ENVIROMENTAL IMPACT EVALUATION TOOLS

For River Engineering Projects in Sudan

Case Study of Rosaries Dam

A thesis Submitted to the University of Khartoum in Partial Fulfillment of the Requirement For the Degree of M.Sc In Environmental Engineering

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Dedication

I dedicate this research to:

My father soul , my great mother

the secret of my life …

who teach me a lot ,
Among their patience,,,

My brothers & sisters , and their sons

who give taste to my life …
Through their smiles ,,,

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My great thanks go to my ***family***, who has given me support and time to do my research.

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List of Acronyms

SMEC	**Snowy Mountains Engineering Corporation.**
FEARO	**Federal Environmental Assessment and Review Office.**
NBI	**Nile Basin Initiative**
GIS	**Geographical Information System**
ENVI	**Environment for Visualizing Images**
FAO	**Food & Agricultural Organization**
ETM	**Enhance thematic mapper**
TM	**Thematic mapper**
MSS	**Multi spectral scanner**
EIA	**Environmental Impact Assessment.**
UNEP	**United Nations Environmental Programs.**
ECBA	**Environmental cost benefit analysis.**
RA	**Risk Assessment.**
ENTRO	**Eastern Nile technical Regional office.**
NGOs	**Non governmental Organization.**
PCBs	**Poly chlorinated biphenyl .**
ROW	**Right of way .**
EMF	**Electromagnetic fields.**
UKCC	**University of Khartoum Consultancy Corporation.**
RDHU	**Rosaries Dam heightening Unit.**

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Abstracts

The objectives of this study is to estimate the reduction of Rosaries reservoir capacity, due to increase of sedimentation rate in the Dam as a result of soil erosion, beside decline in vegetation cover as a result of soil extended mechanized irrigation.

The environmental impact assessment is the tool of analysis, using geographical information system and remote sensing techniques to identify the Land covers classes and forest decline.

The result of the study showed continuous decrease of the capacity of the dam, as the sediment amount accelerate annually, due to vegetation cover removal and consequently soil erosion.

A number of conclusions and recommendation stated to improve the environmental Condition through some necessary technical measures and some remedies to reduce the negative effects of the soil erosion processes.

مستخلص

أهداف هذه الدراسة هي تقدير معدل الأطماء والنقصان في سعة خزان الرصيرص والتي تنتج عن اجراف التربة والذي يحدث نتيجة انحسار وإزالة الغطاء النباتي لصالح الزراعة الآلية مما يضاعف في كميته ومعدله .

استخدمت طريقة تقييم المردود البيئي ، الاستشعار عن بعد والنظام الجغرافي للتعرف على وحدات الغطاء الارضى وانحسار الغابات .

خلصت الدراسة إلى أن هنالك انحسار مستمر في سعة بحيرة الخزان نسبة لكميات الاطماء السنوية نتيجة لإزالة الغطاء النباتي والذي أدى بدوره إلى تعرية التربة .

من مخرجات الدراسة عدد من التوصيات لتحسين الظروف البيئية من خلال بعض المعالجات الفنية للتقليل من الآثار السلبية لعمليات اجراف التربة .

Chapter one
Introduction

1-0 Over view

The production of goods and services to meet global population demands has occasioned a number of activities which have depleted the globe's natural resources and in several instances contributed to environmental degradation through pollution. These activities done in the pursuit of economic development have also caused the loss of several species of plants and animals and now threaten the existence of man himself, if left uncontrolled.

Recognition of the question of the gloped capacity to sustain these activities and the general environmental problems associated with them, which are common at the community, national, regional and international levels, led to a number of international conferences, (*starting at Stockholm in 1972*) treaties, conventions, and protocols on the management of the earth's resources in an effort to ensure sustainable economic development. The concern with methodology or tools to address scientific and policy issues encountered in environmental impact assessment (EIA) has been ongoing since 1970. The attention given to this subject is illustrated by the inclusion of technical sessions on methods at most meetings sponsored by professional societies.

There is continued interest in the development of appropriate methods for use within the EIA process. Early methods development typically focused on systematic approaches to integrate a variety of environmental impact concerns associated with a proposed project, e.g., interaction matrices, networks, simple checklists, or weighting-scaling checklists. Over time, the use and definition of EIA methods has been broadened to also encompass quantified and descriptive models of the anticipated impacts of proposed actions on various environmental media and resources. Now, EIA methods cover environmental transport and fate models, habitat methods and indices, spatial manipulation of information, and numerous other means of impact prediction. The term methods also can encompass approaches used to compare and select a proposed action from a series of alternatives, to determine the effectiveness of

impact mitigation measures, and to facilitate public participation within the EIA process.

This research" environmental impact evolution tools for river engineering projects in Sudan "which is aimed at improving EIA process for River Engineering projects through review of EIA practices in the Sudan , and development of tools of analysis . The major concerns were lack of suitable tools in EIA practice to objectively and scientifically quantify environmental quality parameters.

Since the Environmental engineering is a broad concept and as a profession provides a technical link between traditional engineering and environmental science. This area of work relates strongly to both engineering skills (such as water resource studies and geotechnical assessment) and also broader environmental skills (such as physical environmental science, ecology and planning).River Eng.is the process of planned human intervention in the course, characteristics or flow of a river with the intention of producing some defined benefit. People have intervened in the natural course and behaviors of rivers since before recorded history - to manage the water resources, to

protect against flooding or to make passage along or across rivers easier. From Roman times, rivers have been used as a source of hydropower. From the late 20th century, river engineering has had environmental concerns broader than immediate human benefit and some river engineering projects have been concerned exclusively with the restoration or protection of natural characteristics and habitats.

In this study the Environmental Impact Assessment, for the implemented dam, was performed using GIS and Remote Sensing software-Arc/Info, ERDAS and ENVI, It has been seen that both of them, play an important role in generating automated spatial datasets and in establishing spatial relationships.

(GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. It allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts, and it helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared .GIS technology can be integrated into any enterprise information system framework. On the other hand Geography plays a role in nearly every decision we make. Choosing sites, targeting market segments, planning distribution networks, responding to emergencies, or redrawing country boundaries—all of these problems involve questions of geography.

Component of this Soft ware are Soft & Hard ware, User and Data.

it has a unique kind of database of the world—a geographic database (geodatabase). It is an "Information System for Geography."
Fundamentally, a GIS is based on a structured database that describes the world in geographic terms also there are a set of intelligent maps and other views that show features and feature relationships on the earth's surface. Maps of the underlying geographic information can be constructed and used as "windows into the database" to support queries, analysis, and editing of the information, Beside a set of information transformation tools that derive new geographic datasets from existing datasets. These geoprocessing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets.
By combining data and applying some analytic rules, you can create a model that helps answer the question you have posed.

1 -1 Problem statement

Changes in the landscape resulting from projects activities and infrastructure
Developments cause impacts on the natural environment .
Environmental Impact Assessment (EIA) is an essential approach for minimizing the impact of physical and landscape plans and has a strong legislative, laws and guidance basis. Despite its importance, the scientific Knowledge of EIA in Sudan is scarce and even the existing one is not well coordinated. In addition the lack of unified tools for such assessment,
Make the need to conduct an inventory of existing tools and their integrative nature for all other environmental factors and suggest improvements of concepts, methods and techniques.

1-2 The need for EIA as a tool for decision making

The desirability of taking the environment into account early in the planning process of any project / development is increasing World Wide . Thus the world conservation strategy pinpointed the need to integrate environmental consideration with development in 1980.And the World Bank in 1987 stated that environmental issues must be addressed as part of overall economic policy rather than project by project (Woods, 1995) The addressing of environment issues is through an impact assessment that provides information to the decision maker (s) at early stage of the project planning.

1-3 Objective and Scope

1-3-1 General objective:

The objective of this study is to review and assemble information on the types of methods used within the EIA process for river engineering projects in Sudan.

1-3-2 Specific objectives:

The Specific objectives is to study the suitability of methods and tools, to illustrate various factors to be considered in their selection and application to the main phases and activities of an impact study, in order to enhance the best practices in the Nile projects through improving the EIA process, applying the recommended methods in selected area and reassess the impact , also to contribute to the knowledge base in River Engineering.

As the title suggests, the term tools will be used in a broad context; i.e., it includes both extend and emerging methods and their potential usefulness. The intent as illustrated above is to cover the tools and techniques which can be used within different phases of the EIA process for river engineering projects.

One specific focus is on the selection process for the use of methods based upon professional knowledge and judgment by EIA practitioners, and on systematic approaches to synthesizing qualitative and/or quantitative information; this will be done using GIS and remote sensing.

The tool and the perspectives on its application are based on a review of key literature related to the EIA process and associated methods in the field of rivers projects , throughout the country, Much of the information is organized

in table form, namely classification of tools and techniques, lists of criteria and guidance on their application, examples of the methods that are commonly used in Sudan , and notes on their constraints and limitations.

World bank guide lines will be followed during this stud

1 -4 Thesis structure

This report consists of five chapters with abstract, table of contents, references and appendix.

Chapter one Introduction.

Chapter two literature review.

Chapter three Materials and Methods.

Chapter four Results and Discussion.

Chapter five conclusion and Recommendations.

Chapter Tow

Literature review (1)

2 – 1 Definition - What is an EIA?

This part of the chapter gives an over view of EIA and its definition, and classification according to the World Bank environmental guidelines and policies.

An EIA is a study of the effects of a proposed action on the environment. In this regard the environment includes all relevant aspects of the natural and human resources. The EIA evaluates the expected effects on human health, the natural environment and on property. The EIA is based on predictions. It attempts to predict the changes in environmental quality which would result from the proposed project/action, and finally it is a decision-making tool, the study therefore requires a multi-disciplinary approach. It should be done very early at the feasibility stage of a project. In other words a project should be assessed for its environmental feasibility.

The EIA compares various alternatives by which the project could be realized and seeks to identify the one which represents the best combination of economic and environmental costs and benefits. Alternatives include location as well as methods, process technology and construction methods. Since it is a procedure used to examine the environmental consequences, both beneficial and adverse, of a proposed development project and to ensure that these effects are taken into account in project design.

So it should be viewed as an integral part of the project planning process. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/clean-up costs and impacts of laws and regulations.

According to UNEP the key elements of an EIA are (a) Scoping: identify key issues and concerns of interested parties; (b) Screening: decide whether an EIA is required based on information collected; (c) Identifying and evaluating alternatives: list alternative sites and techniques and the impacts of each; (d) Mitigating measures dealing with uncertainty: review proposed action to prevent or minimize the potential adverse effects of the project; and (e) Issuing environmental statements: report the findings of the EIA.

Unlike the environmental audit (EA), which is conducted on existing projects, the EIA is applied to new projects and the expansion aspects of existing projects.

2-2 Environmental Guidelines

In order to help the concerned authorities, it is necessary to frame certain broad guidelines for setting any activity. It is also necessary to identify the parameters that should be taken into account while setting up activity. With this in view, an environmental guideline is recommended for setting of activities to ensure optimum use of natural and man-made resources in sustainable manner with minimal depletion, degradation and/or destruction of environment. In 1987 the United Nations Environment Programmed (UNEP) adopted a set of goals and principles on environmental assessment. At the national level legislation has been enacted in almost every country.

2-2-1 International Guidance (World Bank guidelines)

The principal international guidance utilized in assessing the significance of impacts from the proposed development, and for determining content and form of reporting, were from the World Bank.{ World Bank Operational Policies OP4.01 Environmental Assessment (January 1999)} ,This sets out the World Bank's policy on projects requiring an EIA and defines what the assessment is designed to achieve and what issues must be considered. It also sets out guidance for screening projects and identifies other World Bank guidance and policies that may be relevant. It defines the *(EIA)* as an instrument to identify and assess the potential environmental impacts of a proposed project, evaluates alternatives, and design appropriate mitigation, management, and monitoring measures .Also it defines *Project area of influence*: The area likely to be affected by the project, including all its subsidiary aspects, such as power transmission corridors, pipelines, canals, tunnels, relocation and access roads, borrow and disposal areas, and construction camps, as well as unplanned developments induced by the project (e.g., spontaneous settlement, logging, or shifting agriculture along access roads). The area of influence may include, for example, (a) the watershed within which the project is located; (b) any affected estuary and coastal zone; (c) off-site areas required for resettlement or compensatory tracts; (d) the air shed (e.g., where airborne pollution such as smoke or dust may enter or leave the area of influence; (e) migratory routes of humans, wildlife, or fish, particularly where they relate to public health, economic activities, or environmental conservation; and (f) areas used for livelihood activities (hunting, fishing, grazing, gathering, agriculture, etc.) or religious or ceremonial purposes of a customary nature.

2-2-2 The Environmental Classification System

At the time of project identification, the Bank screens all proposed investment projects for environmental impacts and classifies them into one of three categories:

Category A : a proposed project is classified as Category A if in the Bank's judgment is likely to have significant adverse impacts that may be sensitive, irreversible, diverse, comprehensive, broad, or precedent-setting. These impacts generally result from a major component of the project and affect the area as a whole or an entire sector. A full environmental assessment is required.

Category B: a proposed project is classified as Category B if its potential environmental impacts are site-specific in nature and do not significantly affect human populations or alter environmentally important areas, such as mangroves, wetlands, and other major natural habitats. Few if any of the impacts are irreversible, and mitigate measures can easily be designed. Although a full EA is not required, environmental analysis is required.

Category C : a proposed project is classified as Category C if it is unlikely to have adverse environmental impacts, or its impacts are likely to be negligible, insignificant, or minimal. EA is not required for such projects.

Category A Projects/Components

Impacts generally result from a major component of the project and affect the area as a whole or an entire sector

(a) Dams and reservoirs;
(b) Forestry production projects;
(c) Industrial plants (large-scale) and industrial estates;
(d) Irrigation, drainage, and flood control (large-scale);
(e) Land clearance and leveling;
(f) Mineral development (including oil and gas);
(g) Port and harbor development;
(h) Reclamation and new land development;
(i) Resettlement and all projects with potentially major impacts on people;
(j) River basin development;
(k) Thermal and hydropower development; and
(l) Manufacture, transportation, and use of pesticides or other hazardous and/or toxic materials.

Category B Projects/Components

The impacts are not as sensitive, numerous, major, or diverse as category A impacts; remedial measures can be more easily designed.

(a) Agro-industries (small-scale);
(b) Electrical transmission;
(c) Aquaculture and Mari culture;
(d) Irrigation and drainage (small-scale);
(e) Renewable energy;
(f) Rural electrification;
(g) Tourism;
(h) Rural water supply and sanitation;
(i) Watershed projects (management or rehabilitation); and
(j) Rehabilitation, maintenance, and upgrading projects (small-scale).

Category C Projects/Components

Professional judgment finds the project to have negligible, insignificant, or minimal environmental impacts.

(a) Education,
(b) Family planning,
(c) Health,
(d) Nutrition,
(e) Institutional development,
(f) Technical assistance, and
(g) Most human resource projects.

2-3 Purpose of Environmental Impact Assessment

The Purpose of Environmental Impact Assessment (EIA) is to identify and evaluate the potential impacts (beneficial and adverse) of development projects on the environmental system. It is a useful aid for decision making based on understanding of the environmental implications including social, cultural and aesthetic concerns which could be integrated with the analysis of the project costs and benefits. This exercise should be undertaken early enough in the planning stage of projects for selection of environmentally compatible sites, process technologies and such other environmental safeguards**.**

The projects which could be the candidates for detailed Environmental Impact assessment include the following:

(i) Those which can significantly change the landscape, land use pattern and lead to concentration of working and service population;

(ii) Those which need upstream development activity like assured mineral and forest products supply or downstream industrial process development;

(iii) Those involving manufacture, handling and use of hazardous materials;
(iv) Those which are sited near ecologically sensitive area, urban centers, hill resorts, places of scientific and religious importance; and
(v) Industrial Estates with constituent units of various types which could cumulatively cause significant environmental damage.

2- 4 Benefits of Conducting Environmental Impact Assessments

- Reduced cost and time of project implementation.
- Cost-saving modifications in project design.
- Increased project acceptance.
- Avoided impacts and violations of laws and regulations.
- Improved project performance.
- Avoided treatment / clean up costs.
- Facilitates informed decision making by providing clear, well structured dispassionate analysis of the effect and consequences of proposed projects .
- Mitigation of negative environmental and social impacts

The benefits to local communities from taking part in environmental assessments include:
A healthier local environment (forests, water sources, agricultural potential, recreational potential, aesthetic values, and clean living in urban areas).

- Improved human health.
- Maintenance of biodiversity.
- Decreased resource use.
- Fewer conflicts over natural resource use.
- Increased community skills, knowledge and pride.

