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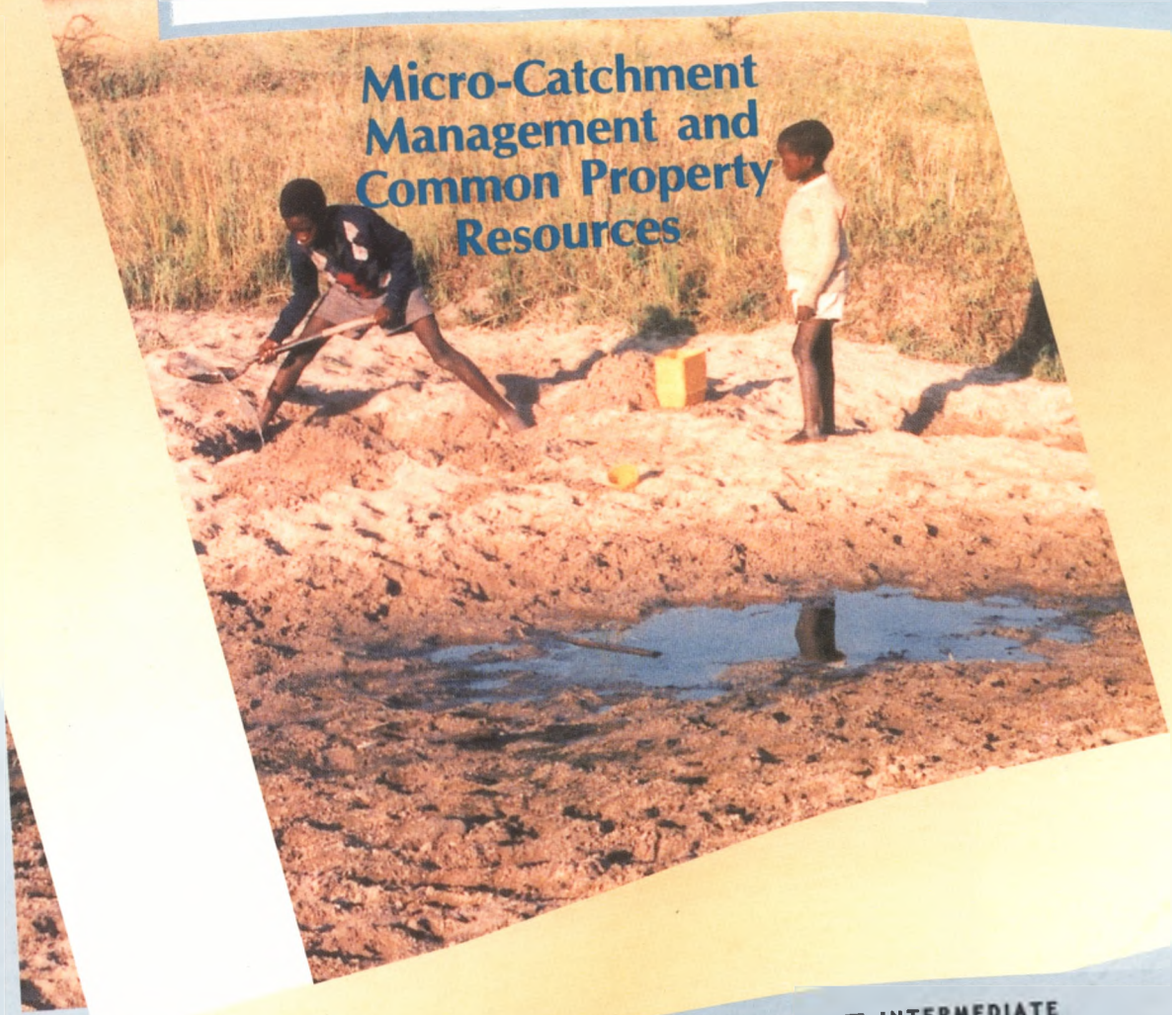
IMPROVING RURAL LIVELIHOODS IN SEMI-ARID REGIONS THROUGH MANAGEMENT OF MICRO-CATCHMENTS

P.G.H. Frost and A. Mandondo



DFID Department for International Development
CARE ZIMBABWE
CIFOR CENTER FOR INTERNATIONAL FORESTRY RESEARCH
INTERMEDIATE TECHNOLOGY
Institute of Hydrology
R&SS

General Project Outline

The Zimbabwe: Micro-Catchment Management and Common Property Resources Project (1999-2001) is a research programme implemented by a consortium of institutions, including the Institute of Environmental Studies (IES) (University of Zimbabwe), the Institute of Hydrology (IH) (UK), the Department of Research and Specialist Services of the Ministry of Lands and Agriculture (Zimbabwe), Intermediate Technology Development Group (ITDG), CARE International in Zimbabwe and the Center for International Forestry Research (CIFOR). The project is funded by the UK Department for International Development (DFID), under its Renewable Natural Resources Knowledge Strategy (RNRKS). The funding is provided through the Semi-Arid Production Systems (SAPS), a portfolio under the Natural Resources Systems Programme (NRSP) which in turn is one of the eleven programmes comprising RNRKS. SAPS is managed by Natural Resources International Limited (NRIL). A component of the research is funded through CIFOR on the project entitled "Stakeholders and Biodiversity in the Forests of the Future" which is funded by the Swiss Development Cooperation.

The objective of the project is to develop and promote appropriate strategies for integrated management of micro-catchments in semi-arid areas in order to improve livelihoods and alleviate poverty through more efficient and innovative use of water resources. The focus is on common property resources (CPRs) although other resources within the catchment are also included in the work. The key project components are: strengthening the capacity of emerging and existing institutions to manage CPRs; characterisation of key biophysical linkages among micro-catchment components and such information made accessible to CPR management; and testing and development of technical and other options for improved micro-catchment management. The emphasis is on the water resources. A guiding hypothesis is that water in semi-arid regions is so valuable that it can be used as the entry point for the management of a broad range of CPRs.

The project is conducted in Chivi District of Masvingo Province in southern Zimbabwe. The area lies in a semi-arid region of the country, marked by unreliable rainfall, frequent droughts, recurrent crop failures and recurrent livestock mortality. CPRs are widespread and significant in the household livelihood systems.

The direct beneficiaries are the smallholder farmers, particularly women who bear the burden of rural livelihood constraints. Government and non-governmental agencies responsible for key natural resources and planners at national, district and local levels are also the target institutions. The project is relevant to communally-managed dryland areas world-wide.

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1999

IES Working Paper Number 12

Published by the Institute of Environmental Studies,
University of Zimbabwe,
P.O. Box MP167,
Mount Pleasant, Harare,
Zimbabwe

DFID Project No. R7304
Zimbabwe: micro-catchment management and
common property resources

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All Working Papers of IES are peer reviewed. For reviewing documents in 1998 we thank: Dr J. Putz, Mr J. Gambiza, Mr D. Kwesha, Mr Wuta, Dr R. Shumba, Prof Ndhlovu, Me E. Madzudzo, Mr Dzama

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This paper reviews some of the issues that need to be considered in external initiatives aimed at improving rural livelihoods and alleviating poverty in semi-arid areas of Zimbabwe through promoting enhanced community-based management of common-pool resources. Particular emphasis is given to the requirements for communal management of micro-catchments in the context of securing both the yield and quality of water delivered by surface and subsurface flow to productive water points (PWPs). These PWPs can be collector wells, conventional wells and boreholes, or dams and weirs. Their key feature is that the water is used primarily for irrigating market gardens, or fodder crops for dairy cattle, or for some other income-generating activity. The hypothesis is advanced that the presence of a PWP is an entry point to initiating a broader range of community-based management initiatives intended to optimize the use of common-pool resources in the catchments of these productive water points.

The review first examines some key biophysical and socio-economic features of rural communities in the semi-arid regions of southern Zimbabwe, to identify the main constraints and opportunities that shape the current livelihood strategies of the people living in this area. This is followed by an analysis of the tenurial and institutional contexts within which any attempts at collective management and use of common-pool resources must function. Options for the management of water and other resources in the micro-catchments of PWPs are then considered. The review ends with some thoughts on how an integrated approach to micro-catchment management might be achieved.

