contribute to developmental change, and then regularly monitor implementation of these strategies, to feed into the learning cycle as well as assess the outcomes and impacts of research and development projects or programmes. Success criteria and indicators agreed early on in a project are the basis for impact assessment and negotiation amongst stakeholders for resource allocation decisions. A strong M&E, as well as knowledge management strategy for collaborative learning, is essential for successful research in NRM.

Evolution of Natural Resource Management Research (NRMR)

A reflection on the changes that have taken place in time with respect to developments in NRM Research is helpful for an assessment of the usefulness of research initiatives. Historic lessons in NRM Research help shape research to solve emerging and future societal NRM problems.

Historic Perspectives

A historical perspective of how the field of NRM Research has evolved illustrates a progressive development in the understanding and appreciation of the complexity of problems to be solved with regards to sustainable NRM. An example of how NRM Research has evolved in the Consultative Group on International Agricultural Research (CGIAR) as narrated by the Technical Advisory Committee (TAC) (TAC Secretariat, 2001) is given in Table 9.1. This evolution points to the emerging Natural Resource Management methods as illustrating the paradigm shift in agricultural sciences: from classical agronomy to ecological sciences; from analytical research to systems dynamics; from top-down to participatory approaches; and from factor-oriented management to integrated natural resource management. Ideas on Natural Resources Management research have been evolving in keeping with new knowledge, with the changes in NRM objectives, and with new thinking on issues such as sustainability and poverty alleviation. Table 9.1 illustrates the evolution in thinking and practice, where new tools and elements are added to existing approaches thus giving rise to ‘new’ approaches (Campbell *et al*., 2005). So, for example, from the farming systems approach emerged participatory technology development and farmer participatory research. The main shift here was from an approach directed by an external actor to greater 'participation' and empowerment of rural dwellers.

Regardless of which line of reasoning is followed, lessons from the past teach us:

i) that a key need is not to let the rhetoric of INRM get ahead of the science and
ii) not to focus too much on concepts without having common definitions and solid operational research approaches and procedures in mind (TAC Secretariat, 2001).

Current and Emerging Perspectives

Probst and Hagmann (2003) present an analysis and report on the state of the art in NRM-based on a review of literature and Internet sites, insights gained from conceptual workshops and project evaluations, and a study of 53 research projects in developing countries. Some of their discussions are here presented: International Agricultural Research Centres face an apparently paradoxical situation with regard to research impact. Some donors want to see impact at the level of resource-poor

Table 9.1: Changing Approaches to NRM Research and Development

Main characteristics	**Types and of Research**			
	Diffusion of Innovations Transfer of Technology (Conservation approaches)	Farming Systems Research (Devolution and decentralized NRM)	Participatory Research in NRM (Adaptive Management, Collaborative Management)	Innovation systems
Era	Central since 1960s	Starting in the 1970s and 1980s	From 1990s	2000s
Mental Model and Activities	Supply technologies through pipeline	Learn resource users constraints through surveys	Collaborate in research	Co-develop innovations Involving multi-stakeholder processes and partnerships,
Knowledge and Disciplines	Single discipline-driven (breeding)	Multi-disciplinary (Environmentalist plus social scientists)	Interdisciplinary (plus sociology and farmers experts)	Extra/transdiciplinary, holistic, systems perspectives
Scope	Productivity increase	Efficiency gains (input-outputs relationships	Resource-users based Livelihoods	Value chains Institutional change
Core elements	Technology packages	Modified packages to overcome constraints	Joint production of knowledge and technologies	Shared learning and change, politics of demand, social networks of innovators
Drivers	Supply push from research	Diagnose resource users constraints and needs	Demand pull from resource users	Responsiveness to changing contexts, patters of interactions
Innovators	Scientists	Scientists and extension	Resource-users and scientists together	Multiple actors, innovation platforms
Role of farmers	Adopters or laggards	Sources of information	Experimenters	Partners, entrepreneurs, innovators, exerting demands
Role of scientists	Innovators	Experts	Collaborators	Partners, one of many-responding to demands
Key changes sought	Farmer behaviour	Removing resource-user constraints	Empowering farmers	Institutional change, innovation capacity
Intended outcomes	Technology adoption and uptake	Ecosystem fit	Co-evolved technologies with better fit to livelihood systems	Capacities to innovate, learn and change
Sustainability	Undefined	Important	Explicit	Championed, normative and multi-dimensional

Source: Adapted from Sanginga et al., (2009) after Scoones et al., 2008

farmers, while others emphasize on 'strategic' research and production of 'international public goods' that can be extrapolated to other locations at the regional and global levels. There is incorporation of highly aggregated development goals such as poverty alleviation, increased income, food security and sustainable resource use into their overall research objectives. Some projects have started engaging in larger scale extension and development activities such as capacity building and organizational development. without necessarily integrating research functions as a continuing part of these development activities.

The overall goals formulated for NRM Research initiatives show that in most research projects, different levels of impact are jointly addressed without clarification of the exact outcomes intended.. These projects focus on research impacts that build local capacity for collective action, and foster people's own efforts to improve management systems (adaptive capacity). The goals and objectives leading to the desired impact remain rather diffuse with no clarification of what research can realistically contribute. 'Hard' impacts related to physical, natural and financial capital and 'soft' impacts related to social/human capital are not clearly separated, even though they would require different strategies. Three major research foci are apparent from contemporary research, namely:

i) The development and assessment of natural resources management technologies;
ii) Generation of new theoretical insights into complex NRM systems to contribute to policy or to management recommendations and
iii) Developing approaches for organizational and institutional innovation (Probst and Hagmann, 2003).

To promote the efficient production and dissemination of their research products, most research organizations seek collaboration with 'adaptive research and dissemination partners', such as national programmes, extension services, Non Governmental Organizations (NGO), development agencies and farmers' groups. These partners form the focal mechanism to reach out to farmers in pilot development projects. There is growing realization that research outputs cannot just be fed into an existing and assumingly functioning research-development continuum. There are a lot of social, cultural, economic and political factors that determine uptake of innovations. An understanding of these factors should be an integral part of the research process.

From their analysis, Probst and Hagmann, (2003) conclude that: research focus and products are mostly derived from a supply-led and discipline-led perspective rather than from a strategic orientation; research projects hardly achieve a true integration of different disciplines and stakeholders from different levels; projects tend to address many compartments of the whole system, rather than the system as a whole and the interaction of its parts. It is still widely assumed that the sharing of tasks within a linear research–development continuum functions, and can be taken for granted. In reality, however, there are fewer and fewer cases and countries where this continuum is really functional. Alternative *scaling-up* strategies are still rare.

This is, however, not to paint a gloomy picture on progress in NRM Research since considerable progress has been made. In the past, research on natural resources has been too often conducted in a disjointed, fragmented fashion. We have now reached a situation where problems in managing natural resources are recognized to be multidimensional, with physical, economic social and cultural dimensions.

Research for Natural Resources Management Innovations

Communities directly interfacing with natural resources in sub-Saharan Africa are largely small-holder farmers facing many challenges; and are dependent on technologies, policies and incentives for fostering innovation within the rural sector. NRM Research in these communities should facilitate innovations aimed at improving food security and livelihoods enhancement. The success of such research is a function of appropriately addressing issues that are relevant to the lives of the communities and that are identified and dealt with in a participatory manner.

There are three prototype approaches to NRM Research for innovation development, namely; (1) participatory research, (2) innovation system research and (3) scenario building research. Regardless of focus, the approaches are meant to address the key loopholes in research that constraint innovations in NRM, namely (Probst. and Hagmann, 2003):

- Many NRM Research initiatives define highly aggregated overall goals, but lack a clear strategy of how to reach these impacts and induce changes through research.
- The research focus is often derived from a supply-led and discipline-led perspective, and it is widely assumed that research outputs can be fed into an existing and functioning research-development continuum.
- Participatory research is often limited to downstream applications, and is seen as an instrument for applied and adaptive research to improve technology transfer. However, more cases are arising that facilitate longer term participatory learning and Action Research processes whilst pursuing Strategic Research questions in NRM.

Participatory NRM Research

According to Ashby, (2003), PNRM Research requires the combination of participatory methods with a wide range of technical and conventional NRM Research methods for “Uniting Science and Participation’. Pound *et al* .(2003) present a collection of cases that illustrate how research for participatory management involves stakeholders in generating new information relevant to making decisions about the parameters and procedures for adaptive management. These parameters or procedures may include the boundaries of the ecosystem, the relevant actors, the physical and social spaces for intervention, the priority problems and opportunities, the alternative development paths, optional interventions (both technical and institutional,) and the tradeoffs these entail for different stakeholders; the combination of Geographic Information Systems (GIS) research with participatory management; and modelling integrated with participatory research methods;

Innovation Systems Research in NRM

NRM Innovation is the process by which communities and other stakeholders develop new and better ways of managing resources by exploring new possibilities, or responding and adapting to changes in the condition of natural resources, availability of assets, markets and other socio-economic and institutional contexts. The concept of innovation means using new ideas, new technologies or new ways of doing things in a place or by people where they have not been used before. The emphasis is on the word ‘using’ to distinguish innovation from inventions. Successful innovations require constant interaction between the organizations and actors who form the users and suppliers of knowledge. In a linear research model, research is completed and then disseminated to end users through some form of extension service, whereas in the innovations approach, users and suppliers of knowledge interact from the outset of research to ensure that innovation takes place.

Essential characteristics of innovation systems are: suppliers and users of research are centrally involved; user needs are understood; investment is made in the innovation system; learning results from iterative action research; pro-poor innovation takes place when new technologies and/or new ways of doing things are observed; institutional arrangements are changed, and infrastructure that supports and enables the innovation system to operate effectively is strengthened (Turrall, 2005). A successful process of research-induced NRM Innovation leads to local innovations that improve the lives of many people in the area (Wettasinha *et al.*, 2008).

According to Rath and Barnett (2005), for NRM Research to spur innovation, it must be characterized by:

- A shift to organising research around beneficiary groups;
- Priority given to its impact rather than to the generation of knowledge for its own sake;
- An emphasis on participatory processes to establish demand and prioritise research needs;
- Greater follow-on and clustering of projects to allow for continuity of research themes;
- More emphasis on dissemination and promotion of uptake;
- Development of explicit capacity building activities;
- Establishment of links with private sector stakeholders as partners and research users.

Although the Innovation Systems Concept is relatively new to NRM, it is increasingly suggested as a way of revisiting the question of how to strengthen natural resource users’ innovation capacity (Hall *et al.*, 2001). Innovations can be divided into four categories, namely: technical, economic, organizational, and institutional/procedural. Most NRM Innovations Research hitherto, however, has focused on the process of new NRM technology product and service identification and development.

Scenario Building Research

The complex nature of environmental management, and the uncertainties associated with key drivers of its change, necessitate the use of scenarios for policy analysis and decision support. Changes in the environment are driven by mainly socio-economic drivers of global scope and high uncertainty. Understanding how the future environmental states might unfold is, therefore, best done using scenarios as they provide alternative images.

Scenarios are indispensable tools for environmental management that focus on large-scale long-term interactions between development and environment (Toth and others, 1989). Scenarios provide a coherent framework for analysis of how various issues or sectors interact and impinge on one another, and serve as tools to foster creativity, stimulate discussion, and focus attention on specific points of interest for policy on environment and development; and for opening up a constructive analysis of future problems. The integration of scientific knowledge helps scenario development, as a tool for "peeping" into the future, to look more closely into what types of development and environmental strategies are risky, and how they can be avoided, as well as into which ones are plausible and need to be reinforced.

A scenario approach can be valuable for stimulating analysis and sorting out urgent policy issues, and as a means of communication between scientists and policymakers. However, it should be strongly emphasized that scenarios are simulations: they make an effort to introduce analysis of different "what if?" developments and should therefore be distinguished from projections.

Scenarios support strategic planning and decision-making, and can help to test the implications and robustness of different policies. The Scenarios method challenges conventional wisdom about the future, stimulating discussion and action, stimulating creative dialogue and collective participation in problem solving and imagining potential outcomes. Equally important, they allow for profound stakeholder participation, enabling the representation of conflicting opinions and world views. *A scenario* can be defined as a consistent and plausible picture of a possible future reality that informs the main issues of a policy debate. Scenarios are creative stories about the future, "plausible futures, each an example of what might happen under particular assumptions" (Millennium Ecosystem Assessment (MA), 2005). The intention of scenarios is to consider a variety of possible futures rather than to focus on the accurate prediction of a single outcome (van der Heijden, 1996; Peterson *et al.*, 2003a).

Table 9.2: Guidance for Developing and Using Scenarios

Getting started	
Step 1	Developing the case for scenarios
Step 2	Gaining executive understanding, support and participation
Step 3	Defining the 'decision focus'
Step 4	Designing the process
Step 5	Selecting the facilitator
Step 6	Forming the scenario team
Laying the Environmental Analysis Foundation	
Step 7	Gathering available data, views and projections
Step 8	Identifying and assessing the key decision factors
Step 9	Identifyuing the critical forces and drivers (the dynamics of 'the way the world might work')
Step 10	Conducting focused research on key issues, forces and drivers
Creating the Scenarios	
Step 11	Assessing the importance and predictability or uncertainity of forces and drivers
Step 12	Identifying key 'axes of uncertainity' (forces and drivers with high importance and high uncertainity) to serve as logic and structure of the scenarios
Step 13	Selecting scenario logics to cover the 'envelope of uncertainity'
Step 14	Writing the story lines of the scenarios
Moving from Scenario to a Decision	
Step 15	Rehearsing the future with scenarios
Step 16	Getting to the decision recommendations
Step 17	Identifying the signposts to monitor
Step 18	Communicating the results to the organization

Source: Ralston and Wilson, 2006.

Scenarios methods were originally developed by the Rand Institute for Military War Games (van der Heijden, 1996) later adopted by Royal Dutch Shell for business strategy development (Wack, 1985), and are now being applied in large-scale environmental assessment such as the Millennium Ecosystem Assessment (2005,) and in regional environmental impact prediction and planning (Peterson *et al.*, 2003b). The power of scenarios in this regard has seen an increase in their use for a wide variety of purposes in NRM at the local, national, regional and global levels with notable examples in the Second Africa Environment Outlook, (AEO-2) (UNEP 2006); Fourth Global Environment Outlook; GEO-4 (UNEP 2007); Millennium Ecosystems Assessment (MA, 2005); and the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007).

Scenario planning, initially developed as a strategic military planning tool (Segal, 2007), is an approach that has evolved to become a widely accepted methodology in understanding and addressing management issues in complex systems. The scenario planning process has two main components. *Firstly,* it analyses the factors or drivers (Schwartz, 1996) that are influencing the system to build a "default" scenario (Hodgson, 2004) or picture of the current system and its complexities. *Secondly,* it extrapolates the current drivers into possible futures that can be used to guide research or management interventions. Table 9.2 illustrates the guidelines for development and use of scenarios.