2-5 Content of an Environmental Assessment Report

An environmental assessment (EA) report for a Category A project focuses on the significant environmental issues of a project. The report's scope and level of detail should be commensurate with the project's potential impacts; The EA report should include the following items **:**

- *Executive summary*. Concisely discusses significant findings and recommended actions.
  (b) *Policy, legal, and administrative framework*. Discusses the policy, legal, and administrative framework within which the EA is carried out. Explains the environmental requirements of any co

financiers. Identifies relevant international environmental agreements to which the country is a party.

- c) *Project description*. Concisely describes the proposed project and its geographic, ecological, social, and temporal context, including any offsite investments that may be required (e.g., dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities). Indicates the need for any resettlement plan or indigenous people's development plan. Normally includes a map showing the project site and the project's area of influence.
- (d) *Baseline data*. Assesses the dimensions of the study area and describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Also takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigate measures. The section indicates the accuracy, reliability, and sources of the data.
- (e) *Environmental impacts*. Predicts and assesses the project's likely positive and negative impacts, in quantitative terms to the extent possible. Identifies mitigation measures and any residual negative impacts that cannot be mitigated. Explores opportunities for environmental enhancement. Identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specifies topics that do not require further attention.
- (f) *Analysis of alternatives*. Systematically compares feasible alternatives to the proposed project site, technology, design, and operation—including the "without project" situation—in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. States the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement.
- *(g) Environmental management plan (EMP).*

  Covers mitigation measures, monitoring, and institutional strengthening.

- *(h) Appendixes*
  - List of EA report preparers—individuals and organizations. References—written materials both published and unpublished, used in study preparation.
  - Record of interagency and consultation meetings, including consultations for obtaining the informed views of the affected people and local nongovernmental organizations (NGOs). The record specifies any means other than consultations (e.g., surveys) that were used to obtain the views of affected groups and local NGOs.
  - Tables presenting the relevant data referred to or summarized in the main text.
  - List of associated reports (e.g., resettlement plan or indigenous peoples development plan).

2 - 6 Tools Inventory and methodology of EIA

This part provides an overview of the types of methods which have been used within the EIA process, fifteen methods will be shown, and uncertainty, impact prediction latest methods also will be discussed.

2- 6 -1 Type of methods and their usage:

Numerous methodologies (tools) have been utilized to meet the various activities required in the conduction of an environmental impact study. The term method or methodology as used herein refers to structured scientific and/or policy-based approaches for achieving one or more of the basic activities.

The following represent brief descriptions of the features of the 15 types of methods, listed alphabetically and not in order of importance or usage, as below:

(1) Checklist: There are many variations of checklists; this type of methodology is the most frequently utilized approach in the EIA process. Typically, checklists contain a series of items, impact issues, or questions which the user should address or answer as part of the impact study. Such checklists represent useful reminders of impacts and provide a systematic and reproducible basis for the EIA process.

(2) Decision-focused checklists represent a group of methods which are primarily related to comparing alternatives and conducting tradeoff analyses. In this regard, such methods are primarily useful for the synthesis of information from impact studies. Each viable alternative is subjected to study. Decision-focused checklists can be useful for both phases, with particular value associated with the synthesis phase. There are several types

of decision-focused checklists, and it is beyond the scope of this report to completely summarize all types.

(3) Environmental cost-benefit analysis (ECBA) represents an emerging type of method within the EIA process. ECBA methods supplement traditional cost-benefit analysis with increased attention to environmental resources and their economic value. Their application to the economic valuation of specific impacts of a proposed project and alternatives has considerable limitations. Estimation techniques vary in their complexity and scope, and place considerable demands on both practitioners and uses of such studies (*Pearce, Markandya, and Barbier, 1989*). Further research is needed to effectively implement ECBA within the EIA process.

(4) Expert opinion, which can also be referred to as professional judgment, represents a widely used type of method within the EIA process. This type of method is typically used for addressing the specific impacts of a proposed project on different components of the environment. Specific tools within the category of expert opinion which can be used to delineate information include Delphi studies and the use of the adaptive environmental assessment process. In this approach groups of experts identify appropriate information and build qualitative/quantitative models for impact prediction, or to simulate environmental processes.

(5) Expert systems are an emerging type of method which consists of drawing upon the professional knowledge and judgment of experts in particular topical areas. Such knowledge is encoded, via a series of rules or heuristics, into expert system shells in computer software. Expert systems are typically user friendly and require the user to answer a series of questions to conduct a particular analysis. Increasing attention is being given to the development of more comprehensive expert systems for the EIA process.

(6) Indices or indicators refer to selected features or parameters of environmental media or resources. They are utilized within impact studies to represent broader measures of media or resources. Specifically, indices refer to either numerical or categorized information for different environmental media or resources. Their usage assists in describing the affected environment, as well as impact prediction and assessment. Numerical or descriptive indices have been developed as measures of the vulnerability of environmental media or resources to pollution or other man-induced stresses and have proven useful in the comparison of sites for a proposed activity such as a new sanitary landfill. On this basis, required mitigation measures can be delineated and can include engineered and/or management controls.

(7) Laboratory testing and scale models can be applied to gain qualitative/quantitative information on the anticipated impacts of particular

types of projects in given geographical locations. While these types of methods have not been extensively used, they are appropriate for certain types of projects. For example, elutriate tests can be conducted to identify the potential impacts of dredging on the aquatic environment by ascertaining the degree of contamination of the dredged material and the potential for release of such contaminants, following the physical disturbance of the bottom materials and their movement to open-water or upland disposal sites.

(8) Literature reviews involve assembling information on types of projects and their typical impacts. As noted earlier in conjunction with analogs, this type of information can be very useful for the early delineation of potential impacts; it can also be used to quantify specific anticipated changes and to identify mitigation measures for minimizing undesirable effects. Considerable information is now available on the typical impacts of certain types of projects.

(9) Interaction matrices represent a widely used type of method within the EIA process. Variations of simple interaction matrices have been developed to emphasize particular desirable features. As can be seen by the examination of Table 1, matrices represent a useful type of method for several study activities within the EIA process.

(10) Monitoring refers to systematic measurements to establish the existing conditions of the affected environment as well as to serve as a baseline for interpreting the significance of anticipated changes from a proposed project. Monitoring could be focused upon the physical/chemical, biological, cultural, and/or socioeconomic environment. Selection of appropriate indicators for monitoring should be a function of the availability of existing information as well as the type of project and anticipated impacts.

(11) Monitoring (field studies) of receptors near analogs represents a particular specialized type of method. Specifically, monitoring and analysis of actual impacts resulting from projects of a similar type to the project are used for impact prediction.

Again, emphasis should be given to monitoring of selected indicators pertinent for the type of project.

(12) Networks refer to a group of methods that delineate connections or relationships between project actions and resultant impacts. These types of methods are referred to in several ways within EIA practice; for example, as impact trees, impact chains, cause-effect diagrams, or consequence diagrams. Networks are useful for showing primary, secondary, and tertiary impact relationships resulting from particular actions. They can also be utilized in conjunction with matrices as a tool for impact identification and qualitative impact prediction.

(13) Overlay mapping was used very early in the practice of EIA. Initial usage primarily consisted of the physical assemblage of maps displaying different environmental characteristics. The application of computer-based geographical information systems (GIS) has been emphasized in recent years. GIS technology represents an emerging type of method in the EIA process. Overlay mapping, either physical or computerized, can be used for describing existing conditions and displaying the potential changes resulting from a proposed action.

(14) Risk assessment is an emerging tool for the practice of EIA. It was initially used for establishing environmental standards based on human health concerns. Risk assessment typically encompasses the identification of the risk, consideration of dose-response relationships, conduction of an exposure assessment, and evaluation of the associated risks. This approach can be applied to both human health and ecological risks.

(15) Scenario building involves considering alternative futures as a result of differing initial assumptions. This technique is utilized within the planning field; it also has EIA applicability, particularly in the context of SEA of policies, plans and programs.

2- 6 -2 the use of methods within the EIA process

The primary selection for suitable tools depends on the nature and the volume of expected impact, for example the use of cost able tools (GIS) Is not justified in the case of small and limited impact.

Table (1) below displays the relative usage of the types of methods in impact studies. Widespread usage is typically associated with checklists, expert opinion and matrices. These types of methods are perceived to be "simpler" than many of the other types of methods.

Table (1): Relative Usage of Types of Methods

Types of Methods	Relative Usage*		
	Selected	**Moderate**	Widespread
Checklists			X
Decision-focused checklists	**X**		
Environmental cost-benefit analysis	**X**		
Expert opinion			X
Expert systems	**X**		
Indices or indicators		**X**	
Laboratory testing and scale models	**X**		
Literature reviews		**X**	
Matrices			X
Monitoring (baseline)	**X**		
Monitoring (analogs)	**X**		
Networks		**X**	
Overlay mapping via GIS	**X**		
Risk assessment	**X**		
Scenario building	**X**		

*"Selected" refers to limited usage of type of method; such limited usage could be due to data requirements, limited knowledge about the method. "Moderate" indicates that the type of method is used for different types of projects different location "Widespread" denotes that the type of method is widely used in a variety of countries with EIA requirements.

Based upon a systematic review of the specific information in Table (1), the following observations can be made:

(1) Each of the listed types of methods has advantages and limitations; these should be considered in selecting specific methods for usage in a given study.

(2) Methods are not "cookbooks" in which a successful study is achieved by meeting the requirements of the methods. Their selection must be based on appropriate evaluation and professional judgment, as must the use of methods and the interpretation of results relative to data inputs and analysis.

(3) Simpler methods, which are less demanding in terms of data, technical and personnel requirements, are probably more useful in the EIA process. To support the usefulness of simpler types of methods, selected results from a recent questionnaire survey will be noted. The questionnaire obtained qualitative and quantitative information related to practices.

3-1 Why Use GIS?

GIS can integrate and relate any data with a spatial component, regardless of the source of the data. It Put Your Data to Work Rather than you working hard to understand your data, GIS puts your data to work for you.
GIS can provide you with powerful information—not just how things are, but how they will be in the future based on changes you apply. It has been used to solve problems as diverse as where to place self-service coin counting machines, how to improve the yield of crops in a tradition vineyard, or how to manage an entire city enterprise.

3 -1-1What Can You Do with GIS?

Map Where Things Are , to see the relationships between places. This gives an additional level of information beyond simply mapping the locations of features you're looking for, and to see where to take action

3 -1-2 Integrating Geography With Information Technology

You will find abundant evidence of the important contributions that GIS technology can make toward improving our quality of life and supporting more analytical decision making.

3-1-3Application and uses of GIS in EIA

1-In Project definition: During project identification and definition, the project proponent conducts feasibility studies and defines the usefulness of the study. GIS can be very well used for defining the project by showing the location of the project and its need can be established with respect to other geographical identities like source of raw material, market for selling, source of laborers, climatic conditions favorable for the project etc.
2- In evaluating environmental and visual impacts: Using GIS various types of visual impacts can be evaluated like, how a road will look like? How much portion of the road will be visible from a particular point? By using DEM we can calculate and visualize the impact on ground levels either in filling or cutting and area of quarries etc *(Oterholm, 1999).*
3- In scoping system: GIS can serve as a basis for scoping of environmental effects. Once the basic databases are available, a GIS based system may provide better-targeted guidelines for EIS. A centralized institutional scoping structure, where by EIS guidelines are issued by a single entity, is found to be important for the operation of such a system as it can enjoy the economies of scale and scope involved in setting up and operating a GIS system for scoping purpose *(Haklay etal., 1998).*
4- In impact significance determination: A spatial impact assessment methodology based on the assumption that the importance of environmental impact is dependent, among other things, on the spatial

distribution of the effects and of the affected environment, For each environmental component like- air, water ,biological resources etc., impact indices are calculated based on the spatial distribution of impacts *(Antunes etal., 2001).*

The fact that GIS is not used in practice to the extent , that it could be used in principle may also be the due to a number of limitations of GIS like availability of digital data , cost of start up ,system maintenance, database construction , and availability of hardware and software

3-2Remote-Sensing

Remote Sensing is the science and art of acquiring information (spectral, spatial, and temporal) about material objects, area, or phenomenon, without coming into physical contact with the objects, or area, or phenomenon under investigation. Without direct contact, some means of transferring information through space must be utilized. In remote sensing, information transfer is accomplished by use of electromagnetic radiation (EMR). EMR is a form of energy that reveals its presence by the observable effects it produces when it strikes the matter. EMR is considered to span the spectrum of wavelengths from 10-10 mm to cosmic rays up to 1010 mm, the broadcast wavelengths, which extend from 0.30-15 mm.

3-2-1Types of remote sensing

In respect to the type of Energy Resources:

Passive Remote Sensing : Makes use of sensors that detect the reflected or emitted electro-magnetic radiation from natural sources.

Active remote Sensing : Makes use of sensors that detect reflected responses from objects that are irradiated from artificially-generated energy sources, such as radar.

In respect to Wavelength Regions , Remote Sensing is classified into three types according to ray :

1. Visible and Reflective Infrared Remote Sensing.

2. Thermal Infrared Remote Sensing.

3. Microwave Remote Sensing.

3-2-2 Bands Used in Remote Sensing

Atoms consist of a positively charged nucleus surrounded by orbiting electrons, which have discrete energy states. Transition of electrons from one energy state to the other leads to emission of radiation at discrete wavelengths. The resulting spectrum is called line spectrum. Molecules possess rotational and vibration energy states. The wavelengths, which are emitted by atoms/molecules, are also the ones, which are absorbed by them. Emission from solids and liquids occurs when they are heated and results in a continuous spectrum. This is called thermal emission and it is

an important source of EMR from the viewpoint of remote sensing, which is reflected or emitted from an object, is the usual source of Remote Sensing data, however, any medium, such as gravity or magnetic fields, can be used in remote sensing.

Remote Sensing Technology makes use of the wide range Electro-Magnetic Spectrum (EMS) from a very short wave "Gamma Ray" to a very long 'Radio Wave'.

Wavelength regions of electro-magnetic radiation have different names ranging from Gamma ray, X-ray, Ultraviolet (UV), Visible light, Infrared (IR) to Radio Wave, in order from the shorter wavelengths, microwave region (1mm to 1m) is another portion of EM spectrum that is frequently used to gather valuable remote sensing information.

Table (2) bands wave length

Band	wavelength (µm)	Principal
1	0.45-0.52	Sensitive to sedimentation, deciduous/coniferous forest cover discrimination, soil vegetation differentiation
2	0.52-0.59	Green reflectance by healthy vegetation, vegetation vigour, rock-soil discrimination, turbidity and bathymetry in shallow waters
3	0.62-0.68	Sensitive to chlorophyll absorption: plant species discrimination, differentiation of soil and geological boundary
4	0.77-0.86	Sensitive to green biomass and moisture in vegetation, land and water contrast, landform/geomorphic studies.

3-2-3Resolution

In general resolution is defined as the ability of an entire remote-sensing system, including lens antennae, display, exposure, processing, and other factors, to render a sharply defined image. Resolution of a remote-sensing is of different types.

- Spectral Resolution: of a remote sensing instrument (sensor) is determined by the band-widths of the Electro-magnetic radiation of the channels used. High spectral resolution, thus, is achieved by

narrow bandwidths width, collectively, are likely to provide a more accurate spectral signature for discrete objects than broad bandwidth.

- Radiometric Resolution: is determined by the number of discrete levels into which signals may be divided.
- Spatial Resolution: in terms of the geometric properties of the imaging system, is usually described as the instantaneous field of view (IFOV). The IFOV is defined as the maximum angle of view in which a sensor can effectively detect electro-magnetic energy.
- Temporal Resolution: is related to the repetitive coverage of the ground by the remote-sensing system. The temporal resolution of Land sat 4/5 is sixteen days.

3-2-4 An Ideal Remote Sensing System

having introduced some basic concepts, we now have the necessary elements to conceptualize an ideal remote sensing system. In doing so, we can then appreciate some of the problems encountered in the design and application of the various real remote-sensing systems . The basic components of an ideal remote-sensing include the following:

- A uniform energy source. This source will provide energy over all wavelengths, at a constant, known, high level of output, irrespective of time and place.
- A non-interfering atmosphere. This will be an atmosphere that will not modify the energy from the source in any manner, whether that energy is on its way to earth's surface or coming from it. Again, ideally this will hold irrespective of wavelength, time, place, and sensing altitude involved.
- A series of unique energy/matter interaction at the earth's surface. These interactions will generate reflected and/or emitted signals that are not only selective in respect to wavelengths, but also are known, invariant, and unique to each and every earth surface feature type and subtype of interest.
- A super sensor. This will be a sensor, highly sensitive to all wavelengths, yielding spatially detailed data on the absolute brightness (or radiance) from a scene (a function of wavelength), throughout the spectrum. This super sensor will be simple and reliable, require, virtually no power or space, and be accurate and economical to operate.
- A real-time data handling system. In this system, the instant the radiance versus wavelength response over a terrain element is

generated, it will be processed into an interpretable format and recognized as being unique to the particular terrain element from which it comes. This processing will be performed nearly instantaneously (real time), providing timely information. Because of the consistent nature of the energy/matter interactions, there will be no need for reference data in the analytical procedure. The derived data will provide insight into the physical-chemical-biological state of each feature of interest.

