PREPARING FOR THE NEXT GENERATION OF WATERSHED MANAGEMENT PROGRAMMES AND PROJECTS

AFRICA

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PREFACE

On the occasion of the International Year of Mountains, and in response to the clear consensus reached by the international community regarding the need to ensure harmonious and sustainable development of mountainous areas and watersheds, the Food and Agriculture Organization of the United Nations (FAO) and its partners undertook a large-scale assessment and global review of the current status and future trends regarding knowledge about and techniques for integrated watershed management.

The objectives were to promote the exchange and dissemination of experiences of integrated watershed management techniques, identify constraints to the implementation and development of those techniques during the decade from 1990 to 2000 and capture relevant new paradigms and approaches. The lessons learned from diverse experiences are being used to define a new generation of integrated watershed management projects.

Experts from four continents contributed to the assessment, which yielded four main outputs: 1) a review of experiences in watershed management, based on questionnaires that were sent to active partners in the field; 2) substantive reports from four regional workshops held in Nairobi (Kenya), Kathmandu (Nepal), Arequipa (Peru) and Megève (France); 3) four case studies from the Mediterranean basin, Nepal, Bolivia and Burundi; and 4) an international conference in Porto Cervo, Sassari Province, Sardinia, Italy.

Watershed management concepts and approaches were reviewed, and different experiences assessed. The results of this exercise are presented in several documents, including the proceedings of workshops and reports on the four case studies.

The conservation, use and sustainable management of watershed resources in order to meet the demands of growing populations have been a high priority for many countries over the past several decades. In this respect, integrated watershed management through people's participation has become widely accepted as the approach that ensures sound sustainable natural resources management and a better economy for upland inhabitants, as well as people living in downstream areas.

The African Regional Workshop on Preparing the Next Generation of Watershed Management Programmes was co-hosted by FAO and the World Agroforestry Centre (ICRAF) at the centre's offices in Nairobi from 8 to 10 October 2003. The workshop brought together 42 researchers, educators, development experts, river basin managers and government officials responsible for agriculture, environment, lands and water from 13 African countries, the United Kingdom, the East African Community Secretariat, FAO and ICRAF. The workshop was organized around technical presentations, a field trip, working groups and plenary discussions. Plenary proceedings were simultaneously translated into French and English.

Several issues emerged as priority, consensus issues. These issues were highlighted in the workshop summary and in the presentation that was made at the International Conference in

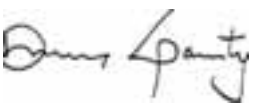
Sassari. The most important of them are poverty, governance, knowledge and information, and the need for enhanced capacity in integrated watershed management.

Levels of poverty are higher in Africa than in other regions of the world, and many African countries are experiencing increasing poverty. High absolute poverty has multiple impacts on watershed management – both resource users and governments have short time perspectives, there are fewer resources available for investment by resource users and governments, public investments are heavily dependent on donor priorities, and donors who put priority on poverty reduction are tending to underinvest in natural resource management.

Watershed governance in Africa needs to cope with the transactional nature of the region's water resources: most African countries share important river basins with other countries, and most important water sources are shared among two or more countries. On the positive side, many African countries have recently enacted new policies for water and environmental management and there are new commitments to regional harmonization of watershed management in many parts of Africa. Many challenges remain. There is still a compelling need to harmonize policies across countries, and to harmonize within-country policies across those sectors that relate to water and environmental management. In addition, there is an urgent need to develop the institutional capacity, financing mechanisms and enforcement mechanisms to implement fully those policies at the regional, national and local levels.

Integrated watershed management is constrained by large knowledge gaps about cause and effect relations in watersheds. These knowledge gaps are particularly large regarding the relations among trees, forests and key hydrologic phenomena, particularly large-scale phenomena such as floods and landslides. Even among those with good general knowledge of these relationships, there are very few data and very little information available to aid the work of management authorities.

Improvements in integrated watershed management in Africa will require substantial investments in capacity building and networking. There is a need to build the capacity of key institutions in Africa, with emphasis on developing tools in Africa that are appropriate for Africa. Systems for routine data collection and monitoring are in various states of repair across Africa. Improved networking among those involved in watershed management across the continent could help to exploit the considerable opportunities that exist for sharing concepts and lessons learned across Africa. Improved networking is needed among scientists of different disciplines, policy-makers and resource users, and among countries at different stages of institutional development.



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EDITOR'S NOTE

Materials prepared for (and during) the workshop are presented in this volume. This includes the 15 full text papers made available by the authors (Chapters 1 to 15), as well as the abstracts of all the communications that were presented at the workshop (Annex A). Given the variety of topics dealth with during the workshop, papers and abstracts were grouped in five parts as follows: FAO watershed management review (Part 1), links among land use, tree cover and water in Watersheds (Part 2), farming and watershed management in sub-Saharan Africa (Part 3), social factors in watershed management (Part 4), and African experiences in watershed management (Part 5). Group work findings and workshop conclusions are presented in Part 6. Additional information is presented in (Annexes B, C and D).

The African Regional Workshop on Preparing for the Next Generation of Watershed Management Programmes and Projects was largely an English-French bilingual event. Hence this publication includes a French section, in which this introduction, the abstracts and the workshop conclusions are presented.

ACKNOWLEDGEMENTS

The editors of this proceedings volume wish to acknowledge the many individuals and institutions that contributed to the workshop and this volume. The Government of the Netherlands provided financial support to FAO for this workshop and other activities undertaken during 2002/03 towards "preparing the next generation of watershed management programmes". Some of these funds were passed through to ICRAF, which handled administrative and logistical arrangements for the workshop. The European Union (EU) and the Danish International Development Agency (DANIDA) provided financial support to ICRAF through funds targeted for policy research in Africa. We also acknowledge the unstinting support and generous contributions of the senior managers of FAO and ICRAF to this collaborative effort. The Director-General of ICRAF, Dr Dennis Garrity, and the Director of the Forestry Resources Division of FAO, Dr El-Hadji Sène, welcomed the participants and made opening addresses to the workshop. The FAO representative to Kenya, Mr Bruce Isaacson, kindly participated in the opening session.