Origination of Natural Resource Management Research Ideas

Where does the research process begin? Who and what process originates the research? In a Participatory Action Research undertaking where local stakeholders are involved in the identification of problems and formulation of solutions, the research process ideally originates with them. This ideal situation implies that the local stakeholders are organized and capable of articulating their needs and desires to researchers and funding organizations who can partner with them in finding solutions and innovations. In most cases, however, the research process is initiated by research funding organizations with an interest in specific NRM issues. Usually these interests are informed by global, regional and or national environmental and food security concerns and developmental interests. These organizations define strategic research thrusts and invite research organizations to apply for funding under these thrusts. In responding to the calls, researchers try to match local community needs with funding organizations' interests. Frequently, the research interests of funding organizations are also advised by inputs from research organizations based on the latter's experiences in working in NRM, and on observations and inferences on NRM research needs.

Research is thus mainly externally initiated, discipline-led and supply driven. Research institutions write proposals according to their strengths and preferences, they manage the funds obtained for development oriented research, and are accountable and report to donors. Local clients in turn have little power and influence on the research agenda. There are emerging financial mechanisms to increase the demand-orientation, and to accomplish more market-led client-provider relationships. A progressive approach would, for example, be that local organizations who have appropriate communication channels to institutions and or enterprises, and who have control over their own and or donated resources, initiate contracts with providers of research services to overcome specific constraints. They would act as clients who commission external service providers, and 'buy-in' the research services they need (Probst and Hagmann, 2003).

Natural Resource Management Research Approach

Scientific investigation is based on certain assumptions about the nature of the world, the humans within it, and the knowledge which can be acquired about both (Bawden, 1995). Two frequently cited epistemological perspectives in the theoretical debate surrounding Participatory Research are *'positivism'* and *'constructivism'*. *Positivism* implies that authentic knowledge is based on experience and positive verification, while *constructivism* is founded on the premise that by reflecting on our experiences, we construct our own understanding of the world we live in. These assumptions can lead to different paradigms, i.e. basic belief systems or world views within which research is carried out. It is critical to be aware of the assumptions one is making for they have implications for the definition of objectives, roles, methods, etc. Paradigms will influence whether systems are seen as real things that can be studied from outside or as abstract concepts which are socially constructed.

The choices will determine whether the process of inquiry is through experimentation or organised as a system of learning, etc (Probst and Hagmann, 2003). These choices are made in a process starting at the conceptualization of the research and after the initial learning following entry into the community. When deciding on their research approach, scientists usually draw on disciplinary measurement habits, use tools that are in vogue and make choices that seem relevant to their research questions. Whatever research strategy is adopted, the INRM research should:- follow a systems approach; be process-orientated but lead to measurable impacts and outcomes; work at multiple scales with multiple stakeholders; address issues of trade-offs; employ new tools and methods, and be amenable to *scaling up* and *out* (Campbell and Sayer, 2003).

The following set of key questions can help researchers to identify the appropriate research strategy based on the impact which should be achieved (Hagmann *et al*., (2002); Izac and Sanchez (2001)):

- What is the overall importance of the problem to be addressed relative to other problems within the domain of expertise, mandate or comparative advantage of the research institute implementing this agenda?
- What are the spatial and temporal dimensions of the problem, what is its relative magnitude, and if and where it is likely to become a problem over the chosen planning horizon?
- What are the foreseeable options/strategies/solutions on offer by the research institute and partners for solving the problem?
- What do we want to achieve, and what is achievable at all? (impact)
- Who should do what differently, if our research is successful? (vision of behavioural change), What is required to support this behavioural change?
- What is the role of research and what are the research outputs in enhancing these factors? What is the role of other actors?

- What are the research questions leading to the research output?
- How can these research questions be best dealt with? (approaches and methodologies)
- With whom and how does NRM research have to collaborate to be effective?

These questions should be asked at the *proposal development* stage as well as during *consultations* with the local stakeholders. This will ensure correct focus and prioritization of issues. Henderson (2005), suggests that NRM Research needs to be characterized by spiralling cycles, rather than as linear causality (Figure 9.3). An approach characterised by iterative loops of action, and by reflection in a collective learning process, is based on evolving plans and continuous internal monitoring and self-evaluation (Probst and Hagmann, 2003). In planning, researchers need to consider the evaluation stages in these spiralling cycles rather than concentrating on evaluation at the end of a project phase (ex-post) as is the tendency in some research projects.

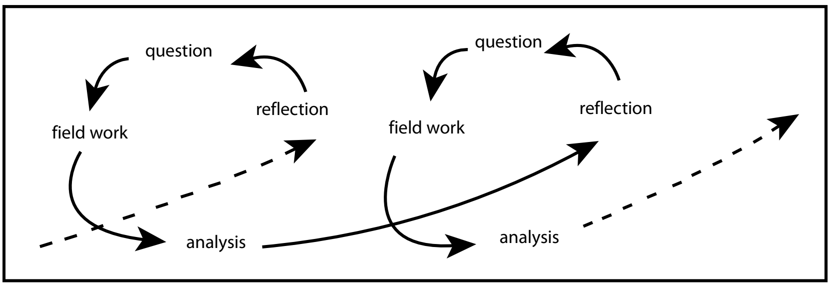

Figure 9.3: Action Research Spiraling Cycles

Source: Henderson, (2005)

Detailed Research Planning

Dixon and Bouma (1984), sees research as an organized and systematic way of finding answers to questions. Planning NRM research involves firstly ensuring that the correct platform is set to enable the asking of questions that have the most relevant and direct bearing on how natural resources are managed to the benefit of various stakeholders. A systematic approach to research involves a careful selection of steps and procedures that will lead to accurate results. The organization of the research process must be influenced by what impacts are intended and by the involvement of various stakeholders. Planning for research extends from the conception of ideas to the more specific definition of activity plans to the implementation and evaluation of the research. Detailed activity planning is necessary, ideally with the input of all stakeholders and involves writing and discussion sessions on the broad research framework and detailed activities and processes. Independent and objective inputs of experts and other stakeholders should be sought in the detailed planning to ensure that no critical details are overlooked. The research process should commence when a research proposal has been unanimously developed by the research team, community stakeholders and funding stakeholders.

Described below are some basic components of the research proposal.

1. *The Title* should be kept short and simple and should clearly describe the basic objectives of the proposed research in as few words, preferably between 10 and 15 words, and should be understandable by a scientist who is not an expert in the research field.
2. *The Abstract* is a short summary (approximately 250 words depending on the requirements of different institutions) of the proposed research, sufficiently informative for other scientists who are not necessarily in the field of expertise. The abstract should contain an overview of the research, followed by the objectives and a brief description of how these will be accomplished, with expected outputs. Considerable attention should be given to the preparation of this item and it is best written as a last item.
3. *Research Problem:* The researcher must address the major question that needs to be answered, or any assumptions or assertions that need to be challenged or investigated. The research problem should always be formulated in such manner as to permit scientific scrutiny. It is important to evaluate the research problem in the light of the available financial and time resources and researchers' and collaborators' expertise and knowledge in the field of study. A brief background to the research should be provided without duplicating the information provided in the setting section.
4. *Relevance of the Research:* In this section one should state and justify the relevance of the research to the countries or region concerned indicate its relevance to the national and regional priorities, and state any economic, social or environmental benefits or consequences of the research project as well. It should also mention any potential commercial applications of the research.
5. *Beneficiaries and Dissemination Plan:* Researchers should also describe the intended beneficiaries, and include a brief plan in this section that indicates how their results will be made available to these beneficiaries such as farmers, local industry, policy makers and natural resource users. If researchers wish to organise dissemination workshops or seminars, and/or publish policy briefs, pamphlets, posters, etc for these purposes, a dissemination line item should be included in the budget.
6. *Literature Review*: It provides a short and up-to-date summary of the present status of scientific knowledge relevant to the proposed research. The literature review section brings clarity and focus to the research problem, broadens the knowledge base in the research area and thereby improves the methodology. It should also demonstrate that the study is not a duplication of what is already known and indicate how this research moves beyond past studies. The section review should be presented as a logical discussion and

not just a listing of literatures and must have a brief introduction at the beginning and conclusion at the end on the arguments presented. Many online resources and search engines are emerging to enable speedy access to literature and library resources. Examples include online journal databases such as Online Access to research in Environment (OARE) at http://www.aorescience.org and Google scholar at http://scholar.google.com/.

7. *Research Objectives:* These are the goals to be achieved in the study and must directly arise from the research problem stated earlier. Their wording determines how the research is classified (e.g., descriptive, correlational or experimental). Objectives should clearly describe the major focus of the study in terms of the main variables or concepts and relationships to be investigated. Care should be taken so that objectives are not too broad to achieve within the time frame and budget given, or too narrow to be of any practical value. Research objectives are best preceded by the specific questions that need to be answered by the research, from which the objectives are derived.
8. *Main objective or aim:* It is an overall statement of the thrust of the study that states, in a sentence, the major research/knowledge gap that the research will attempt to fill. This section should capture the essence of the research problem stated describing it succinctly but sufficiently.

   Here is an example of a main objective for a Forest Germplasm Improvement Study:

   The main aim of this study is to investigate effective ways of increasing the availability of regeneration planting material for establishment of Triplochiton scleroxylon plantations with broad genetic base.
9. *Specific Objectives:* Should be numerically listed, logically ordered, and each should contain only one aspect of the main objective or aim. Specific objectives should be written in action-oriented words or verbs. They should start with words such as 'to determine', 'to identify', 'to describe', 'to explore', 'to measure', 'to correlate', 'to model', etc followed by the major concepts or variables to be considered.

   Using the above study, we can then have the following specific objectives:
   - i). To evaluate genetic diversity within and among populations;
   - ii). To test the effect of several physiological treatments on flower induction;
   - iii). To produce genetically superior seeds and/ or clones for plantations in successive years for plantation programmes.
10. *Hypotheses or Research Questions:* These are statements of the research objectives framed in a way that can be tested scientifically. Hypotheses should be simple, specific and conceptually clear. They must be capable of scientific verification, should be related to scientific body of knowledge, and must be operationalisable (i.e., can be expressed in terms that can be

measured). These can alternatively be expressed as research questions as long as the questions are expressed in terms that can be measured.

Specifically, hypotheses serve the following functions:

- The formulation of a hypothesis provides a study with focus. It tells what specific aspects of a research problem to investigate;
- A hypothesis tells what data to collect, thereby providing focus to the study;
- As it provides a focus, the construction of a hypothesis enhances objectivity in a study;
- A hypothesis may enable one to add to the formulation of theory and help to bridge the gaps in the body of knowledge. Hypotheses are a particularly potent means of objectively bridging the gap between one's beliefs and empirical reality.

The hypotheses or research questions in this section must be linked with all the specific objectives listed above.

11. *The Research Methodology:* This is an extremely important part of a Research Proposal. Reference to a publication cannot substitute for a methodology description unless one is referring to a basic technique which is well-known to specialists and non-specialists in the field. It is imperative to contact a statistician (biometrician or econometrician) during the planning stage of the research project in order to make sure that the research design or set-up of the research permits appropriate statistical analyses and interpretation of the data that will be collected (Manly, 1992).
12. *The Setting:* Briefly describe the setting of the research in relation to the locality in which the study will be conducted. Include short descriptions of chemicals and equipment to be used as well as germplasm details, if any. In describing people, highlight some of the salient characteristics of the group (e.g., its history, size, composition, structure). Discuss the criteria for choosing sites.

Box 9.1: Selecting Research Sites

Deciding where and with whom to work is an important aspect of research planning. Where to work is normally influenced by a natural resource domain that is of interest to the researchers and funders. While objectivity in choosing research locations with respect to local community needs is advocated in the scientific circles, often these choices are affected by such practical factors as accessibility of the areas, budget limitations, acceptability of research ideas by local communities, experience of previous researchers in the area and researcher security concerns. The choice of research sites are further influenced by the local government organization in the area.

For instance, in Zimbabwe, the general recommendation and requirement for researchers is to first consult with the district local government structures before going to local communities. This has the advantage that the researchers are immediately given an actual overview of the district in terms of status and challenges of NRM, previous and on-going NRM research and development efforts, and, NRM research and development organizations. The general idea is to avoid re-invention of the wheel, and to prevent 'over-researching' in certain localities and 'farmer fatigue'. The district authorities are also interested in ensuring that any new research interventions are complementary and not contradictory to general local development strategies. While this initial consultation of district authorities generally contributes to smooth implementation of the research, the authorities may try to influence the choice of exact research sites for various reasons including the equitable spread of research and development activities within the district. This choice of research sites is done usually by referring to local maps. Researchers sometimes already have their own choice of research sites and discuss the rationale of this choice and negotiate final selection with the district authorities. After this selection, the research team is accompanied to the selected research sites and introduced to local traditional and political leadership for permission to work in the area. The local community leadership may also input into the final selection of research sites.

At the research sites, the researchers must engage the local communities. Who is involved will determine who obtains direct benefits from the research and learning process. This will also influence the type, usefulness and social inclusiveness of the products that emerge from research. Therefore, an important distinguishing aspect among participatory approaches is the way in which individual or group actors are differentiated, seek to participate in and bring knowledge to an innovation process. There will be differential interests by different community groupings such as gender groups. The research must be planned in a manner to identify and engage all relevant stakeholders. This identification need not be a once off activity but can be a process to ensure inclusion of all. Participatory stakeholder analysis is recommended where the communities get to identify stakeholders and appreciate the various stakes

Other Considerations in the Research Proposal

The Study design: Should conceptualize the various procedures required to complete your study and ensure that these procedures are adequate and valid. Select, describe, and justify the most suitable study design for your research. The choice of your study design largely depends on the type of hypotheses to be tested and/or the type of research questions to be answered. The design description should give details on your design, indicating plot layout and sizes, including treatments, replications, etc.

Population and Sample: Under this section, the research proposal should have details of the population from which research samples are drawn and how the samples will be drawn, giving details of how the sample size is derived and the reasons for the sample size. The criteria and justification for sample size selection should be given. Justifications for using simple random sampling, stratified sampling, systematic sampling, cluster sampling etc should be given. The sampling strategies in this section must be linked with all the hypotheses or research questions.