Introduction

Three main issues need to be considered in development initiatives aimed at improving peoples' livelihoods in Zimbabwe's communal lands by encouraging more effective management of the common-pool resources. First, what are the key features of the biophysical and economic systems that affect their livelihood systems, particularly in semi-arid areas? Second, what are the tenurial and institutional contexts for collective management and use of communally-owned resources in these systems? And third, given these contexts, what strategies are there for community-based management of common-pool resources? This paper explores some of the issues surrounding these questions, particularly in the context of water as a common-pool resource that is affected by peoples' activities on both private and communal land in the catchments. The review concentrates on recent and on-going research in Zimbabwe's communal lands on these issues, and considers the implications for development initiatives aimed at improving people's livelihoods and alleviating poverty.

Biophysical and socio-economic factors affecting livelihoods in communal lands in semi-arid regions

A range of biophysical and socio-economic factors affects the livelihoods of people living in communal lands in semi-arid regions. Foremost among these are the often-marginal environmental conditions for many forms of agriculture, created by low and erratic rainfall, frequent droughts, and generally poor soils (Anderson *et al.*, 1993; Figure 1). Surface water supplies are often unreliable and of low quality, with contamination by both livestock and people. Groundwater resources are relatively under-developed but are likely to be limited nevertheless by the imperviousness of much of the underlying bedrock.

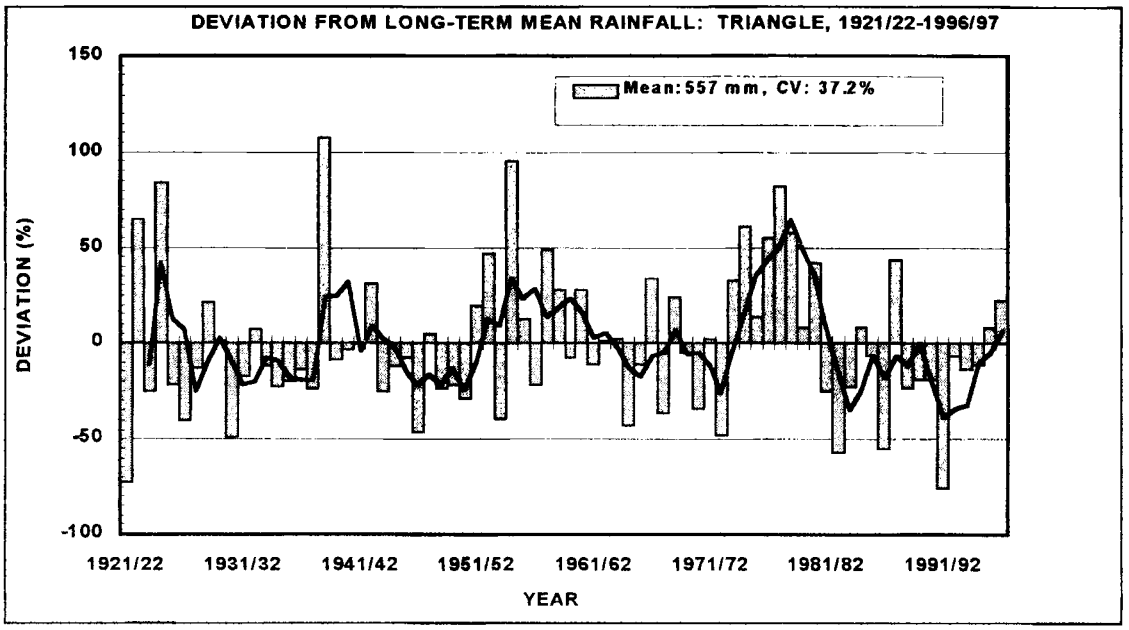


Figure 1. Yearly deviations from mean annual (July-June) rainfall for Triangle, Chiredzi District, 1921/22-1996/97, together with 3-year moving average. The pattern is typical of that of most semi-arid regions of Zimbabwe, with low average rainfall (557 mm p.a.), high inter-annual variability (coefficient of variation: 37 %), frequent severe droughts, and prolonged sequences of years with below-average rainfall (data from Triangle Sugar Estates).

The inter-annual fluctuations in rainfall produce variation both in herbaceous production in grazing lands and in crop yields. For example, coefficients of variation in herbaceous production on fertile but clay-rich soils at Matopos Research Station over 16 years between 1963 and 1981 (data not available for all years) was 48%, whereas on infertile sandy soils over the same period it was 32%. (Although no figures are available, variation in browse production is probably somewhat less because trees tend to be somewhat buffered against inter-annual variations in rainfall by having larger carbohydrate and nutrient stores.) The coefficients of variation in the yields of the four main grain crops grown in Chivi Communal Land during the period 1980/81-1995/96 were: maize, 66%; sorghum, 68%; rapoko, 57%; and mhunga, 57% (data from Famine Early Warning System, Harare, based on Agritex crop production estimates). Coefficients of variation in total production are even higher, 71-100%, partly because of year-to-year fluctuations in the amount of land cultivated.

Access to good-quality agricultural land overall is limited, an inequity resulting from the alienation of the better farming land by colonial governments in favour of expatriate settler farmers, and maintained after independence through continuing exclusion to the benefit of large-scale commercial concerns involved in growing cash crops.

The prevailing climatic conditions limit agricultural production in most places to rain-fed cropping and livestock production; both are affected by frequent drought. Many communities in southern Zimbabwe experience frequent crop failures, even among those crops that are considered to be relatively drought resistant. In some years, conditions are so bad that it is not possible for people to plant any crops. The most extreme example is in Beitbridge District where between 1980/81 and 1995/96 the various communities were able to plant maize in only 3-11 of these years, obtaining a harvest on only 1-9 occasions. During the same period, sorghum was planted in only 8-11 years and a crop harvested on 7-9 occasions.

The result is chronic food shortages. On average, almost 54 % of the population in the districts of Chiredzi, Beitbridge, and Chivi requested food aid each year during the period 1982-1993, ranging from 10 % in 1985/86 to 100 % in 1992/93 (Drought Relief Programme, 1993a, b; Figures 2, 3). The number of people receiving food averaged 95,851 per year over the same period (36 % of the population), ranging from 3,585 (1.5 %) in 1985/86 to 246,828 (79.0 %) in 1992/93, following the extreme drought of 1991/92. The average amount of food distributed annually per person was 116 kg (range 94 - 134 kg), well below the adult maintenance requirement. Even when food aid was supplied, overall food deficits occurred in nine out