The workshop was a success because of the inputs of the 48 individuals who attended, including those who supported logistics, translation and travel. Those who gave presentations and submitted papers contributed valuable time before, during and after the workshop. Three individuals at ICRAF deserve special mention: Mahmouda Hamoud who facilitated the complicated travel arrangements, and Alex Awiti and David Mungai who organized an excellent field trip. Excellent translation services were provided by Clement Sopkor-Dufe, Jean Ngoma and Agbo Lawson.

The Government of Kenya supported this workshop in several ways. Government staff from several ministries, including the ministries and agencies responsible for agriculture, water, planning, lands and environmental management, attended the workshop and field trip. The Director-General of Kenya's National Environment Management Authority (NEMA), Prof. R.W. Michieka, made an introductory address. The Minister of Water Resources Management and Development, the Honourable Martha Karua, provided the opening speech, which was presented on her behalf by the Assistant Minister, the Honourable John Munyes. The Ministry of Agriculture and the Nairobi City Council helped to organize the field trip.

Beyond the workshop itself, several individuals contributed to this proceedings volume. We wish to acknowledge the facilitators, chairs and rapporteurs of the working groups, the authors of the papers (including those who were unable to attend the workshop), the individuals who reviewed technical papers, the copy editor (Ms Kris Vanhoutte) and those at FAO who helped to guide the production of the proceedings volume, particularly Dr Thomas Hofer.

ACRONYMS

AREX	agricultural research and extension services
Cap-Net	capacity building for integrated water resource management
CAPRI	Collective Action and Property Rights Programme
CASS	Centre for Applied Social Sciences
CEH	Centre for Ecology and Hydrology
CF	conservation farming
CFA	Communauté Financière Africaine
CGIAR	Consultative Group on International Agricultural Research
CIFOR	Center for International Forestry Research
CLUWRR	Centre for Land Use and Water Resources Research
CPR	common pool resources
CPRM	common property resource management
CWSA	Community Water and Sanitation Agency
DANIDA	Danish International Development Agency
DDF	District Development Fund
DFID	Department for International Development (United Kingdom)
EAC	East African Community
EAPI	Environment and Policy Institute
ECOWAS	Economic Community of West African States
EIA	environmental impact assessment
EPA	Environmental Protection Agency
EWR	ecological water requirements
FAO	Food and Agriculture Organization of the United Nations
FAWPIO	Forest and Water Policy – Improving Outcomes
FEM	Fonds pour l'Environnement Mondial (Global Environment Facility – GEF)
GIS	Geographic Information System
GPS	global positioning system
HIV/AIDS	human immunodeficiency virus/acquired immune deficiency syndrome
HOF	Hortonian overland flow
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	World Agroforestry Centre (formerly the International Centre for Research in Agroforestry)
IES	Institute of Environmental Studies
IH	Institute of Hydrology
IIT	Indian Institute of Technology, Delhi
IRC	International Water and Sanitation Centre
IWMI	International Water Management Institute
IWRM	integrated water resource management
LWF	Lutheran World Federation
MDGs	Millennium Development Goals of the United Nations
NEMA	National Environment Management Authority
NEPAD	New Partnership for Africa's Development

NGO	non-governmental organization
NRI	Natural Resources Institute
NRM	natural resource management
ONG	organisation non gouvernementale
PRA	participatory rural appraisal
ROPPA	Le Réseau des Organisations Paysannes et de Producteurs de l'Afrique de l'Ouest (Network of Peasant Farmers' and Agricultural Producers' Organizations of West Africa)
SADC	Southern African Development Community
Sida	Swedish International Development Cooperation Agency
SIWI	Stockholm International Water Institute
SOF	saturated overland flow
SSA	sub-Saharan Africa
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme

INTRODUCTION

In 2002–2003, FAO led a global review of watershed management with the aim of reviewing the past generation of watershed management programmes and laying the foundations for the next generation. The review was initiated during the International Year of Mountains in 2002 and completed during the International Year of Freshwater in 2003. This process included several activities and involved a range of agencies and experts. The Forestry Department of FAO led the review, with inputs from other FAO divisions.

The objectives of the overall review were to:

1. review the state of watershed management programmes, policies and knowledge base;
2. identify key achievements and lessons learned during the last 15 years;
3. identify key gaps;
4. develop guidelines for the "next generation" of watershed management programmes.

Several research exercises and consultations were carried out in the framework of the review, including:

- a survey of key actors;
- case studies from four regions;
- a workshop with Consultative Group on International Agricultural Research (CGIAR) centres at the Integrated Natural Resource Management (INRM) Meeting in Aleppo, Syrian Arab Republic;
- a series of regional workshops in Europe, Asia, Latin America and Africa;
- a final global workshop in Sardinia, Italy.

The African regional watersheds workshop was co-hosted by FAO and the World Agroforestry Centre (ICRAF), with funding from the Government of the Netherlands. Workshop objectives focused on watershed management issues specific to the African continent.

THE AFRICAN WORKSHOP

The objectives of the African Regional Workshop on Preparing for the Next Generation of Watershed Management Programmes and Projects were to:

1. assess watershed management programmes and approaches in Africa by identifying and quantifying positive achievements, as well as perceived gaps;
2. review lessons learned and principal issues emerging from past experiences of watershed management in the African region, especially in the decade between 1990 and 2000;
3. identify guidelines for formulating and implementing the next generation of watershed management projects and programmes for Africa.

Participation in the workshop was by invitation. Individuals and institutions were identified by the conference organizers to represent: 1) all regions of the African continent; 2) French-speaking and English-speaking areas of Africa; 3) watershed management issues at multiple scales, from land use at the plot scale to transnational basins; 4) different categories of stakeholders such as international organizations, regional governments, national and local government agencies, elected politicians, water management authorities, non-governmental organizations (NGOs) and researchers; and 5) different disciplinary perspectives, from hydrology, sociology, economics, agriculture and engineering. A total of 48 participants, representing 13 countries and three international organizations attended the workshop. Several non-African experts also attended.[1]

The workshop was held from 8 to 10 October 2003 at the global headquarters of ICRAF. Participants were welcomed by the Director-General of ICRAF, Dr Dennis Garrity, the Director of the Forest Resources Division of FAO, Dr El-Hadji Sène, and the Director-General of the Kenya National Environment Management Authority (NEMA), Prof. R.W. Michieka. John Munyes, Assistant Minister for Water Resources Management and Development of the Republic of Kenya, opened officially the workshop, speaking on behalf of the Minister, the Honourable Martha Karua. Proceedings were held in both French and English, with simultaneous translation.[2]

The workshop was introduced by Moujahed Achouri who presented an overview of the global review. This was followed by a summary of initial findings by Larry Tennyson. Ian Calder discussed some common misconceptions in watershed management and advocated a more evidence-based approach. Jean-Marc Faurès spoke on the need to base watershed programmes on scientific evidence of land–water relationships.