Box 9.2: Who Should be Involved in NRM Research

The outcome of participatory research is affected by both how actors relate to each other (types of participation), and the specific characteristics of the participants themselves, i.e. who is involved or excluded. Who is involved will determine who obtains direct benefits from the research and learning process. Due to the complex nature of NRM, there is usually a large number of different and often competing stakeholders with different perceptions, interests, strategies and knowledge systems (Probst and Hagmann, 2003). For instance, if the natural resource domain is a forest, stakeholders will be interested in various products such as timber, firewood, food, forage and herbs. The 'who' will also influence the type, usefulness and social inclusiveness of the products that emerge from research. Therefore, an important distinguishing aspect among participatory approaches is the way in which individual or group actors are differentiated, seek to participate in and bring knowledge to an innovation process (Ashby, 1996). There are several methods of selecting participants (Johnson *et al.*, 2000):

- Selection based on efficiency criteria such as knowledge, skills or status makes a qualitative difference to the process because of above-average education, literacy or other skills of participants.
- Self-selection of participants is probably the least pro-active and most susceptible approach to gender bias and/or elitism whereby the better off have time and self-confidence to participate and women and marginalised groups seldom do.
- Community selection is also likely to bias the process towards the favoured groups in a society, unless good facilitation reaches agreement on specific criteria that promote the inclusion of disadvantaged groups.

Women and marginalized groups such as children are to be brought into the research process at the same time with other participants. For instance, their involvement in the assessment of the situation before, during and after intervention is crucial in identifying and promoting local or culturally appropriate responses to addressing natural resource management. Vulnerable groups like children can be encouraged to participate in research, enabling them to express their views in both research and practice, and to participate in matters that affect them. A study by CGIAR (2002), revealed that women were not important stakeholders in the natural resource management activities that most projects were promoting because of lack of gender analysis

Instrumentation and data collection: Here the data gathering strategy (e.g. observation, field trials, laboratory experiments, interviewing, questionnaire, etc) should be specified, and the procedure of implementation should be briefly described. There is need to justify the choice of data gathering approach/strategy, highlighting its strengths and limitations and its relevance to the hypotheses or research questions. All variables should be defined and categorized.

Data analyses: The following basic questions need to be addressed:

- Which variables are to be analyzed and what are the statistical methods of analysis? This can be done by identifying analysis objectives with the assistance of dummy tables and graphs;
- What cross tabulations must be worked out based on the relationships that are being investigated?

It is important to ensure that all hypotheses and or research questions listed have matching data analysis strategies, and provide the names of any software programme that will be used.

Workplan: There is need to define milestones, i.e., points at which progress can be assessed for monitoring progress of the research. Examples of milestones include: instrument construction and testing, field data gathering, lab analysis, data entry and analysis, and progress reporting. Presenting *Work Plans* in matrix format of activity and time period helps to quickly visualize the spread of activities across time, and pin-point congested periods. All research team members must have a copy of the Work Plan to facilitate joint planning. This is best presented with the associated requirements of time, human and financial resources. Chapter 7 gives more details on tools and strategies to develop and manage Work Plans.

The Logical Framework (log-frame): This is a tool for improved Research Project Design and Management (Baccarini, 1999) which provides a clear, rational framework for planning and envisioning research. A log-frame summarises in a standard format what the project is going to achieve, what activities will be carried out to achieve its outputs and purpose, what resources (inputs) are required, the potential problems which could affect the success of the project, how the progress and ultimate success of the project will be measured and verified.

Constructing a log-frame matrix is not just about filling-in the boxes as behind every box stands careful analysis and logical reasoning that has to be pursued before filling in the boxes. To ensure the log-frame's validity, the underlying logic should be tested by reading the log-frame from bottom to top to analyze the coherence of its arguments. The logical structure linking the components takes the form: IF [activities] AND [assumptions] THEN [outputs], IF [outputs] AND [assumptions] THEN [purpose], and so on. Chapter 7 of this book contains more details of the construction of a log-frame while Table 9.3 shows an excerpt from an NRM Research Project.

Budget: The successful implementation of research depends on adequate availability of human and material resources. Costs incurred for community involvement and participation must be indicated, although these must be only to facilitate community involvement and not to 'pay' them for involvement. All costs must be identified and accurately indicated in the budget. Budgeting should also consider information dissemination and communication, monitoring and evaluation and data management. Chapter 7 of this book gives more details on budgeting essentials.

Table 9.3: Sample Log-Frame for Community-Based Multi-Level Decision Making Data Requirements

	OVI	**MOV**	**ASSUMPTIONS**
GOAL More secure and sustainable livelihoods for rural families in communal areas of Namibia	Improvements in livelihoods due to rural diversification and improved NRM practices in study sites and/ or sites adopting project findings		That NGO's and other rural development support agencies adopt and implement project findings
PURPOSE To provide findings, based on good data, in order to strengthen decision making about CBNRM at all levels	1. Adoption of lessons from study sites by Namibian communities and CBNRM support organizations by end of project. 2. Adoption of project findings by at least 3 NGO's and/or institutions working with communities to improve rural livelihoods 3. Discussions amongst policy makers of project recommendations, and at least one policy change implemented by the end of the project 4. Discussions of project findings at n' Southern Africa fora by 2003	Records of project steering committee institutions. Project findings are integrated into work plans of NGO's and/or institutions working with communities to improve rural livelihoods. Policy modified or developed. Findings presented at 'n' South Africa Fora	National and local conditions remain conducive to CBNRM in Namibia. Project partner institutions find findings useful and have the capacity to integrate findings That the policy and legislate.ve process are in a developmental stage and/or amenable to change Suitable fora exists for discussion of project findings
OUTPUTS 1) Implications for livelihoods of changing NRM activities and options within conservancies understood	Comparative assessment of the impacts of wildlife uses and other CBNRM options on rural livelihoods in 'n' communities by 'y'	Project documentation and outputs	Appropriate levels of cooperation from government, NGO's, communities and other rural development support organisations achieved to effect changes
2) Critical internal factors(at community level) influencing adoption and impact of changing NRM activities and options documented and understood	Institutional and distributional arrangements that increase the effectiveness, equity and sustainability of community NRM documented by end of project	Project reports and other outputs	That project partners continue to be willing to support research

3 Critical external (regional and national) influencing the adoption and impact of changing NRM activities documented and understood	Social, institutional, political and other factors that increase the effectiveness, equity and sustainability of community NRM identified, documented and 'n' policy recommendations endorsed by NACSO by end of project	Project reports and annual DFID reviews	That project partners continue to be willing to support research
4) The broader social, economic and ecological implications of changing NRM activities assessed, and lessons drawn	Contribution of different community wildlife uses and other CBNRM opportunities to national economic and development objectives assessed. A review of existing work on ecological impacts, and assessments completed. The effectiveness of community participation in NRM /ecological assignments analysed and documented by end of project.	Project reports, discussions papers, journal articles and other outputs	CBNRM in Namibia remains important as a one means to achieve national sustainable development objectives
5) Project data and findings effectively disseminated	Findings of outputs 1-4 and 7 shared in at least one workshop and one report per year by end of project, findings disseminated through both events (workshops) and written materials targeted locally, nationally, within Southern Africa Region and internationally. Lessons learnt , discussed and reviewed by others in RNR and community development sectors in Namibia and region.	Project reports and annual DFID reviews	Audiences find project findings relevant to their work and adopt them
6) Capacity and skills amongst participating stakeholders enhanced	Increase in responsibility and performance of non-expatriate project staff over life of project. At least three partner communities able to continue trade-off analysis and planning using project methods independently of project staff	Communication from communities Ministry partners and NGOs. The production of guidelines for CBNRM extension and planning	Non-expatriate staff available and retained
7) Appropriate methods for understanding existing and new livelihood opportunities tested and documented	Methods for participatory analysis and planning adopted by "n" collaborating communities and support organizations documented by end of project	Project reviews and reports	Time frame of project long enough for adoption by collaborating communities and support organizations. That they find the methods useful and have the resources to implement them.

ACTIVITIES

1. To assess livelihood impacts

1.1 Establish collaborative research sites with four communities

1.2 Identify stakeholder groups and their livelihood strategies

1.3 Develop, apply and continue to adapt methodologies for local-level assessment of development options for wildlife and other resources

1.3.1 Develop and document methodologies for assessing the livelihood impacts of existing and potential wildlife users and other CBNRM options

1.3.2 Develop and document methodologies for identifying current and potential wildlife uses and other CBNRM opportunities

1.3.3 Develop and document methodologies for identifying the tangible and intangible costs and benefits of impacts of existing and potential wildlife uses and other CBNRM options

1.3.4 Develop and document methodologies for prioritization of costs and benefits for different stakeholders

1.3.5 Develop and document methodologies to assess the trade-offs between wildlife uses/other CBNRM options and existing land-use practices

1.4 Analyse and document the tangible and intangible costs and benefits, trade offs between wildlife uses/other CBNRM options and existing land use practices

1.5 In collaboration with Government and other CBNRM support institutions, develop methods to monitor and assess the impact of wildlife uses and other CBNRM opportunities

1.6 Analyse results in a regional and national context to determine suitability of replication of wildlife and other CBNRM options elsewhere

2. <u>To analyse critical internal factors:</u>

2.1 Identify at the community level, social, institutional, political and other factors that differentially affect the adoption and impact of wildlife utilization and CBNRM opportunities

2.2 Compare and contrast the findings from different field sites in the region

2.3 Based on 2.1 and 2.2 identify lessons that may assist other communities and stakeholders to diversify existing land-use practices most likely to enhance rural livelihoods

3. To analyse critical external factors

3.1 Identify the policies, planning systems, institutional roles and market contexts affecting existing community land-use practices

3.2 Analyse and document decision-making processes and implementation practices in the context of policies, institutions, markets and planning

3.3 Identify and analyse incentives and disincentives created by key external factors

3.4 Where appropriate, monitor changes in external context and any observable impact in local attitudes, decision-making and implementation at field sites during the life of the project

3.5 Synthesise other relevant information and analysis from Namibia and comparisons from southern African concerning policy impacts on local

Community Participation in Natural Resources Management Research

Chapter 4 of this book demonstrated that the local people and community perspectives need to be at the centre of research efforts for development. NRM innovations need to be *'owned'* by the local natural resource users if changes in decision-making and behaviour leading to impact are to be achieved. Such *ownership* can be effectively created through research, development and implementation of innovations by local people themselves in cooperation with outsiders (Hagmann and Chuma, 2002). Community participation in NRM Research means that researchers learn with local people and are willing to change their activities and direction in the light of locally articulated needs and knowledge. Generations of people have developed a wealth of detailed knowledge about the quality and quantity of natural resources in their realms and the means to exploit and manage them. This knowledge is a resource commonly neglected yet critical to the success of Natural Resource Management. With community participation in NRMR, local people are no longer regarded as informants but as teachers as well as monitors of change. This section considers community participation in NRMR focusing specifically on the role it plays, the participation process, the participatory frameworks, and the tools as well as the challenges of participation.

Rationale and Importance of Community Participation in Research

The most important issue about participation in Natural Resource Management Research is about the empowerment process generated by asking people to be responsible for producing the information they will need for their planning and development. By giving local peoples participatory investigation tools such as the self-monitoring of natural resource harvest levels, they can begin discovering their own potential for analyzing their own specific problems. It is hoped that this self-reliance will eventually lead to community-created management plans which are adapted for the local conditions: cultural, economic, and environmental (CGIAR, 2002).

The participation of the indigenous people in obtaining the information they will need to make their management decisions causes a change in their attitude about their future. The most important change is the confidence in which they approach the management options which are open to them. They become key players in the negotiations because they can offer hard data instead of just opinions on resource requirements. They also become more inclined to take an active role in the management decisions, as they acquire new skills and new knowledge, gain confidence and self-esteem to articulate their opinions and problems in groups and in meetings with external organizations. They can also support important dimensions of social capital such as exchange of information and knowledge, sharing of resources, collective management of resources, community engagement, spirit of voluntarism, charitable involvement, and local community participation in research and development activities.

The role of the researcher under participatory approaches is to facilitate the learning process. The researcher is not an expert with all knowledge, dishing it out to local people, but is the facilitator who sets up situations that allow people to discover for themselves what they already know along with gaining for themselves new knowledge (Sohng, 1995).

Ashby (2002), demonstrates that participatory research adds value to NRM in several ways, namely:

- By introducing new information and feedback into participatory learning and adaptive management;
- By increasing the capacity to cope with complexity and diversity;
- By the inclusion of lay knowledge in the identification of problems and monitoring of change;
- By enabling diverse stakeholders to challenge accepted wisdom, whether lay or expert;
- By potentially levelling the playing field and breaking down the monopoly of ‘one version of the truth’, which is often that of the dominant elites, and which can short-circuit collective action;
- By helping to establish agreement about what information stakeholders need and can use to make collective decisions;
- By building social capital which ‘spills over’ into collective action;
- By increasing the capacity for innovation.

Participatory Frameworks and Approaches

A wide variety of Participatory Research Approaches, concepts and methods have evolved over the past few decades. However, it is still not yet well understood which types of approaches are useful for what kind of research questions, goals and contexts. Participatory NRM Research particularly requires a strong impact orientation to guide a flexible and dynamic process of socio-technical development.

Probst and Hagmann (2003), identified various types of participation and the varying degrees of involvement in the research as: contractual participation; consultative participation; collaborative participation and collegiate participation.

- *Contractual participation.* The researcher has sole decision-making power over most of the decisions taken in an innovation process, and can be considered the ‘owner’ of this process. Local communities and resources users are ‘contracted’ to provide services and support, for example to provide labour or experimental plots.
- *Consultative participation*. Most of the key decisions are kept with the researcher, but emphasis is put on consultation and gathering information

from others, especially for identifying constraints and opportunities, priority setting and/or evaluation. This has been the case with most conventional participatory rural appraisals where resource users are only consulted in providing information for research purposes.

- *Collaborative participation*. Here, researchers and communities or resource users collaborate and are put on an equal footing, emphasising linkage through an exchange of knowledge, different contributions and a sharing of decision-making power during the innovation process.
- *Collegiate participation*. Researchers and communities or resource users work together as colleagues or partners. 'Ownership' and responsibility are equally distributed among the partners, and decisions are made by agreement or consensus among all actors.

A number of participatory approaches have evolved over the years. Most projects in the region use Participatory Learning and Action Research (PLAR) and Farmer Participatory Research employing gender and stakeholder analysis.

Participatory Learning and Action Research

Participatory Learning and Action Research (PLAR) approaches seek to strengthen the capacities of local people in marginal areas, ultimately to allow the application of more market-led and demand-oriented approaches. PLAR is based on the premise that the mandate of research cannot be satisfied by scientists remaining external actors, and as such, developing knowledge for people and assuming that their products will be taken up by a functioning institutional arrangement. There is a realization that without addressing the functioning and performance of the whole innovation system with its different actors, roles, mandates, and responsibilities, research is bound to have limited effectiveness. It therefore recognizes the need for an understanding of the context of Natural Resource Management. Stakeholder and gender analysis are, therefore, part of PLAR in order to ensure the participation of all stakeholders.

