NATURAL RESOURCES SYSTEMS PROGRAMME

FINAL TECHNICAL REPORT

VOLUME 1
Main Report and Annex A

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Project Title

Zimbabwe: Micro-catchment Management and Common Property Resources

Project Leader

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Organisation

Institute of Environmental Studies, University of Zimbabwe

NRSP Production System

Semi Arid Production System

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MICRO-CATCHMENT MANAGEMENT AND COMMON PROPERTY RESOURCES IN ZIMBABWE:

FINAL TECHNICAL REPORT

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Institute of Environmental Studies, University of Zimbabwe

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Overview of report

Volume 1 – Main report and scientific annex

Main report

Annex A - Scientific Annex

Frost, P.G.H., Campbell, B., Mutamba, M., Lovell, C.J., Mandondo, A., Cain, J., Kozanayi, W. and Luckert, M. 2002. Can rural livelihoods in semi-arid regions be improved through better management of natural resources in catchments?

Annex J – Project Inventory

Volume 2 – Institutional, biophysical and integrative aspects

Annex B

Mandondo, A., Campbell, B., Luckert, M., Nemarundwe, N., de Jong, W. and Kozanayi, W. 2001. Transacting institutional change in contexts of complexity: experiences from Chivi District in Zimbabwe

Annex C

Nemarundwe, N. 2001. Organisations for local woodland management: the case of Romwe catchment in Southern Zimbabwe

Annex D

Nemarundwe, N. 2002. Formal and informal decision-making platforms: Women's role in natural resource management institutions in Southern Zimbabwe.

Annex E

Lovell, C.J., Mugabe, F.T., Moriarty, P.B., Hodnett, M. and Batchelor, C.H. 2001. When is catchment management beneficial? A biophysical case study in a semi-arid crystalline basement area.

Annex F

Mugabe, F.T., Hodnett, M. and Senzanje, A. 2001. Comparative hydrological behaviour of two contrasting catchments in semi-arid areas of Zimbabwe

Annex G

Cain, J., Moriarty, P.B. and Lynam, T. 2001. Designing integrated models for participatory formulation of water management strategies.

Volume 3 - Livelihood aspects

Annex H

Campbell, B.M., Jeffrey, S., Kozanayi, W., Luckert, M., Mutamba, M. and Zindi, C. 2002. *Household Livelihoods in Semi-arid Regions: Options and Constraints*. Bogor: Center for International Forestry Research. [Replaced by a published book with this title and authorship]

Annex I

Sullivan, C.S., Mutamba, M. and Kozanayi, W. 2001. Water use and livelihood security: A study of rural households in Southern Zimbabwe.

Relationship of annexes to logframe milestones

Institutional aspects

An overview institutional paper was called for – this is Mandondo *et al*. (Annex B). Two additional papers have been produced, not originally part of the milestones (Annex C, Annex D).

Biophysical aspects

This called for a review of technical options and finalisation of the modelling approaches. This is Lovell *et al*. (Annex E). One additional paper was produced for biophysical aspects (Annex F).

Livelihood aspects

This required two papers, one of water-livelihood aspects (Annex I) and one on broad livelihood aspects (Annex H). Given the large volumes of data on livelihoods the latter paper became a book, with various papers now in preparation.

Integrated aspects

An integrated paper was also mentioned as a milestone (cross-cutting across all of the outputs). This is Annex A. In addition we have a paper on integrated modelling (Annex G).

TABLE OF CONTENTS – MAIN REPORT

List of Abbreviations

ACRU	Agricultural Catchments Research Unit hydrological model
AGRITEX	Agricultural Technical and Extension Services
AIDS	Acquired Immune Deficiency Syndrome
ASQ	African Studies Quarterly (Journal)
BN	Bayesian network
CPR	Common Property Resource (also Common Pool Resource)
DA	District Administration
DEAP	District Environment Action Programme
DR&SS	Department of Research and Specialist Services
ETFN	European Tropical Forestry Network
GIS	Geographical Information Systems
ITDG	Intermediate Technology Development Group
PAR	Participatory Action Research
POLEX	Forest Policy Experts electronic list serve
PRA	Participatory Rural Appraisal
RDC	Rural District Council
RDCCBP	Rural District Council Capacity Building Programme
MODFLOW	Modular three-dimensional finite-difference ground-water flow model
NGO	Non Governmental Organisation
NR	Natural Resource
NRM	Natural Resource Management
VIDCO	Village Development Committee
WADCO	Ward Development Committee
WRM	World Rainforest Movement
WRMS	Water Resource Management Strategy

1. Executive Summary

A three-year project was undertaken in two micro-catchments in Southern Zimbabwe to develop, validate and promote new approaches to natural resource management that could benefit the poor in semi-arid areas. The project explored the scope for integrated management of livelihood assets and common-pool resources to alleviate poverty. Livelihoods were generally based on combinations of dryland cropping (the mainstay of most livelihoods), irrigated gardening, woodland-based activities, local wage labour and remittances. More than 70-90% of households fell below the poverty line, depending on the poverty measure used. In the few cases where households escaped poverty this was usually based on off-farm income, often involving migration of family members. The institutional setting comprised complex rights of access and use centred on norms and taboos. Constraints on resource management by the community included rent capture by the elite and numerous cases of failure of local organisations. Hydrological modelling indicated that physical catchment management makes little impact on water resources. Evaporation and transpiration account for most groundwater recession; human abstraction has minor impact.

Through investigating livelihood changes and integrated modelling we concluded that rainfall (main determinant of crop production) and macro-economic state (influencing, e.g., the remittances used to buy crop inputs) dominate the system. Human impacts through management appear secondary. We estimated cash income increases of 40% or more between 'bad' and 'good' macro-economies, while local interventions caused increases of less than 10%.

Institutional innovations initiated included incorporating common pool resource systems into the official regulatory framework, and enhancing local management capacity through training for transformation and process facilitation. While institutional interventions impact the entire livelihood system, results from the integrated modelling suggest that these interventions by themselves only improve cash income by 8%. But the impacts of soil and water conservation measures on dryland production, identified and promoted during the project, are even more limited. Similarly low impacts are apparent from other local interventions. Expanding irrigated gardens in both catchments, as promoted through action research, is technically sound, especially if irrigation relies on an opportunistic strategy that makes maximum use of water when available. The impact on poverty is limited to strengthening the safety net, however. For instance, if markets could be secured for crops produced by expanding the area of irrigated gardens by the technically feasible 7-8 times, it would only reduce the number of households below the food poverty line from 71% to 62%. Institutional failures, labour scarcity and the lack of markets are over-riding constraints to expanding irrigation. Interventions focusing on labour-saving devices and technologies are worth pursuing, but by themselves will only make a small impact on poverty. Wealthier households own most of the cattle, so interventions to improve cattle production would have little impact on poorer households. Woodlands are an important source of security during times of stress but, currently, over-harvesting and the low value of most products means that they have limited poverty-reduction potential. Loans from the micro-credit scheme, facilitated by action research, served similar purposes to remittances, and were used mainly to buy crop inputs. The viability of the credit scheme was severely constrained by the high and uninsured risk created by climate variability.

The limited successes, in terms of marked reduction in poverty, achieved with the options we tested and promoted on this project indicate that, by themselves, single interventions are unlikely to reduce poverty substantially. A more integrated, sustained and multi-level set of interventions and support is required. We conclude that a primary objective in development will be to empower local people. For technical interventions all sectors will need to be considered, including considering off-farm options and migration. While research should continue to try and identify improved technologies these should be based on detailed understanding of current livelihoods and constraints, and set within the framework of empowering approaches where farmers are offered choices of technology, access to them, information, experience, and enabling economic and institutional environments. It has to be recognised that large-scale poverty alleviation based on local interventions in these semi-arid areas remote from markets is exceptionally difficult.

2. Background

The goal to which this project contributed was to develop and promote appropriate catchment management strategies in semi-arid environments. To achieve this we need to understand the challenges and constraints that rural households face in living in semi-arid areas. 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 (Frost and Mandondo, 1999; Mortimer, 1998; Scoones *et al.*, 1996). Surface and groundwater supplies are often poorly developed, unreliable or contaminated by livestock. Access to good-quality agricultural land is usually limited, sometimes by high population densities but mostly by the alienation of the better farming land for large-scale commercial agriculture. Food shortages are chronic and widespread. For instance, almost 54 % of the population in the districts of Chiredzi, Beitbridge, and Chivi in southern Zimbabwe requested food aid each year during the period 1982-1993 (Frost and Mandondo, 1999).

The risk and uncertainty associated with semi-arid regions, in particular the recurrence of drought and the frequency of crop failure causes farmers to adopt risk-averse strategies (Frost and Mandondo, 1999; Mortimer, 1998; Scoones *et al.*, 1996). Such strategies, placed in the context of high livestock and human populations, encourage heavy dependence on and use of the environment. Environmental problems include deforestation, overgrazing of rangelands and increased soil erosion, though there is much debate as to the severity, causes and feedback to livelihoods (Bradley and Dewees, 1993; Campbell *et al*., 1997; Mortimer, 1998; Scoones *et al.*, 1996; Timberlake *et al.*, 1993; Whitlow, 1980; Whitlow and Campbell, 1989).

Whereas agricultural production is constrained primarily by the low potential of much of the land, it is also affected adversely by a range of socio-economic factors (Frost and Mandondo, 1999). Over time, the peasant sector has been weakened by the downstream effects of the communal tenure system under conditions of high population growth, including lack of collateral, sub-division into smaller holdings, low productivity and declining surpluses, and very low propensities to save and invest (Phimister, 1988). It is almost impossible for farmers to secure the credit and loans needed to purchase agricultural inputs. Insurance against crop failure is unknown. Markets are under-developed and often difficult to access consistently because of long distances, high cost of transport, and a sometimes poorly developed and maintained infrastructure. Access to appropriate extension advice is minimal.

Many people, mostly men, are attracted by paid employment outside the rural areas, leaving women with the burden of production. Labour shortages are being further compounded by the rising number of deaths and illness as a result of HIV/AIDS (World Bank, 1996). The contribution to household economies of income derived from wage labour, returned through remittances, may be declining, due to stagnating and declining economies in the region (World Bank, 1996; Addison, 1996). 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 (Chipika and Kowero, 2000).

Rural communities depend on a wide range of natural products to supplement their livelihoods, most of them derived from the commons (Bradley and Dewees, 1993; Standa-Gunda and Braedt, 2000). These include fuelwood, construction materials, fibre, wild fruits, medicines, fodder for livestock, and inputs to agricultural fields (Bradley and Dewees, 1993). Most of these resources are obtained from the commons and their management requires collective action. The question of what proprietary rights a community has over 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 have been diminished. But in many cases, for logistic or other reasons, governments have been unable to exercise sustained control over who uses resources and how.

Whereas local communities might be considered to be the obvious appropriate entities for natural resource management (Murphree, 1991), there is a lack of clarity of what the term 'community' really means (Li, 1996). Within a community there is a diversity of groups with different interests and concerns, and overlapping but not wholly concordant memberships and jurisdictions. Preliminary insights from applied social science research conducted around productive water points in south-eastern Zimbabwe showed that there are both multiple-users and multiple interests including project members, non-members, and seasonal and other users (Waughray *et al*., 1997). This diversity, together with other constraints outlined earlier, pose significant challenges to those trying to devise strategies to transact and sustain positive change in such areas.

Although most of these constraints operate in concert, availability of water is widely believed to represent the bottom line for rural livelihoods in arid and semi-arid regions (Annex I). Critical water problems in such regions occur at the local level in small catchments heavily populated by subsistence farmers and their livestock, but there is shortage of data from such catchments (Dubrueil, 1986). Pioneering studies on groundwater development in catchment settings in south-east Zimbabwe had suggested that community management of productive water points could significantly improve livelihoods in semi-arid production systems (Waughray *et al*., 1997). Participants to the inception workshop of this project, including farmers from the target communities, noted the increasing realisation in the natural resource management field that major constraints on the productivity of the natural resource base may not be resolvable at the level of the single farm, or a single resource (Mandondo, 1998). Cognisance was therefore taken of the need to build up thinking about the system dimensions at household, community and regional scale. There was broad agreement that the catchment appeared a logical physical unit in which to try to tackle biophysical and institutional constraints together. Thus, further development of the benefits of productive water points needed to consider the broader biophysical and social contexts of the catchments in which they are located. Hence, the goal of the project was to identify, test and promote appropriate catchment management strategies.

3. Project purpose

The purpose of this project was to develop, validate and promote new approaches to natural resource management that benefit the poor in semi-arid micro-catchment settings. The project envisaged attaining the purpose through three outputs. Firstly, the project aimed to critically appraise existing institutional arrangements to manage CPR, so as to identify and promote approaches to enhancing community capacity to manage CPRs. Secondly, the project aimed to understand key biophysical linkages amongst components of micro-catchments, so as to identify and promote options for more efficient and extensive use of water resources. Lastly, the project aimed to identify options for markedly improving livelihoods in these micro-catchments.