Participants' presentations followed this introductory session. Presentations varied in geographical scope, from plot-level studies (i.e. Alain Albrecht on on-farm effect of agroforestry), watershed-level studies (i.e. Seef Rademeyer on South African watershed management policies), and transboundary watershed studies (i.e. Amadou Aiga's description of a regional-level approach to watershed management in Fouta Djallon highlands). Different disciplines were represented, including rural sociology (i.e. Jean Bonnal on participation and decentralization in watershed management). Development aid policies were also addressed: for instance, Gete Zeleke's presentation stressed the need for larger and more sustained support for natural resource management in Ethiopia, shifting away from short-term support for food aid and relief operations.

During the second day, additional presentations were given including Robert Hope on the Limpopo basin of South Africa, David Mungai on the central highlands of Kenya, Pusmane Diallo on the Niger River basin, Abdellah Zitan on the Upper Atlas Mountains, and Kwame Odame Ababio on the river basins of Ghana.

A field visit followed to Thika district mountains, where participants were Ministry of Agriculture local officers. The group witnessed erosion on steep hillsides and landslide areas,

1. Full contact information for the participants is provided in Annex D.
2. See Annex B for more details of the opening statements and Annex C for the full workshop programme

and visited the Ndakaini dam, which significantly contributes to Nairobi domestic water supply. While the water in the dam appears to be very clear and the catchment area relatively pristine, discussions showed that this water resource is threatened by uncoordinated land use in the catchment area. Major concerns about the use of the dam and its water resources have been raised by both local community groups and downstream companies, but have not been systematically addressed. This experience provided a chance for participants to learn about the on- and off-site challenges and conflicts that impinge on watershed management.

The technical discussions and field trip laid the groundwork for group work during the final day of the workshop. Working groups were convened around three topics. Group 1 considered upland–lowland linkages in watershed management. Group 2 considered the policy and institutional context for integrated watershed management. Group 3 considered implementation issues in watershed management. All groups were asked to consider achievements, gaps and directions for the future. Working group discussions were held in both French and English. Reports were prepared and presented to plenary after lunch. The workshop concluded with the presentation and discussion of a draft summary of the workshop proceedings.[3]

While workshop participants travelled back to their home bases in the days following the workshop, a final workshop summary was circulated by e-mail to all participants. A final summary was approved by participants before being presented at the global workshop that FAO convened in Sassari, Italy, less than two weeks after the Nairobi workshop. Final versions of the technical papers were prepared, reviewed, revised and finalized during 2004. This edited proceedings document includes some papers from individuals who were invited to the workshop, but who for various reasons were unable to attend.

OVERVIEW OF TECHNICAL PRESENTATIONS

Introductory papers by Moujahed Achouri (Chapter 1) and Larry Tennyson (Chapter 2) presented the international process of review and dialogue on watershed management that FAO initiated in 2002.

Tennyson (Chapter 2) presents summary results of the key actor survey, the review of FAO watershed experiences and the previous regional workshops. His paper ends with a table that summarizes the past scenario and provides directions for future watershed management programmes. Key lessons learned from this can be summarized as follows:

- In the past, watershed management has focused on the biophysical symptoms of watershed management: in the future, it should focus on the identification and treatment of the underlying causes of those problems.
- In the past, watershed management has given priority to the downstream impacts of upstream land use: in the future, at least equal priority should be given to the on-site costs and benefits of watershed management.

3. Workshop findings are presented in Part 6 of this publication.

- In the past, watershed management programmes assumed significant government capacity and a conducive policy environment: in the future, programmes should build necessary capacity and ensure appropriate policy changes.
- In the past, watershed management programmes had a top-down approach to technology development and transfer: in the future, there will be greater emphasis on participatory learning by multiple stakeholders.
- In the past, there has been a focus on the production of particular agricultural commodities: in the future, there will be more emphasis on combinations of land use that enhance rural livelihoods.
- In the past, the integrated watershed management approach has been grafted on to existing rural development projects and line ministries: in the future, multiple use of natural resources will be the starting point, with responsibility for particular issues given to appropriate lead institutes.

Presentations in Part 2 review evidence on the links among land use, tree cover and water in order to inform better watershed management. Faurès (Chapter 3) summarizes the results of a review undertaken by the Soil and Water Management Division of FAO of the biophysical links between land use and water. The review indicates that land use has a significant impact on water quality, particularly through pesticides, salinity and soluble nutrients. Land use can have measurable effects on the total availability and seasonal patterns of water in small watersheds, but in larger watersheds these effects are usually overwhelmed by spatial and temporal variation in intensity of rainfall, patterns of rainfall and runoff, soil type, and geography of parent material. Faurès further argued that environmental service mechanisms may be feasible for better linking upstream and downstream components of watersheds, but only when they are based on careful assessment and valuation of linkages and potential interventions.

Calder (Chapter 4) reviews evidence challenging some conventional wisdom, and laments the poor links between policy and science in integrated watershed management. Generalizations about tree–water relationships that are used to justify tree planting and water harvesting programmes are more often wrong than right, resulting in millions of dollars of wasted resources. What is needed is a site-specific understanding of these relationships, supported by empirical models that can easily be calibrated for new conditions.

The other presentations can be distinguished by their scale and scope of analysis, from analysis of institutions governing transnational river basins and watersheds (see Part 5), to the links between land use and water at the plot scale (see Part 2). At the broadest scale are the presentations by Amadou Maiga (abstracted in Annex A) and Ousmane Diallo (Chapter 15) on watershed management in the Fouta Djallon highlands and the Niger River basin. The importance and challenges of managing shared river basins were stressed throughout the conference. While there are some notable examples of effective transnational river basin agreements, for the most part, shared resources remain the least developed and most contentious water resources in the continent. Water resources such as Lake Chad and Lake Victoria have already suffered great damage. Maiga described a promising new approach to shared development of the transnational water resources of the Fouta Djallon highlands and Diallo described the challenges of shared management of the Niger River basin, one of the rivers that emanate from the Fouta Djallon. Governments need to commit themselves to doing much more and should commit to common institutions and laws.