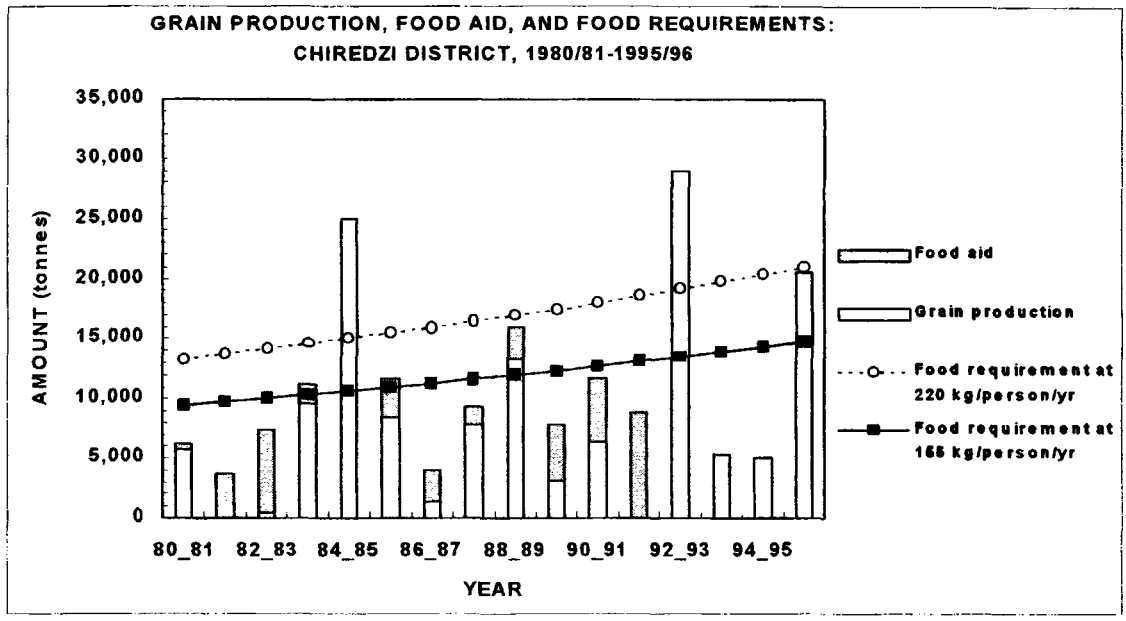


Figure 2. Total production of maize, sorghum and millet in Chiredzi District, 1980/81-1995/96, together with the amount of food aid distributed, 1980/81-1991/92, and food requirements by the population in the district at two levels, 155 and 220 kg person^{-1} yr^{-1} (data from Agritex crop production estimates obtained from Famine Early Warning System, Harare, and Drought Relief Programme, 1993).

of 10 years in Beitbridge District and six out of 10 years in Chiredzi.

The recurrence of drought and the frequency of crop failure cause smallholders to adopt strategies of risk aversion. Expenditure on agriculture is limited to a few low-input, low-output production options (Scoones *et al.*, 1996). Such strategies, placed in the context of traditionally high livestock and human populations, a legacy due in part to former restrictions on where people could live, encourage heavy dependence on the environment (Government of Zimbabwe, 1982; Whitsun Foundation, 1983). A number of national and sub-national surveys show apparent declines in environmental conditions in many communal lands (Whitlow, 1980, 1988; Whitlow and Campbell, 1989; Campbell *et al.*, 1989; Ministry of Environment and Tourism, 1996; Timberlake *et al.*, 1993). Not everyone agrees though on the causes of these changes or their significance for sustainable development (*e.g.* Bradley and Dewees, 1993; Scoones *et al.*, 1996; Campbell *et al.*, 1997). Nevertheless, the issues of deforestation, soil erosion, water deficiencies, poverty and land tenure are perceived by the public to be currently the main environment and development issues in Zimbabwe (Marongwe and Milne, 1993).

Whereas agricultural production in communal areas is constrained primarily by the low agro-ecological potential of much of the land, it is also affected adversely by a range of socio-economic factors. The communal tenure system makes it almost impossible for farmers to secure the credit and loans needed to purchase agricultural inputs. Markets are under-developed and often difficult to access consistently because distances, cost of transport, and a sometimes poorly developed and maintained infrastructure (Muzari *et al.* 1993). The marketing system also tends to favour urban consumers at the expense of rural producers. Access to appropriate extension advice is declining as a result of cutbacks in government expenditure, low morale among extension officers in the field, and increasingly outdated extension messages. Production is further constrained by shortages of labour and inadequate input and output delivery systems. Whereas these problems are widely recognised (*e.g.* Government of Zimbabwe, 1982), the solutions are more complex, not least because many of the problems are interlinked and cannot be tackled in a piecemeal manner.

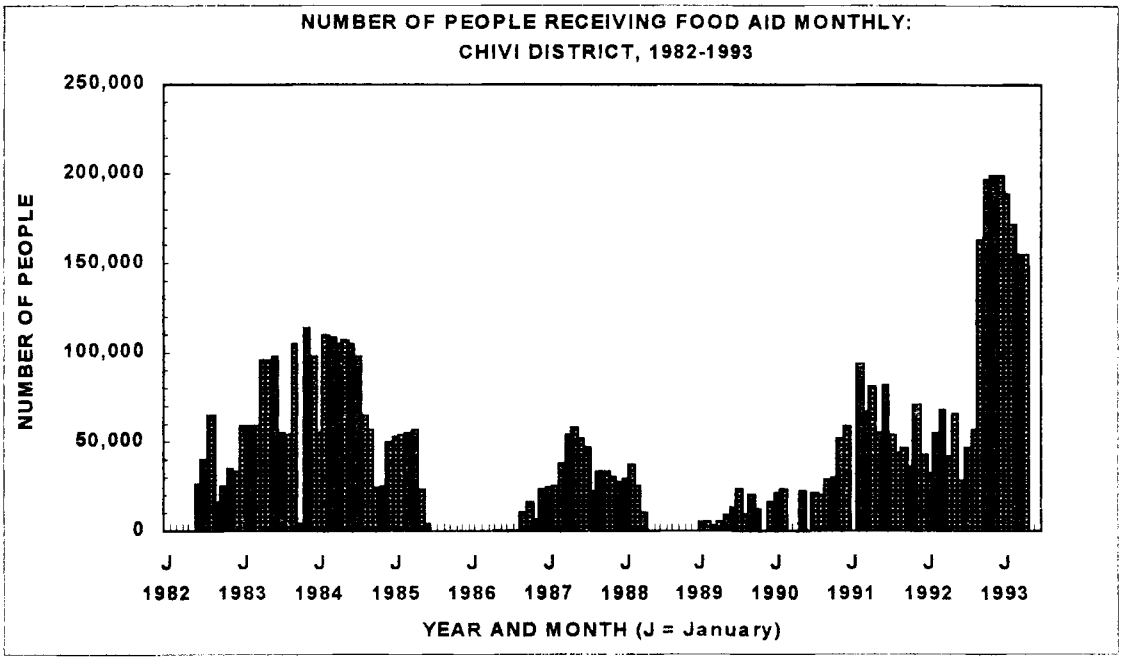
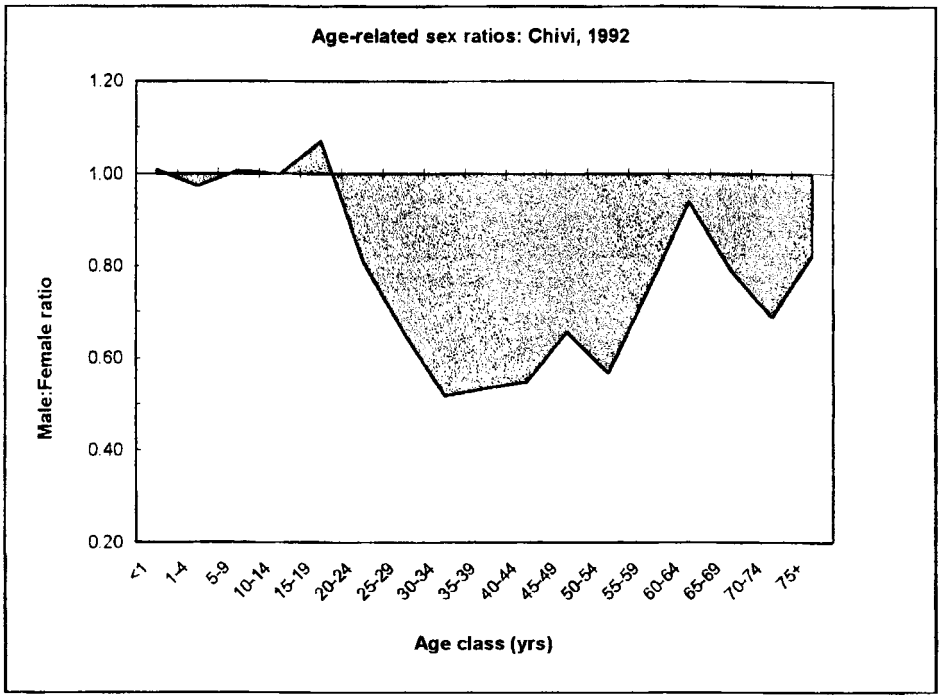


Figure 3. Number of people in Chivi District receiving food aid each month from June 1982 to June 1993. On average, 44 % of the population in the district was registered for food aid during this period, though the number of people actually receiving food averaged only 62 % of the number requesting assistance. A total of 56,516 tonnes of grain was disbursed during this period, equivalent to an average per capita monthly distribution of 9.8 kg among those receiving food aid (Drought Relief Programme, 1993).