Thus, the project was not only about generating knowledge and techniques, but also about seeking to transact and sustain positive change on the basis of the new ideas and skills. On the basis of the project's outputs, changes in knowledge and capacity were sought in several areas including existing institutional arrangements and in people's capacity to manage CPRs; biophysical linkages amongst components of the micro-catchments; options for promoting more effective use of water; and other options for the improvement of livelihoods.

4. Outputs

4.1 Institutional outputs

Tenure surveys show a complex maze of property rights that confounds the simple characterisation of communal areas as 'common property' or 'open access' systems. Legally all communal land is vested in the state, which has decentralised the administration of such land to the Rural District Councils (RDCs). But at the most practical level, residents in Romwe and Mutangi enjoy 'traditional' freehold rights over residential and arable units, together with usufructory rights to resources in surrounding woodland, grazing, riverine and other 'commons'. In depth analyses show

that the property rights encompass a wide variety of resources including exotics, indigenous fruit species, other indigenous plant resources, animals and water. How these rights are exercised varies across land classes such as household plots, community woodlands, riverine areas and sacred areas. Their characteristics include comprehensiveness, exclusiveness, designation of use and users, duration, allotment type and size, transferability, fees, operational requirements and control (Annex B).

Local resource management units are often defined on the basis of social or administrative boundaries. The findings of this project show the existence of many such units at a range of scales, all of them variously associated with resource management and use at the local level, and whose boundaries do not match (Figures 1 and 2). Furthermore, the boundaries of each of the units do not match the resource-use boundaries. Incongruities in social, political and use boundaries are further reinforced by the fluid and amorphous nature of memberships across some of the units, to the extent that some people reside in one village, and consider themselves to be under the jurisdiction of a leader in another village, whilst 'owning' land and using resources from yet another village (Box 1).

Catchments are also often seen as the logical physical units in which to tackle social and biophysical constraints to livelihoods in semi-arid and other settings together (cf. Mandondo, 1998), but our institutional surveys indicate the difficulty of using physical boundaries as the units of management. On the basis of preliminary surveys the project made a distinction between the physical catchment as defined in physiographic and hydrological terms and the social catchment, i.e., area lying beyond the physical catchment, but with people who are variously associated with resource use and management within the physical catchment.

Box 1

The fluid and amorphous nature of membership within villages: cases from Romwe (Mabhachi and Kozanayi, 2001)

- Mr I. Dobhani lives in the Matenhese village of the Romwe area and has his fields in Sihambe and Matenhese villages, but considers himself to be under the jurisdiction of village head Dobhani.
- Mr. B. Mpofu resides in Tamwa village in Romwe but has his fields and a well in Sihambe village. Mr Mpofu took over the fields and the well from his estranged wife, who inherited them from her deceased relative
- One Mhlanga household living in Tamwa village of Romwe has its fields in Sihambe village. The head of this household inherited the fields from his father. The father of the household head used to farm on this land in the 1950s. Although he has been displaced due to the reorganisation associated with colonial land alienation he still considers the fields to be part of an estate to be inherited within the lineage.
- Mr Virima lives in the Mutangi village. Headman Madamba claims that Mr Virima falls under his jurisdiction for reasons that are not disclosed.

On the face of it, the popular notion of local natural resource management often gives the impression that there are clear bodies of actors and rules to enable such management (Campbell *et al*., 2001). The reality is more complex. Findings from the project show that many rules, at various levels, concern themselves with local resource management. At the broad level there are codified rules, mainly in the form of legislation, but these have to operate together with district-level rules (or by-laws), as well as grassroots controls. Unlike district and national-level rules, which are clearly codified and explicit, local controls consist of explicit rules as well as implicit taboos, norms and 'rules of the heart', which are steeped in subtle and complex processes (Mandondo,

2001). The multiple rule systems often do not accord with each other, partly because of their different sources of legitimacy (including the state, devolved units of the state, and customary authorities) as well as their reliance on different and often contradicting enforcement structures and procedures.

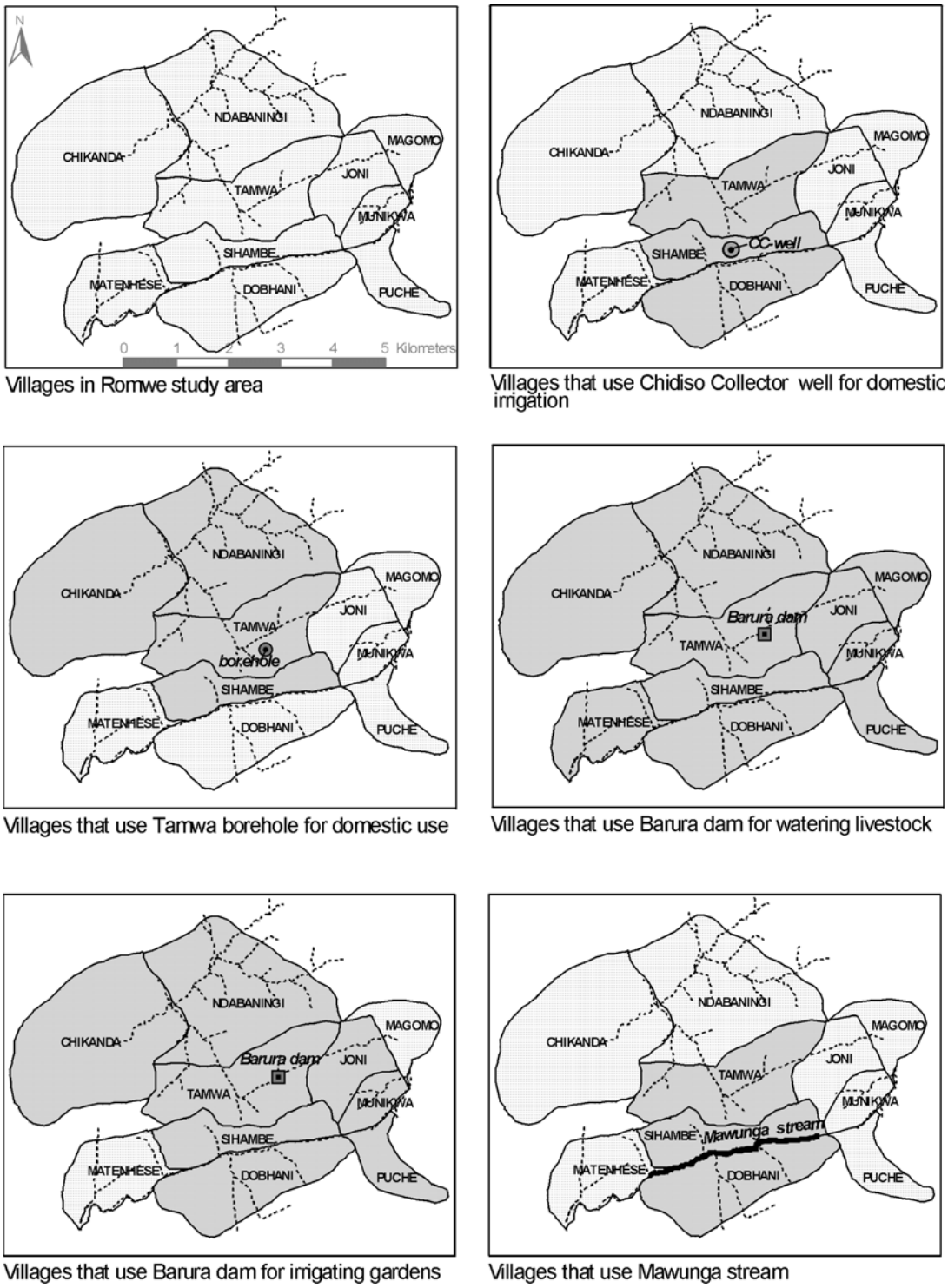
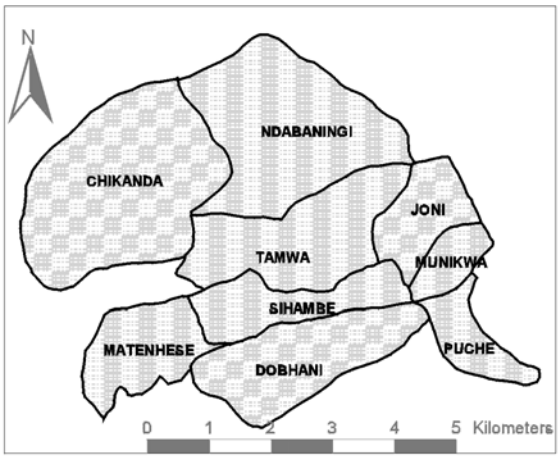
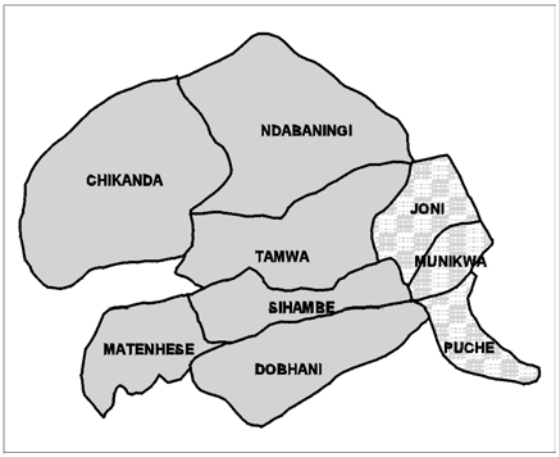


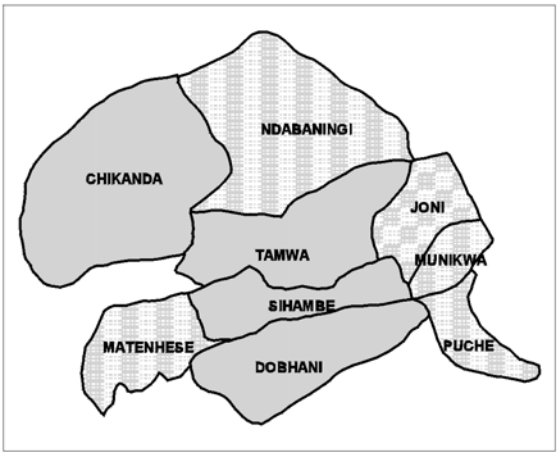
Figure 1. The villages in the Romwe social catchment, showing how members from different villages use the specified water resources in the three villages centred on the Romwe physical catchment (most of Dobhani and Sihambe, and a small portion of Tamwa). The villages belong to two different Wards.



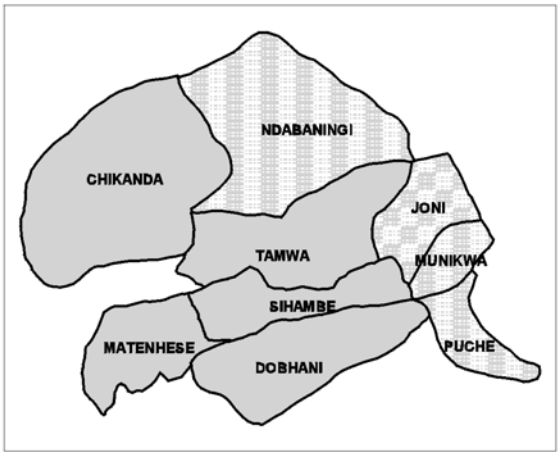
Villages in Romwe study area



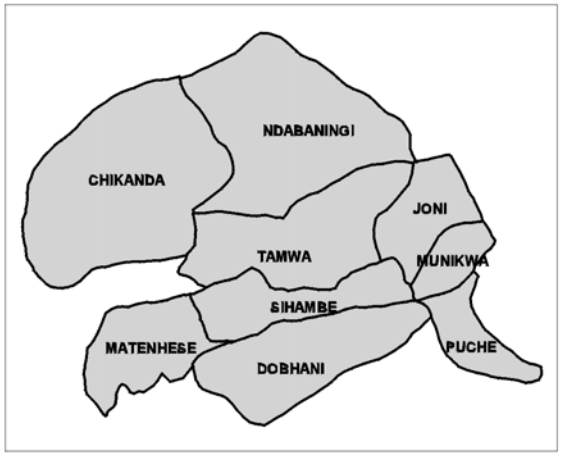
Villages that use Mapande hills for grazing livestock



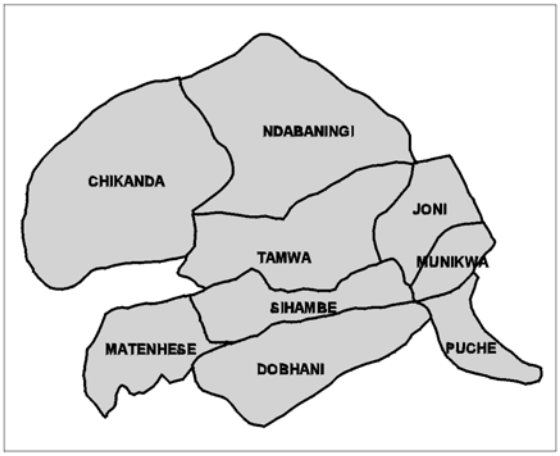
Villages that use Mapande hills to collect firewood



Villages that use Mapande hills to cut timber



Villages that use Mapande hills to collect fibre



Villages that use Mapande hills to harvest mushrooms

Figure 2. The villages in the Romwe social catchment, showing how members from different villages use woodland resources from a mountain (Mapande hills) in Dobhani village in the physical catchment.