Four papers deal with water resource management at the national level. Gete Zeleke (abstracted in Annex A) is concerned with Ethiopia, S. Rademeyer (Chapter 12) with South Africa, Kwame Odame-Ababio with Ghana (Chapter 13), and Hodson Makurira and Menard Mugumo with Zimbabwe (Chapter 14). These papers reflect the major differences that pertain across African countries. At one extreme, Rademeyer shows that South Africa has very limited water resources that it manages in a rigorous and sophisticated manner. Water storage capacity per capita is relatively high compared with other African countries; water management institutions are relatively sophisticated and all but one of the major river basins are interconnected. Water is considered to be a national resource, with each individual guaranteed a minimum amount for domestic and personal use. Significant amounts of human, financial and infrastructure resources are invested in water resource management and in the regulation of water use. Ghana has taken a similar approach, investing in large-scale water storage and a national system for water monitoring and management In 1998, Zimbabwe adopted a new water law that sought to reverse decades of discrimination in water allocation that had been built into previous water acts. The new law is designed to provide for more inclusive involvement of stakeholders in water management, greater efficiency in water use entitlements, water permits to replace water rights, catchment water use plans, and minimum allocations of water for the environment. Unfortunately, the new institutions require additional resources at the very time that both national and donor resources have become very restricted. Ethiopia appears to be an extreme case of undercapacity in water resource management (Zeleke, workshop communication). Although the country receives relatively plentiful rainfall, it has almost no water storage capacity and invests very little in water or watershed management. Ethiopia is very dependent on donor funds, which are directed much more to emergency relief than to long-term development and conservation of resources.

The presentations by Brent Swallow, Leah Onyango and Ruth Meinzen-Dick (Chapter 10), Robert Hope (abstracted in Annex A) and Nontokozo Nemarundwe (Chapter 11) focused on water resource and watershed management at the catchment and village scales; the scales at which social–hydrologic interactions are perhaps most evident. Swallow, Onyango and Meinzen-Dick develop a conceptual model of catchment property rights, and apply that model in an analysis of the effects of property rights on management and use of resources in the badly degraded Nyando basin in western Kenya. Four general implications can be drawn from their conceptual framework and analysis: 1) land tenure, settlement patterns, population density and land-use patterns are closely related by common historical processes; 2) land, water and tree rights are often closely intertwined in African cultures; 3) moderately sized catchments often contain a wide range of overlapping and possibly competing property rights; and 4) the parts of the landscape that have the greatest impact on overall catchment management – especially riverine areas, boundaries and roads – are often the most contested and have the most ambiguous property rights. Hope presented a model of blue–green water allocation and valuation, and applied that model to the Luvuvhu catchment in the Limpopo basin of southern Africa. His analysis relates people's livelihoods to the evaporation and transpiration of water (green water), noting that the relatively poor are particularly dependent on green water for generation of income and subsistence food production. Nemarundwe (abstracted in Annex A) described the flexible and overlapping institutions for water governance that pertain in a single village in Zimbabwe. This detailed village case study shows the diversity of both water resources and the institutional arrangements that exist within particular villages, which have rules that are well known to everyone in the village, but that are implicit, flexible and nuanced. Access to water resources is based on appropriate use, with the understanding of appropriate

use varying across water uses. This case study shows that many African villages have the capacity to develop sophisticated water management regimes, although the details of these regimes may not be transparent to outsiders who look for well-defined boundaries, codified rules and formal enforcement mechanisms.

Presentations by Jean Bonnal (Chapter 9) and Zitan Abdellah (abstracted in Annex A) focused on participation in watershed management. Adbellah describes the participatory approach that was taken to the development of sustainable agriculture in the Tassaout basin in the high Atlas Mountains of central Morocco. The pilot watershed management project put in place in Tassaout between 1996 and 2002 achieved a high level of success owing to the novel way in which it was implemented with the following features: 1) taking account of both hydrologic and ethnic considerations in defining the areas of implementation; 2) recruitment of a local team of organizers who were not overly constrained by existing administrative structures; 3) emphasis on novel approaches to agricultural practices that would conserve soil and water; and 4) a new spirit of cooperation between forestry administration and the local population. Bonnal analysed the socio-political context for participation in watershed management. Decentralization and devolution of authority are necessary for real increases in local participation: decentralization in turn requires attention to institutional and organizational issues within the context of the local political environment. For watershed management best to address local, regional and international concerns, three things are required: 1) sharing of information; 2) strengthened capacity in local organizations; and 3) stronger dialogue between local and national organizations.

Three papers deal with interactions between dryland agriculture and watershed resource management. F.T. Mugabe (Chapter 6) focuses on the effects of land use and land management on groundwater and reservoir recharge in the Romwe catchment in semi-arid southern Zimbabwe. Analysis of detailed data collected throughout the catchment over the last ten years shows that land management has large effects on both groundwater recharge and surface runoff. Groundwater recharge is highly variable across space and time, with most recharge associated with particular rainfall events in parts of the landscape where surface water accumulates, especially above contour ridges and along surface drains. The amount of runoff generated during storms is affected by cultivation, which increases infiltration and reduces runoff. Anja Boye and Alain Albrecht (Chapter 5) described the effects of agroforestry and conservation farming techniques on infiltration and runoff in the farming systems of western Kenya. Experimental results indicate that improved fallows can increase infiltration and reduce soil loss significantly, with the amounts and the statistical significance depending on the soil type. The no-tillage option had surprisingly little impact on infiltration and soil loss. Johan Rockström and Kurt Steiner (Chapter 7) focused on the technical innovation of conservation farming and its ability to increase the availability and productive use of water in agriculture. Trials in semi-arid parts of the United Republic of Tanzania, Madagascar and the Sudan show that conservation farming can generate large increases in agricultural production and water use efficiency. Production and efficiency effects are largest, however, when conservation farming is combined with soil fertility interventions. This supports the conclusion that soil fertility and water conservation are complementary techniques that have the potential to increase drastically both agricultural production and water use efficiency in semi-arid Africa. P. Mbile *et al.* (Chapter 8) explore the links between watershed function and the structure of cocoa agroforests in a humid part of Cameroon. Survey evidence from 30 cocoa agroforests suggests that the cocoa farms now contain large numbers of indigenous trees that provide little direct

economic value, but have significant value in terms of biodiversity conservation, rainfall interception and infiltration. The authors hypothesize that many of these trees will be removed as farmers seek to diversify away from cocoa. These changes are likely to have significant effects on water balances and watershed function.