- Multiple data users. These people will have comprehensive knowledge of both their respective disciplines and of remote-sensing data acquisition and analysis techniques. The same set of data will become various forms of information for different users, because of their vast knowledge about the particular earth resources being used. Unfortunately, an ideal remote-sensing system, as described above, does not exist. Real remote-sensing systems fall short of the ideal at virtually every point in the sequence outlined.

3-2-5 Remote Sensing Satellites

Several remote sensing satellites are currently available, providing imagery suitable for various types of applications. Each of these satellite-sensor platform is characterized by the wavelength bands employed in image acquisition, spatial resolution of the sensor, the coverage area and the temporal converge, i.e. how frequent a given location on the earth surface can be imaged by the imaging system. In terms of the spatial resolution, the satellite imaging systems can be classified into:

- Low resolution systems (approx. 1 km or more)
- Medium resolution systems (approx. 100 m to 1 km)
- High resolution systems (approx. 5 m to 100 m)
- Very high resolution systems (approx. 5 m or less)

In terms of the spectral regions used in data acquisition, the satellite imaging systems can be classified into:

- Optical imaging systems (include visible, near infrared, and shortwave infrared systems)
- Thermal imaging systems
- Synthetic aperture radar (SAR) imaging systems

A satellite with remote sensors to observe the earth is called a remote-sensing satellite, or earth observation satellite. Remote-Sensing Satellites are characterized by their altitude, orbit and sensor.

Land sat is established at an altitude of 700 Kms is a polar orbit and is used mainly for land-area-observation.
Generally, remote sensing refers to the activities of recording/observing/perceiving (sensing) objects or events at far away (remote) places. In remote sensing, the sensors are not in direct contact with the objects or events being observed. The information needs a physical carrier to travel from the objects/events to the sensors through an intervening medium. The electromagnetic radiation is normally used as an information carrier in remote sensing. The output of a remote sensing system is usually an image representing the scene being observed. A further step of image analysis and interpretation is required in order to extract useful information from the image. The human visual system is an example of a remote sensing system in this general sense.
In a more restricted sense, remote sensing usually refers to the technology of acquiring information about the earth's surface (land and ocean) and atmosphere using sensors onboard airborne (aircraft, balloons) or space borne (satellites, space shuttles) platforms.
In satellite remote sensing of the earth, the sensors are looking through a layer of atmosphere separating the sensors from the Earth's surface being observed. Hence, it is essential to understand the effects of atmosphere on the electromagnetic radiation traveling from the Earth to the sensor through the atmosphere. The atmospheric constituents cause wavelength dependent absorption and scattering of radiation. These effects degrade the quality of images. Some of the atmospheric effects can be corrected before the images are subjected to further analysis and interpretation.

Table (3) land sat orbit

Type	Sun-Synchronous
Altitude	705 km
Inclination	98.2 deg
Period	99 min
Repeat Cycle	16 days

Sensors

- MSS (Multi-Spectral Scanner), Being one of the older generation sensors, routine data acquisition for MSS was terminated in late 1992. The resolution of the MSS sensor was approximately 80 m with radiometric coverage in four spectral bands from the visible green to the near-infrared (IR) wavelengths. Only the MSS sensor on Land sat 3 had a fifth band in the thermal-IR.

Table (4) M.S.S characteristic

	Band	Wavelength (μm)	Resolution (m)
Green	1	0.5 - 0.6	82
Red	2	0.6 - 0.7	82
Near IR	3	0.7 - 0.8	82
Near IR	4	0.8 - 1.1	82

- TM (Thematic Mapper), first operational on LANDSAT-4. TM sensors primarily detect reflected radiation from the Earth surface in the visible and near-infrared (IR) wavelengths, but the TM sensor provides more radiometric information than the MSS sensor. The wavelength range for the TM sensor is from the visible (blue), through the mid-IR, into the thermal-IR portion of the electromagnetic spectrum. Sixteen detectors for the visible and mid-IR wavelength bands in the TM sensor provide 16 scan lines on each active scan. Four detectors for the thermal-IR band provide four scan lines on each active scan. The TM sensor has a spatial resolution of 30 m for the visible, near-IR, and mid-IR wavelengths and a spatial resolution of 120 m for the thermal-IR band.
- ETM+ (Enhanced Thematic Mapper Plus), is carried on board Land sat 7. The ETM+ instrument is an eight-band Multispectral scanning radiometer capable of providing high-resolution image information of the Earths surface. Its spectral bands are similar to those of TM, except that the thermal band (band 6) has an improved resolution of 60 m (versus 120 m in TM). There is also an additional panchromatic band at 15 m resolution.

Table (5) land sat T.M & E.T.M characteristic

	Band	Wavelength (μm)	Resolution (m)
Blue	1	0.45 – 0.52	30
Green	2	0.52 – 0.60	30
Red	3	0.63 – 0.69	30
Near IR	4	0.76 – 0.90	30
SWIR	5	1.55 – 1.75	30
Thermal IR	6	10.40 – 12.50	120 (TM) 60 (ETM+)
SWIR	7	2.08 – 2.35	30
Panchromatic		0.5 – 0.9	15

3-3 Limitation of remote sensing system

1. Scale Limitations. There can be a tremendous amount of information available to a remote sensing system. Imaging systems in particular often have more data available than they can collect and transmit back to earth or that can be processed when returned to earth. As a consequence, there are often compromises struck among data resolution, area covered, and frequency of coverage.

These compromises can be a cause of some frustration to the image user.

2. Picture Element Size. There is one feature common to all imaging remote sensing systems which has a direct influence on the analysis of the imagery. This is the size of the picture element, the pixel. Perhaps the best example of pixels comes from photography film. The reason that enlargements look "grainy" is that the individual crystals on the original film are becoming separately visible. Obviously, it takes many silver crystals to define an object. For instance, a hundred crystals may be necessary just to make an object identifiable as a human being. Satellite remote sensing systems divide the earth's surface into an array of rectangular pixels and transmit back to earth a digital signal defining the amount of electromagnetic radiation received at the satellite from that pixel. The size of the pixel on the ground defines the limiting resolution of that particular remote sensing system. It should be clear that in order to "see" something on an image, its minimum size must be comparable to the size of the pixel.

3. Measurable Levels of Radiation. The interpretation of remotely sensed data is ultimately limited by the amount of radiation received by the recording system.

4. Other Limiting Factors. There are many factors which can limit the ability to receive the desired signal even if an adequate signal did originate from the earth's surface. In the case of visual signals, clouds are an obvious example. Clouds can be present over a specific study site a good deal of the time.

2-7 Conclusions

In summary, while many EIA methods exist, they are not uniformly used in all impact studies. Conversely, perhaps the greatest encouragement comes from information dissemination on different EIA methods and their interrelationships. This can be a major inducement to the usage of appropriate methods in impact studies. However, uncertainty is a persistent, ever present characteristic of impact studies; and it requires a systematic response. Specific measures should be taken to document and state the level of confidence in impact predictions and identify qualifications (which, in turn, will point toward monitoring and follow-up requirements).

Literature review (2)

2-2 Analysis of EIA Tools used in Studies of Selected Sites in Sudan

2-2-0 Introduction

The main purpose of this section is to study the suitability of the tools and methods used in the selected projects activities theoretically and practically in impact assessment.

As the purposes of environmental assessment is to improve decision making and to ensure that the project options under consideration are environmentally sound and sustainable, So EA should be a flexible process requiring in classifying projects through important issues such as cost analysis , adherence and compliance with environmental regulations and guidelines , systematic field studies to assess the impacts on environmental factors (biophysical environment ,socio-economic analysis and rehabilitation policy for project affected people),public consultation , alternative options , the Collected data is classified according to the related field in the river engineering, the used tools inventoried, through out all the stages of EIA process(baseline data , impact assessment and environmental management) for projects activates (location , construction ,and operation and maintenance) , finally the usage of tools has been discussed all over and summarized in a table .

The collected data are:

(1) Social and E. impact of heightening Rosaries Dam , classified as Dams and Bridges Construction

(2)E. and social impact assessment – Ethiopia –Sudan power system interconnection classified as Hydro-power generation

(3) E. impact assessment - North Kordofan Water supply project classified as Water supply projects.

2-2-1 Study : Ethiopia – Sudan power system Inter connection

1-General background

The ESIA of ESTIP[1] is being implemented by the NBI[2] under the supervision of ENTRO[3] representing the eastern Nile countries Egypt, Ethiopia and Sudan , it form part of the program on integrated development of the Eastern Nile, it is long –term development objective is to promote regional power trade through planning and power generation and transmission inter connection in the context of multi- purpose water resources development ,the project involves the construction of a high voltage transmission line from Ethiopia to Sudan which would be the first step in realizing an integrated power system in eastern Nile .

Three alternative routes are being investigated (option A , B and C) , pass through the Amhera , Oromiya and Benishangul – gumiz Regions of Ethiopia , Al Qadarif , An – Nile al Azarg states of Sudan ,the recommended route(option C) is 446 km in length , starting from Bahir Dar in Ethiopia and connection to Al Qadarif in Sudan , it considered as the most cost effective option .

The previous study start early on 1982 till 1988 (master plan), In 1994 – 1995 up date the study , In January 2005 September 2006 final up date (current report carried by SMEC[4]) ,the funds for investigation is provided by the World Bank ,The impact is assessed based on both Ethiopian and Sudanese legal , legislation Environmental – policy and guideline of administrative institutes .

The world bank safe guard policies of Environment , Rural and social development have been considered in this report , many other international Agreements are relevance to the project ratified by tow countries .

Construction is expected to start after contract signing following international tendering , the total cost is 57.64 million Euro assume option C is chosen and include costs for both Sudan and Ethiopia , also include 1.5 million Euro for mitigation program for Environment and socio- economic impacts of the project .

Project benefits would come from replacing thermal generation in Sudan with Ethiopian surplus hydro-power .

1 -Eastern Nile transpondery projects

2 Nile Basin Initiative :Establish formally in 1999 , provides for an agreed basin – wide frame work to fight poverty and promote socio- economic development in the Nile countries .

3- Eastern Nile Technical Regional Office.

4- SMEC: Snowy Mountains Engineering Corporatio

2- Base Line Data

2-1 Location

The project area is with in the Blue Nile and Atbara river system which originate in Ethiopia , much of it is under agricultural cultivation and live stock farming .

2-2 Physical Environment

Topography and geology ; the topography along option C route varies greatly from high area (above 2,000 M in Ethiopia) to low land plains-clay- (500 – 900 M in altitude) towards Ethiopia Sudanese border and then to EL Gedarif in Sudan .

The Bahir Dar area is Tertiary and Quaternary volcanic origin , this formations have a general slope which is oriented Westward , while Gedarif area formation are basement complex , Nubian series known as Gedarif formation consist of sand stones , mud stone and sand – mud stone , Volcanic rocks and superficial deposit .

Soil : is predominately blackish clay with stone , soil erosion / degradation is a major problem in two countries .

They are prone to drought , water logging and high run -off , have good natural fertility and intensively used for agriculture and live stock grazing in the dry seasons.

Climate : the climate in the study area is tropical , in Ethiopia the variation in altitude is primary causes of variation in climate as in tropic , lower altitude the higher temperature , and the rain fall is also varies (less than 900 mm a year falling mainly from may to September, the mean temperature is 27.8 C^{O}) , no variation in day length and the angle of the sun throughout the year .

No variation on climate in Sudan as the lack of variation in altitude , study area belong to type 1 Rain fall Regime (Rain fall is 322 mm –761 mm ,high tem. 44 C^{0} in April).

Water Resources : study area lies with in the catchments of the A bay or Blue Nile and Atbara river , flow only during the rainy season for many of water resources , access to potable water supplies is often problem during the dry season , local villages reply on ground water wells and small shallow dams .

2 -3 Biological Environment

Vegetation cover : influenced by climate , topography and population and it disturbed by human activity and change in hydrology , it limited to a few protected area .

Wild life : biodiversity is diverse and severely degraded and reduced especially larger Mammals and bird species .

Many species are now confined to a few protected area such as the Dinder Natural Park , during the field work none of the wild life were observed (except for variety of birds) due to expansion of mechanical farming , civil war and blocking of seasonal migratory routes of wild life .
Area of ecological Importance : include some protected forest areas , lake Tana and Forgera plains in Ethiopia , Dinder National Park in Sudan .

2 -4 Socio – cultural Environment

the main ethnic group in Amhara Region is Amhare with some Weto , Hemra and Agew .
The majority are Amhargina speakers , the major religious is Christianity and Islam .
In Sudan people are Ingssana , Fallatta and Umbarraro ethnic group , Dinka who refugee from the war in south .
Although most people speak Sudanese Arabic , but the area is remarkable for it is linguistic diversity , the majority are muslim faith , Christianity .
Most of them depend on land .
The total population of the Amhara Region was 18 million in 2004 (89% in rural areas) while the population of Gadarif was 1,022,000 in 1993 (71% in rural areas).
The education level is so low in both regions , but in Gadraif is higher than Amhara .the areas under construction suffer from lack of health services , as well as a high rate of maternity mortality .
There are many of cultural Heritage in the areas {churches , burial , temples and mosques } .

3 -Base Line Tools

The base line information for the project is collected from Relevant documents , with governmental authorities and NGOs .
Data related reports and previous environmental studies , detailed survey plan , field investigation , topographical and geological maps , soil maps , aerial photographs , site visit , consultation and meeting with local official and affected peoples , and interviews Analysis : to identify environmentally sensitive areas to negative impact ,Affect from construction and operation of the transmission line and associated structure .
Assess impacts and changes that may be included by the transmission line , and identify the mitigation measure to avoid the negative impact .

4 - Impact assessment tools

Methodology :The potential impact is assessed for different stages of the project (pre construction , construction , operation and maintenance } .

The methodology of this assessment are : scoping to narrowing and determine the borders of impact , impact analysis using matrix and check list , previous studies , interviews with stake holders , collected data from field investigation , literature review ,cost viability for transmission routes and public consultation base on the world bank policies and EIA guide line for the tow countries, .

Assessment finds that expected impact during construction and operation will be electrification, land loss, health impact, and overall disturbance for the varies activities in the project area.

5 - impact evaluation

5-1 Construction phase

Direct positive impact : provision of electricity which is considered to be significant long-term positive impact , temporary employment during construction and income generated by sale of foods and things to migrant workers .

Indirect positive impact : with regards to women' work burden { collecting water and fire wood }as electricity will use as source of energy for pumps others .

Electricity would support investment , power supply to health facilities by cold storage and safe transportation of vaccinations and vital medications .

Direct negative impact : loss of income due to temporary disturbance to field and grazing areas it is short- term .

Loss of land, air and noise pollution , loss of vegetation and biodiversity , increase risk of communicable diseases .

Operation phase

Direct negative impact :

1- disposal of poly chlorinated biphenyl {PCBs}used in electrical equipment power full toxic even at low concentration and bio-accumulation creating adverse health impact and organic pollution (safe removal and disposal of any {PCBs) .

2- possible health impacts of electromagnetic fields associated with power transmission lines {EF produced by voltage V/M, EMF result from flow of current through wires (G) or Tisla (T) international standard right of way = 40 M along high voltage transmission line .

Other impacts

Pre- construction : land loss ,household loss due to resettlement ,crop production,

Construction : access roads affect vegetation cover due to clearance.

Increased traffic : disruption to traffic movement.

Construction of camp sides : water pollution due to solid and liquid waste .

Construction of transmission line tower : cleaning of vegetation , side compaction and land acquisition, air and dust emission , noise .

Operation : air craft disturb , electrocution .

Maintenance : periodic maintenance along ROW of transmission line will require clearing of regrowth along and adjacent to the line, risk of bird collision in flight .

The consultant is recommending that the major impact will be positive and the communities as will as environment will gain a lot of benefits, most negative impact associated with the project are of temporary nature resulting during construction and can be minimized by implementation of appropriate mitigation measure .