Through PLAR, it is expected, for instance, that:

- Practical knowledge and solutions can be developed which are directly useful to practitioners and people in the development process;
- By directly influencing the construction process of social reality, there is an increased probability that behavioural change and impact can be achieved through ownership;
- The people's capacity for experimentation and adaptive management can be developed;
- Scientific knowledge can be generated concerning action reaction links and factors that influence processes of change in a real life context.

The Center for International Forestry Research (CIFOR) pioneered research on Adaptive Collaborative Management (ACM) in southern Africa. This research sought to improve the ability of forest stakeholders to adapt their systems of management and organization to respond more effectively to dynamic complexity (CIFOR, 2001). ACM was an attempt to put Participatory Learning and Action Research into practice. CIFOR's research seeks to enhance the ability of forest users jointly to make and follow through on effective and equitable forest management decisions, and collaborates with many institutions involved in research, implementation and facilitation of change across a number of case studies in several countries.

NRM Participatory Research

Natural Resource Management Participatory Research (NRMPR) emerged as a potential solution to the problem of limited adoption of cropping systems and natural resource management technologies by farmers (Ashby, 2002). One explanation why participatory research methods might increase adoption is that incorporating farmers into the process of designing and developing technologies increases the probability that the technologies will be relevant and appropriate. This type of participatory research is often referred to as "functional" because its purpose is to improve the efficiency of a conventional research process (Ashby, 1996).

NRMPR seeks to improve the knowledge and capacity for innovation in those who participate in the process by empowerment through interactive learning experiences for both resource users and researchers (Okali *et al*., 1994). This type of farmer Participatory Research known as "*empowering*," views the research process as an interactive learning experience for both farmers and researchers. This approach is particularly promoted among practitioners in the area of Natural Resource Management where technologies are often complex and require adaptation to specific agrarian situations.

Ideally, NRM Participatory Research should provide opportunities for local reflection and analyses that promote information sharing, consultation, and self-mobilization. Approaches such as Participatory Rural Appraisal (PRA) have been used widely in African countries to conduct people-centred research and to facilitate development planning and NRM (PRA Programme, 2002). Figure 9.4 summarizes the process of PRA as used in community-led NRM and development research and action planning.

As depicted in Figure 9.4, at the heart of the PRA process is active community involvement in secondary field and technical data collection and analysis. Vernooy and McDougall (2003) summarized the following principles of good practice in NRMPR:

- *The research reflects a clear and coherent common agenda* (or set of priorities) among stakeholders and it contributes to partnership building;
- The research addresses and integrates the complexities and dynamics of change in human and natural resource systems and processes, including local understanding of these;

- *The research applies the 'triangulation principle'* (multiple sources of information and methods), and links together various knowledge worlds;
- The research contributes to concerted planning for the future and for social change;
- The research process is based in iterative learning and feedback loops and there is a two-way sharing of information.

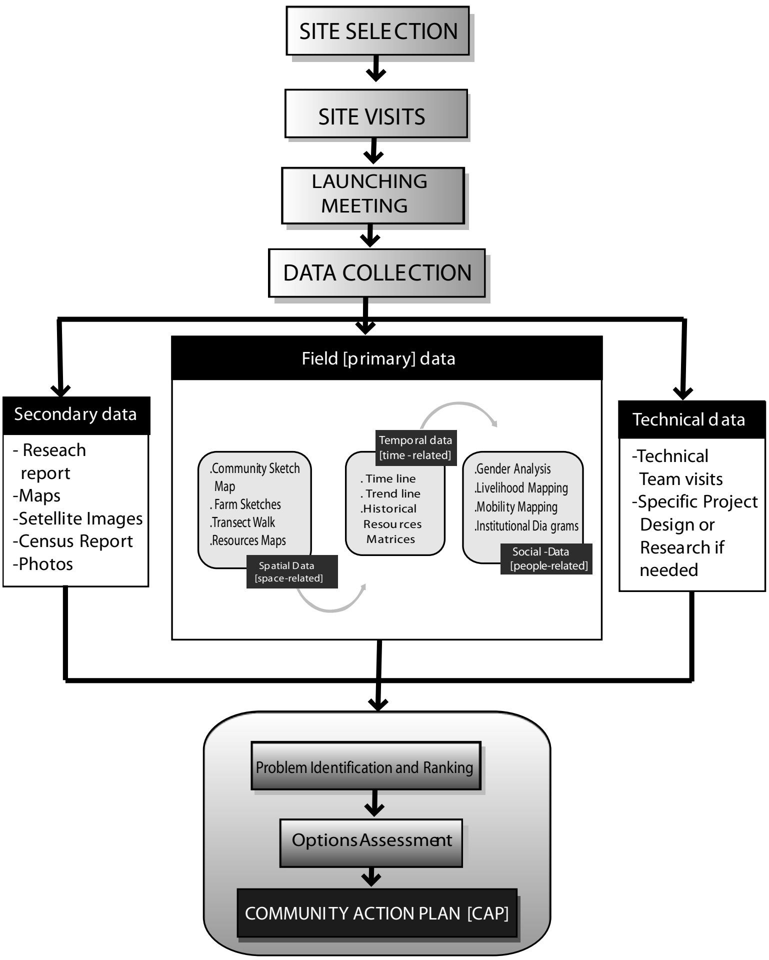

Figure 9.4: The Participatory Rural Appraisal Process

Source: PRA Programme (2002).

Deciding where and with whom to work is an important aspect of research planning. Where to work is normally influenced by a natural resource domain that is of interest to the researchers and funders. While objectivity in choosing research locations with respect to local community needs is advocated in the scientific circles, often these choices are affected by such practical factors as accessibility of the areas, budget limitations, acceptability of research ideas by local communities, experience of previous researchers in the area, and researcher security concerns. The choice of research sites are further influenced by the local government organization in the area.

Most projects are still researcher-led with less participation by local people including women and children. Active participation on communities in NRM initiatives can influence the outcomes, as demonstrated by the case study in Box 9.3.

Box 9.3: Community Participatory Approaches in Natural Resource Management: The Case of Burkina Faso

The Village Lands and Natural Resources Management Project in northern Burkina Faso is based on a village lands management approach that is both flexible and participatory, and that takes account of realities in the field and the various policies and strategies in effect, such as Decentralization in rural areas; and, The International Anti-Desertification Agreement. In its development, the project fits the pattern of a learning process and applies the principles of partnership and accountability with respect to the beneficiary populations. The project has operated in the Kishi Beiga area since 1991. The first steps taken by the project were to systematically set up a village lands management organization and develop miscellaneous infrastructure. Evaluation of these actions served to highlight the following shortcomings: the organization's lack of representativeness and the failure to take certain groups into account, including transhumance pastoralists. The approach was relatively closed and rigid and was designed for land with finite limits, i.e. agricultural lands. It did not take into account the full dimensions of pastoralism and the complexity of the socio-ethnic and political circumstances of Kishi Beiga. Given the failure of the initial intervention, after a pause the project revised its approach and its operating principles.

The new strategy consisted of encouraging an interactive process of communication with all groups and neighborhoods as a way to begin the learning process and develop the local potential for consultation among different groups. The goal was to achieve a level of organization that makes it possible to plan and re-plan actions and encourage collaborative and sustainable management of the land and its resources (both agricultural and pastoral). The role of the project was limited to facilitating discussions about cooperative action, based on the use of participatory tools and an open approach to village lands management.

Once this partnership arrangement was established, the population of Kishi Beiga, eager to secure a radiant future for the area, succeeded in placing collective interests above individual interests, specifically through the creation of a consultative unit linking different groups. The members of the unit are democratically selected by the population of Kishi Beiga insofar as each quarter is represented by at least two elders. Geographic poles of consultation have been set up which, as a result of their proximity to local communities, translate into more effective action and reduce the cumbersomeness associated with such vast spaces; and, Channels of communication have been improved by arranging a series of information releases and keeping records at each level (unit, pole, village, neighbourhood).

As of 1996, i.e. one year after the project was resumed, the unit had already succeeded in setting up rules governing the utilization of resources such as post-harvest pasturage, boulis, salt resources and ponds, as well as the zoning of village lands. In addition, the unit had managed to settle conflicts between Peul transhumants and Mallébé and Bellah agro-pastoralists concerning the management of infrastructure such as pumps. More recent accomplishments (1997), concern:

Setting up new rules to protect trees and natural water points;

Virtually total self-reliance on the part of the unit as regards its operations: many more meetings are held and decisions made without the knowledge of the project and other stakeholders;

Self-planning (i.e. grassroots planning) of development actions in the region at the prompting of the consultative unit, facilitated by planners (men and women farmers) that the project has trained and by the strengthened organizational arrangements resulting from the creation of geographic poles; and,

Initiating forums for negotiations with technical and financial partners in order to mobilize resources for implementation of their micro-projects on the restoration of natural resources and socio-economic development.

Source: Banzhaf et al., (1998)

Challenges of Community Participation in Natural Resources Management Research

NRM researchers often have to work with a rather heterogeneous social and natural environment where people face diverse challenges, have conflicting goals, values, interests and sets of conditions. Under such circumstances, it is still unfortunately assumed by most researchers that an innovation might be of equal relevance to all, and that innovations easily diffuse among users based on rational, causal considerations. Differences between the main actors, including social status, perspectives, interests and expectations, influence the way knowledge is generated and shared. Actors might have differentiated interests, relationships, values, power and access to resources, conditions in which rapid and widespread dissemination of a particular innovation is unlikely.

The following assumptions also act as challenges:

- *Legitimisation*: Participation is evoked to obtain local people's consent for outsiders to do what they perceive as important. Participation may be used because it is fashionable and demanded by donors;
- *Effectiveness and efficiency*: Participation is used to make use of local knowledge and/or to ensure demand-orientation, i.e. that locally-felt needs are addressed. Effectiveness means desired outcome is achieved and efficiency means achievement of outcome is at minimum cost;
- *Capacity-building/learning*: Participation is a means to gaining practical experience through working together, and being involved in analysis, planning and decision-making. It leads to personal and professional growth

among local people and researchers. It can result in changes in attitude, increased capacity for reflection, improved communication skills, more conscious decision making, management and organizational capacity, etc;

- *Emancipation/transformation*: Participation is considered as a means of enhancing local people's capacity for self-directed innovation development or adaptive management. The process is seen to increase capacity for articulation and negotiation of interests, leadership, collective action, critical consciousness, and self-esteem among marginalised social groups.

The above-cited assumptions often hinder the development of truly collaborative or equitable relationships (Sutherland, 1999). Local people may be unaccustomed to articulating their opinions in group settings and or in the presence of professionals, and they may try to anticipate what project staff wants to hear. It is frequently assumed that people know what their problems are, can articulate them, and are ready to share them with outsiders in a participatory appraisal. However, since this degree of emancipation is true in very few cases, the quality of the demands expressed is often shallow. Revealing the issues which really matter presents a challenge to facilitation.

Managing Natural Resource Management Research

Key Research Management Elements

Successful NRM research projects are those that produce tangible outcomes, contribute to progress in integrative research, and provide positive experiences for their participants. Projects should identify a common research question and clear project goals which will identify the relevant disciplinary expertise needed. Because *integrative projects* have higher time demands, time management practices and the allocation of realistic time budgets should be adopted especially at the beginning of projects. Strong leadership plays a crucial role in the success of *integrative research* and requires a high level of interpersonal skills as well as research capability. Frequent meetings, that are subjected to careful time management, among the participants and the support of the wider research environment also help to achieve success. Project teams need to arrive at a common understanding and definition of the *integrative concept* and prepare for overcoming epistemological hurdles by acquiring basic knowledge and skills in the disciplines involved. Projects should be planned for tangible project outcomes or deliverables, such as new technologies, innovations and publications. Projects should also agree on evaluation criteria and use these to assess the project and its outcomes on a regular basis. Experiences contain valuable knowledge that will, over time, lead to more successful *integrative research* that is managed participatively and collegially

Ethical Considerations in Natural Resource Management Research

Research *ethics* define what is or is not legitimate to do, or what moral research procedure involves (Neuman, 2000). *Ethics* of research is not about etiquette, nor is it about considering the poor hapless subject at the expense of science or society (Sieber, 1992). Rather we study *ethics* to learn how to make research work for all concerned. The *ethical* researcher creates a *mutually respectful, win-win relationship* with the research population. This is a relationship in which subjects are pleased to participate candidly, and the community at large regards the conclusions as constructive. Public policy implications of the research are presented in such a way that public sensitivities are unlikely to be offended and backlash is unlikely to occur. *Ethical* responsibilities are associated primarily with the design, conduct and reporting of the research.

Governing principles for *ethical research* are voluntary participation, informed consent, confidentiality and anonimity. The principle of voluntary participation requires that people are not coerced into participating in research. Closely related to the notion of voluntary participation is the requirement of *informed consent*. Essentially, this means that prospective human research participants must be *fully informed* about the procedures and risks involved in research and must give their *consent* to participate. David de Vaus (1995), gives an extensive checklist in regard to *informed consent*, advocating that *informed consent* needs to provide the participants with knowledge of:

- The research purpose and processes;
- Any potential risks or harm;
- The benefits of the research;
- How the participants were chosen;
- The ability to ask questions concerning the research;
- The voluntary nature of their participation;
- The identity of the researcher and sponsor;
- How the findings will be used.

This checklist helps in ensuring that local people participate and *consent* from an *informed* point of view.

Ethical standards also require that researchers do not put participants in a situation where they might be at risk of *harm* as a result of their participation. *Harm* can be defined as both physical and psychological. *Confidentiality* and *anonymity* standards t are applied in order to help protect the privacy of research participants. *Confidentiality* assures that information related to specific individuals will not be made available to anyone who is not directly involved in the study. The stricter standard is the principle of *anonymity* which essentially means that the participant will remain anonymous throughout the study, even to the researchers themselves. This principle applies in some research methodologies where there is individual participation of community members such as in baseline surveys using questionnaires rather than focus group discussions. *Ethical guidelines* are important for ensuring that research funding institutions and research organizations protect themselves and the communities they work with from harm. Box 9.4 illustrates the guidelines from the International Development and Research Centre (IDRC).

Box 9.4: Ethical Guidelines from the International Development Research Centre (IDRC)

An ethical project:

- Does not harm human subjects.
- Follows procedures and protocols to ensure humane treatment of animals.
- Protects the privacy, dignity and integrity of all human subjects.
- Ensures that any corporate or personal information collected involves informed consent.
- Informs people of the aims, methods, anticipated benefits and potential hazards of the research.
- Maintains confidentiality of personal or commercially valuable information.
- Informs subjects of their right to abstain from participation in the research and their right to terminate their participation at any time.
- Refrains from applying any pressure or inducement of any kind to encourage an individual to become a subject of research.
- Destroys information that reveals the identity of individuals who were subjects at the end of a project unless the individual concerned has consented in writing to its inclusion beforehand.
- Does not reveal any information about the identity of any individual in any report, unless the individual concerned has consented in writing to its inclusion beforehand.
- Ensures that when children are involved, their participation is undertaken in accordance with high ethical standards. Children shall not be allowed to participate unless their parents/guardians have been counselled and they have given their free, explicit, and informed consent.
- Informs subjects of any finding that relates to their particular health status.
- Informs subjects of any foreseeable risks, pain or discomfort, or inconvenience to the individual (or others) associated with participation in the research.
- Provides an opportunity to share back with the community and the people involved the results of the research.
- Protects indigenous and traditional knowledge through mechanisms agreed with the respective communities and in conformity with the spirit of the Convention on Biological Diversity (particularly article 8j) and the promotion of fair and equitable sharing of the benefits arising from the use of genetic resources.