In general, our findings suggest that local rules and leadership systems are perceived as being more legitimate but these are largely marginalised within the broader national governance framework. Most of the state and district level laws are imposed on local settings from above, but such laws are largely ineffectual because neither the state nor the districts have the capacity or resources to enforce such laws (Mandondo, 2000). Whereas the state and RDC rules do not appear to work at all, local rules, in so far as they are part of the moral fabric of communities, are followed to some extent.

There was no conclusive evidence to suggest that traditional leaders were necessarily always better than elected leaders of VIDCOs, WADCOs and other committees, or vice versa (Annex A; Annex C). Some traditional leaders were at the centre of illegal land allocation rackets, sometimes depriving less privileged in-migrant clans in adjacent villages of vital land (Annex B). In Romwe, an elite clan tacitly backed one of its members in a racket involving preferential allocation of funds from the micro-credit facility to himself and his clan (Mutamba *et al*., 2000). Among other things, elected leaders in committees and elsewhere were often seen to be clinging to power, subverting constitutions, failing to report back and not being accountable (Gumbo and Hwindizi, 2000).

Although women are normally seldom represented in either traditional or formal organisations, they use a variety of informal institutions and avenues to exert their influence (Annex D). The instance of female-headed and female-managed households at both sites is high, however, and women are increasingly playing a more prominent and public role, including membership of various committees. Both the project and its predecessor, as well as CARE, have encouraged this trend. The livelihood analysis indicates an upsurge of trading activities by women, often involving temporary migration to trading locations.

Studies on CPR systems often implicitly portray two extremes, one emphasising harmony, the other accentuating conflicts, among different interest groups. Our findings show both mutual and contentious resource-use relationships within and across villages. For instance, water point studies centred on private wells in Romwe show how lateral bonds at community level define complex networks of access to private wells (Fig. 3). The wells are shared with relatives, neighbours, church colleagues and friends, so that eventually everyone in the village has access to almost any well within reach. In Mutangi people from villages lacking adequate land and grazing resources often share these with neighbouring villages (Nemarundwe and Kozanayi, 2002; Annex B). Conflicts in accessing and using resources, as well as those over the extent of jurisdictions, were also evident, however. In some instances people take active steps to organise themselves for collective actions and outcomes, but such organisation often entails high transaction costs (Annex B). But people often devise and implement 'soft' and flexible arrangements that provide a hedge against high transaction costs (Annex B).

Two entry-points to enhancing community capacity to manage CPRs were identified on the basis of the above evaluations – addressing the mismatch between district and local level rule systems (Campbell *et al*., 2000; 2001), and enhancing accountability, leadership skills and the knowledge base of the communities through a set of tools including training, exposure visits and social learning approaches (Kozanayi, 1999; Gumbo and Hwindizi, 2000; Nemarundwe, 2002; Annex A). The initiative that involved transacting changes in district-local governance through dialogue between district officials and local communities resulted in the crafting of a radically different and more democratic vision of natural resource governance, some of whose aspects the RDC has started to implement. Implementation of the vision needs to be supported by research on best ways forward, including whether to do it in a comprehensive manner or incrementally in a piecemeal fashion. The range of resources required and the sites to be covered also need further investigation (Campbell *et al*., 2000).

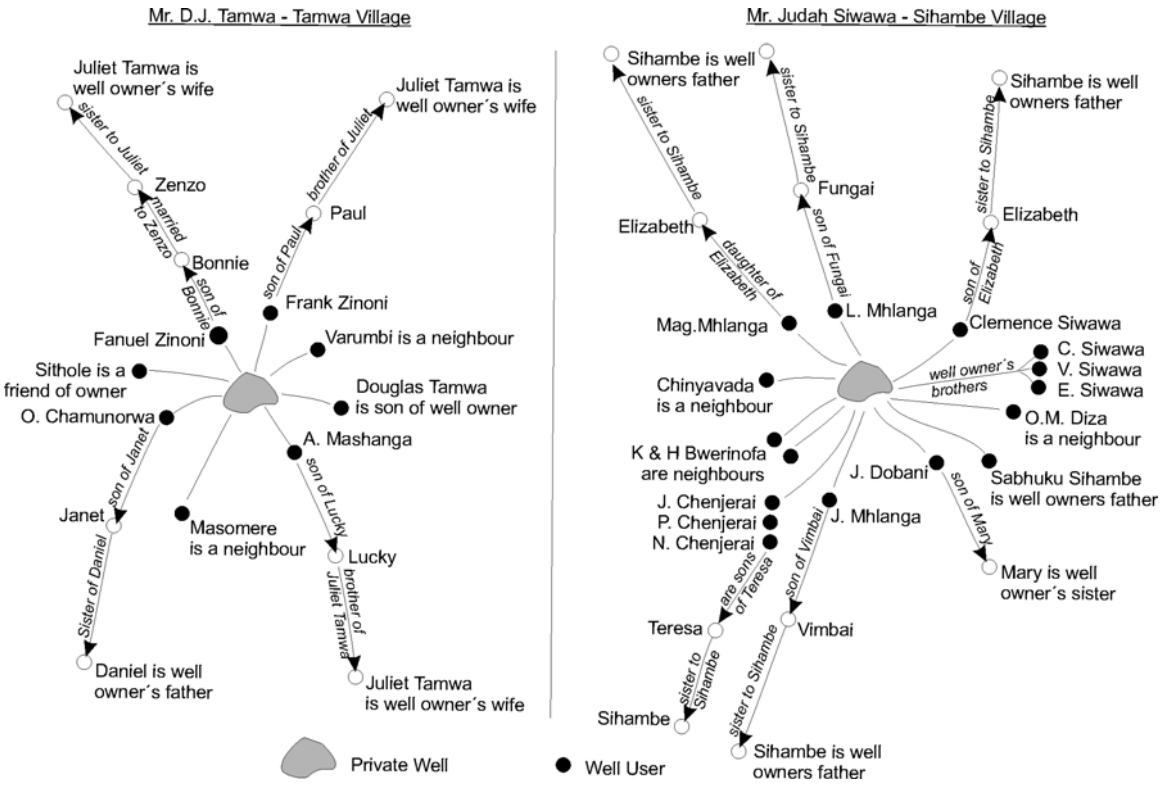


Figure 3. Rights to use water the private wells of Mr Tamwa and Mr Siwawa in Romwe, showing how social networks allow access to supposedly private resources.

4.2 Biophysical outputs

The main driver of various aspects of water balance throughout catchments in Southern Africa is the occurrence of long-term cycles of above-average rainfall (roughly 9 years) alternating with ones of below-average (also about 9 years duration). This means that most catchments in the area fluctuate between semi-arid and semi-humid. The implications for natural resource management are enormous. Related fluctuations can be expected in grain yield, vegetation cover, erosion and siltation. Modelling studies on catchment hydrology in Romwe showed that rainfall is the greatest determinant of natural resource status, with long-term trends in groundwater reflecting the cumulative variation in rainfall over time (Butterworth *et al*., 1999). The main cause of water point failure in the region is natural recession associated with extended dry periods, with human impact through present groundwater abstraction being trivial compared to the natural discharge of groundwater (Table 1). Human impact through changes in land use in the catchment is of secondary importance (Butterworth *et al*., 1999).

Subsequent hydrological modelling results show the effects of catchment management on groundwater resources within a typical semi-arid micro-catchments setting (Table 2). The results confirm that large annual variations in groundwater level reflect values of recession that follow high values of recharge. This recession is principally due to evapotranspiration from the aquifer rather than deep percolation or lateral flow. Our findings show that the magnitude of the groundwater resources under present landuse varies by a factor of 8, from as low as 44 ML in storage at the end of a dry cycle to a high of 350 ML in storage during wetter cycles (Annex E). Runoff control as a management option produces little net gain in ground water as measured at the end of each dry season – if there are any trees or deep-rooted vegetation on the aquifer these consume most of the groundwater. They consume even more when groundwater recharge is increased through runoff control. This is because water availability, not evaporative demand, sets the limit to the amount of water used by the vegetation.

Table 1. The water balance of Romwe catchment[1] under present management, calculated for three successive years at the return to a wetter period (hydrological year 1 July to 30 June) (Annex D)

	Runoff (mm)	Recharge (mm)	Change in ground water storage (mm)	Ground water recession (mm)	Human abstraction (mm)	Balance (actual evaporation + change in soil moisture + other losses) (mm)
1994/95 Rainfall = 738 mm						
Red clay soil	9	51	-19	70	1	677
Grey duplex soil	48	0	-19	19	0	690
Woodland hills	0	na[2]	na	na	0	738
Total catchment	4	38	-34	72	1	695
1995/96 Rainfall = 990 mm						
Red clay soil	46	308	+58	250	1	635
Grey duplex soil	203	138	+46	92	0	649
Woodland hills	81	na	na	na	0	873
Total catchment	93	262	+100	162	1	634
1996/97 Rainfall = 937 mm						
Red clay soil	64	281	+50	231	1	591
Grey duplex soil	335	50	+24	26	0	552
Woodland hills	98	na	na	na	0	839
Total catchment	84	296	+62	234	1	556

[1] The catchment comprises 84 ha red clay, 85 ha grey duplex, and 255 ha miombo woodland on hills. Maximum values of recharge are shown, calculated as rainfall minus Penman potential evaporation and run-off measured during the annual periods of ground water rise, and assuming no lateral flow or contribution to soil moisture storage. Average values of S_y of 0.034, 0.022 and 0.045 for pyroxene and leucocratic gneisses (red clay and grey duplex) and whole catchment, respectively were inferred from these maximum values of recharge and corresponding ground water rise measured across a network of piezometers. Change in ground water storage is annual change in ground water level multiplied by specific yield. Recession is the difference between recharge and change in ground water storage. Human use at 2.8 Ml is equivalent to only 0.6 mm across the catchment (Sullivan *et al*., 2001; Annex I).

[2] na = not available (because of the elevation and geological structure of the hills, their groundwater store is likely to be minimal)

Table 2. Cumulative volumes of water (Ml) over 25 years under three management scenarios

Romwe-type catchment 1973-1998	Recharge	Aquifer storage	Evapo-transpiration	Saturation-excess runoff
Present land use: trees, dryland crops and grass, no runoff control	2311	-122	2131	302
Trees, dryland crops and grass, enhanced recharge through runoff control	3238	-112	3135	215
No trees on aquifer, only dryland crops and grass, no runoff control	2861	11	2539	311

When the removal of the remaining woody vegetation from the aquifer is modelled as a management option, groundwater levels in the entire aquifer system are raised by about 80 mm yr^{-1} in drier periods and 400 mm yr^{-1} in wetter periods compared to the present land cover with scattered trees. Evapotranspiration from the aquifer remains important in both scenarios, however, as the increased groundwater water levels under the no-vegetation scenario are offset through increased evapotranspiration by shallow-rooted crops and grassy vegetation and through seepage. Excess runoff from the aquifer only occurs when it is saturated. It is relatively low and largely unaffected by management, mainly because of the overriding importance of evapotranspiration under all scenarios.

In modelling catchment management in relation to the intensity of groundwater development, Lovell *et al*. (2001a; Annex E) found that catchment management is most beneficial under high

levels of water development (and abstraction). This applied to both wet and dry years, but more so for the latter. In both scenarios, water use was below the potential maximum abstraction rate of 150 ML yr^{-1}. When this high abstraction rate is achieved some wells may mail fail even if there is abundant water catchment-wide due to high rainfall. Such failures signify localised drawdown of the water table around wells that are poorly sited, for example in areas of poor permeability, sections of basement rock devoid of water-holding barriers or without natural groundwater dams. Model results also show that the negative effects of localised aquifer drawdown outweigh the positive effects of improved catchment management, and that the efficacy of catchment management in the face of localised aquifer drawdown is even less in drought years. High recharge may sustain high abstraction from wells and evapotranspiration by plants, but the benefits are short-lived if there is little carry-over from year to year, especially if there are high levels of groundwater development. The level of groundwater development only decreases the saturation-excess runoff in the scenario where there are no trees on the aquifer. Nevertheless, the reduction in runoff is slight compared to that which is potentially lost from the catchment through evapotranspiration (Table 3).