THESE PROCEEDINGS

Materials prepared for (and during) the workshop are presented in this volume. This includes the fifteen full text papers made available by the authors (Chapters 1 to 15), as well all the abstracts of all the communications that were presented at the workshop (Annex A). Given the variety of topics dealth with during the workshop papers and abstracts were grouped in five parts as follows: FAO watershed management review (Part 1), links among land use, tree cover and water in Watersheds (Part 2), farming and watershed management and in Sub-Saharan Africa (Part 3), social factors in watershed management (Part 4), and African experiences in watershed management (Part 5). Group work findings and workshop conclusions are presented in Part 6. Additional information is presented in (Annexes B-D).

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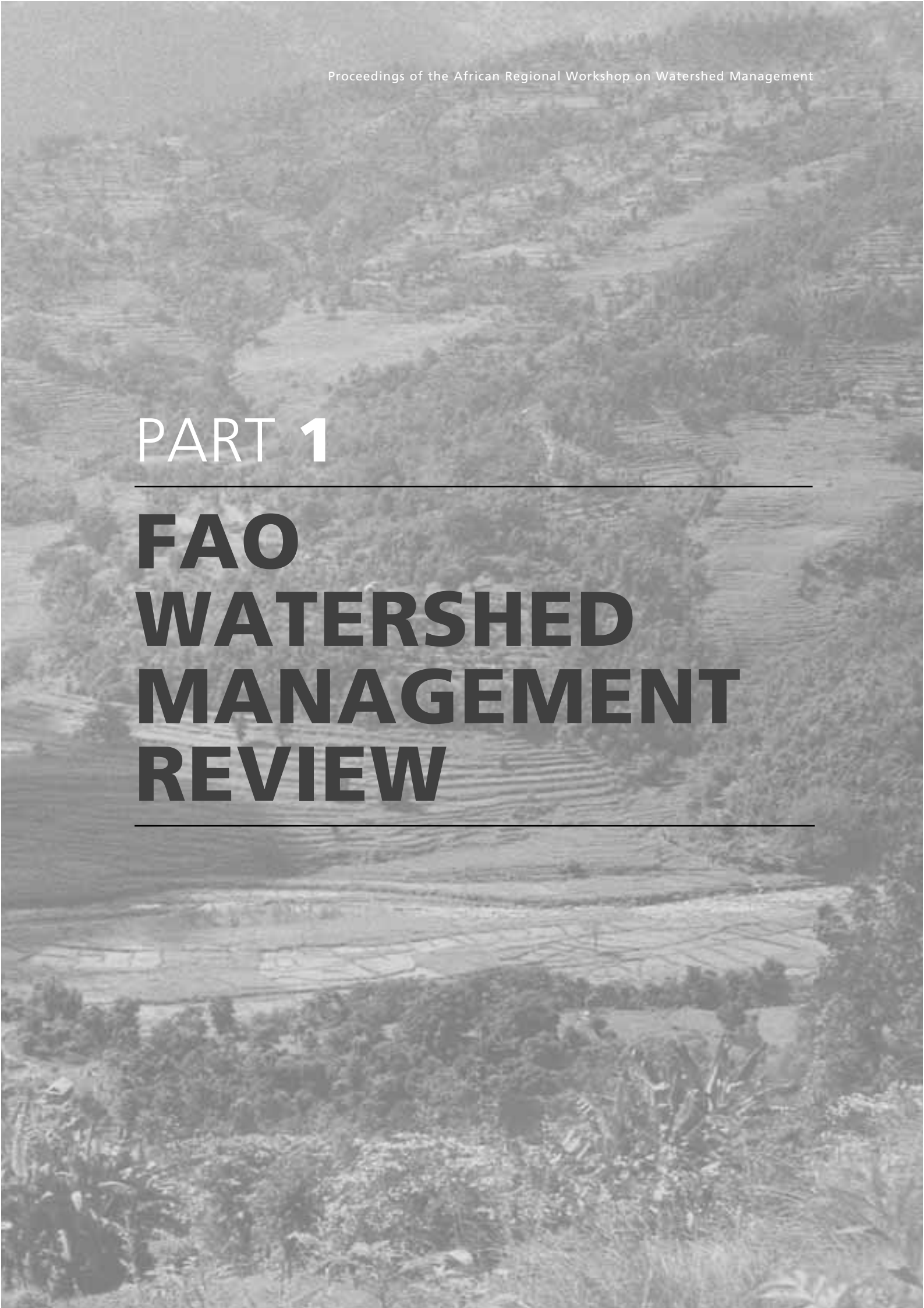

PART 1

FAO WATERSHED MANAGEMENT REVIEW

CHAPTER 1
PREPARING THE NEXT GENERATION OF WATERSHED MANAGEMENT PROGRAMMES

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It is clear that much progress has been achieved in watershed management, especially during the 1990 to 2000 period when new approaches and methodologies were developed to promote participatory integrated watershed management. However, no clear picture has been drawn as to what has really been working and what can be done to improve future watershed management programmes. In fact, there has been no systematic effort to review and assess watershed management strategies and approaches at a global scale since FAO did so at the expert meeting held in Kathmandu, Nepal from 25 February to 1 March 1985. Hence, in-depth analysis of watershed management achievements and existing gaps, with particular emphasis on the experiences of 1990 to 2002, is a prerequisite to further development of watershed management programmes.

This paper has been prepared in response to the raising of key issues of major concern to the development of watershed management. It reviews and assesses watershed management activities and provides reliable information on lessons learned and existing gaps. Such information is needed to justify investment in watershed management activities and to focus such activities on the areas where they are most needed. The assessment concept and approaches were designed to respond to the needs and characteristics of different audiences involved in watershed management.