What you need to do

- For projects involving research on human subjects, an independent *ethical review committee*, whether in the recipient institution or in the host country, must approve *ethical protocols.*
- The proposal should provide detailed information on the *ethical dimensions* of the research and how these will be handled.
- The Recipient shall immediately report to the Centre any difficulties it encounters in complying with the *ethical standards*.
- If you are using assistants, you must also ensure that they have a clear understanding of *ethical issues* and follow *ethical procedures*.

(Source: IDRC)

Figure 9.5:Challenges of Managing Integrated Natural Resource Management Research

Managing NRM research can be faced with challenges concerning working with communities and meeting their expectations, applicability of research methodological approaches, institutional support, funding and stakeholder diversity, among others, as summed in Figure 9:5.

Data Management in Natural Resource Management

As stated before, the research process entails making observations and recording them for analysis and interpretation. These records may be in the form of numbers from empirical measurements or descriptions from qualitative discussions. In most research activities, the data collection process is allocated the biggest share of the research funds and so data collected must be properly managed for the greatest value for money to be derived from it. Data management problems can be a major barrier to the progress of research. There are two aspects of data management, namely managing data collected within a specific research project and managing data across different research projects, research institutes and even countries.

Data Management Within a Research Project

There is an increasing volume and complexity of research data being collected in various research projects. *Research Data Management* needs to be considered from the research proposal development stage so that adequate funding is sought and provided for the technical and institutional capacity required to capture, process and archive data. Organizational provisions must be made for *Data Management* at the research institution as well as across institutions for the purposes of data sharing. The advancements in the electronic services and the deluge of data being collected in various research activities within and across institutions, the cost of data collection and the advancement of data processing and modelling software and packages are making it increasingly necessary for the creation of *Data Management* facilities that facilitate archiving, retrieval, re-use and sharing of data for the advancement of humanity.

Data Management refers to any activity concerned with looking after and processing data collected from field and/or laboratory research activities. These data include numbers resulting from measurements together with information (metadata) about where they came from (Njuho and Nabasirye, 2009). Data is managed so that correct and accurate analyses may be made, thereby leading to correct conclusions. Proper data management also allows for the same data to be made available for future use. This is important because the same data may be required by the same or different researchers in the future and, subsequently, use of it will be an efficient use of research funds.

Research Data Management aspects include (Njuho and Nabasirye, 2009):

- *Planning*: taking into account the objectives, planned outputs, resources, software and skills available. For instance, in a participatory NRM Action Research for Forests Management, quantitative data may be collected on the status and productivity of the forests (this may include maps and *species richness assessments*) as well as qualitative data on community perceptions of the value of the forests. It is important to plan how the different data will be captured in the field to enable ease and efficiency of the statistical analyses and modelling processes
- *Designing field data recording sheets that permit the efficient and accurate capture of the various forms of data:* The researcher must anticipate the various ways in which the data will be presented in the field and ensure that adequate space is afforded on the data sheets.
- *Collecting data with appropriate quality control:* The data collecting team must be adequately trained and sufficient time allocated for each data collection activity so that entries are not hurriedly and inaccurately made. Data sheets must be protected from weather elements.
- *Checking raw data:* Data sheets must be proof-read and checked for obvious omissions and errors, preferably whilst the team is still in the field and appropriate rectifications made.
- *Data entry for organization of computer files:* Data entry into the computer must be done soon after field collection and adequate time must be allowed for this process. Computer files must be designed to store all the raw data so that anyone accessing the files should be able to find and understand everything there is to know about the research. A *spreadsheets package* selected on the basis of ease of use, flexibility and familiarity to users can be used for data capture. Each data worksheet must contain the

experiment/survey details, design factors and measurement variables. Data correctly entered in a worksheet can be directly transferred to a statistical package for analysis. The data must be periodically saved during entry and backed up on more than one external devise such as flash disks and hard disks to eliminate the risk of losing the data.

- *Processing data for analysis*: This includes checking for missing values and errors in entry, data transformations (e.g. units per hectare) and coding for some qualitative variables.
- *Archiving data for future use:* Research data must be managed and properly archived to control the costs associated with storing and retrieving increasing volumes of data. Data archiving and sharing has the advantage of meeting the contractual obligations of research funders who operate data sharing policies, reducing the cost of duplicating data collection efforts, promoting research and may lead to new collaborations with data users, demonstrating the value of researchers' work by allowing continued re-use of the data, which may influence funding agencies to provide further funding.

Technical Data Management problems include inability to use the software, inability to set up data checking procedures and organizing data in ways which are incompatible with required uses. Organizational problems include non-designation of responsible personnel for data checking, multiple copies of files, no clear policy for archiving data and making it available. A*d hoc* organizational methods limit the future usefulness of data. As a result of disorganized data, search and retrieval capability is also limited. Many researchers lack the financial and institutional support for acquiring new expertise or tools for data management. Also, when making funding proposals, most researchers underestimate the resources required for Data Handling and Management. Conceptual Data Management problems include multiple entries of the same data or hand reprocessing of data, poor links between the numbers and information on the source of numbers and poor audit trail.

Data Management Across Research Projects

Field Data Acquisition is very expensive. Research Data Management beyond specific projects is important because we are in an era of increasing data-intensive research with more researchers re-using data more often for multiple purposes. There is need to reduce the costs and raise the benefits of data sharing. Institutions need to take responsibility for the outputs of their research. Hence research strategies should include guidance on how to manage outputs, preserve and archive data. Beagarie *at al.,* (2009) note that expectations about the rate of increase in research data generated indicate not only higher data volumes but also an increase in different types of data, and data generated by disciplines that have not until recently been producing volumes of digital output. This brings with it challenges around data management and preservation that include informing and assisting researchers in best practice to facilitate data re-use and sharing.

Data sharing frameworks are important to facilitate and encourage the use of modern data exchange models and standards which will allow individual researchers with specific problems to have a common layer of inter-operability and analysis; improve the ability of researchers to maintain provenance of research data and models as they evolve over time; and provide a spectrum of support options that could be used to address the range of unique individual researcher needs.

The Principles of Wider Data Sharing are (Lyon, 2007)

i. The roles and responsibilities of researchers, research institutions and funders should be defined as clearly as possible (Table 9.4). This is because research is in a phase where the quantity and the heterogeneity of data have exceeded many investigators' ability to analyze, or in some cases, even archive their own data. There is thus need for collaborative sharing of responsibilities in the management of research data for wider sharing. Key data stakeholders are data creators who produce digital data, data managers who operate databases and are a 'competent partner' in data archiving and preservation, and data users in the scientific, educational and professional communities. The increasing use of core service facilities within institutions to provide expertise such as biostatistics has lowered many technical barriers to data management and sharing and has allowed investigators to generate and collect data outside their own discipline more easily.
ii. Digital Research Data should be created and collected in accordance with applicable International Standards, and the processes for selecting those to be made available to others should include proper *quality assurance*.
iii. Digital Research Data should be easy to find and access; should be provided in an environment which maximises ease of use; should provide credit for and protect the rights of those who have gathered or created data; and protect the rights of those who have legitimate interests in how data are made accessible and used. The "right of first use" must be recognized as scientists are not prepared to let others use their data until they are fully published.
iv. The models and mechanisms for managing and providing access to digital research data must be cost-effective in the use of public and other research funds.
v. Digital research data of long term value arising from current and future research should be preserved and remain accessible for current and future generations. *Data is increasingly becoming of long-term utility*. For instance (Beagrie *et al*., 2009), in a UK survey report that agriculture and forestry data has a useful life of up to ten years.

Access to accurate and up-to-date data and information in a timely fashion is critical to the successful management of natural resources. A number of key information policy issues need addressing, and include cost, format, system design, copyright and Intellectual Property Rights, privacy and liability.

Data ownership implies the right to utilise the data, and in situations where the continued maintenance becomes unnecessary or uneconomical, the right to destroy them. (It is, however, rare for natural resources data to need to be destroyed). Ownership can relate to a data item, a merged dataset or a value-added dataset. Intellectual Property Rights can be owned at different levels, e.g. a merged dataset can be owned by one institution, even though other institutions own the constituent data. If the legal ownership is unclear, the risk exists for the data to be wrongly used, neglected or lost. Ongoing data security audits are necessary to monitor the use and continued effectiveness of existing data.

Table 9.4: Roles, Rights and Responsibilities of Data Stakeholders

Role	**Rights**	**Responsibilities**
Scientist: Creation and use of data	Data first use. To be acknowledged. IPR to be honoured. To receive data training and advice.	Manage data for life of project. Comply with funder / institutional data policies and respect IPR of others.
Institution: Creation of and access to data	To be offered a copy of data	Set internal data management policy. Short term data management. Provide training and advice to support scientists. Promote the repository service.
Data centre: Creation of and access to data	To be offered a copy of data. To select data of long-term value	Manage data for the long-term. Provide training for deposit. Promote the repository service. Protect rights of data contributors. Provide tools for re-use of data.
User: Use of 3rd party Data	To re-use data (non-exclusive licence). To access quality metadata to inform usability.	Abide by licence conditions. Acknowledge data creators / curators. Manage derived data effectively.
Funder: Set/react to public policy drivers	To implement data policies. To require those they fund to meet policy obligations.	Consider wider public-policy perspective & stakeholder needs. Develop policies with stakeholders. Monitor and enforce data policies. Resource post-project long-term data management. Act as advocate for data curation & fund expert advisory service(s).
Publisher: Maintain integrity of the scientific record	To expect data are available to support publication. To request pre-publication data deposit in long-term repository.	Engage stakeholders in development of publication standards. Link to data to support publication standards. Monitor & enforce public standards.

Source: Lyon, 2007

Intellectual Property Rights

Intellectual Property Rights (IPRs) are rights granted to a person or a company by a state for products of intellectual effort and ingenuity. There are various forms of Intellectual Property Rights e.g. patents (Box 9.5), copyrights, logos, trademarks, labels or plant breeders' rights. Arguments for rewarding innovators are that the idea belongs to its creator because the idea is a manifestation of the creator's creativity, ingenuity, entrepreneurship and personality, and that the unpleasantness of labour and cost in time and money should be rewarded with property. In today's market-based economies, the rationale for protecting intellectual property is essentially utilitarian. If everybody is free to access new knowledge, inventors have little incentive to commit resources to producing it. By transferring knowledge from the public good to the private good, creative minds and innovative firms have an incentive to engage in inventive activities and are guaranteed to recover their expenditure in creating new knowledge and therefrom to make profit (Africa-Europe Faith and Justice Network, 2002).

Box 9.5: What are Patents and Who Uses Them?

Patents are a time-limited legal monopoly for inventors, intended to act as an incentive to innovation. Patents can only be granted nationally. There are three basic criteria for patents worldwide: novelty, utility, and inventiveness. To be patentable, an invention must be new, and useful, and must demonstrate an "inventive step". Discoveries are not patentable. To be patentable, an invention must also be replicable by someone else "skilled in the art". In other words, an invention must be well enough described in a patent claim that someone else in the same field could reproduce it from the description.

Patents are a trade-off: patent holders are granted a monopoly in the market place, in exchange for making their "intellectual property" publicly available. Patents give inventors the right to license their "proprietary technology" to others, for a fee (or the right not to, of course). Patents are now routinely used to claim exclusive monopolies over all kinds of living organisms. For instance, individual genes, gene sequences and gene fragments from all kinds: microorganisms, plants, animals and *even people have been patented*. Whole microorganisms (including viruses involved in human and animal diseases) have been patented, as well as whole plants, and whole transgenic mammals (e.g. mice, cows, sheep). Patents have also been granted on a whole range of life processes that produce patented organisms. Overwhelmingly, patents have been used as an industrial strategy by large corporations with the support of governments of the North, where they are headquartered. Industrial countries hold 97 percent of all patents worldwide.

Source: Christie (2001)

NRM IPRs relate to the value of the biodiversity and traditional knowledge. The Africa Regional Intellectual Property Organization (ARIPO)[1] states the importance of African traditional knowledge and the need for related intellectual property protection. Africa is endowed with rich and highly diverse biological resources and traditional knowledge which have been practised for centuries before the advent of colonialization. This knowledge reflects the cumulative body of knowledge and beliefs handed down through generations by cultural transmission and the relationship of the local people with their environment. The African traditional systems have developed as a matter of survival of the communities in the management of socio-economic and ecological facts of life. It includes mental inventories of local biological resources, animal breeds, and local plant, crop and tree species. It may include such information as trees and plants that grow well together, and indicator plants, such as plants that show the soil salinity or that are known to flower at the beginning of the rains. It includes practices and technologies, such as seed treatment and storage methods, and tools used for planting and harvesting. Traditional knowledge also encompasses belief systems that play a fundamental role in a people's livelihood, maintaining their health, and protecting and replenishing the environment. Traditional knowledge is dynamic in nature and may include experimentation in the integration of new plant or tree species into existing farming systems, or a traditional healer's tests of new plant medicines.

In spite of the important role traditional knowledge plays in sustainable development, it continues to be largely disregarded in development planning. It currently plays only a marginal role in biodiversity management and its contribution to the society in general is neglected. Furthermore, traditional knowledge is being lost under the impact of modernization and the ongoing globalization processes. Traditional knowledge may contribute to improved development strategies in several ways such as by helping identify cost-effective and sustainable mechanisms for poverty alleviation that are locally manageable and locally meaningful,; by a better understanding of the complexities of sustainable development in its ecological and social diversity, and by helping to identify innovative pathways to sustainable human developments that enhance local communities and their environment.

The notion of the protection of traditional knowledge has taken the centre stage in the global debate on the actions that could be taken to preserve, protect and promote the development of the knowledge. Cross-cutting issues including the rights of indigenous populations to benefit from the use of their resources, the relationship between the patent requirements of the Trade-Related Aspects of Intellectual Property Rights (TRIPs) Agreement, the substantive obligations of the Convention on Biological Diversity (CBD), the asymmetry between the benefits obtained by

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1 ARIPO is an inter-governmental organization with 16 Member States established to foster regional cooperation in IPR issues (www.aripo.org)

companies that exploit traditional knowledge-based products and the lack of benefit for the traditional knowledge holders - have engaged the attention of the international community.