Table 3. The effects of management and ground water development on the aquifer water balance (Ml $year^{-1}$)

		No development				**Low development**				**High development**			
Recharge		Storage	Et	Wells	Runoff	Storage	Et	Wells	Runoff	Storage	Et	Wells	Runoff
Present land use													
1981	131	13	117	0	1	6	115	10	0	-17	94	54	0
1982	74	-13	86	0	1	-15	79	10	0	-6	56	23	1
1983	7	-25	32	0	0	-22	25	4	0	-12	19	0.04	0
1984	39	1	38	0	0	1	33	5	0	0	30	9	0
1985	215	53	158	0	4	52	150	10	3	25	123	62	5
1986	17	-42	57	0	2	-44	50	10	1	-17	32	0.12	2
Total	483	-13	488	0	8	-22	452	49	4	-27	354	148	8
Enhanced recharge through runoff control													
1981	185	18	164	0	3	11	162	10	2	-26	135	75	1
1982	104	-18	119	0	3	-20	112	10	2	-7	75	33	3
1983	11	-34	45	0	0	-34	38	7	0	-15	25	0	1
1984	56	3	53	0	0	3	46	7	0	2	40	14	0
1985	300	70	215	0	15	70	207	10	13	28	172	87	13
1986	24	-58	80	0	2	-58	71	10	1	-22	40	3	3
Total	680	-19	676	0	23	-28	636	54	18	-40	487	212	21
No trees on aquifer													
1981	163	14	136	0	13	7	133	10	13	-52	95	109	11
1982	91	-14	99	0	6	-16	93	10	4	-21	33	76	3
1983	9	-37	46	0	0	-37	36	10	0	-37	7	36	3
1984	48	0	48	0	0	0	38	10	0	-7	9	46	0
1985	267	61	175	0	31	62	168	10	27	65	87	104	11
1986	20	-46	66	0	0	-47	57	10	0	-37	13	43	1
Total	598	-22	570	0	50	-31	525	60	44	-89	244	414	29

The results of surface-water modelling show that open-water evaporation from a reservoir completely overshadows the decreases in inflow to it due to reducing runoff by improved in-field water harvesting, and so is the driving force determining water levels in the dam. Open-water evaporation is therefore a major non-productive loss (see Annex F). Since the study catchments are small headwater micro-catchments, damming water in catchment reservoirs does not have much downstream effect because the volume of runoff captured by such reservoirs constitutes a relatively small proportion (31%) of total runoff. In assessing the trade-off between management of groundwater and surface water the model results show a potentially significant trade-off. Harvesting all runoff to enhance groundwater recharge increases drainage (potential recharge), as

well as baseflow and evapotranspiration, but significantly reduces runoff (Table 4). The net effect is to cause the dam to dry up on the average 3 times in 25 years, and to remain less than a third full most of the time (Lovell *et al*., 2001a; Annex E).

Lovell *et al*. (2001a; Annex E) used two separate models, ACRU for surface water and MODFLOW for groundwater. The modelling framework has limitations – ideally the surface water and groundwater models should be integrated in the manner described by Sophocles and Perkins (2000). For use in semi-arid crystalline basement areas, *MODFLOW* ideally requires revision to better cope with high evaporative demand (frequent drying of cells), relatively thin aquifers in steep topography, and induced recharge following aquifer depletion. ACRU ideally requires revision to better indicate evaporative losses and to distinguish between saturation-excess runoff from the aquifer area and infiltration-excess runoff from the catchment as a whole. Despite these limitations, however, the simplified conceptual models used in this paper have still provided valuable insights in the way a complex system works and the implications of management over space and time, especially the role of evapotranspiration, the mechanisms of well failure, the brevity of management benefits, and the limited downstream effects of this management. The study confirms the need for integrated watershed modelling in development programs to highlight misconceptions associated with the usual catchment management practices.

Table 4. The effect of harvesting all runoff to enhance groundwater

Av. over 25 years	Evapotranspiration (mm)	Drainage (mm)	Dam storage (per cent full)	Runoff (mm)	Baseflow (mm)
No re-infiltration	507	70	37	21.0	0.7
Full re-infiltration	523	92	11	5.4	4.8

4.3 Livelihood outputs

Livelihood analyses were done within the sustainable livelihoods framework. The uniqueness of the survey has been noted in Section 5. Most of the households within the catchment are severely constrained in terms of their capital assets (Campbell *et al*., 2002). In terms of gross income profiles, most households within the study sites rely on income (cash and subsistence) from a variety of sources, including dryland crop production (100% of the households), gardening (84%), livestock production (78%), woodland activities (100%), wage or home industries (82%) and remittances (91%) (Campbell *et al*., 2002). Households differ with regards to the amount of income that these activities bring in, however. Different household livelihood strategies therefore comprise various combinations of the same basic set of activities. One key factor driving differentiation is whether a household has access to remittance income, as this is re-invested in farming activities (especially livestock and crops) and education, two variables which can further change household status (Campbell *et al*., 2002)

There is pervasive poverty in the study areas – 70% of the households fell under the food poverty line, while 90% fell below the consumption poverty line[1]; 87% of households fell below the December 1999 national poverty datum line; and only 3% of the households had an income greater than US$1 per person per day. *De facto* female-headed households are shown to be better off than *de jure* female-headed households or male-headed households, indicating the importance of remittances to uplift a household, as *de facto* female-headed households have high remittances, also resulting in high cattle numbers. Seventy four percent of male-headed households are under the food poverty line, while only 56% of the *de facto* female-headed households are in this state (Campbell *et al*., 2002).

[1] The ICES 1995/96 food poverty line represents the income required to meet basic nutritional needs, while the ICES 1995/96 consumption poverty line allows for basic food consumption and some allowance for housing, clothing, education, health and transport (Cavendish, 1999).

What determines whether households are out of poverty is largely their ability to access large remittances and dryland crop cash incomes. We identified 10 types of households according to their different strategies, only two of which have almost no households below the food poverty line. These only comprised 8% of households in the sample. They are characterised by high remittances and high crop sales. Numbers of cattle, size of dryland fields and educational status are also negatively correlated with high poverty. Access to assets is thus important in determining poverty levels. This is probably a self-reinforcing cycle in which access to assets allows households to improve income, and to invest in further assets. In contrast, lack of access to assets is unfavourable to achieving high income, which further prevents asset accumulation. These latter kinds of households are in a poverty trap from which it is difficult to escape (Campbell *et al*., 2002). Most case studies of successful households indicated that access to non-farm income was crucial, and success generally meant migration of one or family members at one time or other.

Considering that income from livestock is largely based on unimproved grazing, the common pool resources of woodlands and grazing areas provide 30-40% of income for all wealth quartiles, with this income being predominantly grazing in the top quartiles and predominantly forest products in the lowest quartile. Water is also largely a common pool resource[2] in such areas – it is essential for garden production, which contributes nearly 10% of the total income in all the quartiles. Thus common pool resources form the basis for between a third and a half of all the income.

Largely on the basis of key informant interviews, the following key drivers of livelihood change were identified: (a) rainfall, (b) macro-economic changes, (c) changing institutional arrangements and social processes, and (d) demographic processes and HIV/AIDS. In spite of the pressures, households have a rich and varied livelihood portfolio, with displays of infinite resourcefulness to make ends meet. It is not uncommon for households to have its members variously involved in raising livestock, growing a diversity of crops, collecting forest products for subsistence or sale, off-farm employment and remitting money back home, small scale industries (e.g. craft production or beer brewing), etc.

A Bayesian Network (BN) model was used to investigate the best ways of improving cash income of poor people (Annex G). The model also used the concept of 'vulnerability', which was considered as a composite of cash income level and the resilience of that income. Results from the model show that: macro-economic and rainfall effects on local livelihoods outweigh the effects that can be achieved through local development initiatives; market development is critical to improved cash income; capacity building of organisations can be as important, if not more so, than any focus on a particular production system; and an integrated approach covering several production activities, is required to make a sizeable impact on cash income (Cain *et al*., 2001; Annex G).

We also modelled crop income (subsistence and cash) and showed that, in dry years, an intervention involving doubling the garden area could provide a major boost to average crop income but would not compensate for the loss of income from dryland crops during drought years. Through action research in Romwe one of the irrigated gardens was increased in size, doubling the number of beneficiaries. This enhanced the safety net but, to date, has not made a fundamental difference to the poverty status of the community. A similar initiative in Mutangi saw a new garden being developed – which doubled the garden area – and gravity-fed water being provided. The new options need to be complemented by further action research on adaptive management to match the new levels of water use to the spatial and temporal variations in availability of the surface and ground water resources (Lovell *et al*., 2001a; Annex E). Increased production alone is not enough, however, if the target includes boosting household cash income. There is need for research aimed at enhancing marketing opportunities, improving post-harvest storage or processing the produce.

[2] There are some private wells that are used to irrigate gardens but most of these are accessed by more than one household, through kin-based and neighbour-based networks (Figure 3).

5 Research Activities

Multidisciplinary research activities were conducted over a three-year period within the framework of a comparative analysis of two semiarid case-study sites, Romwe and Mutangi, in Chivi District (Mugabe *et al*., 2001). A multi-stakeholder inception workshop, held prior to commissioning the project, decided to restrict the studies to two sites so as to allow for more focused analyses that would enhance project rigor and depth. The workshop emphasised that the two-site strategy be adequately augmented by other approaches including trend analyses, scaling-up reviews and modelling, to enhance the policy relevance and potential for dissemination of the findings (Mandondo, 1998). In the Romwe micro-catchment, project activities were an extension of a project (R5846) on groundwater development in crystalline basement areas (Bromley *et al*., 1999). A scoping exercise, involving the screening of 10 micro-catchments in Chivi and Mwenezi Districts, was undertaken to identify the additional catchment (Mapfumo, 1999). Catchment selection was done by a multi-stakeholder group including development NGOs active in the districts (CARE, Intermediate Technology Development Group), the Department of Research and Specialist Services, Agritex, RDC officials, local communities, and project researchers. Mutangi was selected as the second catchment on the basis of its contrasting social and biophysical characteristics to those observed at Romwe (Mapfumo, 1999).

One project output envisaged identifying and quantifying key biophysical linkages amongst components of the micro-catchment in relation to hydrological behaviour, and making the results accessible to CPR management. Prior to the current project, the physical state of the Romwe catchment had been recorded in baseline surveys of geology, vegetation, soil, land use, water sources, population, and agricultural practices (Bromley *et al*., 1999). Similar surveys also preceded the installation of hydrometric equipment in Mutangi e.g. for geology and soils (Gotosa *et al*., 1999), for landuse patterns (Hodnett 2000), and for vegetation (Mapaure 1999, Kwesha and Mapaure, 2000).

A hydrological monitoring programme was commissioned in each of the catchments through the installation of hydrometric equipment to record various aspects of the hydrological cycle, including partitioning of rainfall into surface runoff, interflow, evaporation from soil and vegetation, baseflow to streams and rivers, groundwater recharge and human abstraction. Given the spatial variability in geology, weathering, soils, topography, vegetation, land use and management, different approaches were taken to investigate potentially important hydrological processes. Measurements were made at four scales in both catchments: catchment, sub-catchment, transect and point. Three sub-catchments were studied in Romwe: red soil area 0.025 km^2, grey duplex soil area 0.011 km^2, and miombo woodland area 0.5 km^2. In Mutangi, four sub-catchments associated with tributaries of the Mutorahuku River, which feeds into the dam were instrumented. Given the importance of surface water in Mutangi both the dam and tributaries of its feeder stream were gauged. The hydrological monitoring programme also extended to include the groundwater component. Other considerations in the design of the instrumentation programme in Mutangi were variations in catenary position (upper ridge, lower slope and valley floor), and in landuse - arable, fallow, and mopane woodland (Hodnett, 1999). Limitations of instrumentation and design, especially with regards to capturing spatial and temporal variation, were offset somewhat by using a variety of approaches – modelling spatial and temporal dimensions, scaling-up studies, and the collection of historical data, wherever it was available in surrounding areas (Lovell *et al*., 2001a; Annex E).

Another project output included critically appraising existing institutional arrangements to manage CPRs so as to identify possible approaches to strengthening local people's capacity in this regard. Institutional analyses were done mainly at the local level, but were extended to consider how local arrangements fitted into the broader district-to-national governance framework. PRA techniques were used mostly to understand the governance setting at the local level including: the distribution of both settlements and resources within the catchments; the range of users and uses of various resources; characterisation of users according to their socio-economic status; local rules and their

enforcement structures and procedures; leaders and their various roles, and the relationships among them; units of social organisations, and how resource users across these relate to each other; people's priorities and expectations with regards to natural resource governance; perceptions of trends, etc (Nemarundwe, 2001: Nemarundwe and Kozanayi, 2002).

Most group activities were stratified by gender, age and socio-economic status since these represent axes along which social difference among local communities is most commonly reported (cf. Berry 1989; Fortmann and Nabane, 1992). Less obtrusive approaches, including participant observation and partial participant observation, were used for more sensitive analyses, especially those aimed at understanding local conflicts and the related micro-politics. One researcher resided at Romwe for over a year, whilst two more resided with the communities in Mutangi and Romwe for over 2 years. In that time there was complete integration of researchers in all aspects of social life (they were allocated fields to work, attended all community activities, were involved in all manner of reciprocal relations).