BACKGROUND

Interest in and awareness of the multiple environmental, economic and social benefits provided by watershed management and development have greatly increased in recent decades. This may be particularly true in developing countries where the economy depends predominately on agriculture, but there are also fast-growing urban populations that depend on water and food supplies on an unprecedented scale.

Degradation of natural resources is considered to be the greatest constraint to sustainable agricultural development in most developing countries. It is generally accepted that sustainable use and management of land resources will only be achieved by adopting a system of improved land, water and vegetation management and use based on an integrated approach to land resources development with the direct involvement and participation of the different actors.

Given that watershed management is the implementation of management systems that ensure the preservation, conservation and sustainable use of all land resources, the development of watershed management is recognized as a prerequisite for the sustainable management of land resources and the improvement of upland inhabitants' living conditions. In fact, watershed management integrates various aspects of forestry, agriculture, hydrology, ecology, soils, physical climatology and other sciences to provide guidelines for choosing acceptable management alternatives within the specific social and economic context.

Integrated watershed management through people's participation has become widely accepted as the approach that ensures sound sustainable natural resources management and a better agriculture economy for upland inhabitants as well as the people living in downstream areas.

As a consequence of the attention paid to and the important investments secured for the development of watershed management, much progress has been achieved in this field. However, several issues of major concern, which were raised many years ago, still require in-depth analysis and consultation among all concerned parties for better understanding and implementation of effective watershed management.

The expert meeting on strategies, approaches and systems for integrated watershed management held in Kathmandu, Nepal in 1985 highlighted the threats that environmental and water degradation represent for the livelihood of millions of people, and the related constraints to the development of a healthy agricultural and natural resources base. This meeting, which was organized jointly by FAO, the International Centre for Integrated Mountain Development (ICIMOD) and the East-West Centre, Environment and Policy Institute (EAPI), also identified and recommended relevant action for urgent implementation.

The main actions it recommended can be summarized as follows:
- develop significant policy and programme responses;
- develop national conservation strategies and frameworks to achieve appropriate and comprehensive management of mountain watersheds;
- develop relevant training, efficient applied research and the demonstration projects required to achieve effective watershed management.

In spite of the progress achieved in developing watershed management approaches and application, most of the actions identified 17 years ago are still in urgent need of implementation, even though some of them were proposed with time deadlines; for example, the development of relevant policies and programme responses was projected to be achieved by 2000.

In addition, issues such as people's participation, in which watershed management scientists and practitioners feel that major progress has been achieved, are now being raised by many as requiring further analysis and clarification. Questions that still require satisfactory responses include: What kind of participation are we using? Are we achieving what was expected? and What is missing for the institutionalization of participatory approaches?

Another important issue that many consider to be a major gap in the evolving watershed management concept is the still very limited dissemination and exchange of information on achievements and lessons learned. Owing to various reasons – mainly a lack of adequate

institutional and organizational arrangements – project experiences and lessons learned are sometimes not even shared among concerned institutions of the same country.

In this connection, the World Bank carried out a review of its own watershed management projects in May 2000. The findings of this review of 42 projects, which had a total budget of US$2.37 billion and were implemented between 1990 and 1999, also call for in-depth analysis to identify what has been achieved and what can be done to improve future watershed management programmes.

In view of these issues, an assessment and review of results and lessons learned in watershed management are considered prerequisites not only for providing answers and clarifications of the issues raised but also, and mainly, as an important preparatory stage for the next generation of watershed management projects and development programmes.

ACHIEVEMENTS AND EXISTING GAPS

During the last few decades, watershed degradation has been seen as a serious threat to environmental conditions and to the well-being and survival of millions of people living in watershed and downstream areas. Many countries recognize the importance of upper catchment conditions, and have made reversing watershed degradation a priority.

However, many watershed management programmes have failed to achieve their objectives, mainly owing to the following reasons:

- They focused too much on natural resources conservation.
- They were designed with little attention to human activities and the priorities and needs of people.
- They neglected beneficiaries' involvement and contribution to the planning and implementation of watershed management interventions.
- They were frequently limited in span and scope, and lacked the long-term commitments needed to address underlying causes and long-term management issues in a satisfactory way.

Consequently, new concepts and approaches were developed to reverse watershed degradation and establish an improved agricultural and rural economy. In order to achieve such objectives, social and economic aspects were given particular attention in watershed management programme/project formulation and implementation. In addition, *people's participation* was recognized as being key to the success of watershed management programmes.

Recognizing that the management and conservation of land resources through physical structures, reforestation and other conservation measures would not be sustainable and replicable unless people's concerns were taken into account, the *integrated concept* was developed as a process in which community problems and needs can be considered as an important component of development programmes. People's participation was also recognized as a principal component in all phases of the development of watershed management programmes.

The *participatory integrated watershed management* approach introduced and developed over the last decade includes, in addition to the technical aspects, the economic, social, political and cultural dimensions of natural resources conservation and management. Watershed management has become a multi-disciplinary activity in which appropriate institutional and organizational mechanisms are required for the coordination/implementation of watershed management activities.

The development of concepts and approaches, and the watershed management experiences from many parts of the world now call for further investigation, analysis and consultation among watershed management stakeholders for greater consensus on what has been achieved and on how things could be done better. Stakeholders are stressing the need for a clearer overview of several key issues of major concern to watershed management development.

Although it is generally agreed that integrated watershed management can play an important role in natural resources conservation and improvement of the conditions of upland people, conflicting views on the approaches and methods of watershed management continue to be the subject of concern and controversy.

A quick overview of the last decade's findings and recommendations on watershed management activities outlines a number of key questions.

Are we sharing experiences and lessons learned? It is recognized that significant progress on watershed management approaches and methodologies has been achieved in different parts of the world. However, sharing these results and identifying appropriate mechanisms for disseminating such information are important issues that require urgent action in order to benefit watershed management users/new projects from experiences learned and to avoid the duplication of efforts.

Are we using the appropriate participatory processes? The experience of participatory approaches during the last decade has raised several issues: What kind of participation is taking place? To what extent can participatory approaches be used? Are we overestimating what can be achieved through participatory approaches?

Participatory processes are recognized as primordial in watershed management at all stages, from project identification to the appraisal and implementation of activities. Experiences have shown that one-sided bottom-up or top-down approaches do not work. This leads to the conclusion that no single approach or method can be considered as the most appropriate one, but rather a variety of approaches and methods should be pragmatically used and adjusted according to specific circumstances.