NRM researchers are obliged to observe IPR of communities as per Article 7 of the TRIPs Agreement which states that the protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge, and that in a manner conducive to social and economic welfare, and to a balance of rights and obligations.

Research Communication, Dissemination and Knowledge Management

The whole point of research is to provide information and knowledge that enable the various stakeholders to improve their management practices and attitudes, and to make more informed decisions on various courses of action. This requires an effective communication, information and knowledge sharing strategy. Communication and uptake promotion are increasingly recognised as essential considerations for the planning, conduct and management of NRM research. It is therefore important for research teams and projects to develop and implement sound communication strategies as an integral part of the research process. This will ensure that new knowledge is available for users (scientific community, policy makers, development practitioners, planners, farmers, etc.) in forms that they can adapt and utilize.

Designing a Research Communication and Dissemination Strategy

Successful NRM research should include a communication strategy that puts into focus the generation, dissemination, utilization and continuous evaluation of the information and knowledge needs of stakeholders and other pertinent research management issues important to the implementation of the study. A research communication strategy serves as the mechanism and platform for communication, awareness raising and knowledge management for a research project (Allen & Kilvington, 2003). It considers:

- Products and issues to communicate to various stakeholders at various stages of the research;
- The knowledge, attitude and practice of the stakeholders with respect to NRM information and knowledge generation and utilization;
- Action expected of the stakeholders after communication;
- Content, method and media of project communication for various stakeholders;
- Feedback needed from stakeholders for improvement of communication strategy and project implementation.

DfID's Natural Resources Systems Programme provides list of 10 questions to answer when designing and implementing a communication strategy, Box 9.6.

Specific strategies must be designed for both short- and long-term communication needs of the stakeholders. The short-term communication strategy includes those communication activities necessary for the establishment and launching of the research project and its output based research, policy and product development components. The production and use of various media and visits to be undertaken by various categories of stakeholders must be clarified. Long term communication actions are primarily aimed at sustaining efficient research management and enhancing sustainability with regard to continuity, support from partners, and *quality assurance* over the research period. It also entails intensions to disseminate the process and findings of the research through a variety of channels. Table 9.5 is an example of a communication strategy drawn from a cassava project of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA).

Box 9.6: NRM 10 Key Communication Plan Questions

Q1 What are the aims of the project's Communication Plan in relation to the project purpose?

Q2 Who within the project team will be responsible for the implementation of the Communication Plan?

Q3 Who are the communication stakeholders for the project?

Q4 What are the research products and other issues that the project team need to communicate about with the communication stakeholders?

Q5 What are the current Knowledge, Attitudes and Practices (KAP) of the communication stakeholders in relation to the products to be promoted?

Q6 What are the objectives of communicating about the products to the communication stakeholders (i.e. what might they want to be able to do once the project team have communicated with them)?

Q7 What media and channels might be used to communicate with the various communication stakeholders in relation to the research products (e.g. what is accessible to them, what are their preferences, what can be sustained after the project is over)?

Q8 How will the project team ensure that communication materials are useful (e.g. contain relevant information), usable (e.g. in a language they understand) and accessible (e.g. at a suitable time and place) for those with whom the project wishes to communicate during and after the project?

Q9 Are the proposed Communication Plan activities and materials included in the project budget?

Q10 How will the project team monitor and evaluate the implementation of the Communication Plan and its component parts?

Table 9.5: Excerpt of Communication Plan of the ASARECA's Cassava Mega Project

Stakeholder(s)	Products and issues to communicate	Knowledge, attitude and practice (KAP)	Action to be taken after communication	Method/media of communication	What feedback needed from them
Farmers	Varieties Planting materials	All target groups and farmer associations are adequately aware of the development, products and services from the mega project	To own the technologies Plan for sustainability, Integration of farmer technology and extension needs in further project work and products/services	Extension document, Leaflets, Operating manuals, extension releases, Field days, Newsletters, Booklet, Visit, Farmer led-project proposals	Approval and internalisation Budgetary allocation in support of project activities in response to farmer needs
Private Sector (industrialists, seed companies, input suppliers, processors, exporters, buyers, small traders)	Value addition to their business, Networks for joint production, processing and marketing, Market information Value addition to their business environment (better policies, timely communication)	Aware of the low capacity of agricultural extension staff in technology diffusion and marketing. Eager to promote innovative cassava developments.	Value contribution of the process and output of cassava production and commercialization Increasing profit/wealth Demand for quality cassava product and by-products Demand for better policies for investment in cassava	Operating manuals, Press releases, Policy briefs, Newspapers, Websites, Posters, Attending PS Meetings, Newsletters	Sponsorship of members to project meetings, More enlightened willingness to adopt technologies

Researchers provide NRM information and knowledge to empower stakeholders in making evidence-based decisions. Yet, research is frequently not available, accessible, relevant, or useful – which limits its applicability for improving NRM systems. An effective research dissemination strategy is likely to increase stakeholders' research uptake. The strategy should be considered during the research planning process and address the communication objectives, target audiences, appropriate channels, and assessment of use. Stakeholder groups vary by their information use, familiarity with research terminology, and preferences for receiving information – resulting in the need to tailor research findings and recommendations for different audiences.

Knowledge Management

There is no one universal definition of knowledge management (KM), just as there's no agreement as to what constitutes NRM knowledge in the first place. The utility of KM in NRM research is best considered in the broadest context. KM is the process through which research participants generate value from the knowledge generated from research as well as from their intellectual and NRM knowledge-based assets. This often involves codifying what resource users and stakeholders and knowledge customers know as well as sharing that information effectively in an effort to devise and influence best practices in resource conservation, policy making and other NRM decision-making. A knowledge management strategy considers NRM knowledge acquisition, sharing and utilization (Figure 9.6).

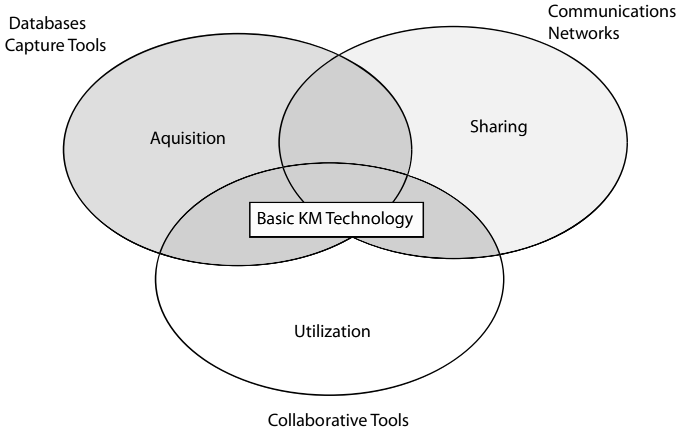

Figure 9.6: Basic Elements of Knowledge Management

It is important to understand the concept of data, knowledge, understanding and wisdom as they relate to KM in NRM research. *Data* is the raw unprocessed facts, objects and other output of an investigation. *Information* is data that has been given meaning by way of relational connection while *Knowledge* is the appropriate collection of information, such that its intent is to be useful. *Understanding* is an interpolative and probabilistic process by which one can take knowledge and synthesize new knowledge from the previously held knowledge. *Wisdom* is extrapolative and non-deterministic, non-probabilistic process by which we also discern, or judge, between right and wrong, ethical or unethical, good and bad. Figure 9.7 represents these four knowledge management levels. Our choice of an NRM research dissemination approach will depend to a large extent on the level of research operation.

The key KM questions to ask in an NRM research process include (Allen & Kilvington, 2003):

- Is the researcher process properly storing its information? Is it secure? Is it organised in a way that makes it accessible?
- Can stakeholders easily access the information and research findings so that they can readily respond to NRM?
- Is research process aware of the difference between "information" and "knowledge" and the different ways in which they need to be managed?

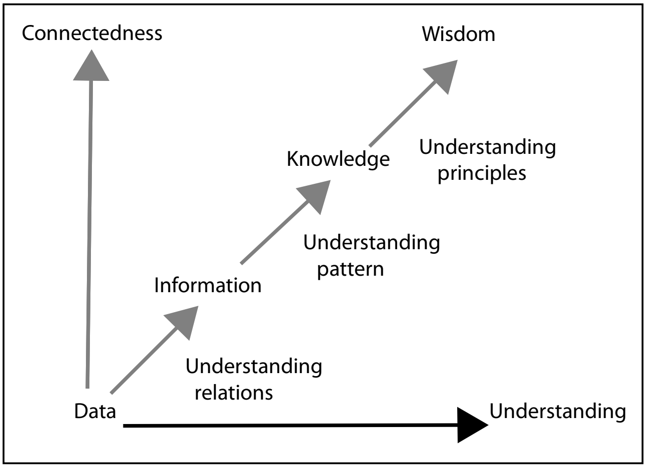

Figure 9.7: Representation of Knowledge Levels for NRM Research Communication

Source: Ackoff (1989)

- Can NRM stakeholders and researchers easily access past work so that practitioners are not constantly re-inventing the wheel?
- Are we communicating information and knowledge to your stakeholders in the best possible way?
- Are stakeholders accessing the best available information and knowledge to use in NRM decision making?

Information Dissemination

NRM researchers and research organizations need to become more adept at sharing their findings and knowledge through collaborative learning processes and appropriate dissemination products. Efforts to foster knowledge sharing and collaboration among actors in NRM research have tended to focus on better management of information flows and on the capture of codified knowledge resulting from NRM research. These efforts focus only on aspects related to information management rather than on knowledge sharing. Though necessary and important, these activities are not sufficient for helping scientists deal with the complex challenges of sustainable NRM Management and Development.

Although some *communication methods and formats* may be effective with multiple stakeholder groups, stakeholders generally prefer key messages that are concise and actionable. A range of media outlets are available that provide researchers with several communication options. Yet, in reality, the options may be limited by budget considerations and by which audiences are being targeted. Some of the most common methods of disseminating NRM research information are summarized in Table 9.6.

Table 9.6: Suggested Dissemination Methods for Various Stakeholders

Policy Makers, Politicians and Government Officials: ▪ dissemination workshops ▪ face-to-face meetings ▪ policy forums ▪ policy briefs, brochures, and executive summaries ▪ public Web sites *NRM Programme/Project Managers* ▪ monthly or quarterly reports ▪ summary reports ▪ executive summaries ▪ audiovisual presentations *Civil Society, NGOs and Professional Associations:* ▪ fact sheets ▪ brochures and other handouts ▪ audiovisual presentations	*Private-Sector:* ▪ fact sheets ▪ audiovisual presentations *General Public:* ▪ magazines ▪ newspapers ▪ press releases ▪ radio ▪ television ▪ Web-based media *Donors/Funders:* ▪ full research report ▪ audiovisual presentation *Academic Researchers and International Agencies/Organizations:* ▪ peer-reviewed article ▪ research databases ▪ oral and poster presentations ▪ CD-ROM ▪ Web sites

Knowledge sharing must adopt a practical approach building on previous efforts. Expertise in several knowledge sharing-related areas – such as facilitation (including on-line facilitation), participatory decision-making, and the use of knowledge-sharing approaches and tools that allow researchers and their partners to discover and experiment with new ways to establish collegial relationships and foster more creative scientific collaboration – must be advanced.

Scientific Writing

Scientific report writing should be guided by a plan. Use of a template to put the report together, and assembling one's thoughts in a logical order while clarifying specific questions to be answered, makes the task less daunting. Planning the report should involve defining of tasks for writing the various components of the report and giving feedback. The formatting requirements of the intended report recipient, such as a donor or a journal, should be well understood before writing commences. An ideal scientific report form an NRM study should be no longer than 6000-8000 words. Only sufficient background about why you did the study, sufficient methods to repeat the study, and sufficient data and explanations to understand the results should be provided. Report writing is a process that should involve preparation of drafts, reflecting on them, revision, feedback by colleagues, revision and more feedback and revisions until an acceptable final report is produced.

The style of writing and presenting the report is of fundamental importance for achieving brevity and clarity. Ideas must be presented logically. Tight writing is the art of achieving brevity by using short, concise sentence of about 20-30 words maximum.

Most NRM journals provide instructions to authors with guidelines for writing articles and contributions. These include African Journal of Ecology (See details at: http://www.wiley.com/bw/journal.asp?ref=0141-6707&site=1).

The following is a standard format of a report:

The Title: Must effectively identify the main issue of the research: beginning with the subject of the research – it is accurate, unambiguous, specific, and complete; does not contain abbreviations; and attracts readers.

The abstract: Should be a short summary of the completed research project and sufficiently informative for other scientists who are not necessarily in the field of expertise. The abstract should contain the aims of the study, the basic study design and methods, the main results and the conclusion and interpretation. It is suggested that this item should be written last after all sections of the document are completed.

Introduction: Should be short and arresting and tell why the study was undertaken. It should adequately review the background and state the aims. The first paragraph should be a very short summary of the current knowledge of the research area. This should lead directly into the second paragraph which summarizes what other people have done in this field, what limitations have been encountered with work to-date, and what questions still need to be answered. This, in turn, should lead to the last paragraph that should clearly state what was done and why. This includes research objectives or aims.

The purpose of the Materials and Methods: This section describes how the results were obtained by giving precise details of where the study was conducted, the study design, sampling details, the methods that were used, and how the data was statistically analyzed. Every measurement reported in the results section must have a description of the method used to obtain it. This section should only be as long as is needed to describe the essential details. In reading this section, one should be able to appraise the work critically or repeat the study as it was conducted.

The Results Section: Is the most important part of the Scientific Report because its function is to give specific answers to the aims that were stated in the introduction. It is important to convince the reviewers that the study extends knowledge rather than merely confirms what is already known. A good practice is to describe what you found in the text and then back it up with results that are shown in a figure or a table. Always try to present results in an objective and dispassionate way and only extrapolate findings to values within the range of the study sample. Tables and figures should only be used where necessary and should be adequately captioned.

The Discussion Section: Should reiterate the main findings but in the context of furthering knowledge or impacting on current natural resources practice, policy or future research. This is the time to be honest about any limitations of your study, to explain how your findings fit in with established knowledge, and to explain any inconsistencies. The “so what?” aspect of the research needs to be clearly addressed here. The best “Discussions” sections end with statements that recommend policy or practice without generalizing results beyond the bounds of the type of samples included in your study and without over-interpreting your findings.

The References Section: Is important for giving credit to the ideas and work of other scientists. If you are quoting a method, a sentence, an idea, or some results published by another researcher, then you must cite the original source here. Using other researchers’ ideas or any parts of their writing as your own is a serious offence of plagiarism against copyright laws. It is also immoral and unethical!. A golden rule for a research report is to cite a maximum of 20-35 references maximum.