Property rights surveys were also used at the local level to explore and characterise the diversity of rules that make up the property rights systems associated with different resources and land classes in both micro-catchments. The tenure surveys were intended to provide a finer analysis of the concept of property rights than the conventional notion of a bundle of rights broadly related to state, private or common property (Berkes and Farvar, 1989, Ostrom, 1990). Our researchers adapted a method used by Luckert (unpublished) that describes property-rights systems according to various characteristics, identified from property-rights literature, that are hypothesised to have systematic effects on resource management. These characteristics include: comprehensiveness; exclusiveness; use designation; duration; allotment type; size; transferability; fees; operational requirements; operational control; and security. Using the above structure, a standardised interview was designed and administered to key informants in the study areas. Because the researchers were seeking to describe village-level rules, village-level officials, such as village headman and councillors, were interviewed. Five officials were interviewed in Romwe and six in Mutangi. Land classes across which the above characteristics were investigated included household plots, community woodlands, riverine areas and sacred areas. The analysis of these characteristics of property rights also extended to different types of products including exotic and indigenous fruit trees, other indigenous plant resources, animals and water. The tenure survey was based on key informant interviews in both the catchments.

A review was undertaken of how the local institutional setting was placed within the broader district-to-national governance framework (Mandondo 2000, 2001). The review investigated the assignment of authority and responsibility among actors at various levels including the state, district and the grassroots levels. This work also involved attending district-level meetings.

Baseline institutional analyses, together with scoping studies that assessed people's priorities and expectations, were key in identifying entry points for strengthening community capacity to manage common property resources. The project used a wide repertoire of participatory action research (PAR) tools to transact changes in institutional arrangements and to enhance community capacity to manage common pool and other resources. PAR techniques used included leadership training, exchange visits both within and outside the catchments, social learning approaches focused on tree planting in the woodlands, visioning and scenario building approaches to transact changes in district-local governance arrangements, and a micro-credit scheme using on funds kindly provided by the Irish charity War on Want. PAR approaches were also used to facilitate the process of expanding the community garden around the collector well in Romwe. Most of these techniques were used in a complementary fashion i.e., exchange visits and leadership training helped build the confidence and self-esteem that proved essential in dialoguing with district level officials during the 'scenarios' meeting.

Scenario building is a methodology that involves participants building visions of the future as a first step towards redefining current development pathways. Visioning is widely used in the

corporate sector (Becker 1983), but it has also been developed as part of participatory research and development in rural contexts (Wollenberg *et al*. 2000). In our case, visions were developed around governance systems, particularly the nexus between the district and local levels. Scenario-building exercises were thus used as a tool for facilitating the crafting of a common vision for natural resource governance between district authorities and local communities. This involved having communities first articulate their own visions, after which there was a joint meeting at the district level aimed at crafting a joint vision between the communities and district level officials (Campbell *et al*., 2000).

The last project output involved identifying and promoting options for markedly improving livelihoods in the micro-catchments. Baseline studies included the use of a household questionnaire to collect data to support livelihood analyses. There are few detailed household livelihood analyses in dryland Africa so the research team followed the methodology developed by Cavendish (1999; 2002) in neighbouring Shindi Ward, with some modifications that we believe are improvements. Cavendish (1999) notes that such survey instruments lead to unique empirical results; very few of the resource-use patterns recorded would be captured in standard household budget surveys (e.g., collection of wild fruits, collection of poles). Standard surveys consistently underestimate woodland-based income; hence overestimating agriculturally based income. The survey was conducted as a quarterly household income and expenditure survey, over 15 months from late 1998 to early 2000. A stratified random sample was taken with households selected from each of the villages in the social catchment in proportion to the total household number in the village. The Romwe area contained 416 households in 10 villages, whilst the Mutangi area contained 453 households in 18 villages. The final sample size was 199 households.

The focus of the survey was in tracking how households use their available resources in pursuit of livelihoods, and the returns that they receive from these activities. The survey paid particular attention to the need to ask questions that did not require long-term detailed memory and so could be answered reasonably accurately. By visiting each household once a quarter, sufficient observations could be obtained on information that was only likely to be recalled over a short time span. The resulting data were therefore initially highly disaggregated; they were only aggregated later after analysis. Because households have to cope with substantial seasonal variability, the first level of aggregation of the data was by quarter.

The collection of livelihood data through the questionnaire was augmented by numerous key informant interviews and case studies of different kinds of households. In addition assessments were made of people's livelihood options, needs and priorities (Kozanayi and Mandondo 2000, Mabhachi and Kozanayi 2000). Various options were then screened in terms of their potential for improving livelihoods by using a variety of approaches, including multi-criteria analysis, cost-benefit analysis and Bayesian network (BN) (Cain *et al*., 2001).

The Bayesian network (BN) was one of the tools used to achieve integration of the various components of the project. We developed an "integrated" model to aid in conceptualising and investigating the interactions between the linked biophysical and human components of the system (Cain *et al.*, 2001a). The model was designed to investigate likely impacts of development options on livelihoods.

Biophysical surveys also provided several subsidiary data layers including vegetation types, cropping patterns, geology, household locations and water sources as well as the usual physiographic features. All these were incorporated into a GIS. This enabled researchers to overlay income and other household characteristics on the biophysical data sets.

6 Contribution of outputs

6.1 Output 1

Existing institutional arrangements to manage common-property resources (CPRs) critically appraised, and innovative approaches to strengthening the capacity to manage CPRs investigated and promoted.

The project was not only about generating knowledge and techniques, but also about seeking to transact and sustain positive change on the basis of the new ideas and skills. The more immediate contribution of the institutional baseline surveys and related analyses was, therefore, an improved understanding of the institutional setting of common pool resources in the two study communities, and in particular the complexity of rights of access and management. Such rights are largely based on an informal system of norms, mores and taboos that mostly lie outside the sphere of official rule systems. These define a complex maze of property rights that vary across categories of resources and land units, and shape equally complex kin-based webs of access that extend beyond source villages. Related constrains include boundary mismatches between resource units, user groups, social groups and administrative units; rent capture by the elite; and numerous cases of failure of local organizations.

The OVIs for this output were that at least two approaches to community based management would be developed by the end of the project. This required that researchers give considerable emphasis to process facilitation. The first approach that we adopted was to assist the local communities to negotiate with the Chivi RDC the right to formulate, harmonise and enforce rules, and to impose, collect and use fines, whilst the RDC accepted responsibility for coordinating, endorsing and monitoring the exercise of these powers (Campbell *et al*., 2000). A needs assessment had identified the issue of harmonising district-level and local rules as one of the communities' priorities in the area of the environment. To do this required helping the community and RDC to develop a common vision of natural resource governance, first through meetings in the catchments in which communities developed their own vision of governance, and later through a joint meeting with district level officials to develop the common vision. After a day-long dialogue, the participants emerged with a vision of governance that was hailed by the various actors as being more democratic. The participants[3] included RDC executives, councillors, the district administration, Agritex and forestry officials, CARE (our NGO development partner in the catchments), researchers and community representatives including headmen and village heads.

Because of the limited timeframe, project facilitators had to disengage from the process before the vision was implemented, but the Chivi RDC remained keen on implementing the vision, at first through pilot sites, and then scaling up. A first step in this direction has involved doing away with council-paid enforcers of official natural resource by-laws in favour of local enforcement mechanisms that include traditional leaders. This novel approach enhances social capital and gives voice to the poor in the management of their natural resources, but it is likely to be constrained by high transaction costs associated with organizing for collective action.

The alternative option was more broad-based and aimed at enhancing human capital especially leadership skills, accountability, adaptiveness and general widening of the knowledge base. A wide range of techniques were used for capacity enhancement including leadership training (Chikuvire and Chuma, 1999), training for transformation (Gumbo and Hwindizi, 2000), exchange visits, feed-back workshops and demonstration and extension oriented field days. Much of the work of the locally-based research assistants comprised facilitating various social processes, including processes surrounding micro-credit, expanding gardens and improving dryland production. Much

[3] Although they did not directly participate, experts in the Rural District Council Capacity Building Programme (RDCCBP), particularly Mike Holdgate and Mr Felix Gwenzi, gave advice on power plays within RDCs and actors involved.

of the latter targeted soil and water conservation, which was identified, through needs assessments, as areas that people tend to prioritise.

Both approaches served to give local people a greater say in the running of their affairs, and to demand greater transparency and accountability on the part of those who represent them. Given that 'voicelessness' is often cited by the poor themselves as an indicator of poverty (World Bank, 2001), the approaches promoted in this project should have a positive impact on at least this one dimension of the problem.

Systems modelling with the BN model was used to assess whether "functioning" institutions, considered together with a range of other internal and external variables, would have a thoroughgoing impact on poverty, for instance through increased cash income and its resilience to externally induced shocks. The model indicated that household vulnerability was highly sensitive to changes in the macro-economy and to the rainfall regime, with the degree to which institutions are functioning or not functioning only playing a secondary role. For instance, a "good" macro-economy can increase cash income, relative to a "bad" macro-economy, by 40% or more. In comparison, moving from a system with non-functioning institutions to one with functioning institutions only increases cash income by up to 8%, suggesting that improving institutions on its own is unlikely to have significant and thoroughgoing impacts on poverty (Frost *et al*, 2002; Annex A). Nonetheless, institutional interventions generally had even higher impacts on cash income that technologies within single sectors (e.g. improving crop production only raised cash income by 3%).

6.2 Output 2

Key biophysical linkages amongst components of the micro-catchments identified, quantified, and made accessible for CPR management, and options for more efficient and extensive use of water resources identified and promoted in these micro-catchments.

The OVIs for this output were that an integrated soil, vegetation and hydrological monitoring programme would be in place and functioning at Romwe by end of Year 1 (an extension of past 5 years of activity), and in the new micro-catchment by the end of Year 2. Furthermore, at least two options for more efficient and extensive use of water resources would be promoted by end of Year 3 with the involvement of key stakeholders. If viable options were not identified, the project findings would be communicated to all major stakeholders.

An integrated monitoring programme was set up in both micro-catchments as planned. Members of the two communities took part in recording information and assessing its implications. Discussions with farmers in the two communities indicated that their own monitoring of resources was usually confined to periods when the resource concerned was becoming scarce, and that observations were seldom written down. For those variables requiring instrumentation and infrastructure as part of a monitoring programme, there is almost no prospect of on-going community involvement unless supported from outside.

The main findings from the biophysical component of Output 2 were that: evapotranspiration, and not human abstraction, accounted for much of the loss of ground or surface water within the catchments; various forms of management in the upper catchments did not have significant effects on downstream catchments; localised drawdown during dry cycles could lead to well failure; and for surface water a balance was needed between runoff control in fields in relation to water availability in the dam. The findings justified expanding the use of water to compete with various natural water losses (evaporation from surface water; evapotranspiration from groundwater), while cautioning on need for adaptiveness in matching abstraction rates to temporal fluctuations and spatial variation (e.g. local conditions at well sites). Related cost-benefit analyses for the mainly groundwater Romwe catchment suggested that the best way to implement the opportunistic strategy would be to develop and upgrade wells at prime groundwater locations into community wells to cushion people during times of stress, but augmenting these with ephemeral private wells that make greater use of water when it is available. In the mainly surface water Mutangi catchment the optimum strategy

would be to upgrade the underused dam, maintaining the outflow statistics but competing more vigorously with evaporation loss.

Accordingly, the two options for more efficient and extensive use of water resources that we chose to promote were the expansion of the irrigated gardens at Romwe and Mutangi, and encouragement of better soil and water conservation in people's fields. Both options had been identified by members of the communities as among those that they wanted to explore and both were carried out in conjunction with community members. Promotion of these options was facilitated with the assistance of AGRITEX in Romwe, and CARE in Mutangi.

Expanding the community gardens allowed new members to access the opportunity of benefiting from additional and more diversified agricultural production. At Romwe, the garden was doubled from 4214 m^2, which before expansion catered for 50 members, 36 of whom were women including 12 widows, with each member owning seven plots measuring 6 m^2 each. Expansion of the garden allowed for an additional 50 members including 4 widows, 16 young and newly married people, 3 women from polygamous families. Doubling of the garden therefore increased the number of direct and indirect beneficiaries from 400 to 900. Expanding the garden in Mutangi entailed relocating the garden downstream of the dam, so as to allow for gravity-fed irrigation, and increasing its size. Both are likely to increase abstraction rates. There is a need for information on how users can adjust their rate of abstraction in relation to the amount of the water in the dam, particularly during dry cycles or in the case where improved runoff control in fields upstream of the dam leads to less inflow.