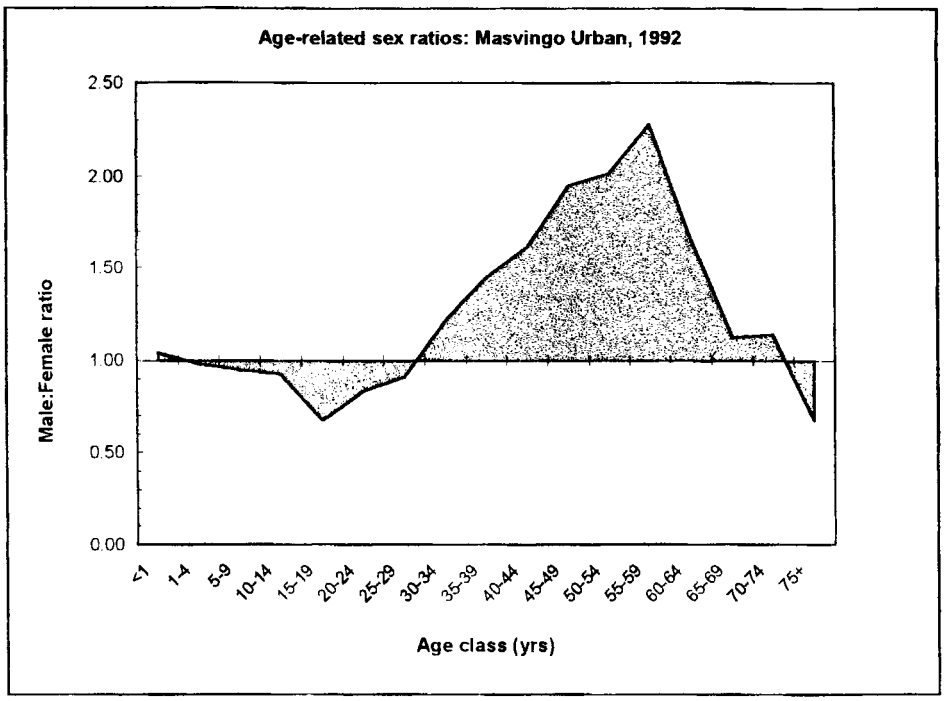
Several other factors underlie the typically low household income profiles of communal areas. Many able-bodied people within these communities, mostly men, are attracted by prospects of earning a wage through the labour market outside the communal areas (though this option is currently being constrained by low economic growth). This results in proportionately fewer males in the 20-65 year age range in rural communities (and, conversely, proportionately more men in that age group in urban areas: Figure 4). This leaves women with the burden of household production in the communal areas (Whitsun Foundation, 1983). Remittances of income earned by migrant workers outside the communal areas has long been an important source of income to households in rural communities, but with the decline in wages in real terms over the past decade, the level of remittances has been gradually declining. Remittances are important for the purchase of inputs needed to support small-scale agriculture.

Livelihoods are also vulnerable to economic policy shifts, particularly economic reform programmes whose pressures reinforce dependence by the poor on the environment, often causing further rapid deterioration in its quality (Mukamuri *et al.*, 1997; Kowero and Chipika, 1997). With the increase in unemployment that has accompanied economic structural adjustment, some people are returning to the rural areas from the towns and cities where they were formerly employed, adding to the pressures there. At the same time, populations continue to grow, generally at rates above that of economic growth, so that the disparity between the number of people seeking employment and the extent of economic opportunity is ever widening. The consequence of these and other factors is a high incidence of poverty, both in absolute and relative terms.

In part because of this, rural communities depend on a wide range of natural products to supplement their livelihoods. These include fuelwood, construction materials, fibre, wild foods, medicines, fodder for livestock, and inputs to agricultural fields (Bradley and Dewees, 1993). Although households and individuals may derive considerable internal economic benefit from these products, their economic value when traded in the wider market is generally low (Campbell *et al.* 1997) and there is only limited potential to add value to the harvested products. Most of these resources are obtained from the commons and their management requires concerted community action.



(a)



(b)

Figure 4. Comparison of age-related sex ratios in (a) Chivi, a rural area, and (b) Masvingo Urban, the main urban area in Masvingo Province, 1992. Values >1 indicate a preponderance of males; values <1 a prevalence of females. The differences between Chivi and Masvingo Urban suggest differential migration of young males to urban areas where most remain until late middle age. Data from CSO (1993). It should be noted, however, that the 1992 census was carried out immediately after one of the most severe droughts of the 20th century. This may have resulted in higher than normal migration rates of people, particularly men, out of rural areas in search of work.

The weakness of local institutions, however, makes it difficult for communities to implement and maintain appropriate policies and practices in relation to sustainable use, particularly the integrated approaches needed for effective management of common-property resources. In part this is because governments have over the years appropriated responsibility for these resources without really having the capacity to manage them (Murphree, 1991). The provisions made for such management have tended to rely more on restrictions and coercion than on incentives and encouragement. The shortage of accurate information on the state and dynamics of the natural resource base and, even when available, the inadequate use made of such information in decision making, adds to the problem.

Research and development in this area should be directed at developing and promoting adaptive agricultural and resource management strategies aimed at optimising both commodity production and environmental benefits under a range of scenarios. Work from preliminary activities on the development of productive water points, for example, suggests that these can have a positive impact by broadening the commodity base of smallholder farmers, thereby reducing risk and increasing incomes (Waughray *et al.* 1997). Adaptive management requires a functioning monitoring and resource information system that enables people to assess the condition of their environment, the status of key resources, and effects of management. A challenge in community-based resource management initiatives is to internalise these procedures. This would allow local people to take quick and full advantage of opportunities, enable them to identify and overcome constraints, and eventually reduce their dependence on outside technical assistance.

Tenurial and institutional contexts for common property resource management

Functional systems for common property management have to address a number of tenurial and institutional challenges typical of communal areas, including those in south-eastern Zimbabwe. These include, among others:

- the nature of the land tenure system and its influence on the property rights of individuals and communities;
- the presence of multiple-stakeholder interests in the resources, including stakeholders who may have more than one, sometimes conflicting, interests;
- communities that are heterogeneous with respect to composition, preferences, affection, interests, socio-economic status, and power;
- a variety of institutions with overlapping and competing claims to authority;
- complex sets of local rules, and problems relating to their enforcement and maintenance;
- frequent absence of well-defined boundaries to both territorial and resource management units and, when the boundaries are defined, often a lack of correspondence between the two.

The question of what proprietary rights a community has over the resources of an area is central to the issue of managing common-pool resources. Over time, central governments in most countries, including Zimbabwe, have assumed responsibility for managing natural resources and regulating their use. In so doing, the rights and responsibilities of local people over these resources has been diminished or removed completely. But in many cases, for logistic and other reasons, governments have been unable to exercise sustained control over who uses the resources and how, with the result that an 'open access' regime of resource use often emerges. Under an 'open access' regime no individual or group has property rights, and the benefits from using the resource goes to those who use the resource first. Because individuals compete with one other for prior access to, and use of, an 'open access' resource, this regime is not one, which is conducive to sustained use, for there is no incentive for individuals to limit their level of use or manage the resource. Resource management initiatives aimed at promoting sustainable patterns of use therefore have to be able to convert an 'open access' resource regime into one based on some for of common property.