Are the technologies developed producing the desired results? Greater emphasis is being put on the services and benefits that watershed management can provide. Watershed management is increasingly seen as an appropriate vehicle not only for environmental conservation, but also for the improvement of rural livelihoods . In this regard, there is demand for the development of appropriate technologies that can ensure sustainable development and natural resources management. Specific issues are also raised regarding watershed management scale problems, upstream–downstream relationships and the technologies and methodologies needed.

Are project activities sustainable and replicable? There is uncertainty about the sustainability and replicability of the technologies that projects implement. The World Bank (2000) review of watershed management projects raised this concern, stating that "many Bank projects, while able to achieve considerable gains in the short term as a result of an intensive injection of funds and expertise, are neither replicable nor sustainable following project completion".

To what extent have the institutional/organizational and legislative arrangements been developed? Institution building for watershed management has been mentioned as one of the most neglected parts of watershed projects. It is recognized that there is a need for improved understanding and identification of the institutional and organizational arrangements required for effective watershed management. An appropriate legislative framework to support watershed management policies is an important tool that needs particular attention.

Are the expected policies/strategies in place? Recent assessments have shown that although broad environmental policies are in place in many countries, generally no attention has been given to the development of watershed management policies. Lacking or inadequate national policies, strategies and action plans are recognized as principal constraints to implementing sustainable watershed management programmes.

These are some of the relevant controversies and watershed management issues that have emerged from watershed management experiences all over the world, especially those carried out during the 1990 to 2000 period.

In order to achieve effective watershed management, it is necessary to examine state-of-the-art watershed management programmes and concepts. In this context, the review and assessment intends to address the key watershed management issues raised, in preparation for future watershed management projects/programmes.

ASSESSMENT: LESSONS LEARNED AND FUTURE PROGRAMME DEVELOPMENT

The assessment and review of watershed management activities is being conducted with the broad objective of promoting, disseminating and exchanging information on watershed management achievements and existing gaps and providing support for the development of effective watershed management through relevant projects and programmes. It aims to provide an adequate opportunity for all concerned parties to share information and contribute to a better understanding of the current status of watershed management, and to provide awareness raising and the required advocacy and support for the implementation of effective watershed management at the local, national and regional levels.

Based on the in-depth analysis of watershed management activities carried out over the last few decades, with emphasis on the last decade (1990 to 2000), and in view of important events such as the International Year of Mountains (IYM), the assessment/review initiative was developed with the main objectives of:

- assessing and identifying the nature and extent of achievements and existing gaps in state-of-the-art watershed management programmes and concepts;
- identifying lessons learned and principal issues emerging from the experiences of FAO and other relevant organizations, with particular focus on the 1990 to 2000 period;

- identifying guidelines for the formulation and implementation of the next generation of watershed management projects/programmes;
- contributing to implementation of Agenda 21, Chapter 13 (Sustainable Mountain Development) and to the outcome and follow-up of the IYM and the International Year of Freshwater.

The assessment's approach was carefully developed in order to respond to several needs while considering the characteristics of the different audiences involved in watershed management at the global, regional and national levels. It includes:
- stakeholder identification, participation and contribution;
- steps in the assessment development process that allow relevant parties to contribute;
- output that responds to the issues raised by stakeholders.

The following steps were identified as necessary for the proposed watershed management review and assessment.

Consultation: The review/assessment concepts and approaches were discussed in-house. Comments and suggestions were sought from technical divisions involved in watershed management activities.

Investigation: In-depth investigation was conducted to identify whether FAO and/or others had conducted other reviews and assessments on issues related to watershed management activities.

Stocktaking: FAO experiences of watershed management were emphasized, with particular attention on the period 1990 to 2000. Project formulation documents, evaluations and findings, recommendation reports and the outcomes of watershed management events such as seminars, conferences and workshops represent a principal source of information for the assessment. To be in line with the assessment objectives, experiences and information from other relevant organizations were taken into account during this phase of the assessment.

Case studies: Selected case studies treating watershed management issues were identified for in-depth analysis to provide reliable information on state-of-the-art watershed management. By highlighting what does or does not work, the case study analysis can also orient the formulation and implementation of the next generation of watershed management projects. Ongoing work on sustainable mountain development case studies could be a good source of information for the watershed management activities assessment.

Workshops: In order to learn from regional experiences, regional workshops were conducted. Watershed management experts who had been involved in watershed management shared experiences and lessons learned. Workshop participants commented on the outcome of the assessment steps, and contributed to the exercise's findings and recommendations.

International conference: An international conference was planned where key partners in watershed management could discuss the findings/recommendations of the review and guidelines for the next generation of watershed management programmes for dissemination at the global scale.

Dissemination of results: The review and assessment results will be disseminated through reports and relevant Web sites. An FAO Conservation Guide on future watershed management programmes is an outcome of this exercise.

The potential users of the watershed management activities review and assessment include FAO and other relevant international organizations, national institutions/decision-makers dealing with watershed management activities, and watershed management specialists, including researchers involved in watershed management development activities.

Potential uses include: sharing/promoting lessons learned from past experiences; greater streamlining and consensus on the issues raised; raised awareness on the role of watershed management in rural development/poverty alleviation programmes; development of future watershed management plans and strategies; guidance for policy development and formulation of relevant projects/programmes; and orienting research action to identified key issues for the development of watershed management programmes.

The findings and recommendations of the watershed management activities review and assessment will be presented in an FAO Conservation Guide. The results are also available through relevant Web sites.

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CHAPTER 2
REVIEW AND ASSESSMENT OF WATERSHED MANAGEMENT STRATEGIES AND APPROACHES

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The importance of multiple economic, social and environmental benefits derived from land-based resources has increased in recent years. Sound management of these resources is therefore prerequisite to sustainable resource-based production systems. Watershed management, which in essence is the application of land resource management systems, is considered by many to be the most appropriate approach to ensuring the preservation, conservation and sustainability of all land-based resources and improving the living conditions of people in the uplands and lowlands. Integrated watershed management with participation of all the relevant key actors has become widely accepted as the approach best suited for sustainable management of renewable and non-renewable natural resources in upland areas.