Scientific publications are of use only to academics and researchers and inappropriate for generally many policy and decision makers who do not have the time to read them and may not be able to comprehend the scientific jargon. For this audience, policy briefs and brochures might be more useful (Table 9.7).

Table 9.7: Tips for Developing Press Releases, Brochure and Policy Brief for Research Dissemination

Tips for Writing a Press Release	**Tips for Developing a Brochure**	**Tips for an Effective Policy Brief**
Make it short (one page) and use simple, non-academic language. Follow the format of a news story. The headline should contain keywords and catch the reader’s attention. The first paragraph should address the ‘How’, ‘who’, ‘what’, ‘where’, ‘when’, ‘where,’ ‘why’ and ‘which’ questions. Write in the third person. Use short sentences. Use active verbs and avoid passive voice.	Readers should be able to understand the message at a glance. Colours, images, and effective typefaces add flavour. State the problem in terms of an objective. Review the background and rationale for the initiative. Present research results and their implications. Include an overview of the research project/institution /team. Provide links to further sources of information. Provide contact information.	Identify a problem, propose a solution and present a compelling recommendation. Use a professional and not. academic tone. Ground the argument in the evidence. Make it interesting by using images, quotes, photographs, boxes, etc. Make sure the recommendations are feasible. Consider providing supporting documents with the policy brief. The length depends on the intended audience (two to eight pages).

Source: Campbell et al., 2008

The policy brief is an especially important research outreach document. It outlines the rationale for choosing a particular NRM policy alternative or course of action in a current policy debate and emanating from an NRM research. As with all research communication tools, the key to success is targeting the particular audience for the research and policy message. The most common audience for a policy brief is the decision-maker but, it is also not unusual to use the document to support broader advocacy initiatives targeting a wide but knowledgeable NRM audience. In constructing a policy brief that can effectively serve its intended purpose, the brief must be focused; professional and not unduly academic; evidence-based; limited to a comprehensive but targeted argument; succinct but understandable in language and context; accessible; promotional; practical and feasible. For an example of a policy brief visit *www.worldagroforestry.org/downloads/publications/PDFs/BR09326.PDF* that captures the findings of fodder *research* programme at the World Agroforestry Center (WAC) in collaboration with the Kenya Agricultural Research Institute (KARI) and the Kenya Forestry Research Institute (KEFRI) in and other national agricultural research and forestry institutes in Burundi, Rwanda, Tanzania and Uganda developed fodder trees as a viable technology in East Africa and a further catalytic action-research role in its scaling up. The policy brief is based on the study by Place *et al., (*2009).

For some rural farmer communities, use of vernacular posters, pamphlets and brochures in simplified language is recommended. Other useful dissemination methods include farmer discussions and presentation at field days and agricultural shows, as well as radio broadcasts.

Summary

This chapter has addressed the major components for consideration in designing and implementing NRM research. The conceptual difference between *conventional scientific and NRM research* is based on the need for the researchers and the NRM community to be joint learning partners in the process, with expectations of each party being clearly recognized. NRM research approaches have been evolving towards participatory solving of issues of concern to and identified by the communities. NRM research should facilitate innovations aimed at improving food security and livelihoods enhancement. The success of such research is a function of appropriately addressing issues that are relevant to the lives of the communities and that are identified and dealt with in a participatory manner. NRM research needs to be characterized by iterative loops of action and reflection in a collective and participatory learning process. Ethical considerations are important in NRM research as they define what is legitimate and acceptable for all stakeholders involved.

Careful detailed planning of the stakeholders to be involved, and how they will be involved, the research problem to be tackled, and approaches and processes of doing it, and details of collecting data and processing it into information, must be clearly defined before embarking on the research.

Community participation in Natural Resource Management Research means that outsiders learn with local people and are willing to change their activities and direction in the light of locally articulated needs and knowledge. The most important issue about participation in Natural Resource Management Research is about the empowerment process generated by asking people to be responsible for producing the information they will need for their planning and development. Successful NRM research projects are those that produce tangible outcomes, contribute to progress in integrative research, and provide positive experiences for their participants, including protection of the communities' intellectual property.

There is an increasing volume and complexity of research data being collected in various research projects. Research data management needs to be considered from the research proposal development stage so that technical and institutional capacity required to capture, process and archive data is provided. Proper data management within and across projects is essential for efficient use of research by various stakeholders to improve their management practices and attitudes and to make more informed decisions on various courses of action. This requires an effective communication, information, and knowledge sharing strategy that addresses the needs of the various research stakeholders.

Learning Activities

Learning Activity 9.1

Using the discussions of Section 8.2, define the specific essential elements to be considered in the planning of research on a community project to improve livelihoods through the marketing of an indigenous forest fruit.

Learning Activity 9.2

Discuss the critical factors for consideration in designing NRM research to influence innovative production and marketing of natural spring water by a local community.

Learning Activity 9.3

Discuss all the principles of community participation that are demonstrated in the Burkina Faso case study

Learning Activity 9.4

Using IDRC ethics guidelines, and assuming that you are a government administrator in an area where research on the community management of a wetland will be conducted, state the specific and comprehensive ethics considerations that you will insist on before the research can commence

Learning Activity 9.5

The following are examples of NRM research dissemination products:

- Journal articles,
- Policy brief,
- Media release,
- Scientific poster,
- PowerPoint presentation,
- Extension/operating manuals.

Identify the principal audience for each of these products and explain the key writing principle you would uphold to ensure effective NRM research dissemination.

Revision Questions

1. Using specific natural resource and NRM examples, discuss the contribution of research to the achievement of sustainable natural resource management. How can research contribute to our enhanced understanding of concepts, principles and theories underpinning natural resource management?
2. Review the current thrusts in NRM research in your country. What is driving the research initiatives and processes? What NRM impacts should be expected from these initiatives?
3. Using available library and internet sources, conduct a literature review on the following topics and present your synthesis identifying the overview of knowledge, gaps, theoretical bases, and emerging trends in the area:
    - IPR in relation to NRM in Africa,
    - Community participation in NRM research,
    - Information and knowledge sharing in NRM research in Africa,
    - Data management challenges in NRM research in Africa.

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Glossary

This glossary provides clear and accessible definitions based on current usage of the terms in this book and in the scientific literature on NRM.

Action research

A systematic research process that comprises iterative cycles of planning, action, evaluation, reflection and revision of the original plan with the aim or solving problems and improving the way processes are performed, resources are managed and services are delivered.

Adaptive cycle

Is a metaphor used to describe four commonly occurring phases of change in complex systems. The four phases are: exploitation, conservation, creative destruction, and renewal (also referred to as r, K, *omega, alpha*).

Adaptive management

An ongoing process of designing and implementing management strategies, and then revising those strategies, on the basis of learning acquired through testing, monitoring and evaluation in an environment where there is scientific uncertainty, and changing environmental conditions and knowledge.

Agreements

Instruments of a technical or administrative character, which are signed by the representatives of government departments, but are not subject to ratification.

Assessment

A process (which may or may not be systematic) of gathering information, analysing it, then making a judgment on the basis of the information about the success of a project or programme.

Asset

A useful thing or quality; something that has a value. In the NRM context, assets can be classified as follows: *human capital* - labour and influences on the productivity of labour, including education, skills and health; *social capital; natural capital* - land, water, atmosphere and biological resources; *physical capital* - value produced by economic activity, including infrastructure, equipment and technology: *financial capital* - savings and credit.

Assumption

Any external factor (such as an event, condition or decision) that could affect the progress or success of NRM. Assumptions are necessary to achieve NRM projects/programme objectives, but are largely or completely beyond the control of project managers. They are worded as positive conditions. Initial assumptions are those conditions perceived to be essential for the success of a project or programme. Critical assumptions are those conditions perceived to threaten the implementation of an NRM project or programme.

Attribution

The causal link of one thing to another. For example, the extent to which observed (or expected) changes can be linked to a specific intervention in view of the effects of other interventions or confounding factors.

Audit

An independent, objective assurance activity designed to add value and improve NRM/ecosystems operations. An ecosystems audit, can help accomplish the objectives of ecosystems management by bringing a systematic, disciplined approach to assessing and improving the effectiveness of ecosystems processes.

Baseline information

Information—usually consisting of facts and figures collected at the initial stages of a project –that provides a basis for measuring progress in achieving NRM project objectives and outputs.

Benchmark

A reference point or standard against which performance or achievements can be compared. A benchmark might refer to what has been achieved in the past by other comparable NRM initiatives/projects, or what could reasonably have been achieved under the circumstances.

Biodiversity

The sum total and variation of life forms and interactions within a given ecosystem, biome, or on the entire earth. Biodiversity is often used as a measure of the health of biological systems or natural resource systems. Biological variety occurs at three levels, that is, genetic diversity, species diversity and ecosystem diversity.

Biome

A recognisable plant and animal community that is determined primarily by global climatic patterns, or a broad ecological unit that represents major life zones extending over large natural areas.

By-laws

Are secondary laws or a body of local laws and customs of a village, town or city, or rules made by lower local government councils and provide the local guidelines to be followed in implementing sectoral policies in agriculture and NRM.

Capacity

The ability of individuals and organizations to undertake activities and projects effectively, efficiently and in a sustainable manner.

Capacity building

Enhancing the ability of individuals, groups and organizations to effectively, efficiently and in a sustainable manner achieve NRM outcomes. Examples of capacity building outcomes in the NRM context include enhanced awareness, skills, knowledge, motivation, commitment and confidence.

Causal relationship

A logical connection or cause-and-effect linkage existing in the achievement of related, interdependent NRM results. Generally the term refers to plausible linkages, not statistically accurate relationships.

Climate change

Changes in the mean and/or the variability of its properties that persists for an extended period, typically decades or longer. It is a statistically significant decadal variation in either the mean state of the climate or in its variability.

Climate change adaptation

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007). Adaptation refers to the 'actions taken to help communities and ecosystems cope with changing climate conditions' (UNFCCC).

Climate change mitigation

Human intervention to reduce the "sources" of greenhouse gases or enhance the "sinks" to remove carbon dioxide from the atmosphere carbon sequestration can be achieved through, inter alia, afforestation, reforestation and restoration of degraded lands, agroforestry, and cropland and grazing management. All these activities promote increased carbon stocks in biomass and enhance soil carbon through, for instance, alternative tillage practices in cropland management.

Climate variability

The variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc) of the climate on all temporal and spatial scales beyond that of individual weather events. It is the short-term fluctuation around the mean climate state.

Co-management

A situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources. It is a pluralist approach to managing natural resources, incorporating a variety of partners in a variety of roles, generally to the end goals of environmental conservation, sustainable use of natural resources and the equitable sharing of resource-related benefits and responsibilities.

Complex adaptive systems

Systems of people and nature in which complexity emerges from a small set of critical processes which create and maintain the self-organizing properties of the system. A dynamic network of many agents (which may represent cells, species, individuals, firms, nations) constantly adapting and changing in the face of new circumstances in order to sustain themselves.

Common property

Rights are exercised by a defined group with rules defining rights to access, use and management. Sanctions ensure compliance.

Common Pool Resource (CPR) or Common property resource

This is a type of good consisting of a natural or human-made resource system (e.g. an irrigation system or fishing grounds), whose size or characteristics makes it costly, but not impossible, to exclude potential beneficiaries from obtaining benefits from its use.

Common property regime

This is a particular social arrangement regulating the preservation, maintenance, and consumption of a common-pool resource.

Community

A group of people bounded by geographical links, such as a village, settlement or district, politics or natural boundaries but also includes those brought together by lifestyle, culture, religion, hobby and interest.

Community-Based Natural Resource Management (CBNRM)

The management of these local resources through which the 'community' in question have the legal right, the institutional base and the economic incentives to take substantial responsibility for the sustained use of local natural resources.

Convention

Formal multilateral treaties with a broad number of parties, normally open for participation by the international community as a whole, or by a large number of states. Usually the instruments negotiated under the auspices of an international organization are called conventions.

Collective action

Action taken by a group (either directly or on its behalf through an organization) in pursuit of members' perceived shared interest" Includes forming and enforcing rules for use (or non-use) of resources, voluntary (not paid or forced).

Conflict management

The process of planning to avoid conflict where possible and organising to resolve conflict where it does happen, as rapidly and smoothly as possible.

Critical reflection

The process of questioning and analysing experiences, observations, theories, beliefs and/or assumptions.

Culturally sensitive

Any traditional or cultural issue that in accordance with traditional laws and customs, including as advised by local communities or cultures, is considered to be sensitive, or of a secret or sacred nature.

Devolution

Transfer management responsibility from government to user groups.

Disturbance

Is a relatively discrete event in time coming from the outside, that disrupts ecosystems, communities, or populations, changes substrates and resource availability, and creates opportunities for new individuals or colonies to become established.

Ecologically sustainable development

Recognizes that development should not compromise or degrade the quality of natural resources such as air, land, water, vegetation and biodiversity.

Ecosystem

Assemblages of biotic (living) organisms in association with their abiotic or physical and chemical environment. "An ecosystem consists of organisms (plants, microbes, and animals - including people) and the physical components (atmosphere, soil, water, etc.) with which they interact. All ecosystems are influenced, to a greater or lesser degree, by social processes (i.e., are social–ecological systems), although ecosystem studies tend to focus on biological interactions".

Ecosystem approach

An approach to NRM that recognizes that the ecosystem is not defined just by the bio-physical variables but incorporates the human factor as well as institutional, social and economic factors that affect human activities within the ecosystem.

Ecosystem dynamics

Changes within and between ecosystem components as a consequence of the interactions involving abiotic and biotic components. These changes are associated with qualitative and quantitative variations in energy flows and material fluxes.

Ecosystem resilience

The capacity of an ecosystem to cope with disturbances such as fire, herbivory, pollution, drought, etc. without shifting into a qualitatively different state. It is a measure of resistance to disturbance and the speed of return to the equilibrium state of the ecosystem.

Ecosystem services

The benefits that people derive from the ecosystem. These might include the production of goods e.g., food, fiber, water, fuel, genetic resources, pharmaceuticals, etc.; regeneration processes e.g., purification of air and water, seed dispersal and pollination; stabilizing processes e.g., erosion control, moderation of weather extremes; life-fulfilling functions e.g., aesthetic beauty, cultural value; and conservation of options e.g., maintenance of ecological systems for the future.

Effect

An intended or unintended change resulting directly or indirectly from an intervention.

Effectiveness

A measure of the extent to which a NRM programme, project or initiative has attained, or is expected to attain, its relevant objectives efficiently and in a sustainable way.

Efficacy

The extent to which a NRM objectives were achieved or expected to be achieved, taking into account their relative importance.

Efficiency

The notion of getting the highest value out of NRM programme or project resources.

Environmental governance

The rules, processes and behaviours that affect the way environmental policies are enacted, particularly in relation to transparency, participation, accountability, effectiveness and coherence.