Common-property ownership gives individuals in a group the right to benefit from the use, exchange or sale of common-pool resources, provided that this does not infringe or diminish the same rights of others within the group. Viewed this way, 'property' is not an object, such as land, but rather a *right* to a flow of benefits from an asset that others are morally and legally obliged to respect. This right, however, is only as secure as the degree to which others exercise their duty to respect it. How these rights and obligations are institutionalised within a society is the essence of a *property regime* (Bromley and Cernea, 1989). Moreover, while individuals have both rights and responsibilities for the use and management of common-pool resources, the group as a whole has to be able to exclude outsiders from having access to the resource, or at least be able to regulate such access and the extent of use. Crucial to the success of such an institution therefore is a system of

community-based authority that can define membership, allocate rights and responsibilities among the members of the group, and draw up and enforce rules governing their behaviour.

Identifying discrete units of social organisation that can exercise these rights and responsibilities is a particular challenge. Whereas local communities might be considered to be the obvious appropriate entities for natural resource management (Murphree, 1991), there is lack of clarity on what the term 'community' really means (Mandondo, in prep.). A common assumption is that communities with the potential to manage natural resources are congruous with sub-district administrative institutions (*e.g.* Wards, Villages). The assumption is confounded by the presence of many and varied institutions exercising administrative functions at the sub-district level - political, social, spiritual, developmental, and others - and their dynamic nature (King, 1994; Sithole, 1997).

At one level of analysis, community-level institutions at a sub-district level in the communal lands of Zimbabwe tend to be aligned broadly within a dual administrative framework: a customary chief-headman system; and the statutory village and ward development committees (VIDCOs and WADCOs), which are agents of central government. Conflicts over the boundaries of responsibility and the exercise of power, usually centred on regulating access to land and its resources, are common between the two, and alone can undermine the scope for sustainable management of common property resources (Lue Mbizvo and Mohamed, 1993).

But the potential for conflict extends below this administrative framework. The underlying communities themselves are inherently heterogeneous in terms of ethnic composition, power relationships, politics of affection, preferences, interests, socio-economic standing, and livelihood strategies (Brigham, 1994; Scoones *et al.* 1996). This heterogeneity occurs at a range of scales: ethnic groups, clans, discrete household clusters, family units within these clusters, and even within families (Mandondo in prep.). These can act both independently and interactively within the broader social and political units in which they are nested.

Theories of collective resource use, such as common-property theory, are often based on assumptions of communities as bounded and homogenous entities (Salazar and Lee, 1990; Lawry, 1991). As shown above, the reality is different. Within a 'community' there is a diversity of groups with different interests and concerns, overlapping but not wholly concordant memberships and jurisdictions, and varying degrees of association and affection within and among them, and through time. Applied social science research conducted around productive water points in south-eastern Zimbabwe, showed that there are both multiple-user and multiple-interest groups comprising, among others, project members, non-members, seasonal users and other interest groups including schools, businesses and individual entrepreneurs (Waughray *et al.*, 1997). This diversity poses a significant and ongoing challenge to those trying to facilitate the establishment of robust institutions for community-based natural resource management.

Access to and use of resources in dryland catchments is therefore subject to competing claims, making conflict inevitable. Thus a key requirement of any common-property management regime is for mechanisms to resolve conflicts. Such mechanisms must be adaptive. Initiatives intended to promote sustainable use need negotiation and brokerage because no party has the capacity to manage the resources by and for itself (Hasler, 1993). A comprehensive brokerage process is required to allocate and enforce a range of rights, including access, exclusion, withdrawal, alienation, and management (Ostrom and Schlager, 1996).

The manner and extent to which these various rights are exercised depends, to some degree, on power relations within the target communities. The rules governing these rights can be used to self advantage by political elites in societies with pronounced power asymmetries. Mukamuri (1995) has shown how, in south-central Zimbabwe, local power elites manipulate ambiguously-defined local rules for selfish ends. They achieve this by manipulating social controls so that they are inclusive with respect to cost but exclusive with respect to benefit. Cousins (1992) found the same thing in a communal-land-grazing scheme in central Zimbabwe.

Local rules for management of resources are known for their subtlety and complexity. They include norms, conventions, taboos, mores and formal codified rules (Mandondo, in press). The enforcement of these rules can also be complex, relying on public goodwill, official discretion and incorporating a spiritual domain (ancestral spirits) (Mandondo, in press). Attempts to promote effective community-based natural resource management may need to facilitate the process by encouraging communities to clarify, simplify and codify the rules and incorporate them into usable institutional texts.

In terms of spatial scope, most soil and water conservation initiatives are promoted at the micro-catchment scale, for obvious practical reasons. In practice, however, this biophysical unit is not congruous with those of resource ownership, use or

management. This presents a significant problem in attempts to promote participatory, multipurpose, watershed management (Rhoades, 1997). Village boundaries often extend across watersheds, rather than being encompassed by them. People acquire resources both from within their own villages and from adjacent ones (Lynam *et al.* 1996; Gwaai Working Group, 1997; Mandondo, in prep.). In an extended and detailed study of resource use by households in a number of villages in the Zambezi Valley, Lynam *et al.* (1996) showed that whereas all households gathered resources from within their village areas, 86 % also collected resources from neighbouring villages within the same ward, and 20 % gathered resources from across ward boundaries. The Land Tenure Commission (1997) recommended that traditional villages (kraals) should be given legal exclusive authority over the resources in their area. But the findings of these studies show that villages are surrounded by soft boundaries. How best to ensure that the various political and administrative boundaries within communal areas correspond more closely with the relevant resource management units at a range of scales is an important emerging policy issue.

The issue of scale is also important in other contexts. The problems of scaling up resource management initiatives from a local level to the broader catchment or watershed scale have recently been critically discussed by Rhoades (1997). The implicit assumption that social, economic, political and biophysical functioning at a broad scale is simply a composite of functioning at finer scales, or that it can be reasonably approximated by aggregation, is almost certainly wrong. An increase in the extent of the management area, without changing the degree of resolution of socio-economic and biophysical variables, means an increase in heterogeneity within these variables (King, 1990). More stakeholders, with more interests, objectives and agendas, are added. Different political and other interest groups, which function at the larger scale and are therefore only marginally involved at the local level (if at all), become apparent and more central. Whereas the amount of heterogeneity perceived can be lessened by reducing the degree of resolution used to differentiate communities, this risks marginalising some groups (women, the elderly, the very poor) who are important at a local level and whose quality of life such programmes aim to improve. Moreover, the transaction costs of implementing and sustaining such broad-scale CBNRM schemes are consistently grossly underestimated. Whereas Rhoades' (1997) criticisms are directed primarily at the assumptions of, and expectations created by, participatory multipurpose research and management initiatives being undertaken at the watershed (large catchment) scale, many of them apply also to initiatives undertaken at other scales. It is assumed that these problems are somewhat less acute at the smaller, micro-catchment, scale, though the *critical questions* (Rhoades, 1997) remain the same:

- Where are the community boundaries (and how are they defined and maintained)?
- Who are the legitimate authorities (and from where do they derive their legitimacy)?
- Who are the stakeholders (and what is their stake)?
- What conflicts are going on (and what are their origins)?
- What are the population-livelihood dynamics?

Management of common-pool resources

Experiences emerging from a number of studies of community-based natural resource management initiatives show that functional institutional arrangements for CBNRM need to fulfil a number of criteria (Murphree, 1991; Nangati, 1997). These include:

- The resource managers must own the resource and benefit directly from its use.
- There should be a close and proportional link between resource production and benefits.
- The benefits must be tangible and immediate.
- There should be local autonomy in decisions on how the products and benefits of the scheme are distributed.
- The user group should be small enough to be cohesive and to lower transaction costs, but not so small that it becomes exclusive and wholly self-serving.
- The leadership must be accountable, transparent, and broadly representative of the community it serves.
- Responsibility at different scales should be nested to give effect to the principle of subsidiarity, with local issues being dealt with locally, not regionally, and regional issues being addressed at that level rather than being referred upwards for decisions.
- The boundaries of the management units should be distinct and exclusive.

Given the need to have the political and administrative boundaries of these management units coincide broadly with the biophysical ones, and given the impracticality of re-orientating the biophysical boundaries, this implies a need, in some cases, for re-negotiation and re-structuring of the institutional landscape. The difficulties of doing this democratically and fairly should not be underestimated.