2-2-2 Study : North Kordofan Water Supply Project (Feasibility study and impact assessment)

1 - General background

Water situation in Kordofan State is critical , North Kordofan , in particular , is worse , the state 'government has decided to develop a project for water supplying from the white Nile for human and animal uses .

The project concern is construction of water conveyance system to carry treated water (estimated as 250,000 cubic meter / day)from the white Nile and distributed through sub mains and branching lines , the project area falls in the North , centre , and east part of the state .

The visibility study (carried out in 2005 by University of Khartoum Consultancy Corporation UKCC) is concern with identification of technically and economically location of the intakes pumps, options for the routes of supply system and carry out E I study for the proposed project.

2- Base Line Data

2-1 Location

NKS lies in central Sudan between 27.5^0 – 32.15^0 E and 11.15^0- 16.45^0 N in area of 58,000,000 feddan .

2-2 physical Environment

Geology : geological formation are : basement complex , Nubian Sand stone , Um Rawaba formation and superficial deposit , landscape varies from flat to complex nature with a few hills and rocky outcrop.

Land uses : grazing and agricultural activities differ due to variation in precipitation rates an type of soil.

Soils : soil is sandy in northern and central , clayey in hills area , while it is alluvial deposit on the wadies of the state .

Climate : falls with in four climatic zones : Desert , Semi Desert ,Dry and Semi Dry ,rainy season starts on June – October with a mount of 100 mm in north to 400 mm in south , temperature also varies from south to north 40 – $45C^0$ in summer , - 11 C^0 winter .

Water resources: the main source is the annual precipitation as surface water , ground water is present in several aquifers .

2-3 Biological Environment

Vegetation cover : occupies 5,274,000 feddan , most of it are thorny trees of which Acacia Senegal (Hashaba) is the most important , forests represent 80% of biomass energy 20% of grazing capacity beside providing fruits and building needs .

The most threats to forests are uncontrolled cutting for fuel wood and construction of cottages , a lot of woody trees and grasses cover the state , the density of biomass reduces from south to north .
Wild life: renounced of its wildlife which could be important tourist revenue, especially in Abu Oroug area as it is proposed as a wildlife protected area .
Area of ecological important: there is no important places considered to be important at the state .

2-4 socio – cultural Environment

Population: Population: equal to 2,353,460 person at 2002 , water has a clear impact in livelihood patter and distribution of settling , population density increase in south locality and decrease in north one , the movement is affected by intensity and duration of rainy season .

3 -Base line tools:

Field visit, collection and review of available data, and photographic documentation.

4 -Impact Assessment tools

Methodology : in conducting environmental assessment study , several methods and procedures were adopted those are : check list for impact evaluation (world bank guidelines)Workshops, water samples procedure and meeting with the state's officials .
Assessment : the project expected to have some EI on many environmental components on both a aquatic and terrestrial Environment , In the area where it will be situated { soils , range lands cultivated areas , forests , natural seasonal ways , human settlement , drinking water }.

5 -Impact evaluation

Construction phase

Construction : main impact due to site grading , trenching and excavation ,change the soil structure and character , disturb of farming and grazing areas , crops destroyed , noise , forest damage .
This is an negative impact which is temporary – short term impact.

Operation phase

Development and better utilization of the natural resources , improvement of health and hygiene facilities by availability of water , accelerate vegetation cover , decrease soil erosion , improve air quality (less dust) , wild life improvement , employment opportunity.

Beside social impact (improvement women and family life by saving water, time and effort) .
This is a positive impact which is continuous - long term impact (significant)
No negative impacts are foreseen to be caused (insignificant).
Many mitigation measure and monitoring plan for environmental components are recommended to avoid the negative impact.

2-2-3 Social and Environmental Impact of heightening the Rosaries Dam

1 -General background

The construction of the Rosaries Dam (R.D) was proposed earlier in 1952 with storage 1.0 milliard m^3 in the area of AL – Damazin .

Investigation surveys revealed that storage in excess of one milliard could be provided by a higher Dam , further studies come out with the recommendation of a Dam with an initial use full storage capacity of 3 milliard m^3 at reduced level 480 m with lake area of 290 km^2 , to be increased to 7.4 milliard at reduced level 490 m, with lake area of 626.9 km^2 as a second stage , In 1959 the Nile Water agreement defined a share of 18.5 milliard m3 for the Sudan and allowed the construction of R.D .

On the other hand the expansion of the Geziera scheme required more water for irrigation . , beside hydro-power generation , In 1961 the construction of the Dam was started , and completion was in 1966 , to increase the water volume a joint operation of the Rosaries and the Sennar Dam was adopted.

The Nile Water studies recommended heightening the Rosaries Dam to R.L 490 m in order to compensate for the loss live storage of the reservoir caused by siltation , to increase the hydro – power potential , and to meet the crop water requirement as expansion of the cultivated areas , beside the heightening of Rosaries Dam will allow the full utilization of the Sudan share of the Nile water according to the Nile water Agreement in 1959 .

Beyond this benefits an adverse impacts from the effected of the project on the Environment are expected , half of population in the reservoir basin would have to be moved following heightening of the Dam with a high cost of their resettlement .

In 1991 the Government of the Sudan decided to execute the heightening of the Dam On May 1992 an a agreement was signed between the (RDHU) represents the Government , and the consultant (Jaffar Karrar & Partiers)to under take the study .

The main guidance for the style format used in planning and executing the study are : Environmental Impact Assessment for developing countries , Geping (1987) , World Bank Operation Direct Manual (1991).

2 Base Line Data

2-1 Location

the main study area lies up stream on the Blue Nile from AL-Damazin to AL – diem on the Sudanese – Ethiopia border , between latitude 11^{o} 14^{-} N - 11o 50^{-} N , and longitude 34^{o} 15^{-} E - 34^{o} 57^{-} E.

2-2 Physical Environment

Topography and geology : the surface is shaped by active water erosion , the clay plain in the north , mountains rocks reduced to plains

It composes of basement complex rocks (Marble and Mica schist's are developed) .

Soil : soils of the clay plains are dark (high in clay content , > 60% clays) have a high cat ion exchange capacity (50 meq / 100 gm soil), low in organic matter and nitrogen .

Climate : high temperature and the seasonality of the rain fall are the main characteristic of climate , high temperature is 44 C^{0} in April , and lower is 8.7 C^{0} in December , the a annual rain fall is 712 mm (begins on March) , relative humidity is about 48 % .

Potential evaporation is estimated to range from above 2000 mm per year at a dam , to below 1800 mm at the border .

Water Resources : surface water are Blue Nile , Khors , Rain water and Hafirs , ground water is available from three aquifers : Quaternary cover of clays sands and gravel , Alluvial sediments , fracture zones in basement complex rocks .

2-3 Biological Environment

Vegetation cover : woody land occurs when the annual rain fall increases , a wealth of tree cover of varying types that can easily lend themselves to a variety of usages , tall grasses also occurs .

Wildlife: the area is known for its variety of wild life, the distribution is controlled by water availability and habitat suitability.

Fish and animals : huge amount of fish and animals , fish from inland waters (Nile and its tributaries) and Rosaries reservoir , the fish population of reservoir is made up of 37 species .

Area of ecological Importance: Dinder National Game Park is only one protected habitats.

2-4 Socio – cultural and economic Environment

Population : 72100 persons inhabit live in the west and east bank ,(east bank is more density) , composes of more than 14 tribes , major are the Hawsa , Fung and Fallata , other like Barta , Gumiz .

Occupation are farming , agricultural , labor , Government jobs , and unemployment .
Social services : education and health are poor , the illiteracy rate is higher a among the west bank population, there is neither a hospital , nor a health centre in the area ,it suffers from prevalence of diseases such as Malaria , Bilharzias and a high mortality rates .
Houses are built from straw and mud , most villages lack all normal housing utilities (no pit latrines , no bath room , and no clean drinking water).

3- Base Line Tools

The base line information for the project is collected from Literature review and previous work , collected data – field visit and survey ,Expert opinion ,Satellite maps image ,Comprehensive questionnaires ,Sampling procedure .

4 - Impact assessment tools

Methodology : The impact assessment for this project was carried out using the methodology of site investigation and maps ,literature review , public participation, interviews, sample procedure and socio-economic survey .
In addition to quantitative models, hydrological model, correlation equation and empirical relationship.
Assessment: The expected impact on the Environment is increase power generation, displacement, land loss and clearance, health risk , sedimentation and life habitat .

5 - impact evaluation

Construction phase

The needs of trees clearance from the reservoir area , spills of pollutants , disturbance to flora and danger to fauna, land loss , dust and air pollution , work accidents and use of hazardous materials , diseases brought by immigrant labour .all this is going to be adverse impact on the environment .
It is a negative short – term impact (moderately) .

Operation phase

power generation **:** which is direct positive impact **,** reduce variation in discharges and levels for both Nile and Blue Nile , increase releases down stream during recession period improve, decrease bank erosion , improve river transport , proper , increase the aquatic weeds , tourism facilities ,

development of mining project ,resettlement conditions with proper services, this is indirect positive impact .

Sedimentation rate will increase , less area inundated , fish species decline affect the settlement on the bank (displaced), affect wild life habitat by blocking the route spread of some diseases, water quality deteriorate, this is Direct negative impact

most impact associated with the project are of temporary nature resulting during construction and operation , can be minimized by implementation of appropriate mitigation measure .

Table (6) summary table

Category	activities	Project name	Tools used		
			Baseline	Environmental impact	management plan.
River Engineering	1-Dams and Bridges Construction	Heightening of Rosaries Dam	1-litreture review and previous work 2-data collection 3-field visit and survey 4-expert opinion 5- satellite maps image 6-Comprehensive questionnaire 7-Sampling procedure	1-Hydrological model. 2-Correlation equation and empirical relationship . 3-Interviews 4-Site investigation . 5-Puplic participation .	Monitoring and follow – up .
	2- Hydro – power generation projects	Ethiopia Sudan power system interconnect ion ESIA	1- previous study 2- interviews 3- meetings Field work 4-matrix 5- communities participation	1- public consultation 2- data collection 3- field investigation 4- stake holders consultation. 5-Matrix.	-
	3-Water supply projects	North Kordofan water supply	-	1- field visit 2- meeting with officials people 3- collection and review of available data 4- sample collection 5- checklist 6- photographic	Monitoring and risk analysis .

2-3 Conclusion

(1) Ethiopia – Sudan power system Inter connection :

this report assessing and evaluating the environmental impact of power transmission lines which is considered to be huge developing project through the tow countries , the tools used during this study illustrate and identify the expected impact which can be remedial , such tools are useful in this case as the activities will be carried out during the project process have minor effect on the environment of this undeveloped area , and the supervision of power will increase the environment.

Base line tools are adherence to collect the needed data through field investigation and detailed survey , maps and soils analysis in addition to previous work ..

Impact assess and evaluation tools check list and matrix , cost analysis , direct consultation with communities are reasonably acceptable for minor impact .

Over all views realizes that such tools are simple but acceptable for this cases .

(2) North Kordofan Water Supply Project :

This project is considered as environmentally friend project with large amount of development , as the water supply will be available any where of the state .

The base line tools field trips , previous data and meeting is extremely enough to collect data ,tools of evaluation check list , work shop , discussion and samples technique are so useful for limited application as this is combined (Feasibility study and E impact assessment) , no quantitative impact measure as is not important here .

(3) Social and Environmental Impact of heightening the Rosaries Dam :

The heightening of R.D is considered to semi huge project, that expected to be useful and offer great banalities to the communities , on the other hand it will cause many affect to the environment of the project area , as it clear from above the this impacts were assessed by many tools , the most important effect is the displace of people in the contacted areas , the comprehensive socio-economic survey proposed a plan for resettlement for them with better condition, also the methods of public consultation , interviews and questionnaire and very effective in such case .

Chapter Three

Materials & methods

3- Environmental Impact Assessment For Implemented / Constructed Dam using GIS/Remote Sensing

3 -0General

Sudan is a vast country extends from the desert in the north with hot dry climate and almost no vegetative cover, to the African Sahel Zone in the center with light and dense Savanna, to sub- tropical region in the south with heavier rains and dense forest cover; this endows the country with various environments and different agricultural systems.

There are numerous environmental problems in Sudan; one of the important problems perhaps appear to be poor land use practices in the watersheds resulting in increased soil erosion and excessive silt deposition in Sudan's rivers, reservoirs and irrigation canals. The annual peak of silt load in the Blue Nile thought to have increased from 40 million tons in 1965 to 140 million tons in 1979. There appears to be some correlation between tree clearance and removal of the vegetation cover for agriculture and the increased silt load in the Blue Nile *(World Bank, 1986).*

The sedimentation, which results mainly from bad practices and land misuse, especially in the watersheds, varies from one year to anther depending on different factors including the density of the vegetation cover

Detection of forest cover changes on the Blue Nile flood basin and clay plains, over the period 1980 – 2004 indicated progressive declining in trend as a result of deforestation in the area , increasing the bare areas to about 30% of the forest area .

The main cause of deforestation is the expansion in mechanized agriculture.

The annual clearance rate is 0.4 – 0.589 million hectars *(a fricover 2003)*

The decline of the forest cover has negative impacts on the Nile ecosystem including flood, biodiversity loss , soil erosion and siltation .

Erosion caused by surface floods in the clay plain area removes the soil and deposits silts in the river basin.

This study is an environmental impact analysis for the Rosaries dam on the Blue Nile in Sudan.

The study attempts to assess the present problem of siltation in the area and to provide suggestive measures for the watershed improvement of the dam.

The study shall assess the status of erosion and land degradation in the catchments area to prevent siltation and to suggest the future plan of treatment.
Various information layers were integrated through the GIS software Arc/Info using overlay methods.

3-1 Study Area

The selected case for this study is Rosaries reservoir, which is located in Sudan across the blue Nile 630 km upstream of Khartoum was built in 1966, the dam is multi-propose irrigation, fisheries and hydropower. The dam was designed for an operating range between 467 and 480 giving alive storage of 2400 million m3 to be released for use down stream *,(Gibb, 1996)* , Because of the siltation, maximum retention level was raised to 481 to provide additional storage (The original design allowed for subsequent increase of 10m height).
The study area for this research will be the Rosaries Dam and its influenced area (rivers banks , agricultural areas fig (1)), location map .It lays on the coordinates : (11^o 30^- , 12^o 0^o) latitude & (34^o, 35^o) longitude .

3-2 General description of the interested study area

Location: it is located between (11^o 30^- , 12^o) latitude, & (34^o, 35^o) longitude .

Feature of the environment

The climate of the study area characterized by two mean traits : sustained heat and marked seasonality of rain fall , The annual average rain fall is 700 mm and falls June to October in Damazin and 1500 mm in Eldeim. Rainfall increases gradually upon going South and decreases towards the North till it is almost dry , it is hot in summer and rains but in winter is cold, the temperature is between (27°—46°c) in December and April respectively .
The soil properties of the study area are clay layers covered by hilly forest at Eldeim then surround by poor savanna in Rosaries and Damazin, the mean annual relative humidity is 48% during the rainy season . the prevailing wind is northerly during November and February westerly in march , and southerly during the remaining months of the year , the mean annual wind velocity is around 6 mph.

(Ministry of agriculture in Blue Nile State, 2008).

Geomorphology

The surface of the study area has been greatly shaped by active water erosion . mountains of igneous rocks have been reduced to plains . only remnants of the basement complex can be observed in the area as rock outcrops . the area is flanked by the Ethiopian plateau in the East and the Ingessana hills in the west .the area between those hills and the river terrace is sloping gently , this sloping feature helps the development of a huge sheet of water during the rainy season which will further develop with slope , into streamlets and wadies . this feature encourages headword erosion and formation of gullies which are very active during the rainy season where the run off occurs as a result of heavy rain.

Geology and structure

The area is composed of basement complex rocks made up of gneisses in which bands of marble and mica schist's are developed . Intrusive bodies of ultra basic and basic rocks are numerous, the most interesting of them from an economic point of view, are those of the Ingessana hills and those east and west of Rosaries Dam , acidic and intermediate intrusive bodies are also common west and south west of the lake area .

Soils

Soils of the clay plains (cp) are dark and very dark grayish brown cracking clays , also in the depressions very dark grey soils occur . they are high in clays content (> 60 % clays)and have a high cat ion exchange capacity(>50 meq / 100 gm soil)water holding capacity of these soils is high , they have low nitrogen and organic carbon content .