Environmental impact assessment

Concerns a policy 's impacts on natural systems, including ecosystems, land, air and water. They also include the environmental impacts of products and services; energy, material and water use; greenhouse gas and other emissions; effluents and waste generation; impacts on biodiversity; use of hazardous materials; recycling, pollution, waste reduction and other environmental programmes; environmental expenditures; and fines and penalties for non-compliance.

Environmental entitlements

The alternative sets of benefits derived from environmental goods and services over which people have legitimate effective command and which are instrumental in achieving well- being the capacity of natural resources accessible to the poor to produce streams of products and environmental services essential for livelihood. Conceptual framework highlighting the central role of institutions in mediating environment-society relationships.

Evaluation

In the NRM context, a periodic assessment of the impact, appropriateness, quality, relevance, effectiveness, efficiency and legacy of an activity, research process, policy, programme or project 'through a set of applied research techniques to generate systematic information that can help improve performance'. It includes formal external, independent evaluations and 'self-evaluation processes [that] can help to build an internal culture of reflection and evaluation, as well as stronger ownership of the results'.

Evaluation questions

A breakdown of the key evaluation question. Within the context of MERI for NRM, these questions link to the outcomes in the different levels of the programme logic and to the five broad evaluation categories – appropriateness, impact, effectiveness, efficiency and legacy.

Hierarchy

Semi-autonomous levels that form from the interactions among a set of variables that share similar speeds [and geometric spatial attributes].

Gender

The social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys. In the context of NRM these attributes, opportunities and relationships are socially constructed and are learned through socialisation processes in relation to access and control over natural resources and their use.

Gender analysis

Systematically exploring roles and responsibilities of women and men and their access to and control over resources and benefits within a particular setting, project, household or community. It is also the process of systematically assessing the differential impact of proposed and/or existing NRM initiatives on men and women of different characteristics.

Gender analysis framework

A step-by-step tools for carrying out gender analysis, which help to raise questions, analyse information, and develop strategies to increase women's and men's participation in and benefits from projects and programmes.

Gender equality
The equal treatment of women and men in all aspects of development including laws, policies and opportunities as well as access to all resources and services in families, communities and society at large.

Gender equity
Fairness and justice in the distribution of benefits and responsibilities of NRM initiatives between women and men and related social groups.

Gender mainstreaming
The systematic inclusion of gender concerns in all aspects of NRM and organizations life such as programmes, policies, budgets, skills, financial and human resource systems.

Goal
The higher-order objective to which an NRM programme/project is intended to contribute.

Governance
The interactions between structures, processes and traditions that determine how power is exercised, how decisions are taken on issues of public concern, and how citizens or other stakeholders have their say. Governance is about power, relationships and accountability. It is the proper functioning of institutions, structures and the processes by which people in societies make decisions and share power.

Immediate outcomes
Easily identifiable activities and related immediate goods, services and infrastructure.

Impact
A change in the condition of biophysical, social, economic and/or institutional assets. An impact may be positive or negative, primary or secondary, short term or long term, direct or indirect, and/or intended or unintended. Impacts are sometimes realised after the NRM project is completed.

Indicator
A quantitative or qualitative factor or variable that provides a simple and reliable basis for assessing achievement, change or performance. It is a unit of information measured over time that can help show changes in a specific condition. A given goal or objective can have multiple indicators.

Indigenous knowledge
Include local knowledge, indigenous skills, traditional knowledge or cultural knowledge and generally refers to the matured long-standing traditions and practices of certain regional, indigenous or local communities. It also includes the

wisdom, knowledge, and teachings of these communities that have been passed on orally from one person to another over generations.

Information management system

A system of collecting, collating and organising data that should provide selective information and reports to management to assist in monitoring and controlling programme organization, resources, activities and results.

Input

The financial, human and material resources necessary to produce the intended outputs of an NRM programme or project.

Institutions

The set of instruments through which people, living in a state and believing in common core values, govern themselves and includes policy, laws, rules and regulations as well as custom.

Institutional

Of or pertaining to a policy, organization, rule, agreement, value or cultural norm.

Institutional arrangement

Includes instruments for defining and enforcing NRM policy and related property rights. They can include formal procedures, social, beliefs or attitudes which determine the legitimacy and recognition of these rights.

Integrated Natural Resource Management (INRM)

Responsible and broad-based management of the land, water, forest, and biological resources base (including genes) needed to sustain development and avert resource degradation. The INRM operates on the principle that natural resources are neither indestructible nor infinite; they can be destroyed or depleted through exploitation and they require to be managed in a holistic and integrated manner, accounting for the complexity of ecosystem and the inter-relations amongst its various components.

Intellectual property

Includes all copyright, all rights in relation to inventions (including patent rights), plant varieties, registered and unregistered trademarks (including service marks), registered designs and circuit layouts, and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields, as well as traditional indigenous knowledge or cultural asset.

Intermediate outcomes

A combination of biophysical and non-biophysical results that lead to change by way of maintenance of and/or improvement in NRM asset condition.

Invasive species

Are biological organisms that have moved beyond their normal range of occurrence. Invasive species are found in all phyla, from micro-organisms to various aquatic and terrestrial plant and animal organisms.

Landscape

A heterogeneous land area consisting of a cluster of interacting components repeated in a similar format throughout. A landscape is characterized by a cluster of ecosystems, flows or interactions among the ecosystems of such a cluster and disturbance regimes in such a cluster.

Learning

The process of reflecting on experience to identify how a situation or future actions could be improved and then using this knowledge to make actual improvements. This can be individual or group-based. Learning involves applying lessons learned to future actions, which provides the basis for another cycle of learning.

Livelihood

The ways and means of 'making a living'. A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living' A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base.

Logical framework (logframe)

A tool for improved research and project design and management which provides a clear and rational framework for planning and envisioning a project programme. A log frame summarises, in a standard format: what the project is going to achieve, what activities will be carried out to achieve its outputs and purpose, what resources (inputs) are required, the potential problems which could affect the success of the project, how the progress and ultimate success of the project will be measured and verified.

MERI

Monitoring, evaluation, reporting and improvement—an approach that is iterative and integrative and aims to result in learning and adaptive management of NRM projects and programmes.

Monitoring

The regular collection and analysis of information to assist timely decision making, ensure accountability and provide the basis for evaluation and learning. It is a continuing function that uses methodical collection of data to provide management and the main stakeholders of an ongoing project or programme with early indications of progress and achievement of objectives.

Monitoring and evaluation

Monitoring and evaluation are two processes that often overlap and are part of a systematic learning process. The combination of monitoring and evaluation provides the knowledge required for effective programme management and reporting and accountability responsibilities.

Natural capital

the natural resource stocks (forest, soil, water, air, genetic resources etc.) and environmental services (hydrological cycle, pollution sinks etc) from which resource flows and services useful for livelihoods are derived.

Natural resource management

A scientific and technical principle that forms a basis for *sustainable* management (conservation and use) and governance of natural resources such as land, *water*, *soil*, *plants* and *animals*, with a particular focus on how management affects the *quality of life* for both present and future generations.

NRM resource managers

Managers (including individuals, organizations, institutions and communities) of natural and management resources.

Outcome

The results achieved at the defined levels of the outcomes hierarchy in the programme logic.

Outcome mapping

A method for planning, monitoring, and evaluating development activities that aims to bring about social change. It seeks to clarify what human, social, and environmental betterment projects or programmes hope to contribute and then focus monitoring and evaluation on factors and actors within their direct sphere of influence.

Outputs

The tangible (easily measurable and practical), immediate and intended results to be produced through sound management of the agreed inputs. Examples of outputs include goods, services or infrastructure produced by a programme or project and meant to help realise its purpose. These may also include changes resulting from an intervention that are needed to achieve the outcomes at the purpose level (IFAD nd).

Panarchy

A model of linked, hierarchically arranged adaptive cycles that represents the cross-scale dynamic interactions among the levels of a system and considers the interplay between change and persistence. It is the interacting set of hierarchically structured scales (nested adaptive cycles), with influences between multiple scales of space, time and social organization, and the interactions across scales.

Participation

One or more processes in which an individual or group takes part in specific decision making and action, and over which they may exercise specific controls. It is often used to refer specifically to processes in which primary stakeholders take an active part in planning and decision making, implementation, learning and evaluation of NRM initiatives.

Participatory Action Research (PAR)

An approach that seeks to involve research subjects in all aspects of the research process to support knowledge development, group empowerment and social change.

Participatory evaluation

An evaluation method in which representatives of agencies and stakeholders (including beneficiaries) work together in designing, carrying out and interpreting an evaluation.

Performance

The degree to which an NRM intervention operates according to specific criteria, standards or guidelines or achieves results in accordance with stated goals or plans (adapted from IUCN, 2002).

Policy

A definite course of action to guide present and future decisions. Policies are decisions taken by those with the mandate to do so on particular issues or resources, with indications of the strategies and means of implementing the decisions.

Policy resistance

Is the tendency for interventions to be defeated by the system's response to the intervention itself.

Practical gender needs

These are gender needs that women and men can easily identify, as they relate to living conditions. Women may identify safe water, food, healthcare, cash income, as immediate needs which they must meet while men may identify care, sex security and money.

Primary stakeholders

The main intended beneficiaries of a programme, project or activity.

Process evaluation

An evaluation aimed at describing and understanding the internal dynamics of an NRM project, programme or institution.

Productive roles

The set of work that produces goods and services for consumption by the household or for income and is performed by both men and women.

Programme logic

The rationale behind a programme – what are understood to be the cause-and-effect relationships between programme activities, outputs, intermediate outcomes and longer-term desired outcomes. Represented as a diagram or matrix, programme logic shows a series of expected consequences, not just a sequence of events.

Project

An intervention that consists of a set of planned, interrelated activities designed to achieve defined NRM objectives within a given budget and a specified period of time.

Purpose

The publicly stated objectives of an NRM programme or project. It is a synthesis of the outcomes, and presents the actual expected contribution of the project towards the ideal situation described in the goal. It is the highest level of result that should occur as a direct consequence of interventions during the life of the project. The NRM project is therefore committed to achieve this contribution within an agreed timeframe and budget.

Qualitative

Something that is not summarised in numerical form, such as minutes from meetings and general notes from observations. Qualitative data normally describe people's knowledge, perceptions, feeling, aspirations, attitudes or behaviours (IFAD nd).

Quantitative

Something measured or measurable by, or concerned with, quantity and expressed in numbers or quantities.

Remote Sensing (RS)

The capture, processing, analysis and display of remotely sensed information, mainly satellite images, radar images and aerial photographs. In the field of natural resource management RS is mainly used for analysis and monitoring of land cover and land use status and change.

Reproductive roles

Work involving the bearing and rearing of children and all the tasks associated with domestic work and the maintenance of all household members. These tasks include cooking, washing clothes, cleaning, collecting water and fuel, caring for the sick and elderly. Women and girls are mainly responsible for this work which is usually unpaid.

Research

Is the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or, practical application of such new or revised theories or laws. In the broadest sense of the word, research includes any gathering of data, information and facts for the advancement of knowledge.

Resilience

Describes the capacity of an ecosystem to cope with disturbances without shifting into a qualitatively different state. In other words resilience describes a measure of resistance to disturbance and the speed of return to the equilibrium state of the ecosystem.

Resource condition monitoring

An ongoing process of collecting and analysing quantitative and qualitative data and information about NRM assets including environmental, economic and social assets.

Sample

A representative part of a population selected in order to determine parameters or characteristics of the whole population.

Scale

Is the spatial and temporal frequency of a process or structure. Scale is a dynamic entity. In NRM, a focal scale of the social-ecological system of interest is usually determined from among: landscape/local scale, sub-continental/sub-regional, continental/regional, and global scale, over a specified period of time.

Cross-scale

Influences between the dynamics of systems at one scale and the dynamics of those that are embedded in it or enfold it.

Scaling up

Is bringing more quality benefits to more people over a wider geographical area more quickly, more equitably and more lastingly. Scaling out or horizontal scaling up is geographical spread to cover more people and communities through replication and adaptation, and involves expansion within same sector or stakeholder group. Vertical scaling up is institutionalization. Vertical scaling up may mean moving from individual to collective decision making, or it may involve moving from simple organizations based on face-to-face interaction to complex, hierarchical organizations.

Scenario

A plausible description of how the future may develop, based on a coherent and internally consistent set of assumptions about key relationships and driving forces (e.g. rate of technology changes, prices, climate change and other global or local changes and drivers).Scenarios are neither predictions nor forecasts.

Social capital

The social resources (networks, social claims, social relations, affiliations, associations) upon which people draw when pursuing different livelihood strategies requiring coordinated actions.

Social-ecological systems

Are complex, integrated systems in which humans are part of nature. This stresses that the delineation between social and ecological systems is artificial and arbitrary.

Social resilience

Is the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval. In other words social resilience is the ability of groups or communities to adapt in the face of external social, political or environmental stresses and disturbances.

Stakeholder

An agency, organization, group or individual who has a direct or indirect interest in an NRM project or programme, or who positively or negatively affects or is affected by the implementation and outcome of it.

Stakeholder analysis

Is a technique you can use to identify and assess the importance of key people, groups of people, or institutions that may significantly influence the success of your activity or project.

Stakeholder participation

Active involvement by stakeholders in the design, management and monitoring of a project or programme.

Strategic gender needs

Needs identified by women because of their subordinate position to men in their society. They relate to issues of power and control and the gender division of labour and may include changes in the gender division of labour (women to take on work not traditionally seen as women’s work, men take more responsibility for child care and domestic work), legal rights, an end to domestic violence, equal wages and women's control over their own bodies.

Sustainability

The likelihood that the positive effects of a project or programme will meet the needs of societies today, while conserving the nation’s ecosystems for the benefit of future generations. It is the capacity to create, test, and maintain adaptive capability.

Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Target

A specified objective that indicates the number, timing and location of that which is to be realised for an NRM activity, research, policy, programme or activity.

Target group

The specific group for whose benefit an NRM project or programme is undertaken.

Tragedy of the commons

describes a situation in which multiple individuals, acting independently, and solely and rationally consulting their own self-interest, will ultimately deplete a shared limited resource even when it is clear that it is not in anyone's long-term interest for this to happen.

Triangulation

The practice of employing several NRM research tools within the same research design. Triangulation enables particular research parts or findings to be viewed from more than one perspective and hence increases validity and reliability.

Validation

The process of cross-checking to ensure that the data obtained from one monitoring method or NRM research is confirmed by the data obtained from a different method.

Validity

The extent to which the data collection strategies and instruments measure what they purport to measure.

Vulnerability

The tendency of something to be damaged. The opposite of this is resilience, or the ability to resist and/or recover from damage.

Writeshop

An intensive participatory workshop to write and learn to produce information materials and documentation about a particular topic.

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