An issue of particular concern is how best to manage project membership to ensure that the more marginal and disadvantaged members of a community have equal access to a scheme and its potential benefits (Waughray *et al.*, 1997). Experience with communal grazing schemes (Cousins, 1992) and even some CAMPFIRE initiatives (Murombedzi, 1991) suggests that initiatives designed to manage common-pool resources can become vehicles for the more affluent and influential members of a community to accumulate further personal wealth, by various means, from resource, often to the disadvantage of others in the community. These and the other institutional issues need careful and sensitive, but thorough, investigation.

Increasing the productive base of people living in the semi-arid communal areas of Zimbabwe is essential to ensuring the viability of their livelihoods and reducing their vulnerability to drought and other external perturbations (Scoones *et al.*, 1996). A key step in this regard is to increase agricultural production while decreasing the risk associated with it. Investments in water management are crucial to the success of such initiatives. Investments are needed both in systems to deliver adequate amounts and quality of water, and in appropriate management of the catchment to ensure the continuation of that supply (Figure 5).

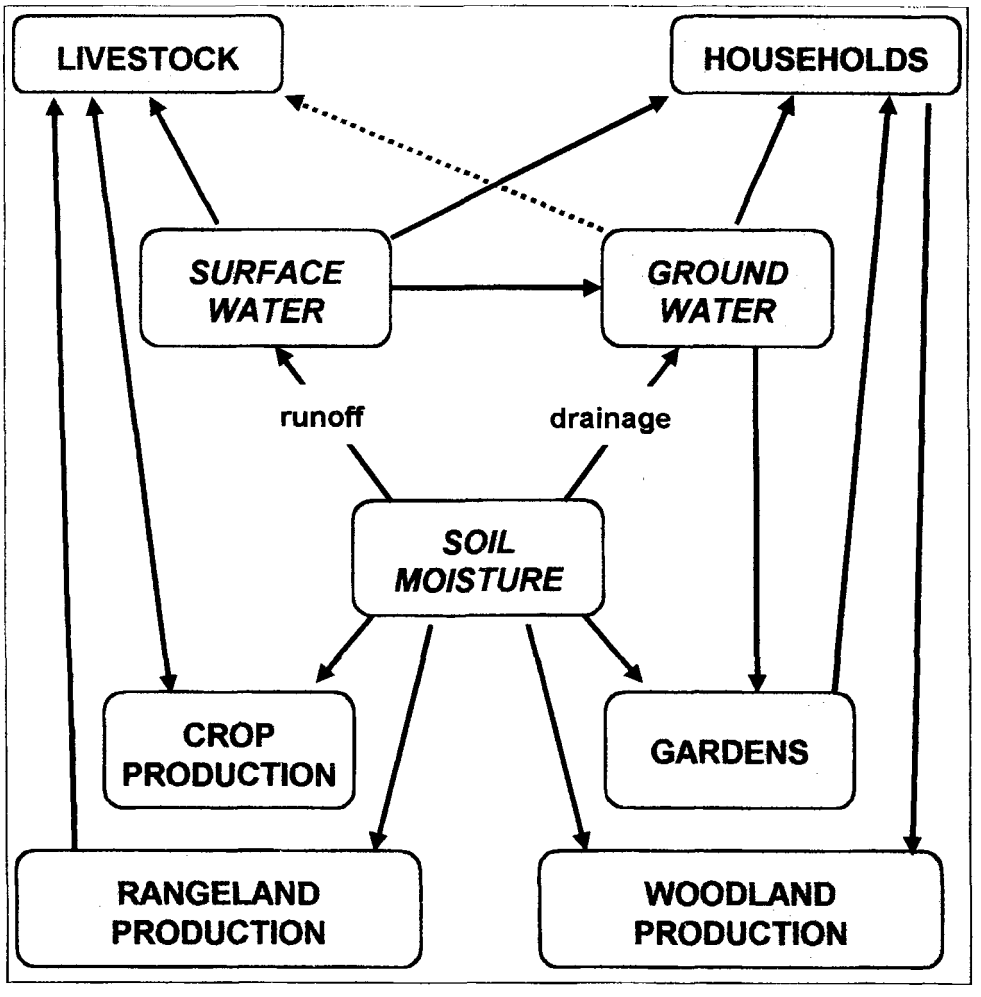


Figure 5. Water is central to people's livelihoods in semi-arid areas, linking the different components of their livelihood production system. Water of suitable quality is needed in sufficient amounts to meet increasing demands. This requires trade-offs among competing uses, and minimising, to the extent possible, adverse impacts on downstream users.

Given the central place of water in the livelihoods of people in these semi-arid areas, it may be the ideal common property through which to initiate a broader community-based resource management programme. Its economic benefits in communal lands have seldom been valued, however. One study in southern Zimbabwe estimated the average income from community gardens in 1995/96 to be Z$ 280 (s.d. Z$ 100; range Z$ 150 - Z$ 1,080: Waughray *et al.* 1997), though this did not include the development costs of the collector wells supplying these gardens.

To put these earnings in context, they can be compared with the dividends received by households from revenues earned through trophy fees and the sale of hunting rights in communal lands under the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE: Martin, 1986). In 1995, the average dividend payment to households in 112 wards was Z$ 150 household^{-1} year^{-1} (s.d. Z$ 463; range Z$ 1 - Z$ 4388: data from I. Bond, WWF Zimbabwe). (The lower amounts were usually not paid out to individual households but used to support community-wide projects.) The distribution of dividend amounts was highly skewed, with the median dividend payment being only Z$ 44 per household; 89 % of households received less than Z$ 200 annually.

On average, only about 57 % of the total revenue received by the district councils was paid to wards. If this is taken into account, potential earnings would still only average Z$ 258 household^{-1} year^{-1}. Yet despite these sometimes-meagre returns, most communities remain committed to the CAMPFIRE process. This implies that the prospect of substantial dividend payments may not necessarily be the only reason for becoming involved. Local empowerment, a sense of ownership, and even the prospect of externally funded projects, may all be motivating factors. It suggests that other common property resources could be a focus for community-based management initiatives, provided that some benefits are perceived to be likely in the short term, and that they accrue primarily to individuals and their families (Campbell *et al.*, in prep.).

Woodlands are another communal resource from which people derive benefits. Campbell *et al.* (1997) estimate the total economic value of products extracted from communal woodlands by people living in two villages in eastern Zimbabwe to be about ZW$ 279-459 household^{-1} year^{-1}, though much of this value is derived through household consumption and represents what villagers would have to pay if the products were bought on the open market, rather than what they earned through the harvest and sale of woodland products. Nevertheless, the extent of this benefit may not be fully appreciated and may not be sufficient stimulus to common property management. This is because the benefits are seldom received in cash, and because the total value is made up of a mix of direct values (products), indirect values (ecological services) and existence values (inheritance, sacredness *etc.*: Campbell *et al.*, 1997), not all of which are easy to value in monetary terms by a community.

Efficient use of water by a community therefore may generate a greater and more sustained economic return than most other common-property resources. The average income from community gardens irrigated from collector wells is, on average, greater than that being earned by most households under CAMPFIRE. Moreover, the returns to households are more direct, immediate, and transparent, factors which should add to the attractiveness of being involved in the management of productive water points and, by extension, of the catchment that supports them. Water is also essential to the production of different components of the agricultural ecosystem and thus serves to link them (see Figure 5).

We therefore hypothesise that the presence of a productive water point is a key to establishing a broader range of common property management initiatives. (These productive water points include collector wells, boreholes, dams and weirs.) The underlying argument is that activities centred on community-owned productive water points, and the direct, immediate and tangible benefits accruing to individuals and households participating in joint management of this common property, provide the stimulus and incentives needed to extend community management to other common-pool resources and the areas sustaining them. Of course, this does not preclude the need to consider the benefits and incentives provided by other options for more efficient use of water resources, such as conservation tillage, but these options need to be assessed in the context of the overall development initiative. The importance of developing the insights and tools needed to undertake such integrated assessments cannot be over-stressed.