Water resources

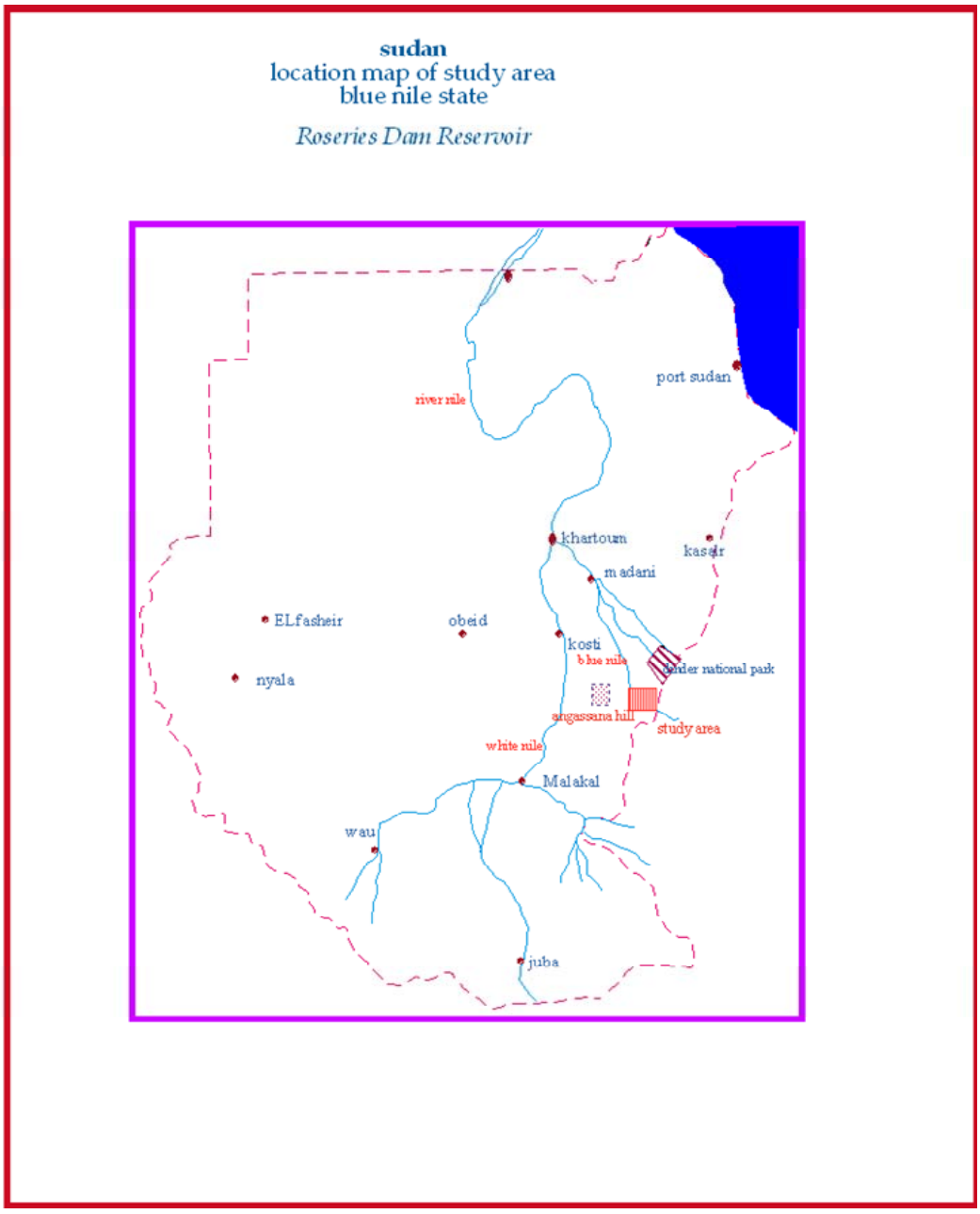
Two sources for water are identified in the area surface and ground , four sources of surface water are : blue Nile , Khors , rain water and Hafirs , there are three potential sources of underground water the Quaternary cover of clays , sands and gravels forming the flat plains east and west of the lake , Alluvial sediment with resent and old channels ,and Fracture zones in basement complex rocks .

Vegetation cover

The area lies within the low rainfall woodland Savanna Zone , a marked change of tree species is observed whenever there is a change in physiographic and soil texture .

Woodland dominated by *Acacia seyal* occurs when the annual rainfall increase , tall grasses form the under storey ,in the drier part of this zone species such as *Acacia melifera* occur in association with grasses .

In hill slope and well drained sites , Habeel and Tarag found together , the under storey is formed of a mixture of short and tall grasses .



STUDY AREA

Fig (1) Location Map of the study area

4 . Problem and Justifications

Watershed degradation in Sudan

According to World Bank (1986) "the relatively rapid development of Sudan's agricultural sector through intensification of existing agricultural system (both irrigated and rain fed) and the exploitation of "unused" land and removal of tree cover have led to a number of negative environmental impacts on the country's watersheds, including:

1. Changes in the physical and chemical properties of the soils
2. Increased soil erosion/water runoff and reduced water retention . In addition to other environmental problems, while these problems clearly exist, very few if any, empirical or quantitative studies assess their magnitude particularly as they are related to decreasing hydroelectric power and agricultural productivity. These problems also lead to increase the production cost in both hydroelectric power generation and agricultural production" The impact of the sediment load on Sudan reservoirs, rivers and irrigation canals is considerable and has resulted in:
   - Reduced efficiency of the *Roseries, Sennar* and *Khasm el Girba* dams in providing water for the major irrigated agricultural schemes. The *Khasm el Girba* Dam designed for a total volume of 1.3 billion cubic meters but the capacity reduced to 0.61 billion cubic meters in 2000 due to silting. More reduction in its capacity expected, unless costly dredging actions are undertaken. The original live storage capacity of *Roseries* Dam was 3.24 billion cubic meters but siltation reduced this capacity to < 2 billions cubic meters in year 2000. The rate of sedimentation recorded was over two times greater than the design estimates. This reduction in storage capacity of *Roseries* Dam has resulted in decrease in hydroelectric potential necessitating costly heightening of the dam and importation of dredging equipment.
   - Increased of sediment in the irrigation canals, partly due to reduced of water flows and velocity encourages the growth of aquatic weeds, which further reduce flows and increase sedimentation and the risk of canals breakage. The net result is a decrease in available water to the agricultural schemes or substantial increase in recurrent costs. For example, one major canal in the *Rahad* scheme designed to have a cross section of 10 cubic meters but now the actual area was 4.7 cubic meters, thus reducing the irrigation potential by more than 50%.

- Reduction of Rosaries hydroelectric output by as much as 80% during peak flood periods due to debris accumulation at the turbine intakes.
- Migration of rivers and tributaries within the flood plains away from the established traditional agricultural areas and water capture points.

A land use study on the catchments of the Rosaries Dam was carried out by a team from the National Energy Administration (*NEA, 1984*), this study revealed that the annual suspended silt load of the Blue Nile was estimated at 135 million tons, and although most of the load passes through the dam, only 550 million cubic meters were deposited in the first 10 years of the dam's operation (1966-1976), further 100 million cubic meters were deposited in the next 5 years (1979-1983), mostly in the live storage zone of the dam.

Erosion is high. This is true both upstream of Lake Tana and all through the Blue Nile basin (hence the name as its dark waters join the clearer White Nile waters in Khartoum), and is exacerbated by clearing of woodlands. About 150 million tons of silt entering Sudan annually via the Blue Nile reduce the hydropower benefits downstream and increase irrigation system desilting O&M costs.

At Rosaries nearly all the dead storage volume has been filled and the live storage is depleting gradually . a lot of years of experience with the operation of the dam has shown that , despite special provisions and reservoir management procedure , the siltation problems causes serious difficulties in August at the intakes of the power station.

A ready source of silt originating mainly from severe erosion in the upper catchments area in Ethiopia , intense rain fall and the steep gradients required to keep the silt in suspension .

Sediment measurement data on the Blue Nile prior to the construction of Rosaries dam was scare and led the designers to underestimate the rate at about 15.3 mm3 per year .

(Alexander Gibb 1996)

A lot of bathymetric surveys of the reservoir were carried out together with systematic suspended load measurement .

5. Available data description

Beside the collected reports and review of data for Rosaries dam, the following data have been collected to meet the demand of this study :

5-1 Bisymmetric surveys

The survey was carried out by Ministry of Irrigation and water resources , at a water level of 480.54 m with different cross-sections location (coordinate data),in different years , and it aims to:-

- ✓ Determine the actual contents of the reservoir at different levels for operation and planning purposes.
- ✓ To compare the results of this survey with former surveys in order to assess the build up of silt in the reservoir .

Table (7) Storage capacity (design capacity in 1966)

R.L	1966	1976	1981	1985	1992	2005	2007
	(Mm^3)	(Mm^3)	(Mm^3)	(Mm^3)	(Mm^3)	(Mm^3)	(Mm^3)
465	454	68	36	26	23	4.5	6.21
467	638	152	91	80	60	13.71	13.98
470	992	444	350	342	235	72.46	72.38
475	1821	1271	1156	1088	932	517.46	566.85
480	3024	2474	2384	2020	1886	1658.38	1637.56
481	3329	2778	2689	2227	2104	1934.73	1920.89

5 -2 Digital elevation model

Is a raster representation of height data (above sea level) , from which we derived the contour map , drainage system, slope ,and water shed .

5-3 satellite imageries

Such data (raw data) are needed to use with remote sensing soft wares, for detailed analysis and processing , it consist of multiple bans layer for different sensors of land sat , the available data are five seines of land sat for different satellites *E.T.M , T.M & M.S.S* .

The images have same spatial resolution (72 m x m), but different time series ,for *E.T.M & T.M* tow scene found for the whale area , but one scene found for *M.S.S* ,the table below shows the detailed of data :

Table (8) land sat raw data

Senior or satellite	No. of scene	No. of bands	Date
E.T.M	Two	8	November 1999, November 2001
T.M	Two	7	January , October 1987
M.S.S	One	4	November 1972

5-4 forest cover changes

Forest cover changes and annual rate of forest clearance during the period 1980 – 2005 , this is available form forest resources assessment 2005 .

FAO forestry paper

6 . Methods and techniques

The following tasks have been undertaken ,after data collection and description, to meet the study objectives :

- ✓ 1-Calculation of silt volume and silt decline rate
- ✓ 2-Generate the graphs of storage capacity , silt volume and silt decline for different water level at different years .
- ✓ 3-Generate thematic maps of various natural resources
- ✓ 4- Integrate the thematic maps
- ✓ 5-Define the plan of implementation

The use of satellite data in recent years has gained much importance for natural resource mapping ,this study is carried out by combining the features of satellite imagery, topographic sheets and secondary maps data to produce the necessary information layers of natural resources .

The processing steps is divided into two steps :

(1) pre – processing using R.S to extract information , spatial and spectral subset , mosaic , and classification , (*the output will be input for the second steps*)

(2) processing using GIS data base review, map view , data management and correction ,geoprocessing, to show the Environmental impact on dam reservoir and land cover .

The input data from all of the above diverse sources are translated into the thematic maps by the methods of:

- o interpretation,
- o classification,
- o manipulation,
- o integration,

- editing and
- analysis

The data translation into thematic maps employed the *GIS* software *Arc/Info* and *Arc View* , and the use of remote sensing software *ERDAS* and *ENVI* . The multi layer thematic maps generated necessary information to provide detail insight to suggest the necessary improvement of environmental conditions.

The results has been shown as tables , graphs and visual view as maps and layers .

6-1 Remote sensing processing

The satellites imageries of land sat data for different years , were processing and classified to illustrate further extent of forest losses ,the total number of classes are made to five classes , which are water , forest , shrubs & trees , agricultural land , and bare land .

Prior to data analysis, initial processing on the raw data is carried out to correct for any distortion due to the characteristics of the imaging system and imaging conditions, some standard correction procedures may be carried out by the ground station operators before the data is delivered to the end-user., geographical location of an area on the image needs to be known, ground control points (*GCP's*) are used to register the image to a precise map (geo-referencing).

A Multispectral image consists of several bands of data , or in combination of three bands at a time as a color composite image, interpretation of a multi spectral color composite image will require the knowledge of the spectral reflectance signature of the targets in the scene ,

In displaying a colour composite image, three primary colors (red, green and blue) are used.

Many colours can be formed by combining the bands together , here we used bans 7,4,2 for thematic mapper sensor , and bans 4,3,2 for Multispectral scanner sensor , as we need to obtain the land cover and water with their real colour , fig (2& 3).

Mosaic is the process of joined tow scenes together, this only possible when they have same coordinate for one edge , mosaic was created for the tow scene of thematic mapper to cover the whole study area .

Different land cover types in an image can be discriminated using some image classification algorithms using spectral features, i.e. the brightness and "colour" information contained in each pixel. The classification procedures can be "supervised" or” unsupervised".

In supervised classification, the spectral features of some areas of known land cover types are extracted from the image. These areas are known as the "*training areas*". Every pixel in the whole image is then classified as

belonging to one of the classes depending on how close its spectral features are to the spectral features of the training areas.
In unsupervised classification, the computer program automatically groups the pixels in the image into separate clusters, depending on their spectral features. Each cluster will then be assigned a land cover type by the analyst; unsupervised classification was run to obtain the different land cover classes , fig(11,12, & 13).
Each class of land cover is referred to as a "theme" and the product of classification is known as a "thematic map".

6-2 GIS Process

Any GIS application and/or operation contain five essential elements:
data acquisition; processing; data management; manipulation and analysis; and production generation ,data acquisition refers to the process of identifying and gathering the data required for the application. After data gathering, the procedures used to convert a dataset into a suitable format , data format conversion, such as digitization of maps and printed records and recording this information into a computer database, is the key step in processing which includes map projection, data reduction and generalization data management .
data overlay and analysis relative to site impact prediction, wider area impact prediction , (figure 2 & 3) .