Although expanding the gardens resulted in greater access by under-privileged families to the benefits of improved water developments at the local level, the impact of expanding the gardens on poverty reduction as a whole is projected to be small, because of higher-level constraints such as lack of markets, labour constraints and institutional failures (Campbell *et al*. 2002; Annexes A and H). Research and development on labour-saving devices or technologies is worth pursuing, but, once again, by itself will only make a small impact on poverty status. The development of gravity-fed irrigation at Mutangi addressed one of the identified labour constraints – hand-watering of crops using buckets – and so provides additional benefit, but increasing incomes from gardens alone is not sufficient to enable people to break out of poverty. Even if markets could be secured for additional crops produced by a substantial increase in the area of irrigated gardens (by the technically feasible 7-8 times the current size), it would only reduce the proportion of households below the food poverty line from 71% to 62% (Annex A). Nevertheless, in expanding people's food supply, especially during times of drought, this intervention helps to strengthen their safety net and lessen their vulnerability to intermittent failures in dryland crop production. We estimated income profiles for Romwe in a dry year and explored the impacts of doubling garden area. If the garden area is doubled, this would provide a major boost to average crop income (dryland and garden, for both subsistence and cash) in dry years, causing an increase of nearly 60% over what would have been achieved without the extra gardens. The increase (about Z$2000) would unfortunately not compensate fully for the losses in dryland production caused by the dry year (about Z$4000).

The second option for more efficient and extensive use of water resources that was identified and promoted in the two micro-catchments was encouraging the uptake of measures to enhance soil and water conservation in fields. This was done primarily through demonstrations and visits to neighbouring communities where improved soil and water conservation measures, many of them designed by the farmers themselves, were being implemented. This initiative was closely integrated with broader discussions on the need to adopt an adaptive water resource management strategy, as the aim of this intervention was to increase the amount of water available for crops (and reduce soil and nutrient loss), as well as to enhance the prospects for recharge of groundwater.

The need for an adaptive water resource management strategy was partly addressed by holding courses on hydrology with the communities at the catchment level. It is highly unlikely though that such a strategy, on its own, will have immediate impact – there is need for sustained as well as

multi-scale promotion of its elements. The dissemination of hydrological information on how water can be better used has been extended to other levels, including a policy brief in which water management issues are placed within a broader context (Lovell *et al*., 2001b), and a poster on water livelihood linkages (Hodnett *et al*., 2001). There is further need for such information to feed into new structures created as a result of recent reforms in the water sector, particularly the catchment and sub-catchment councils, and the Water Resource Management Strategy (WRMS). The project involved WRMS representatives in most of its consultative meetings and scientific report backs, and thus enhanced scope for impact at that level.

6.3 Output 3

Options for markedly improving livelihoods in the target micro-catchments identified and promoted.

The OVIs for this output included robust screening of options for improving livelihood with a view developing and implementing an intervention plan, or if options do not work to communicate the results to major stakeholders. Most capital assets are severely constrained, and livelihoods are variously based on mixtures of dryland cropping, irrigated gardening, woodland based activities, local wage labour and remittances. The options screened were therefore representative of the above major livelihood sectors. Foregoing sections have already outlined the potential impact of expanded irrigation and of soil and water conservation on dryland productivity, these being options that were both screened and promoted.

Another option that was promoted included a micro-credit scheme that the project inherited from a preceding project in the Romwe catchment. The first phase of the scheme faced several constraints including lack of regular and scheduled meetings and elections, poor accounting systems and financial records, domination by members of elite lineages, inequities in the distribution of the loans in which political and economic elites gained at expense of the less privileged, as well as low repayment profiles (Mutamba *et al*., 2000). Researchers sourced more credit funds and facilitated the formation of a new and more representative loan committee. In spite of this, some members from the old committee, particularly those from influential lineages still found their way into the committees, and the disbursement of funds still remained largely inequitable, with influential village heads generally getting much more than ordinary people, particularly young families (Mutamba *et al*., 2000). But in general more people from less privileged groups were able to access the loans than before. The overall impact of the scheme on poverty is constrained by the limited nature and distribution of the funds and the high and uninsured risk resulting from high climate variability, which sees many people unable to service their loans (Mutamba *et al*. 2000). We conclude that there will be an inevitable collapse of the scheme as funds dry up because of bad debts. Remittances and micro-credit serve similar purposes, but micro-credit in these risky environments does not have much potential.

From needs assessments, options for improving livestock were not met with as much enthusiasm as dryland agriculture or irrigated gardens. Cattle are, moreover, largely owned by wealthier households, so any intervention to improve cattle production would have less impact on poorer households (20% of the households own 61% of the overall cattle herd). Drylands remain a cornerstone of livelihoods. In relation to inorganic fertilisers, research is needed on how best to apply fertiliser opportunistically as the season develops. As farmers continuously assess the likelihood of a good harvest, and adjust their fertiliser applications accordingly, there is also a need to investigate the possibility of local markets for small quantities of fertilisers that can be purchased at short notice. Breeding for more appropriate crop varieties may be appropriate, but we do wonder the extent to which further major gains can be made. Zimbabwe is relatively well-endowed with crop improvement programmes and most farmers are already purchasing improved seed. The problems for the breeder are illustrated by the three years of study, which were marked by normal rainfall, followed by waterlogging, followed by poor distribution of rainfall. Targeting woodland resources as a basis for income-earning opportunities is constrained by the limited stock of woody biomass (Frost *et al*. 2002; Annex A). Although woodland activities are most important among the

poorest of the poor they only provide 30% of total income. While the woodlands provide security during droughts and disasters they are unlikely to lift significant numbers out of poverty, with their impact likely to be more than just a safety net among few individuals e.g. master carvers. A range of options was screened, with some actually being promoted but no clear-cut intervention plan can be recommended.

The limited success achieved with many of the options we tested and promoted on this project indicate that, by themselves, single interventions are likely to have limited impact in reducing poverty. A more integrated, sustained and multi-level set of interventions and support is required. We also suggest that it has to be recognised that large-scale poverty alleviation in these semi-arid areas is a near impossible task. While the livelihood analysis shows that households are incredibly adaptive in coping with their situations, in the absence of better markets for products, there is little they are able to do to escape poverty. The Chivi site is not that far from markets and good roads, illustrating that in even more remote locations the situation will be more difficult. The few cases where households escape poverty are usually based on success in raising income from off-farm sources, often involving migration. Many of those having escaped poverty will have productive farming operations, often based on cash crops, especially cotton, but this is invariably subsidised and supplemented by off-farm income. Many of the successful households will have assistance from family members who migrated to better opportunities.

We conclude that a primary objective in development will be to empower local people. As approaches to empower people and the development of social capital are so critical, short project timelines are hardly sufficient to make any impact. Transitional arrangements, e.g., to ensure market access, may need to be made over some considerable time period. Without some significant external influences, we will not be able to improve much upon the local situation. Local people already know how to do better than we can ever hope to do. Technical research should continue to try and identify improved technologies but these should be based on detailed understanding of current livelihoods and constraints, and set within the framework of empowering approaches where farmers are offered choices of technology, access to them, information, experience, and enabling economic and institutional environments.

6.4 Dissemination and uptake

Cutting across all the outputs is the issue disseminating information, knowledge and experience arising from our studies and the interventions they produced. A variety of promotion and dissemination pathways targeted at various levels were pursued. Two journal articles on the institutional dimensions of the project have been published, with one receiving critical acclaim from well-known scholars including Bill Hyde, Daniel Bromley, Roy Behnke and Robert Fisher. The other one was recommended by NRSP for submission to the British Secretary of State as a good example of DFID-funded work on the programme. One other journal paper awaits publication while 9 other drafts have been submitted or will be submitted shortly. Five articles on various aspects of the project have also been done and published through institutional report series distributed to various government departments, local DFID NR advisers, and the RDC and DA, with whom the project has data sharing agreements. Excerpts of two articles produced on the project featured in wide-circulation newsletters including CIFOR News and ETFN.

The project produced two promotional brochures on CPR management, three of which outlined CPR options, one of them being translated to Shona and distributed and used at community meetings. Three posters were also done on the project on various aspects of water and catchment management and these have been distributed to district departments of government, the RDC, CARE and to local schools. Prior to distribution, the salient aspects of the content of all the above materials had been presented in symposia, conferences and workshops. Project researchers also participated in the production of manuals and guidelines, including one on catchment management done in conjunction with CARE, two CIFOR brochures on micro-politics and scenarios on governance, and another brochure on participatory methods done by CIAT, with input from the project.

Multimedia promotional activities were used including demonstration and extension activities and interviews that were covered on radio and television. Two of the papers have been web sited through an electronic journal (ASQ) and electronic newsletters including POLEX and the WRM newsletter. A project CD that can be used on any computer without need for advanced software has been set up. It contains over 200 documents together with databases, working models, and all livelihood and GIS data. This has been distributed to key stakeholders. Many of the outputs can be accessed through the project website.

Project researchers have gained considerable experience on leadership issues in common property management initiatives. Such experience represents an invaluable resource that went into the development, in conjunction with CARE, of a handbook on catchment management in which leadership issues formed a module theme. The manual should prove useful for field practitioners across a variety of sectors including forestry, agriculture and water. Given the importance of micro-political issues, we also put effort into producing a guide to analysing those village-level interactions that can jeopardise projects (Sithole, 2002). This guide is currently aimed at university-level classes or senior NGO or government officials. In future it would be appropriate to rework this to make it more directly relevant to the needs of grassroots extension agents and NGOs.

While the project team held many feedback sessions with the local community, including some formal training courses (e.g. on leadership issues, managing water opportunistically), our close association with CARE has meant that there has been much mutual learning, and CARE's wide reach has ensured that important lessons will reach many other local people.

One unplanned activity from the project was the major input from project participants towards a new way of doing business in the CGIAR, with its 16 international research centers (a daunting task!). The stimulus for this initiative was from Prof. J Sayer, head of the CGIAR Center Director's Task Force. At the workshop in Penang in 2000 three project participants attended and presented their work (Campbell, Lovell, Lynam) which has subsequently been published, and this was followed by Sayer inviting Campbell to work on the synthesis of all material emerging from this initiative. The Chivi project is one of the three case studies highlighted in the forthcoming book, which essentially tackles how to do more integrated science (Sayer and Campbell, 2003).

7 Publications and other communication materials

7.1 Books and book chapters

7.1.1 Published

Frost, P.G.H. 2001. Reflections on integrated land and water management. In: J.H.C. Gash, E.O. Odada, L. Oyebande, and R.E. Schulze (eds) *Freshwater Resources in Africa*, pp. 49-56. BAHC, Potsdam, Germany.

Nemarundwe, N. 2002. Institutional collaboration and shared learning for forest management in Chivi District, Zimbabwe. In: E. Wollenberg, D. Edmunds, L. Buck, J. Fox and S. Brodt (eds). *Social Learning in Community Forestry Management: Linking Concepts and Practices*, pp 85-108. Bogor: Center for International Forestry Research.

Campbell, B.M., Jeffrey, S., Kozanayi, W., Luckert, M., Mutamba, M. and Zindi, C. 2002. *Household Livelihoods in Semi-arid Regions: Options and Constraints*. Bogor: Center for International Forestry Research.

7.1.2 Pending publication

Sayer, J. and Campbell, B. 2003 *The Science of Sustainable Development: Local Livelihoods and the Global Environment.* Cambridge University Press

Nemarundwe, N. 2002. Formal and informal decision-making platforms: Women's role in natural resource management institutions in Southern Zimbabwe*. In:* C. Colfer (ed.) *No Fair!*

Enhancing Equity in Forest Management [to be submitted to Resources for the Future – RFF Press].

7.2 Journal articles

7.2.1 Peer reviewed and published

Campbell, B., Mandondo, A., Nemarundwe, N., Sithole, B., de Jong, W., Luckert, M. and Matose, F. 2001. Challenges to proponents of common property resource systems: despairing voices from the social forests of Zimbabwe. World Development, 29(4): 589-600.

Campbell, B., Sayer, J.A., Frost, P., Vermeulen, S., Ruiz Pérez, M., Cunningham, A., and Prabhu, R. 2001. Assessing the performance of natural resource systems. Conservation Ecology 5(2): 22. [Online] URL: http://www.consecol.org/vol5/iss2/art22

Lovell, C.J., Mandondo, A., Moriarty, P. 2001. The question of scale in Integrated Natural Resources Management. Conservation Ecology 5(2): 25. [Online] URL: http://www.consecol.org/vol5/iss2/art25

Mandondo, A. 2001. Allocation of governmental authority in tiered governance systems: the case of the Chivi Rural District Council landuse planning and conservation by-laws. African Studies Quarterly, 5(3): [Online] URL:http://web.africa.ufl.edu/asq/v5/v5i3a3.htm

7.2.1 Pending publication (in press)

Nemarundwe, N. and Kozanayi, W. 2002. Institutional arrangements for water for water resource use: a case study from Southern Zimbabwe. Journal of Southern African Studies [in press]

7.2.3 Drafted (most submitted)

Cain, J., Moriarty, P.B. and Lynam, T. 2001. Designing integrated models for participatory formulation of water management strategies.

Frost, P.G.H., Campbell, B., Mutamba, M., Lovell, C.J., Mandondo, A., Cain, J., Kozanayi, W. and Luckert, M. 2002. Can rural livelihoods in semi-arid regions be improved through better management of natural resources in catchments? World Development.

Lovell, C.J., Mugabe, F.T., Moriarty, P.B., Hodnett, M. and Batchelor, C.H. 2001. When is catchment management beneficial? A biophysical case study in a semi-arid crystalline basement area. Journal of Hydrology.