There are outstanding issues, nevertheless. The issue of equity, both in terms of access to and benefits received from PWPs, and in the distribution of responsibilities for resource management and its associated costs, is particularly important. This applies not only to potential differentiation among households but also within households in relation to gender, age and status. In a study of community-garden

associations, which included people from all socio-economic strata within the community, members of associations were on average four times wealthier than non-members in the same community (wealth estimate based on total asset value), suggesting that it is often the wealthier and more influential members of a community who tend to become involved in such projects (Waughray *et al.* 1997). How to ensure greater equity of access to, and opportunity from PWPs is obviously a key issue that needs to be explored.

Strategies for managing micro-catchments

Strategies for the rational management of micro-catchments are important for developing sustainable and productive livelihoods in semi-arid areas. The capacity to store surface water is limited by the strongly seasonal climate, compounded by low rainfall, repeated droughts, high evaporation, and a generally unfavourable topography in which to build dams. This leaves groundwater as the most important water source, with shallow, seasonally-recharged aquifers in the regolith providing a more workable resource to exploit than the deeper aquifers situated in joints and fractures in the crystalline bedrock (Butterworth, 1997). But the functioning of shallow aquifers may be more closely influenced by land use and land management practices, pointing to the need to explore these issues in more detail and to develop appropriate community responses.

A considerable amount of research has been aimed at improving semi-arid rural livelihoods through increased agricultural production. But adoption of the results remains relatively low because of frequently perceived lack of appropriateness by intended beneficiaries who, of necessity, are generally risk-averse. Even transferring the results of on-farm research can be rendered ineffective by site specificity and irrelevance at a broader and more complex scale. Process-based hydrological research centred on understanding and improving water yield from small catchments undertaken in south-east Zimbabwe showed that improved access to water broadens the livelihood strategies of people living in these semi-arid zones (Butterworth, 1997; Waughray *et al.*, 1997). A priority for future research is to place these evolving water-management and livelihood strategies in the context of a range of broader institutional, social, economic, and biophysical processes occurring at the micro-catchment scale and above.

A key issue in this regard is whether the aggregated impact of improved resource management at a micro-catchment scale, and the common-property institutions that drive and sustain it, are sufficient to enhance functioning of the larger catchment. Because water flows through catchments uni-directionally, there is an asymmetry in the impacts of user communities on each other, with upstream users being able to influence both water quality and yield to those further downstream. This suggests that integrated catchment management will require additional institutional development at the larger scale and some limits on the kinds and extent of use of water resources in the upper micro-catchments. The notion that appropriate institutional arrangements and management responses can be worked out among the communities within a catchment to extend the gains of improved micro-catchment management to the catchment as a whole remains to be tested.

Butterworth *et al.* (1995) identified a number of options with potential application to the management of micro-catchments from their study of the Romwe catchment in southern Zimbabwe. These options fall into three groups: management of cultivated areas; management of communal soil and vegetation resources; and management of water resources. Whereas the management of cultivated areas is mainly the responsibility of individual farmers, the last two involve community decision making and action. All three are linked, however, in that actions taken in one area have consequences for actions and outcomes in other areas.

Potential interventions within the cultivated areas are focused primarily on managing water movement across and into cultivated land, by improving contour design and functioning, by appropriate management of soil properties through various mulching and ploughing practices, and by applying various water harvesting techniques. They also involve the use of contour bunds and depressions as additional sites for planting crops. This practice is contrary to current extension advice but it has been shown to produce marked benefits in terms of both soil and water conservation, and enhanced crop production (Chuma and Hagmann, 1995; Nyamudeza and Nyakatawa, 1995). Such interventions have various short- and longer-term advantages including greater water retention on fields, leading to improved crop yields; increased areas for planting, by using currently unplanted sites such as contour banks and furrows; a greater diversity of crops through using a wider range of microsites, thereby spreading the risks of total crop failure; reductions in draught power and labour; and reduced erosion. They also potentially influence groundwater recharge, depending on how much of the conserved water is transpired by the more vigorously growing crops and how much drains down to the regolith. The optimum trade-off between these contrasting benefits needs to be explored.

At least three interventions are suggested for the management of communal resources: planting or encouraging the growth of plants in gullies and along eroding streams (to form so-called "green plugs": Butterworth *et al.* 1995); community-based livestock management; and community forestry initiatives. Planting vegetation to stabilise gullies and stream banks is aimed at increasing infiltration, reducing runoff and erosion, and thereby increasing the potential for groundwater recharge. These benefits may take time to materialise. Moreover, their success depends in part on reducing surface runoff from areas higher up in the catchment, thus linking these activities with the land management practices of individual farmers and with community-based livestock and forestry management practices.

The issue of livestock management is particularly sensitive. Livestock are a key component of the socio-economy of communal lands. This is especially true of cattle. There are close relationships among the number of cattle to which a household has access, agricultural output, and household wealth (GFA, 1987). Cattle provide draught power, manure, milk, meat, a means of investment (through natural growth of the herd), and social currency. Few household in the communal lands have sufficient cattle to meet their needs (and 20-40 % of households have no cattle at all: GFA, 1987), yet consistently it is claimed that most communal lands are overstocked. As the area of cultivated land increases, thereby increasing the need for more cattle to maintain the same level of inputs, so the area of land available for livestock grazing decreases, increasing the pressure on the soil and vegetation (Swift *et al.*, 1989). Attempts by outsiders to regulate the number of cattle have always failed. Many grazing schemes have been established but few of these have been successful (Cousins, 1992). The presence of a collector well or some other kind of productive water point could result in a more reliable water supply for livestock and, possibly, in the establishment of a fodder bank to provide supplementary feed for the animals. If linked to other aspects of livestock management, including controls on where the animals graze and the numbers involved, this could help reduce overgrazing and erosion, and increase recharge of groundwater.

Community forestry initiatives aim to manage the use of existing woodland resources and, where necessary, re-establish trees to ensure a sustained supply of wood and other products. Because deep-rooted trees deplete groundwater, there is a need for close liaison between farmers and hydrologists to determine the optimum sites for growing trees. This requires trading off the needs of trees for suitable conditions for growth and the need to maximise, to the extent possible, the amount of groundwater available for abstraction.

Management of the water resource itself is also needed. A trade-off is likely between abstraction of groundwater from individually-owned wells and those owned and managed communally. At some localities, negotiations and trade-offs may even be needed between communities living further up a catchment, but outside the area served by a productive water point, and the community using that waterpoint. (Romwe is situated at the head of a larger catchment, so the issue of external impacts on groundwater supplies and re-charge has not arisen in any serious way.) Management of the resource also entails optimising the efficiency of water use in gardens through appropriate soil and water management practices, and ensuring an equable allocation of water among users and uses. The potential short-term benefits are better crop yields and quality; increased water availability; and fewer unproductive investments in cropping by allowing for closer tracking of water availability (Butterworth *et al.* 1995). The longer-term potential benefits are likely to be a reduction in the reliance of farmers on rain-fed cropping for food security, and perhaps less need to cultivate potentially erodable sites such as stream banks.

Ultimately, the success of any community-based management programme will depend on it being able to demonstrate the benefits to those involved. People will only participate in managing their environment when they perceive that the benefits of doing so are greater than the costs (Murphree, 1991). The benefits may include both a demonstrable improvement in people's livelihoods and a reduction in degradation that threatens to undermine their livelihood systems and lower the quality of their environment. In the context of communal lands in the semi-arid areas of Zimbabwe, it is probable that the former will take precedence. Helping the community to establish the links among actions and outcomes at varying spatial and temporal scales will be an essential task in building a sustainable management programme.