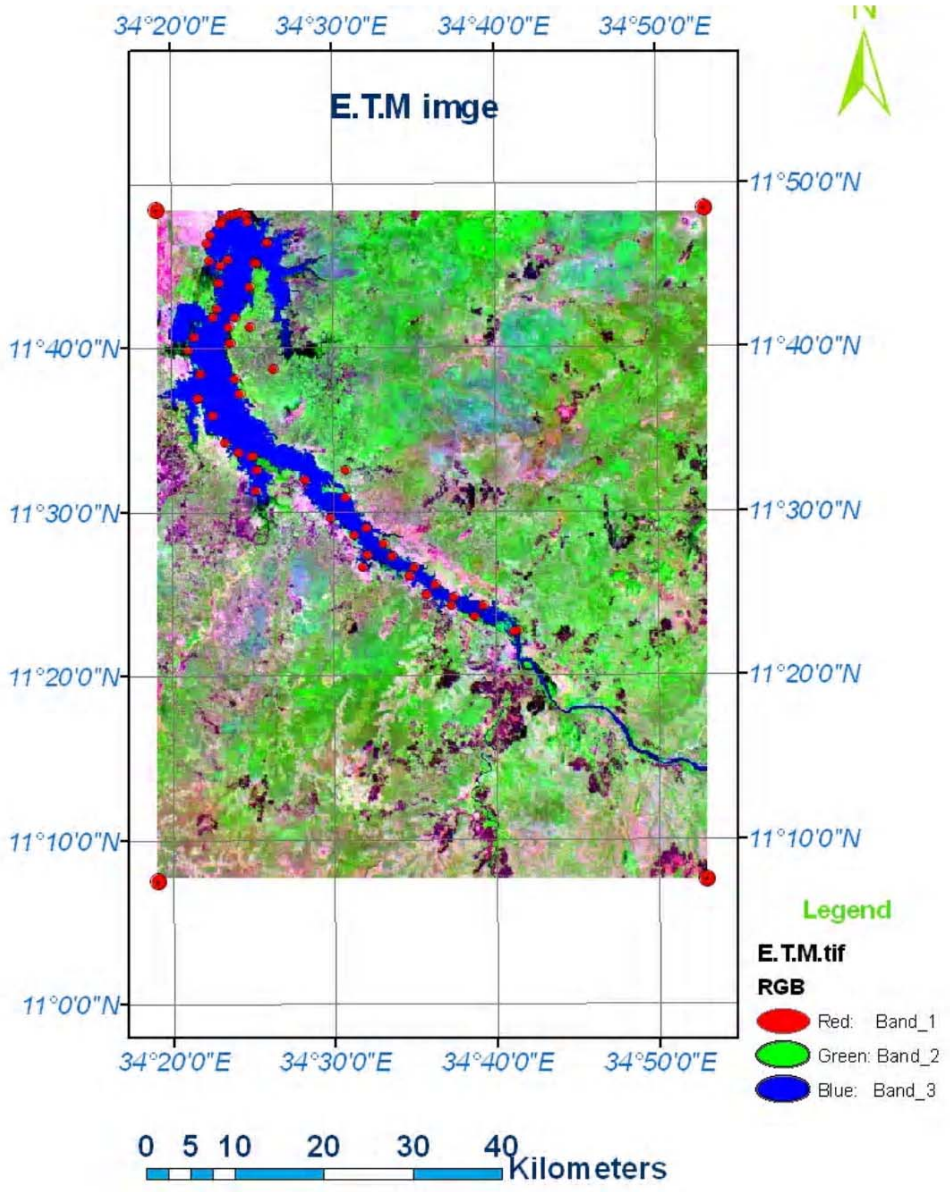


Fig (2) Enhance Thematic Mapper Image

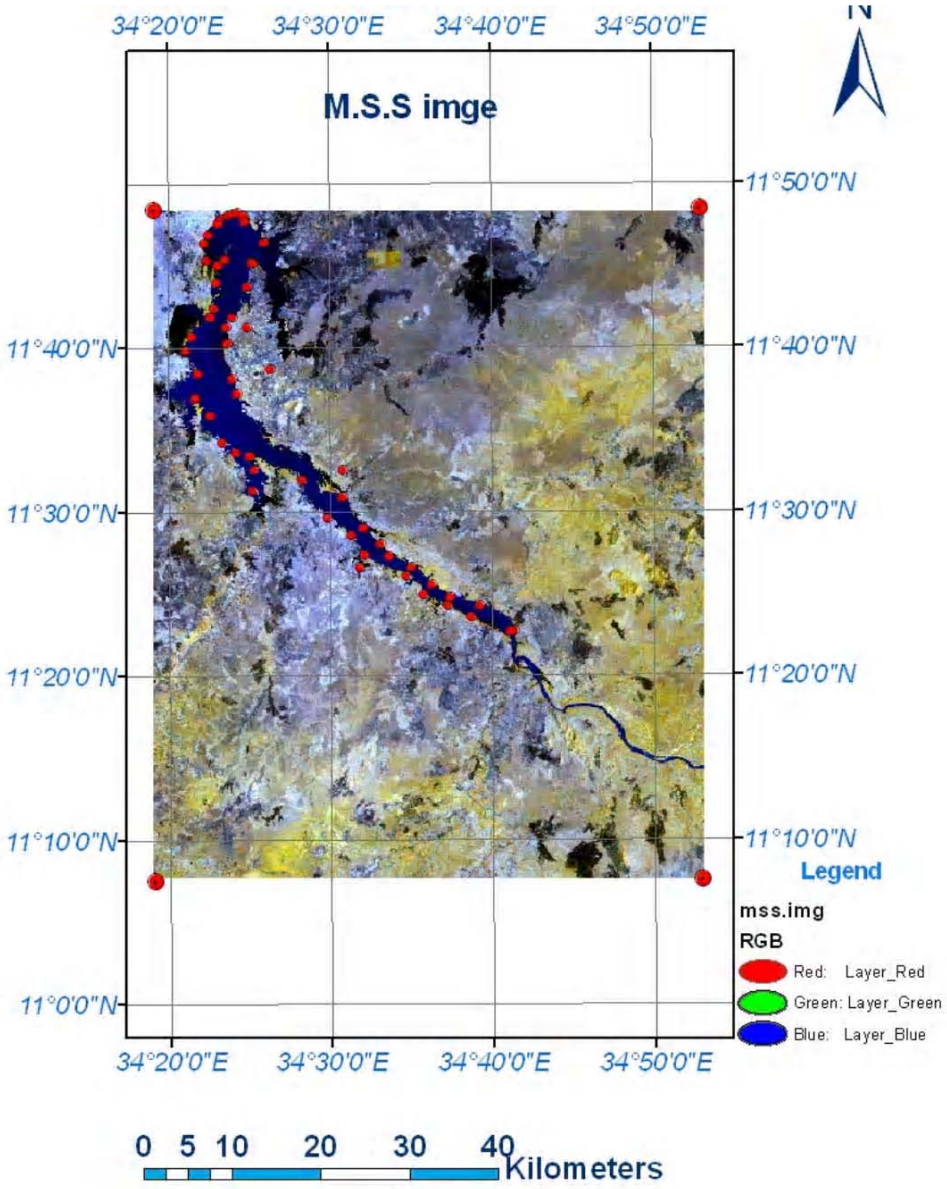


Fig (3) Multi Spectral Scanner Image

Chapter four

Results & Discussion

The impact assessment of Rosaries reservoir using GIS and remote sensing, showed that as result of soil erosion and forest decreasing, the sedimentation is high in the Dam reservoir, this clear since : The storage capacity of the reservoir is decreased gradually and rabidly from 3024 mm^3 at R.L 480 in the year 1966 (start point) to 1886 mm^3 at the same level in the year 1992 (after 26 years operation) , the percentage of decline is more than 37.63%, the capacity is nearly the same in years 2005 -2007 , fig (4) this is due to decline in silt accumulation , the silt volume is high in the high level (more than 470 m) at bottom of the reservoir , showing rapid increase with time -fig (5) – table (11) , but there are slight increase at low levels(less than the 468 m) as the silt volume decries with decreasing levels at the top of the reservoir ,the silt deposit rate is decline with time , as capacity decline(due to siltation) , the velocity will increase for the same discharge at the same level , increasing the carrying capacity of water for suspended sediment. The high rate was 83.4 in 1976 , after ten years of operation , reduced to 57.7 in 2007 for the same level , less than 30% after 30 years of operation . (fig (6) - table (12).
The rate of forest area decline is increasing from the period 1980 - 2005 , the annual removable rate was more than 440 (for 1000 hectare) in the period 1990 – 2000 . as the result the in serious environmental problems , example is erosion , which led to siltation problems .

4-1 Land use/ Land cover

Digital interpretation for different scenes dates is done in *ERDAS* for identification of different land use land cover classes based on the image characteristics. The multi date imagery are interpreted for the details result of slope ,water shed , and contour map of the area , five classes of land use / land cover classes have been identified in the area .

4-2- Slope

The slope map is derived by using the *GRID* and *TIN* features of Arc/Info, The input data is the *DEM* ,In area, the plateau tops have slopes of 0.23676s% in the reservoir bed and the steep hillsides are 55.3807% to the south and east of the reservoir fig (10)

4 -3 Contours

The contour lines of elevation is drawn with interval 10 M, the high value is 1010 M , and the low one is 420 M, above the sea level fig (9).

4 -4 Results

After analysis of different images for the area , it shows that the forest density declined clearly in classified images for the period for 1972 – 2001 , the different satellite data illustrate the land use battens change form one scene to another .

Fig (11 ,12, & 13) – show clear decline in vegetation cover , as forest decline

The table(9) below shows the decline of forest for the year 1972 , 1987 & 2001 :

Table (9) Forest decline (area in hectare)

Category	1972 M.S.S	1987 T.M	2001 E.T.M
Forest	263384.2	153878.8	105369.6
Agri.	48659.6	97019.5	64257.9
Bare land	64268.1	64128.2	136220.23

Table (10) Impact significant

Category / year	1972	1987	2001
Forest	+	- -	- -
Agri.	+	- -	-
Bare land	-	-	- -

Significant : - -
Moderate : -
Insignificant : +

4 -5 Discussion

During the last few decades GIS software has gained importance for generating overlays and making site-specific decisions. Multi-spectral remotely sensed satellite data plays a vital role in the generation of the overlays , manual integration of the entire surface and sub-surface information, requires huge expenditure of manpower and time. Working on the GIS platform is faster, more accurate and therefore cost effective.
The integration of the satellite imagery and GIS has eased the data integration and analysis of very large data sets. The database (both spatial and non-spatial) is imported and created or generated in Arc/Info. The required non-spatial database is attached to the respective coverage ,the GIS package Arc/Info is extensively used, various overlay methods, etc ,based on the criteria selection analysis in Arc/Info various types of treatment needs have been suggested
While GIS offers many advantages as a tool in impact studies, there are some limitations:-

a) GIS modeling technology has not yet been developed sufficiently to achieve certain complex environmental modeling .
b) links to other software packages or to special purpose programs may need to be developed especially for an EIA application .
c) very little of the information required for EIA studies is also available in a form which may be loaded directly into GIS.

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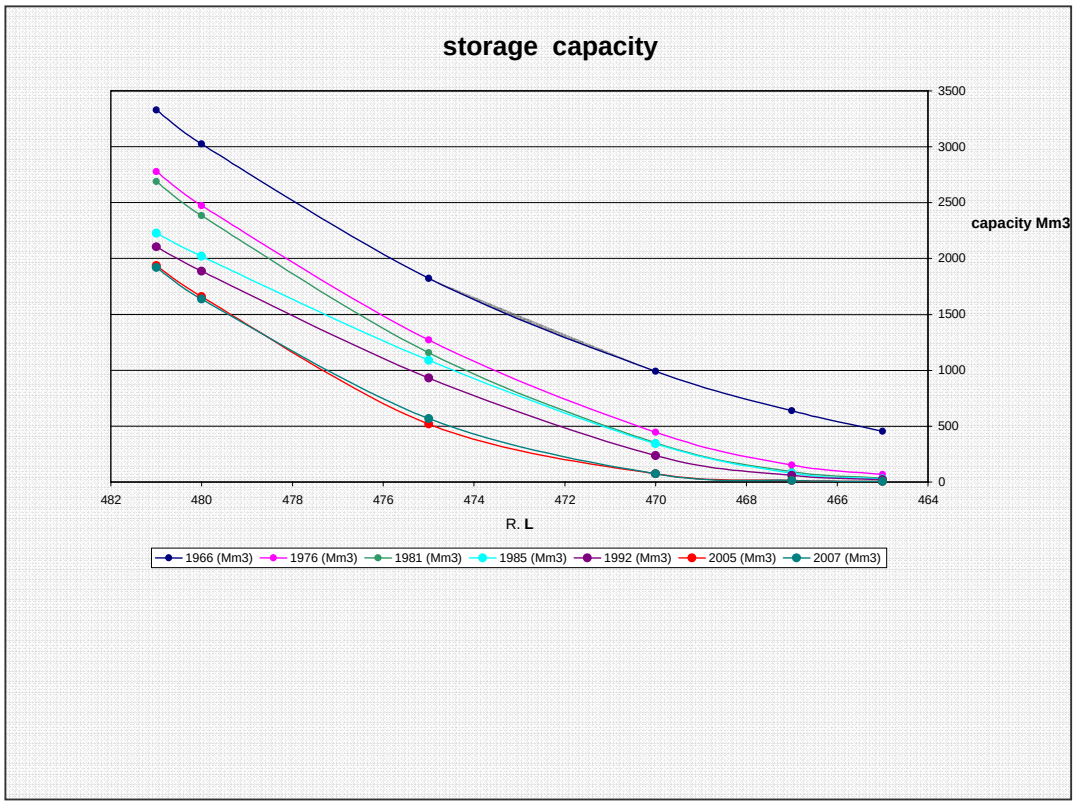

Fig (4) loss in capacity
Of the dam reservoir

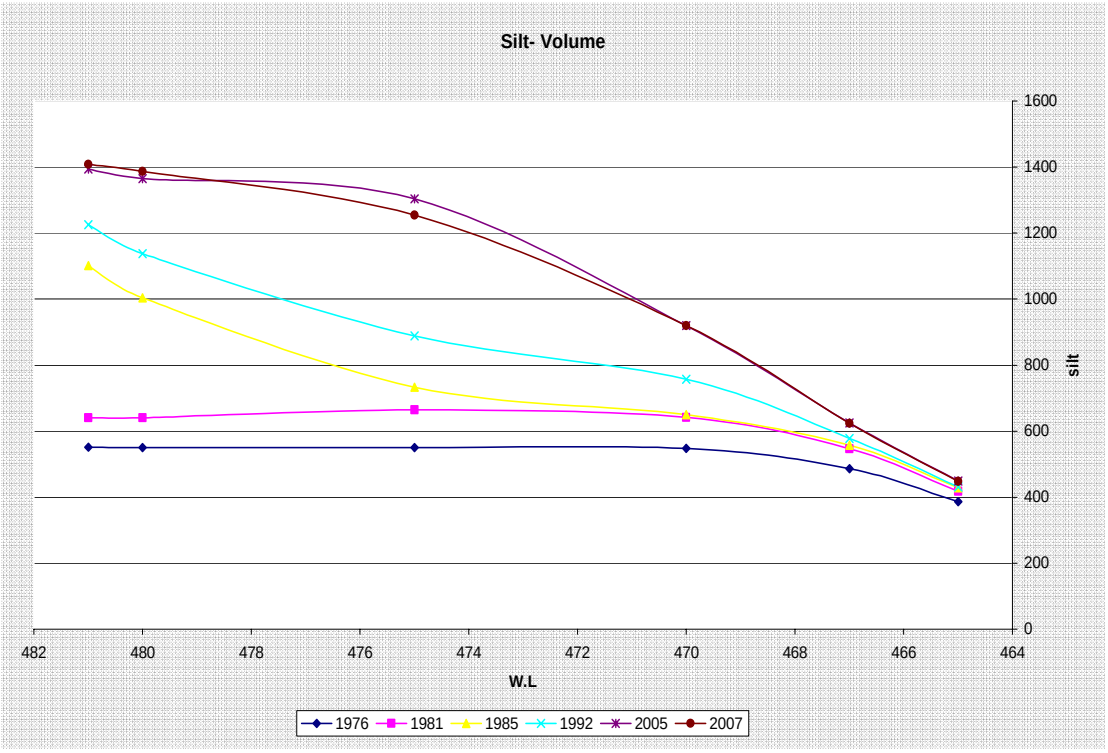

Figure (5) silt volume for the period 1976 - 2007

Table (11) Silt volume for the period 1976 - 2007

R.L	1976 (Mm^3)	1981 (Mm^3)	1985 (Mm^3)	1992 (Mm^3)	2005 (Mm^3)	2007 (Mm^3)
465	386	418	428	431	449.5	447.79
467	486	547	558	578	624.29	624.02
470	548	642	650	757	919.54	919.62
475	550	665	733	889	1303.54	1254.15
480	550	640	1004	1138	1365.62	1386.44
481	551	640	1102	1225	1394.27	1408.11

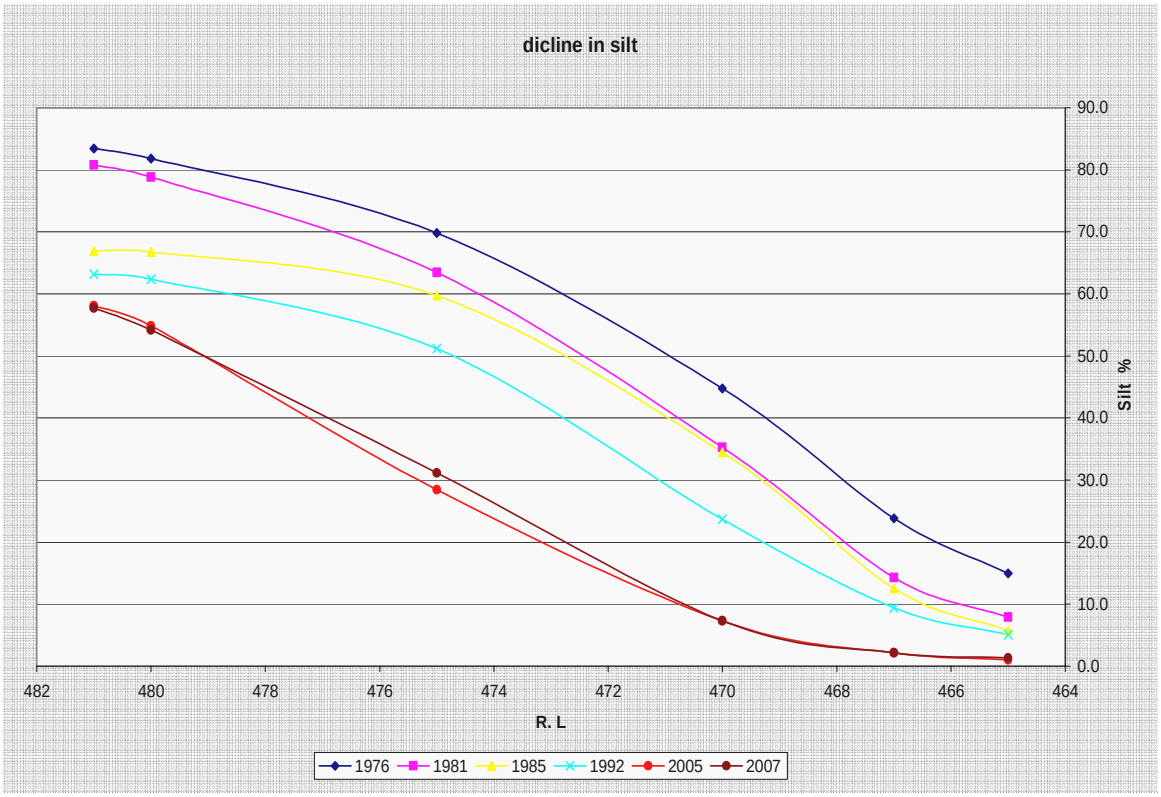

Fig (6) Decline In Silt

Table (12) decline in silt deposit rate with time

R.L	1976 (Mm^3)	1981 (Mm^3)	1985 (Mm^3)	1992 (Mm^3)	2005 (Mm^3)	2007 (Mm^3)
465	15.0	7.9	5.7	5.1	1.0	1.4
467	23.8	14.3	12.5	9.4	2.1	2.2
470	44.8	35.3	34.5	23.7	7.3	7.3
475	69.8	63.5	59.7	51.2	28.4	31.1
480	81.8	78.8	66.8	62.4	54.8	54.2
481	83.4	80.8	66.9	63.2	58.1	57.7