Mandondo, A. 2001. Forging (un)democratic resource governance systems from the relic of Zimbabwe's colonial past. Society and Natural Resources.

Mandondo, A., Campbell, B., Luckert, M., Nemarundwe, N., de Jong, W. and Kozanayi, W. 2001. Transacting institutional change in contexts of complexity: experiences from Chivi District in Zimbabwe. World Development.

Mugabe, F.T., Hodnett, M. and Senzanje, A. 2001. Comparative hydrological behaviour of two contrasting catchments in semi-arid areas of Zimbabwe.

Nemarundwe, N. 2001. Organisations for local woodland management: the case of Romwe catchment in Southern Zimbabwe.

Sullivan, C.S., Mutamba, M. and Kozanayi, W. 2001. Water use and livelihood security: A study of rural households in Southern Zimbabwe. *Journal of Water Policy*.

7.3 Institutional Report Series

Frost, P.G.H. and Mandondo, A. 1999. Improving rural livelihoods in semi-arid regions through management of micro-catchments in semi-arid regions through the management of micro-catchments. Institute of Environmental Studies Working Paper 12. Harare: Institute of Environmental Studies, University of Zimbabwe.

Mandondo, A. 2000. Situating Zimbabwe's natural resource governance systems in history. Centre for International Forestry Research Working Paper 32. Bogor: Centre for International Forestry Research. [Available online at http://www.cifor.cgiar.org/publications/pdf_files/OccPapers/OP-32.pdf]

Mandondo, A. 2001. A critique of by-law development and implementation in Chivi District, Zimbabwe. Institute of Environmental Studies Working Paper 19. Harare: Institute of Environmental Studies, University of Zimbabwe

Moriarty, P.B. 2000. Towards the development of a decision-support system for water resource development in semi-arid micro-catchments. Institute of Environmental Studies Working Paper 20. Harare: Institute of Environmental Studies, University of Zimbabwe.

Moriarty, P.B. 2000. Development of a groundwater model of the Romwe micro-catchment, Zimbabwe. Institute of Environmental Studies Working Paper 21. Harare: Institute of Environmental Studies, University of Zimbabwe.

7.4 Symposium, conference and workshop papers and posters (not listed elsewhere)

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Frost, P.G.H., Kozanayi, W. and Mabhachi, O. 2001. A Multi-Objective Analysis of Catchment Management Options in Chivi District, Southern Zimbabwe [PowerPoint presentation]

Lynam, T., Cain, J., Moriarty, P., and Frost, P.G.H. 1999. Micro-Catchment Management and Common Property Resources: First Integrated Modelling Workshop – INTMOD1. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Makumire, T. 2000. Zimbabwe: Micro-Catchment Management and Common Property Resources Project. Proceedings of the Mid-Term Review Workshop. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Mandondo, A. 1998. Zimbabwe: Micro-Catchment Management and Common Property Resources Project: A Team-Up Workshop Report. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Mandondo, A., Campbell, B. and Kozanayi, W. 2001. Strengthening Community Capacity to Manage CPRs, and its Contribution to Poverty Alleviation. Harare: Institute of Environmental Studies, University of Zimbabwe [poster]

Mapfumo, P. 1999. Zimbabwe: Micro-Catchment Management and Common Property Resources Project. Proceedings of the First Planning Workshop Together with Catchment Selection Report. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Mugabe, F. 1999. Zimbabwe: Micro-Catchment Management and Common Property Resources. Proceedings of the Second Planning Workshop. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Mugabe, F. 2000. Zimbabwe: Micro-Catchment Management and Common Property Resources Project. Proceedings of the Third Planning Workshop. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Mutamba, M., Campbell, B.M., Luckert, M., Zindi, C., Kozanayi, W. and Jeffrey, S. 2001. Is there a role for natural resource management in poverty alleviation in semi-arid Africa? [PowerPoint presentation]

7.5 Newsletter articles

Campbell, B. 2002. Giving local people control in Zimbabwe. CIFOR news.

Mandondo, A. 2000. Abstract of "Forging (un)democratic resource governance systems from the relic of Zimbabwe's colonial past" European Tropical Forest Network Newsletter 32

7.6 Academic theses

Moriarty, P. B. 2000. *Integrated Catchment Management and Sustainable Water Resource Development in Semi-Arid Zimbabwe*. PhD Thesis, UK: University of Reading.

7.7 Extension-oriented leaflets, brochures, posters & policy briefs

Campbell, B. 2000. Institutions and natural resources in the miombo region: where to with institutional arrangements and governance. Bogor: Center for International Forestry Research [policy brief]

Campbell, B.M., Kozanayi, W., Lovell, C., Mandondo, A., Nemarundwe, N. and Sithole, B. 2000. Managing common pool resources in catchments: are there any ways forward? Bogor: Center for International Forestry Research [policy brief].

Campbell, B.M. and Lovell, C. 2000. New ways of managing common property resources - experiences from Tanzania and Zimbabwe. Shona CPR facilitation brochure translated by K. Risinamhodzi, C. Chirara and A. Mandondo. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished leaflet]

Campbell, B.M. and others, 2000. Micro-catchment management in semi-arid regions - which way forward? A brochure of technical and other options [unpublished leaflet]

Center for Ecology and Hydrology. 2001. Managing our resources in an integrated way. Wallingford: Center for Ecology and Hydrology [poster]

Center for Ecology and Hydrology. 2001. Policies for natural resource management. Wallingford: Center for Ecology and Hydrology [poster]

Hodnett, M, Lovell, C., Mugabe, F. and Stevenson, K. 2001. Improving livelihoods through increased water use. Harare: Institute of Environmental Studies, University of Zimbabwe [poster]

Institute of Environmental Studies. 1999. Zimbabwe: Micro-catchment management and common property resources. Harare: Institute of Environmental Studies, University of Zimbabwe [brochure]

Lovell, C., Campbell, B., Mandondo, A., Sayer, J. and Stevenson, K. 2001. Achieving integrated resource management across scale [draft policy brief]

Makumire, T.B. 2001. Zimbabwe Micro-catchment management and common property resources: Hydrological course for farmers in Mutangi and Romwe micro-catchments. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished lecture notes]

7.8 Manuals and guidelines

CARE International. 2002. Catchment Management Manual. Harare: CARE International [This project contributed material for some sections and reviewed the bulk of the manual]

CGIAR Programme on Participatory Research and Gender Analysis. 2000. Equity, Well-Being, and Ecosystem Health: Participatory Research for Natural Resource Management. Cali: CGIAR Programme on Participatory Research and Gender Analysis [one section highlights the scenario building methods used on the project to change governance arrangements].

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Gumbo, D. and Hwindizi, F. 2000. Training for Transformation for leaders in Romwe and Mutangi micro-catchment areas, Chivi District, Zimbabwe. Zvishavane: Zvishavane Water Project [unpublished report]

Sithole, B. 2002. Making Sense of the Micro-Level Politics of Multi-stakeholder Groups: A Methods Manual. Bogor: Centre for International Forestry Research. (in press – draws on numerous case studies from Chivi)

Wollenberg, E., Edmunds, D. and Buck, L. 2000. Anticipating Change: Scenarios as a Tool for Adaptive Forest Management. Bogor: Centre for International Forestry Research [one section highlights the scenario building methods used in the project to change governance arrangements]

7.9 Media presentations

Kozanayi, W. 1999. Report on the demonstration at Romwe that was covered by the Zimbabwe Broadcasting Corporation. Institute of Environmental Studies, University of Zimbabwe.

Mandondo, A. 2000. Forging (un)democratic resource governance systems from the relic of Zimbabwe's colonial past. Entire article promoted on the Polex electronic listserve (polex@cgiar.org)

Mandondo, A. 2000. Forging (un)democratic resource governance systems from the relic of Zimbabwe's colonial past – abstract circulated in World Rainforest Movement, Newsletter 35 (website http://www.wrm.org.uy)

7.10 Reports and data records

7.10.1 Citation for the project Final Technical Report (FTR)

Mandondo, A., Frost, P., Campbell, B & Mutamba, M. 2002. *Micro-Catchment Management and Common Property Resources in Zimbabwe: Final Technical Report.* Harare: Institute of Environmental Studies, University of Zimbabwe.

7.10.2 Internal project technical reports

Campbell, B. 2002. Guide to the Numerous SPSS Syntax Files. Bogor: Center for International Forestry Research. [unpublished report]

Campbell, B., Mandondo, A., Lovell, C., Kozanayi, W., Mabhachi, O., Makumire, T., Mugabe, F., Mutamba, M. and Siziba, S. 2000. Forging New Institutional Arrangements for Common Property Resource Management – A Case from Southern Zimbabwe. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Gotosa, J., Makumire, T., Mugabe, F.T. and Muzuva, J. Geology and Soil Surveys of Mutangi catchment. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Hodnett, M. 1999. Report on the Pre-Instrumentation Survey of the Mutangi Micro-Catchment. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

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Kozanayi, W. 2001. Participatory Extension Approach in Practice: An Overview of Experiences from Romwe Micro-catchment in Chivi South District. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Kozanayi, W. 2001. Summary of Catchment Activities: DFID Project 1999-2001. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

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Mabhachi, O. 2001. Zimbabwe Micro-Catchment Management and Common Property Resources Project: Summary of Activities Undertaken During the Period January 1999 - April 2001. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

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Mabhachi, O. 2001. Participatory Extension Approach in Practice - An Overview of Experiences in Mutangi. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

Mabhachi, O. and Kozanayi, W. 2000. Soil and Water Conservation and Fertility Management in the Mutangi and Romwe Micro-catchments: Farmer Perceptions, Practices, Priorities and

Problems. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].
Mabhachi, O. and Kozanayi, W. 2001. The Village Boundaries of Romwe and Mutangi. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].
Mugabe, F.T. 2000. Proposal on Monitoring Interventions. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].
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7.10.2 Literature reviews (other than those mentioned under other categories)

Chuma, E., Marovanidze, K., Munyanyi, J. and Nyagumbo, I. 2000. A Review of Technical Options in Croplands, Grazing Lands and Woodlands of Semi-Arid South-Central Zimbabwe. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].
Edziwa, B. 2001. Zimbabwe: Micro-Catchment Management and Common Property Resources: Review of Dissemination Strategies. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

7.10.3 Scoping studies

Mapfumo, P. 1999. *Zimbabwe: Micro-Catchment Management and Common Property Resources Project*. Proceedings of the first planning workshop together with catchment selection report. Harare: Institute of Environmental Studies, University of Zimbabwe [unpublished report].

7.10.4 Datasets, software applications

Sampurna, Y., van Heist. M., Chandra, R., Agustian, I., Hendrik, Campbell, B. and Yuzar, Y. 2002. *Data Archive for an Integrated Natural Resource Management Research Programme in Southern Zimbabwe*. Bogor: Centre for International Forestry Research. A CD containing the following information on the institutional, biophysical, livelihood, integration, technical options and administrative components of the project:
- Scientific papers
- In-house reports
- Technical reports
- Workshop and conference proceedings
- Project administration reports
- List of participants for exchange visits
- Reports on field visits
- List of participants to quarterly questionnaire survey
- Quarterly questionnaire survey data (raw)
- Tenure survey data (raw)
- PRA surveys (raw and semi-processed data)
- Detailed records of all community meetings
- GIS data for both catchments

- All working models

7.10.5 Project website

http://www.uz.ac.zw/ies/mcm/

Project also featured on:

(a) http://www.fao.org/ag/agl/watershed/papers/case19.pdf (Land-water linkages in rural watersheds: electronic conference Sept-Oct 2000)

(b) http://www.livelihoods.org/lessons/project_summaries/water1_projsum.html

(c) http://www.cifor.cgiar.org/publications/Html/AR-2000/Content-6.html (local governance and the legacy of colonial rule)

(d) http://www.cifor.cgiar.org/publications/Html/AR-2000/Content-6.html (challenge of governing common-property resources)

(e) www.inrm.cgiar.org/Workshop2000/docs/Bruce/bruce_main.pdf (paper presented at Penang workshop 2000)

(f) http://www.inrm.cgiar.org/Workshop2000/abstract/Lovell/lovell.htm (paper presented at Penang workshop 2000)

(g) http://www.etfrn.org/etfrn/newsletter/nl31_oip.htm (news on the project: institutions and natural resources in the miombo region)

(h) http://www.cifor.cgiar.org/publications/pdf_files/SCENARIO.pdf (results from the scenarios building exercises with communities)

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Butterworth, J.A., Schulze, R.E., Simmonds, L.P., Moriarty, P. and Mugabe, F.T. 1999. Hydrological processes and water resource management in a dryland environment IV: Long-term ground water level fluctuations due to variation in rainfall. *Hydrology and Earth Systems Sciences*, 3(3): 353-361.