Conclusion

In summary, development research aimed at alleviating poverty and enhancing peoples' livelihood strategies through promoting improved management by communities of their common-pool resources, needs to address the following questions:

a) What are the key biophysical and socio-economic components and processes of semi-arid agropastoral ecosystems?

b) How can the resilience and productivity of these systems be maintained in the face of the increasing pressures being placed on them?
c) How can the diversity in people's livelihood strategies in these systems be maintained and extended?
d) What are the features of the various resource-use regimes in these ecosystems?
e) Who are the actual and potential managers of these resources, what resources do they currently manage and how?
f) What management is needed of which resources under what circumstances?
   - what are the incentives for management?
   - what are the appropriate units and scales of management?
   - what is the nature and magnitude of the benefits accruing from management, and what are the associated costs?
   - who benefits and who pays?
   - what trade-offs are necessary and possible among private and public benefits and costs?
   - what information is needed for long-term effective management of particular resources, and how best can this information be acquired, processed and used?
g) What institutional arrangements are needed to support community-based management of common-pool resources?
h) How best can these management structures and associated institutional arrangements be implemented, strengthened and extended?
i) What overall approaches to sustainable development should we be encouraging and supporting?

An outline of the main components, processes and linkages of the research needed to address these questions is given in Figure 6. The framework emphasises the iterative nature of the required research activities. These include identifying and strengthening the resource-management institutions; developing options for community-based management and use of micro-catchment resources; assessing the impacts of these options on both biophysical processes and livelihoods; and considering the issue of dissemination and uptake of the results and their wider applicability at a catchment scale. The importance of carrying out the necessary research in close collaboration with the communities concerned must be emphasised.

This iterative procedure is consistent with process-based rather than plan- or blueprint-based approaches to development (*sensu* Sandford, 1983). Despite some apparent shortcomings from the perspective of programme management, namely the often open-ended and uncertain nature of the products, and the relatively slow pace of development, at least initially, there is evidence from an increasing number of development initiatives for the merits of the process-based approach in stimulating sustainable development (Hagmann *et al.* 1996a, b, 1997). Some of the elements of this approach, and the contrasts with the more conventional approach to development, are given in Table 1.

Acknowledgements

This publication is an output from a research project funded by the Department for International Development of the United Kingdom. However, the Department for International Development accepts no responsibility for any information or views expressed. DFID Project No. R7304 – Zimbabwe: micro-catchment management and common property resources – is a project of the Semi-Arid Production Systems component of DFID's Natural Resources Systems Programme, managed by Natural Resources International. Chris Lewcock (NRInternational) was instrumental in facilitating this support. Peter Frost also acknowledges the support of the United States National Aeronautics and Space Administration (NASA) Land Cover and Land-Use Change programme under NASA Grant No. NAG5-6384 through the University of Virginia.

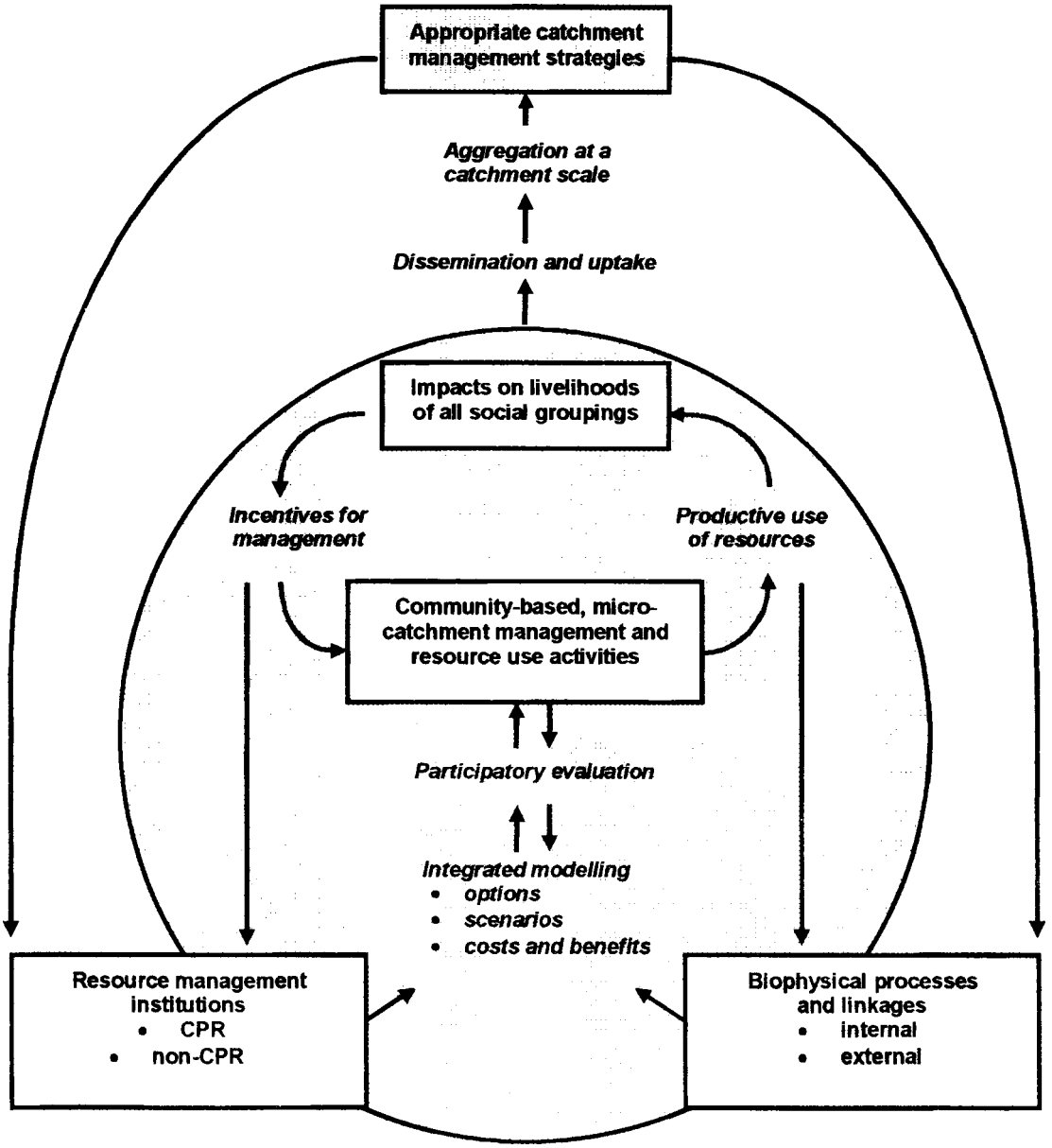


Figure 6. Outline of the main components, processes and linkages of an integrated approach to the development of a community-based micro-catchment management project aimed at contributing to enhanced management of whole catchments (shaded box at the top). Items in the clear boxes require assessment by both the community and external facilitators. A key assumption is that the results of micro-catchment management can be aggregated at a catchment scale, primarily through the mechanism of dissemination and uptake, though that process is also likely to require assistance. Key processes and outcomes are shown in italics. The large shaded circle represents the boundaries of a micro-catchment.

Table 1. Comparisons and contrasts between the process-based and plan- or blueprint-based approaches to development (*sensu* Sandford, 1983).

Attribute	**Plan- or blueprint-based approach**	**Process-based approach**
Focus	narrowly-based: -products -technology	broad-based: -processes -practices
Driving forces	largely external	mainly internal
External agents as:	directors, controllers	catalysts, facilitators
Internal stakeholders as:	recipients	owners
Structure	rigid	flexible
Functioning	controlled, unidirectional, reflexive	accommodating, iterative, reflective
Progress	pre-determined	incremental, variable
Pace	often rapid (in the short term)	often slow (at the outset)
Timeframes	short	long
Outcomes	closed, predicated	open-ended, uncertain
Achievements	~quantitative	~qualitative
Durability	brittle	robust
Extension efforts	instructions -prescriptive	suggestions -supportive
Role of research	tactical, "what is the answer"?	strategic, "what are the issues"?
Application	applied	adaptive
Cost-effectiveness	low-moderate	moderate-high
Track record	patchy, at best	so far, quite good

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