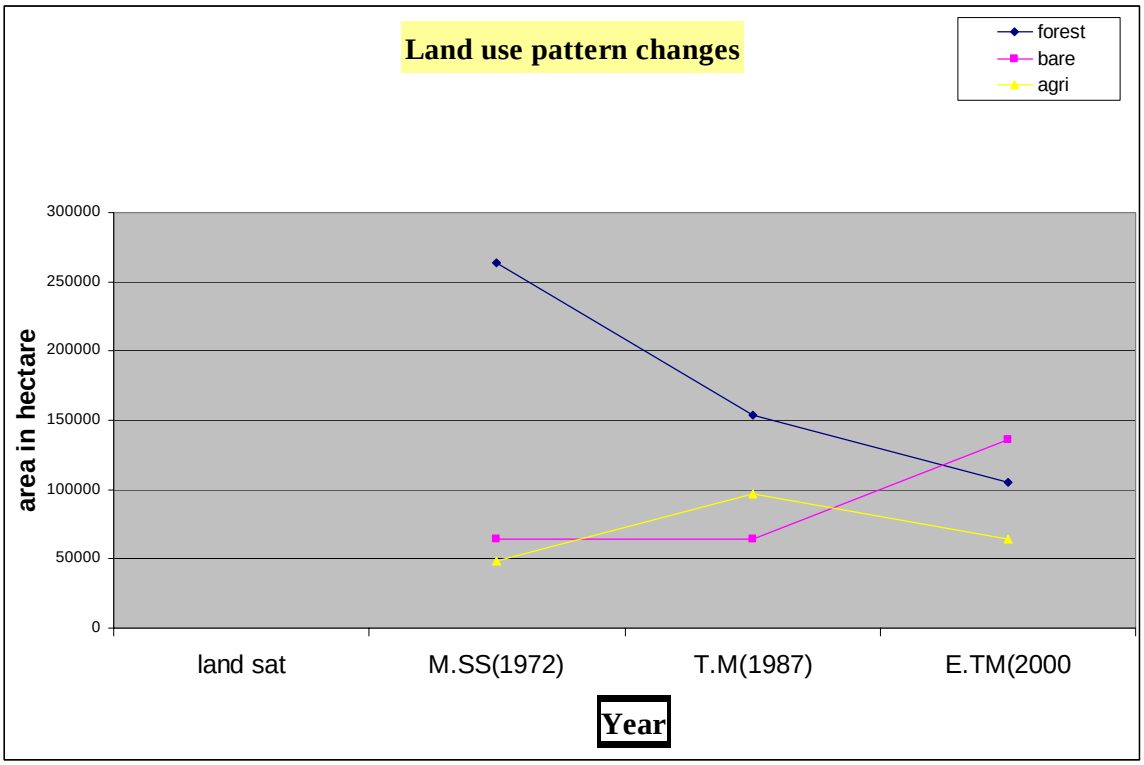

Fig (7) Land use pattern changes in the study Area

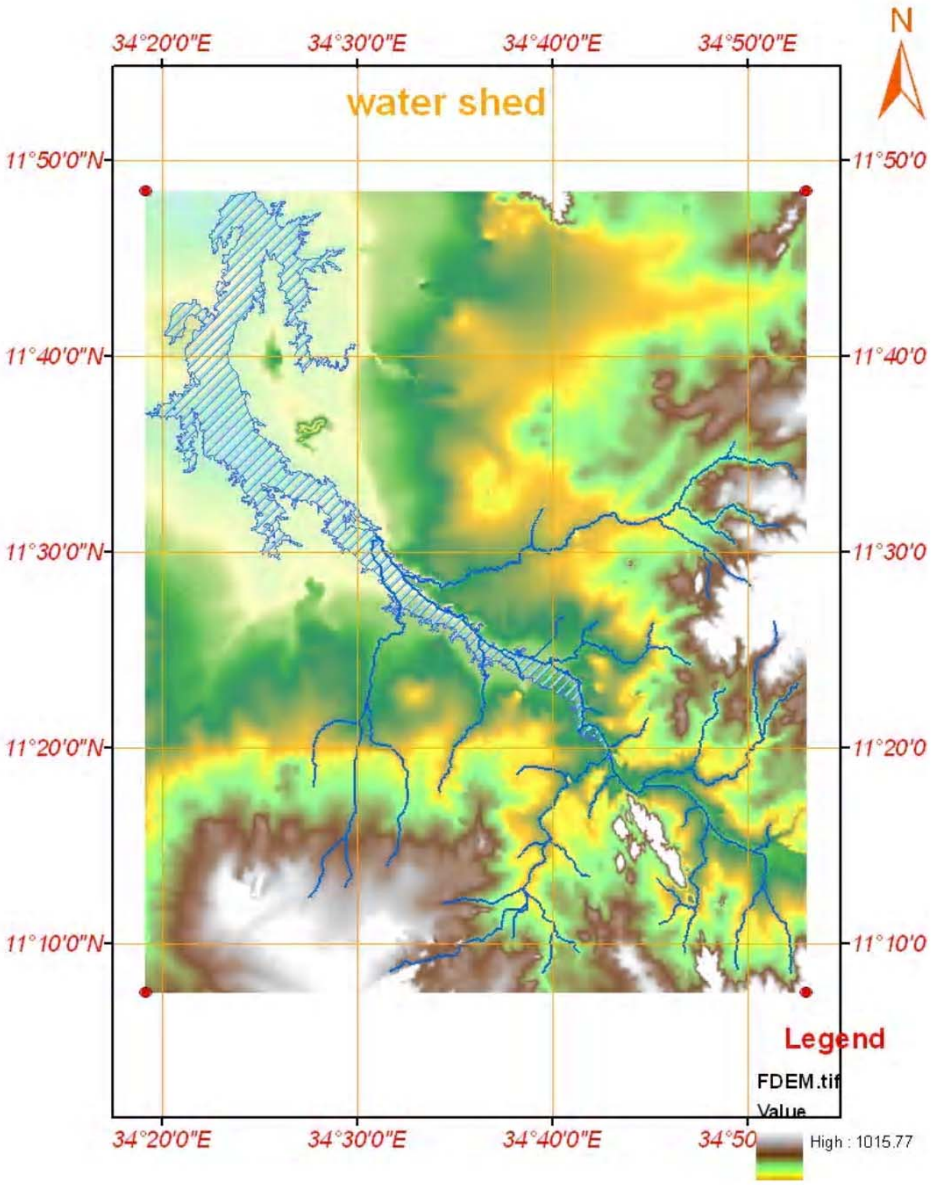

Fig (8) water shed for the study area

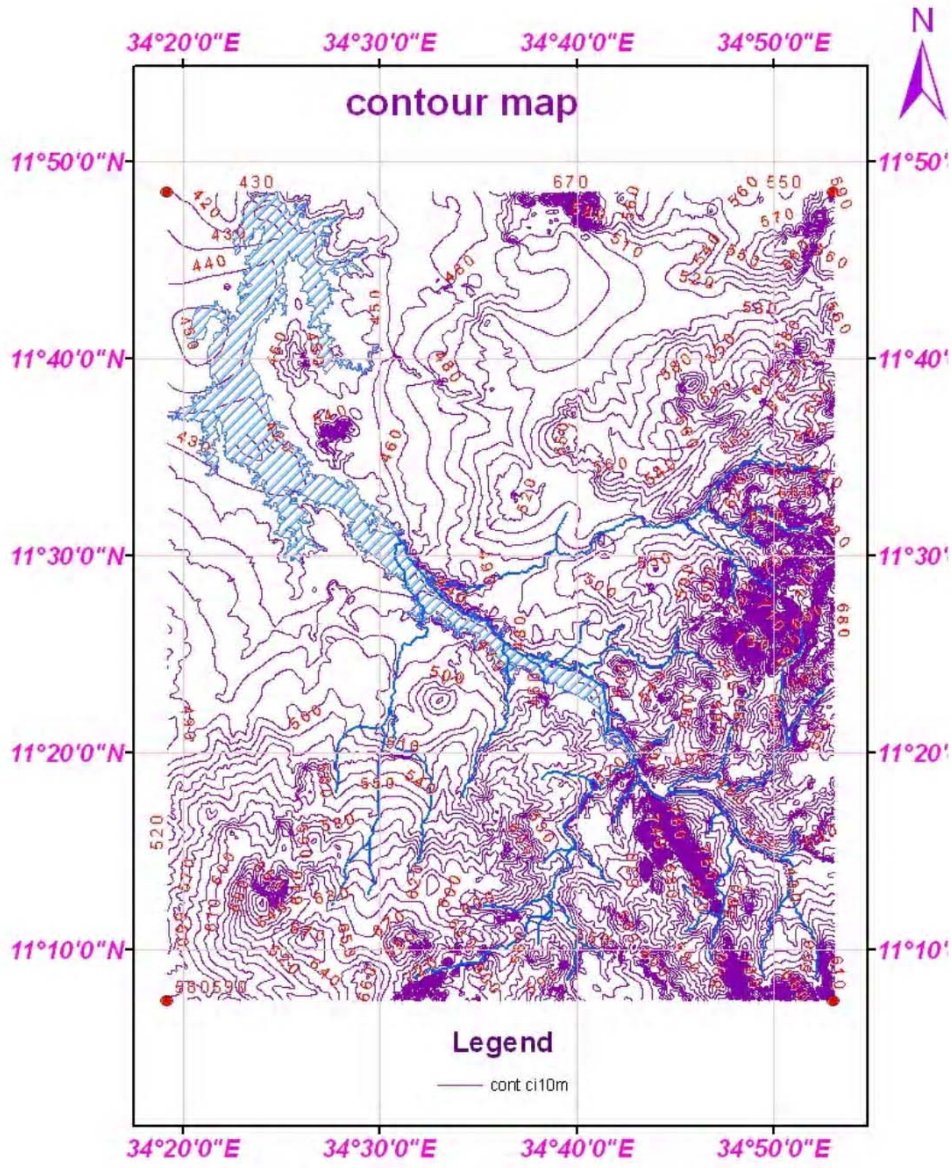

Fig (9) contour map of the study area

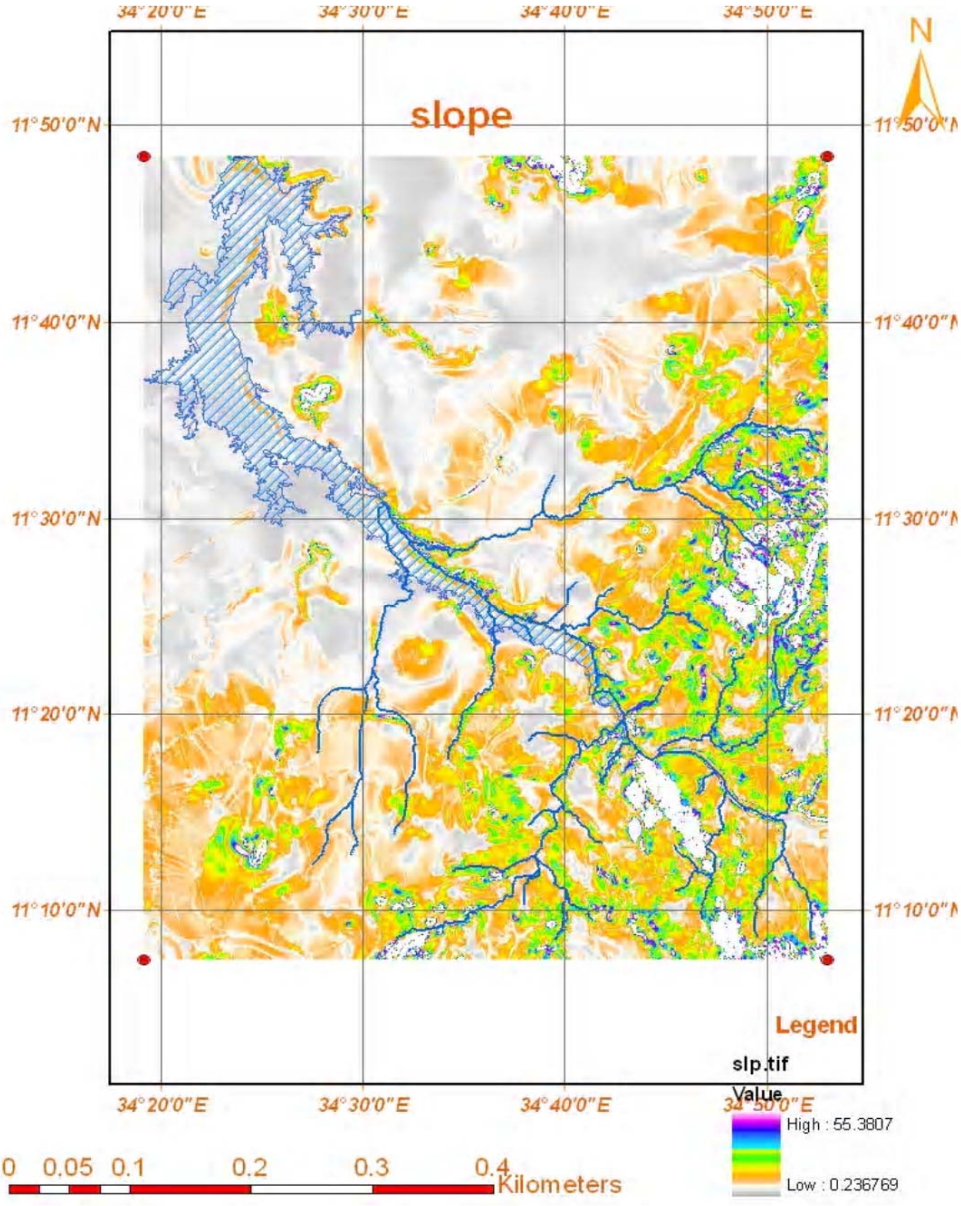

Fig (10) slope of the study area

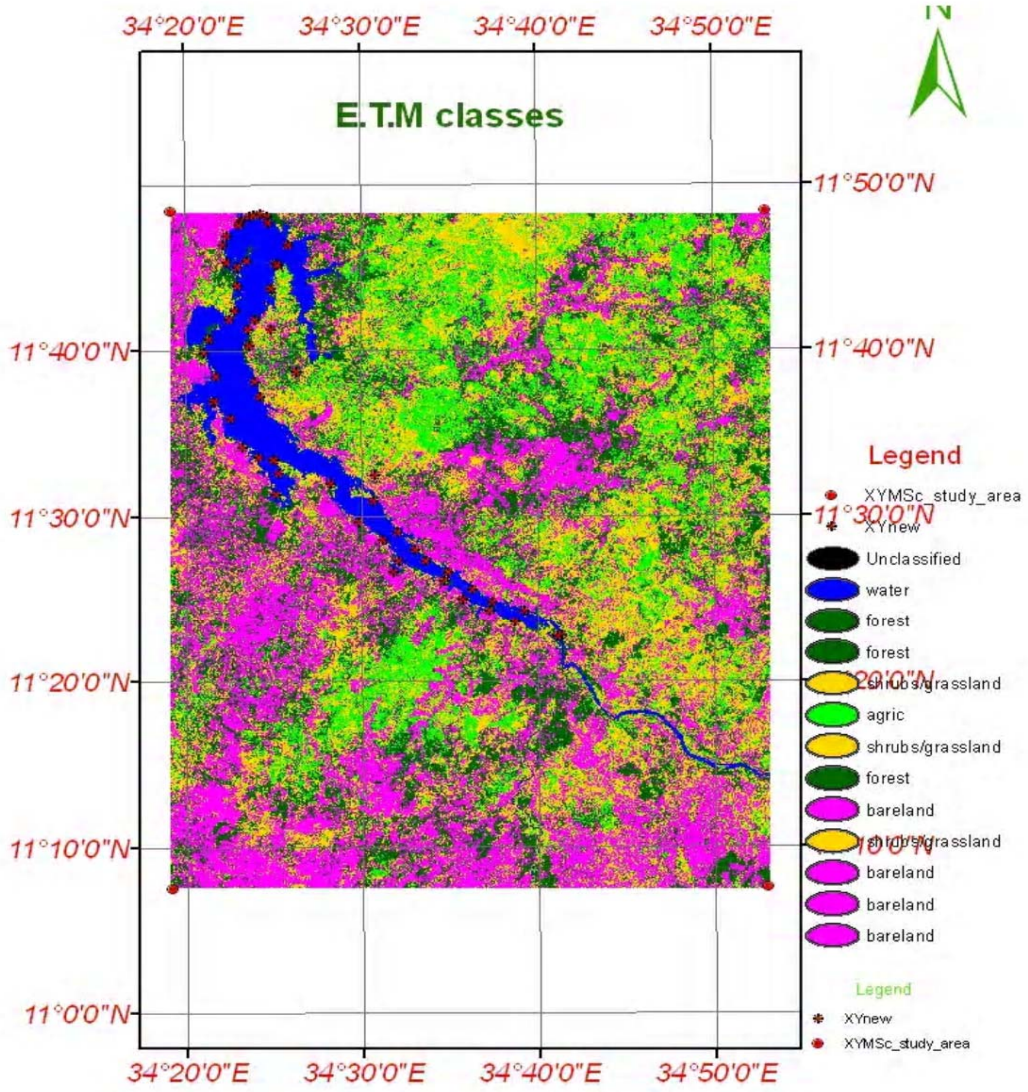

Fig (11) Enhance Thematic Mapper Classes of the study area

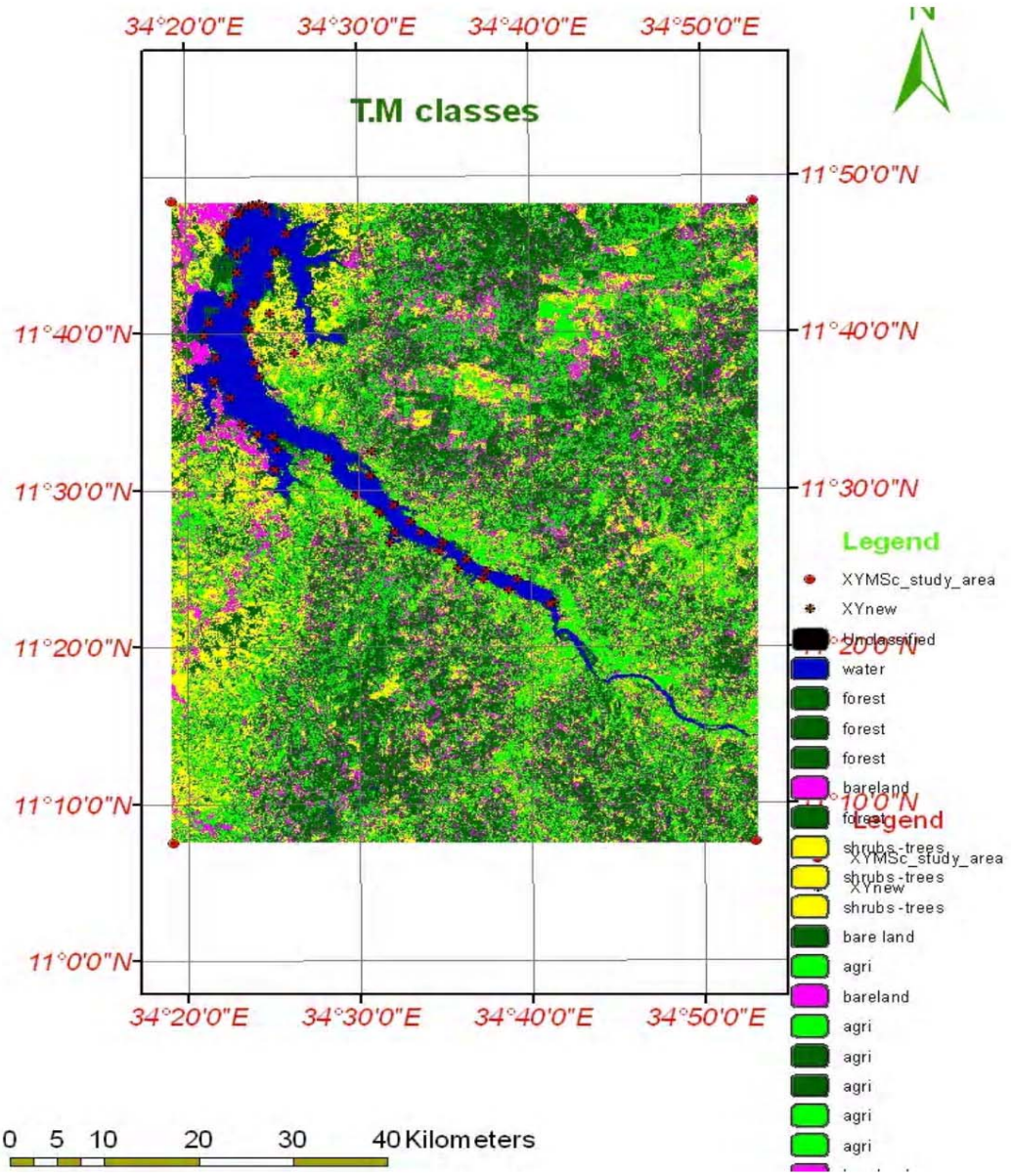

Fig (12) Thematic Mapper Classes of the study area

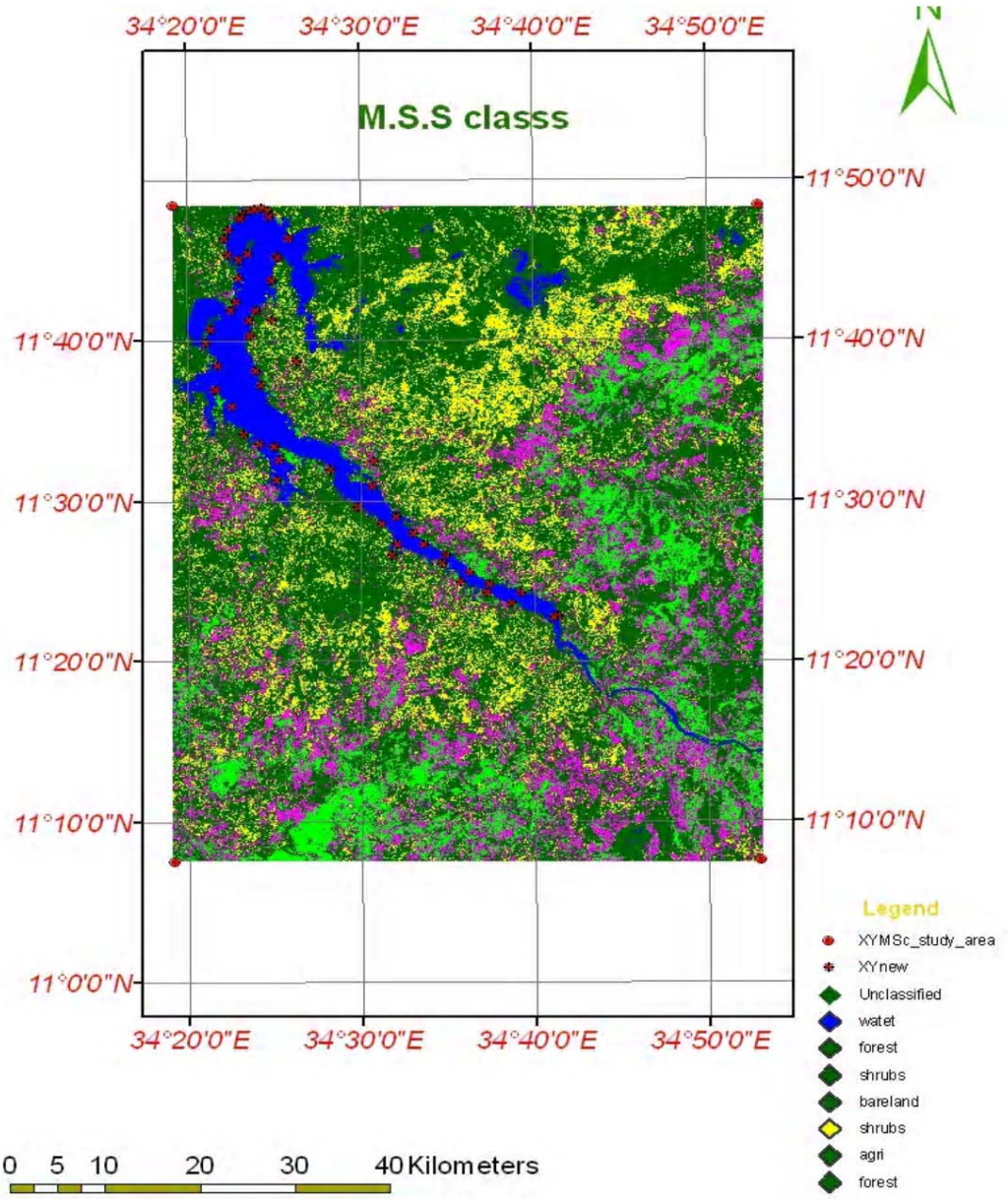

Fig (13) Multi Specter Scanner classes of the study area

Chapter five
Conclusion & Recommendations

5 – 1 conclusion

The entire study was carried out by using, Arc/info, Arc view and *ERDAS*. The elaborated overlays, which are manually impossible to generate ,along with the detailed calculation have been successfully performed. The study concluded:

1. Deforestation in Blue Nile State, caused by forest conversion for agricultural land use, constitutes a major environmental problems, as forest clearance result in various negative impact .

2. Deforestation and soil erosion are the main factors for the problems of siltation and water resources degradation in Sudan.

3. Due to the geological feature for the area , slope is high & the soil composition , the Blue Nile with it is high velocity , carrying almost all the silt into the Rosaries reservoir .

With regards to the methods and techniques, the study concluded:

a) The GIS is very efficient and convenient to collect, manage and analyze the data and visualize the result of assessment, based EIA is having the final output in pictorial form, which is very helpful and easy to understand by non technical decision makers.
b) Since GIS based database can be easily integrated with remote sensing data, so the process of impact detection can be more easily .
c) No comprehensive programs exist for research on EIA methods. This reflects the fact that the EIA systems of many countries are primarily focused on procedures and implementation of specific guidelines, with minimal attention given to research.
d) Several types of methods are typically used in a given impact study, Simple interaction matrices, networks, and simple or questionnaire checklists can be very useful in identifying impacts at the beginning of the EIA process; these types of methods are also useful for summarizing the study results.

e) A total of 15 types of methods have been described here in for project-level studies; their application, along with several other policy-related methods, are also addressed with reference to cumulative impact assessment and strategic environmental assessment. 6-The most-used types of methods tend to be simpler ones, including analogs, checklists, expert opinion , mass balance calculations, and matrices.
f) Emerging types of methods include geographical information systems, expert systems, risk assessment, and economic valuation of environmental impacts. Irrespective of the methods used, uncertainty exists in various facets of the EIA process; such uncertainty should be described in impact study documentation.
g) Integration of results from the usage of a variety of methods is a key consideration in planning and conducting an efficient and effective impact study.
h) Geographic information systems (GIS) have particular usefulness for larger scale projects and cases in which retrospective analysis can be useful to identify how environmental conditions have changed over; time, with this information then being used to forecast further anticipated changes.

5-2 Recommendations

1) Based on the soil, land use, slope, land irritability etc. of the area, suggestions have been made to change the land use pattern and undertake reforestation in some of the areas , along with some preventive measures for reducing the soil erosion .

2) Based on the output of analysis , it has been found that east and west bank area of expected to produce better crop by irrigation water from the dam, provided proper drainage facilities are present.