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9 Project logframe

R7304: Project Logical Framework – Zimbabwe Micro-Catchment Management and Common Property Resources

Narrative Summary	Objectively verifiable indicators	Means of verification	Important assumptions
Super Goal (purpose of NRSP SAPS)			
Benefits for poor people in target countries generated by application of new knowledge to natural resource management in semi-arid production systems	By 2005 evidence of the application of research products to benefit target communities by achieving one or more of: - Sustainable production increase - Less variable production - Productivity increase - Improved employment (numbers, income, quality) - Improved access by poor people to RNR output	DFID commissioned reviews Monitoring against baseline data collated by the programme Reports of in-country institutions National statistics	Enabling environment (policies, institutions, markets, incentives) for widespread adoption of new strategies and practices exists Climatic conditions are favourable
Goal Appropriate catchment management strategies developed and promoted	Livelihoods of at least 10% of the poor improved in semi-arid communal areas in Zimbabwe by 2005.	GO, NGO and CBO reports	Target beneficiaries adopt and use strategies Enabling environment exists
Purpose New approaches to *NRM* that benefit the poor developed and validated in representative micro-catchment sites in the semi-arid communal lands of Zimbabwe	*By Dec 2001:* Major stakeholders engage with the new knowledge generated on the relative dependence of poor communities on wildlife, livestock and crops and their interaction and on the role of human and social capital in catchment management Local institutions take steps to continue the promotion of institutional and technical changes for the management of CPRs and the improvement of people's livelihoods	Journal papers *Project FTR* Records and planning documents of CBOs and NGOs including informal information sources	Communities and extension agencies are interested and willing to adopt outputs
Outputs 1. Existing institutional arrangements to manage common-property resources (CPRs) critically appraised, and innovative approaches to strengthening the capacity to manage CPRs investigated and promoted.	At least one approach to community-based management of CPRs developed by end of Year 2, with an alternative approach being developed by the end of Year 3	PRA and other reports	Concerted community action through local CPRM institutions are able to bring current 'open access' resources under community control and management as common property resources CPRM-relevant institutions exist at local level; sufficient incentives for these to be mobilised and strengthened and to be effectively integrated into, programmes for managing larger catchments

Narrative Summary	Objectively verifiable indicators	Means of verification	Important assumptions
Outputs (continued)			
2. Key biophysical linkages amongst components of the micro-catchments identified, quantified, and made accessible for CPR management, and options for more efficient and extensive use of water resources identified and promoted in these micro-catchments.	Integrated soil, vegetation and hydrological monitoring programme in place and functioning at Romwe by end of Year 1 (an extension of past 5 years of activity), and in new micro-catchment by end of Year 2 At least two options for more efficient and extensive use of water resources promoted by end of Year 3 with the involvement of key stakeholders, or if viable options not identified, project findings communicated to all major stakeholders.	Reports on the monitoring programme Report on end-of-project key informant interviews	Biophysical processes operating at a micro-catchment scale are directly related to the functioning of catchments at a larger scale (see Activity 2.1a)
3. Options for markedly improving livelihoods in the target micro-catchments identified and promoted	By month 4 of year 3, robust screening of options for improving livelihoods of people in the target micro-catchments completed and intervention plan developed and implemented or, if viable options not identified, project finding communicated to all major stakeholders By end of year 3, if intervention plan has moved ahead, at least two options for improving livelihoods promoted with the involvement of key stakeholders	Intervention plan report Report on end-of-project key informant interviews	
Activities 1.1 Identify and establish study areas (Romwe plus one new catchment) using agreed criteria based on prior experience, local knowledge, reconnaissance surveys, and advice from key institutions	*Milestones* Selection criteria for the additional catchment agreed upon by end of Month 2 Additional study site identified by end of Month 3		
1.2 a) Identify and characterise internal and external institutions influencing the range of CPRs and other resource management regimes within the study areas b Review issues related to the scaling up of micro-catchment management to whole catchment functioning (see Activity 2.1a and Assumption for Output 1)	Paper on the characteristics of local institutions and their relationships to the management of common property and other resources by end of Year 1.		

Activities (continued) 1.3 a) Evaluate the capacity of local institutions to undertake CPRM b) At least two options for enhancing capacity by way of human resource mobilisation, training, advocacy and exposure to other CPRM initiatives, identified through literature review and survey of expert opinion, and tested	***Milestones*:** a) Capacity of identified local institutions within the two micro-catchments evaluated by end of Year 1 b) Options for enhancing capacity identified by end of Year 1. At least one option developed and tested by end of Year 2; additional option tested by mid Year 3	
1.4 Assess incentives for, and constraints on, effective CPRM	Overview institutional paper, including a classification of CPRS with an analysis of the competing uses and the current institutional arrangements governing their use, by mid Year 3. This paper will include the results of capacity-building exercises	
1.5 Integrated assessment of the circumstances under which catchment management may be appropriate (same activity as 2.5 & 3.3)	a) Overview synthesis paper drawing on bio-physical, institutional, livelihood and economic data by end of year 3 b) Report on end-of-project key informant interviews	
1.6 Develop dissemination materials for wider enhancement of capacity of local CPRM institutions (linked to activities 2.7 and 3.6)	a) Handbook on different facets of CPRM prepared by end of Year 3 b) Other dissemination options finalised by end of Year 3.	
2.1a) Review literature and expert opinion to produce a synthesis of existing understanding of issues associated with scaling up of key biophysical processes from micro-catchments to whole catchments (see Activity 3.1a and Assumption for Output 2) b) Identify and select study micro-catchments using agreed biophysical criteria (components and key processes) based on prior experience, local knowledge, reconnaissance surveys, and advice from key institutions	b) Draft review of scale-related issues in catchment functioning produced by end of Month 2 Full review and synthesis of scale-related issues completed by end of Month 6 b) Selection criteria agreed upon by end of Month 2 Micro-catchments identified and selected by end of Month 3 See also Milestone 1.1	
2.2 Instrument micro-catchments, survey key biophysical trends, and establish data collection programme	Monitoring instruments in place by end of Year 1 Monitoring programme functioning with community participation by mid Year 2	
2.3 Available and new technical options for improved water and micro-catchment management evaluated and their potential for independent uptake and sustained use assessed	Review of potential technical options and their likely uptake and impacts by Year 2; Review of options for micro-catchment management and improved water management by mid Year 3	
2.4 Model and validate linkages among components of the micro-catchments to better understand: impacts of potential technical options; improved water management and hydrological functioning during dry periods (low rainfall cycles)	Model of Romwe micro-catchment operational by end of Year 1 and validated and revised by end of Year 2; model extended to include new catchment by mid Year 3	

Activities (continued) 2.5 Integrated assessment of the circumstances under which catchment management may be appropriate (same activity as 1.5 & 3.3)	***Milestones*:** a) Overview synthesis paper drawing on bio-physical, institutional, livelihood and economic data by mid Year 3 b) Report on end-of-project key informant interviews	
2.6 Plan for a long-term micro-catchment management monitoring and demonstration facility, as a component of dissemination.	Joint report by government, non-government and project implementers on the vision and plan for the demonstration facilities	
2.7 Develop dissemination materials for wider understanding within communities of the: key biophysical components and processes involved in long-term management of micro-catchments; options for improved water use and options for technical interventions (linked to activities 1.6 and 3.6)	a) Handbook on different facets of CPRM prepared by end of Year 3 b) Other dissemination options finalised by end of Year 3	
3.1 Livelihoods analysis to identify the different groups of resource users and quantify their dependence on each class of resource relative to the other components of their livelihoods	a) PRA reports by end Year 1 b) Paper on broad livelihood options by end of Year 3 (draft ready by mid Year 3)	
3.2 Analysis and evaluation of water resources - livelihood linkages in the context of the farming and production systems of the participating communities, including water sources, users, and uses, and economics of improved water use	Paper on water resources -livelihood linkages and options for enhancing livelihoods through more productive use of water resources by mid Year 3 (draft paper ready by end Year 2)	
3.3 Integrated assessment of the circumstances under which catchment management may be appropriate (same activity as 1.5 & 2.5)	a) Overview synthesis paper drawing on bio-physical, institutional, livelihood and economic data by end of Year 3 b) Report on end-of-project key informant interviews	
3.4 Robust screening of options for improving livelihoods of people in the target micro-catchments completed	Intervention plan report	
3.5 At least two options for improved livelihoods promoted or, if viable options not identified, project finding communicated to all major stakeholders	Results on livelihood options promoted incorporated into final papers on livelihood options (see 3.1 and 3.2) Report on end-of-project key informant interviews	
3.6 Develop dissemination materials for promoting the improvement of livelihoods and the more productive use of water resources (linked to activities 1.6 and 2.7)	a) Contributions on livelihood issues made to the handbook on different facets of CPRM completed by end of Year 3 b) Other dissemination options finalised by end of Year 3.	

Activities continued 4.1 Draw up proposals for and agree on future management of the micro-catchment monitoring and demonstration facilities	***Milestones*:** Agreement on future management of the facilities secured by end of Year 2.	
4.2 Develop and implement a strategy for promoting long-term monitoring and other uses of the facilities in the micro-catchments	Report on long-term strategy for monitoring and other uses by mid Year 3	

10 Keywords

Zimbabwe, Chivi District, Common Property Resources, Livelihoods, Micro-catchment Management, Strategy, Communities, Target institutions

11 Annexes

Annex A. Scientific Annex – attached, see below

Frost, P.G.H., Campbell, B., Mutamba, M., Lovell, C.J., Mandondo, A., Cain, J., Kozanayi, W. and Luckert, M. 2002. Can rural livelihoods in semi-arid regions be improved through better management of natural resources in catchments?

Annexes B-I Publications – see separate volumes

Institutional aspects

Annex B

Mandondo, A., Campbell, B., Luckert, M., Nemarundwe, N., de Jong, W. and Kozanayi, W. 2001. Transacting institutional change in contexts of complexity: experiences from Chivi District in Zimbabwe

Annex C

Nemarundwe, N. 2001. Organisations for local woodland management: the case of Romwe catchment in Southern Zimbabwe

Annex D

Nemarundwe, N. 2002. Formal and informal decision-making platforms: Women's role in natural resource management institutions in Southern Zimbabwe.

Biophysical aspects

Annex E

Lovell, C.J., Mugabe, F.T., Moriarty, P.B., Hodnett, M. and Batchelor, C.H. 2001. When is catchment management beneficial? A biophysical case study in a semi-arid crystalline basement area.

Annex F

Mugabe, F.T., Hodnett, M. and Senzanje, A. 2001. Comparative hydrological behaviour of two contrasting catchments in semi-arid areas of Zimbabwe

Integrated aspects

Annex G

Cain, J., Moriarty, P.B. and Lynam, T. 2001. Designing integrated models for participatory formulation of water management strategies [submitted].

Livelihood aspects

Annex H

Campbell, B.M., Jeffrey, S., Kozanayi, W., Luckert, M., Mutamba, M. and Zindi, C. 2002. *Household Livelihoods in Semi-arid Regions: Options and Constraints*. Bogor: Center for International Forestry Research. [Replaced by a published book with this title and authorship]

Annex I

Sullivan, C.S., Mutamba, M. and Kozanayi, W. 2001. Water use and livelihood security: A study of rural households in Southern Zimbabwe.

Annex J – Project Inventory

[List all equipment (>£500) purchased under the project, noting any changes during the quarter.]

Item	Make and Model	Serial No.	Date received	Purchase price	Location	Person responsible for Safekeeping*	Disposal		
							To	Date	Authorised
Photocopier	Canon NP 6216	UW33484	17/3/99	£2517	IES. Zimbabwe	Prof. Feresu			
Pin boards	N/A		2/2/99	£992	IES, Zimbabwe	Prof. Feresu			
Computer	Acer Entra	9174302109	27/01/99	£1266	IES Zimbabwe	Prof. Feresu			
Isuzu Vehicle	KB250D, 2WD Double Cab	4JA1586250	4/99	£7086	IES, Zimbabwe	Prof. Feresu			
Isuzu Vehicle	KB250D, 2WD Double Cab	4JA1581365	4/99	£7086	IES Zimbabwe	Prof. Feresu			
Computer	Acer Entra	9174302109	23/12/99	£1077	IES Zimbabwe	Prof. Feresu			
Water Level Gauge	Unidata 6541	586	19/9/99	£526	IES Zimbabwe	Prof. Feresu			
Radiometer	NR-Lite Net	990302	19/9/99	£565	IES Zimbabwe	Prof. Feresu			
Data Logger	CR10X	XE1180	19/9/99	£779	IES Zimbabwe	Prof. Feresu			
Water Level recorder	6541	463	19/9/99	£526	IES Zimbabwe	Prof. Feresu			
Water Level Recorder	6541	564	19/9/99	£526	IES Zimbabwe	Prof. Feresu			
Laptop	Toshiba 2060CDS	To be supplied	19/9/99	£1250	IES Zimbabwe	Prof. Feresu			
Unidata Water Level Recorder		To be Supplied	19/9/99	£526	IES Zimbabwe	Prof. Feresu			

* This is a new requirement from DFID – preferably project leader or overseas counterpart

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Six Monthly Check:	Completed By	_____
	Signature	_____
	Date	_____
Yearly Check:	Completed By	_____
	Signature	_____
	Date	_____