3) Forest conservation and protection should be conceived as vital from social , environmental and economic views.

4) Improve The land capability by improving the quality of soil with appropriate treatment of nutrients and fertilizer.

5) The drainage line treatment is also necessary in the catchments area to prevent soil erosion.

6) protection and enhancement of riparian zones of waterways and drainage lines .

7) Assessment of impact significance: The significance of all those impacts for any projects , should be assessed using the appropriate national and international quality standards and methods ,where available.

8) Mitigation: All significant adverse impacts should be considered for mitigation and specific mitigation measures put forward where practicable, Mitigation methods considered should include modification of the project, compensation, and the provision of alternative facilities as well as pollution control.

9) Research is needed, involves the incorporation of new tools for information aggregation and decision making into the overall EIA .

10) Adequate information is essential for a clear understanding of the problem of resources management, sound policies and programs, for sustainable management .

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APPENDIX (A) coordinate system

Coordinates system				
Start point		**End point**		
E	**N**	**E**	**N**	**Length**
652001	1305002	651195	1304548	931
652453	1305091	651035	1304329	1610
653092	1305216	650869	1303999	2550
649690	1302806	653747	1305037	5110
649281	1301793	653969	1304350	5340
656052	1301888	649665	1299864	6700
654797	1299761	651752	1300066	3060
656052	1301888	654885	1299565	2600
654797	1299761	650802	1299308	4020
654230	1296955	650751	1297334	3500
650405	1294436	652554	1293487	2350
649980	1293515	651841	1292439	2150
652028	1290566	647902	1291293	4190
652028	1290566	647325	1289770	4770
648598	1287217	652517	1286583	3970
648318	1284375	650017	1282473	2480
648348	1284375	653073	1284991	4765
654203	1292392	651350	1279364	4160
652927	1278252	654631	1277854	1750
656819	1287679	654474	1277924	2483
654978	1276330	654806	1273986	2350
664954	1276304	660435	1275321	1810
664894	1273364	663257	1270983	2890
667323	1269932	665865	1269039	1710
667468	1266773	669188	1268030	2130
666863	1265442	670185	1266729	1430
672626	1265476	672203	1264504	1060
674141	1262384	675067	1263487	1440
677148	1262138	676813	1261143	1050
680494	1261129	679523	1259986	1500
684317	1258450	683848	1258265	505

Appendix(B)

SEDIMENTREMOVER

APPENDIX C

ROSEIRS DAM RESERVOIR & MAIN BODY

APPENDIX D


MINISTRY OF IRRIGATION & HYDRO-ELECTRIC POWER
ROSEIRES DAM
FIRST STAGE
CAPACITY 3024 MILLION CUBIC METRES
MAXIMUM HEIGHT 68 METRES
LENGTH 15½ KILOMETRES
CONSTRUCTION STARTED NOVEMBER 1961 ✦ FIRST FILLING 1ST JULY 1966
INAUGURATION
10TH DECEMBER 1966 BY
SAYED ISMAIL EL AZHARI
PRESIDENT OF THE SUPREME COUNCIL
CONSULTING ENGINEERS : SIR ALEXANDER GIBB & PARTNERS
COYNE & BELLIER
PRINCIPAL CONTRACTOR : IMPRESIT – GIROLA – LODIGIANI
GATES : SOREFAME
SERVICE POWER PLANT : MATHER & PLATT
This dam was built to store flood water of the Blue Nile for use in many parts of the Sudan throughout the year and to provide power. Its construction was possible through the efforts of the people of the Sudan and of many other nations and the International Bank for Reconstruction and Development, the International Development Association and Kreditanstalt fur Wiederaufbau of West Germany.
بسم الله الرحمن الرحيم
وزارة الري والقوة الكهربائية المائية
خزان الروصيرص
المرحلة الاولى
سعة : ٣٠٢٤ مليون متر مكعب
اقصى ارتفاع : ٦٨ متراً
الطول : ١٣٫٥٠ كيلومتراً
تاريخ بدء الانشاء نوفمبر ١٩٦١
تاريخ الملء الاول اول يوليو ١٩٦٦
الافتتاح قام بالافتتاح سيادة
السيد الرئيس اسماعيل الازهري
رئيس مجلس السيادة
في يوم السبت ٢٧ شعبان ١٣٨٦ الموافق ١٠ ديسمبر ١٩٦٦
المهندسون الاستشاريون
مقاول الاعمال الرئيسية
مقاول البوابات
مقاول محطة القوى الكهربائية المائية : مذر وبلات