WATERSHED MANAGEMENT – A HISTORIC VIEW

Large-scale removal of forest lands by humans in the nineteenth and early part of the twentieth centuries created significant changes in the hydrologic function of watersheds. Downstream flooding occurred more frequently, with subsequent increases in loss of life and damage to infrastructure. Accelerated erosion, produced by changes in the biotic and hydrologic components of natural drainages (watersheds), created unprecedented large-scale siltation of developed lowlands. At the time, the general consensus was that the removal of forest was causing these undesirable impacts. However, the mechanisms for reversing the process through sound scientific management had not been developed.

During the second quarter of the twentieth century, the discipline of forest hydrology evolved from the need for scientific management of the soil and water resources of headwater catchments in order to minimize the flooding and siltation of productive lands and infrastructure in the valleys and plains inhabited by humans. As the importance of rangelands and cultivated lands in the hydrologic cycle and the erosion–sedimentation processes of catchments became known, forest hydrology gave way to the more comprehensive, present-day watershed management.

Over time and in response to changing needs, the scope of watershed management has broadened from the initial concept of technical management of the water resource to an integrated discipline that applies biological, technical, social and economic principles to maintain the productivity of headwater and lowland areas through the scientific management of soil, plant and water resources.

Watershed management in its truest form is the conservation management of the soil, plant and water resources of a catchment to benefit humanity. It involves managing the land and human resources of the drainage in a manner that sustains adequate levels of water, soil, food and fibre production. This form of management requires a participatory integrated approach that includes the various physical, vegetative and human components of areas that range from a few hectares to large river basins.

The watershed part of watershed management implies management of these resources, to the extent possible, within a defined physiographic boundary. From a conceptual perspective, when the boundaries of a management system are defined it is easier to identify and monitor the components (e.g. inputs, storage and outflows) of that system – e.g. the hydrologic cycle. However, from a land management perspective, these physical boundaries are considered to be simply topographic demarcations within political and administrative boundaries that usually overlay a series of watersheds.

The theoretical concept of participatory integrated management of natural resources is difficult to apply. The myriad uses, ownerships, political and social constraints and biophysical systems in large watersheds limit application of the idealistic integrated approach. In practice, large catchments are usually managed according to economic, social and political considerations.

Management of the natural resources in headwater watersheds has the greatest potential for application of the participatory integrated concept. Agricultural, forest and rangelands often represent a potentially significant production resource for local inhabitants. However, the natural physical and biological constraints of uplands often limit productivity compared with lower elevations where major production and population centres are located.

WATERSHED MANAGEMENT REVIEW AND ASSESSMENT OF STRATEGIES AND APPROACHES

Degradation of the natural resources of upland areas has been occurring on the global scale for several decades. In an attempt to reverse this trend, concerned governments and development assistance organizations have been employing watershed management principles since the 1960s. Through these years of development, strategies and approaches for implementing watershed management interventions have changed as the discipline moves forward along the learning curve. By responding to research results, lessons learned, failures and successes, periodic reviews and evaluations, the discipline continues to be dynamic, with adjustment and modification as required to meet changing needs.

During the past decade, the social and economic aspects of watershed management have been given high priority. In addition, people's participation has been recognized as one of the keys to successful management of natural resources (Bendtsen and Sthapit, 1999; Petersen, 1999). The integrated concept has expanded to include community needs and problems as part of a holistic watershed management development scheme.

The last review and assessment of watershed management development strategies and approaches by FAO was held in 1985–1986 (FAO, 1986b). In view of the development changes that have occurred during the past decade, and the period of 17 years since this review, it was

decided to conduct a stocktaking exercise to determine the present status of watershed management development, identify any gaps and formulate guidelines for future development projects/programmes.

Objectives

The overall aim of the assessment was to promote, on the global scale, the dissemination and exchange of information regarding achievements and gaps in watershed management, and to provide future support for effective watershed management projects and programmes. Specific objectives include:

- to conduct a study, on the global scale, of the nature and extent of accomplishments in watershed management;
- to identify major gaps in watershed management strategies and approaches, with focus on the 1990 to 2000 period;
- to formulate guidelines for the next generation of watershed management development projects and programmes.

Procedures

A five-pronged approach was followed to collect information. The first step was to identify key actors involved in watershed management development during the study period. A set of questions designed to provide information relevant to the study was prepared and sent to the key actors. The responses were reviewed and summarized.

The second step was to conduct stocktaking of FAO experience of watershed management development projects/programmes during the 1990 to 2000 period. This process included reviewing project terminal and evaluation reports, proceedings of seminars, conferences and workshops, personal and group consultations, and other information sources.

The third step was selection and review of case studies on completed watershed management projects or programmes. The selected case studies are summarized in this paper.

The fourth step was to convene a series of regional workshops to provide a forum for regional, national and local actors in watershed management.

The fifth and final step was to prepare a summary of the results of the first four steps and to formulate guidelines and strategies for future watershed management development programmes, with subsequent distribution on the global scale.

RESULTS

Initial findings of the watershed management review are presented in the following sections.

Key actors survey

The survey questionnaire was sent to 30 key actors (organizations, agencies and institutions). A total of 18 responses were received: 14 of these provided answers to the questions, and four provided information on contacts and publications (see Table 1).

TABLE 1

Key actors survey: organizations and names of respondents to FAO review questionnaire

CGIAR, Consultative Group on International Agricultural Research.
Ruth Meinzen-Dick, Senior Research Fellow, International Food Policy Research Institute.

CIAT, International Center for Tropical Agriculture.
Joachim Voss, Director-General.

CIFOR, Center for International Forestry Research.
Mike Spilsbury.

CONDESAN, Consortium for the Sustainable Development of the Andean Ecoregion.
Roberto Quiroz.

DANIDA, Danish International Development Agency.
Poul Richardt Jensen, TSA.

DFID, Department for International Development, United Kingdom.
Professor Ian R. Calder, Director, Centre for Land Use and Water Resources Research.

EU, European Union.
Helmut Bloch, M.Sc., Ph.D., Director-General Environment.

FAO, Food and Agriculture Organization of the United Nations.
Kumar Upadhyay, CTA, and Prem N. Sharma, Consultant.

IADB, Inter-American Development Bank.
Roberto E. Quiroga, Senior Economist.

ICIMOD, International Centre for Integrated Mountain Development.
Roger White.

IWMI, International Water Management Institute.
Frits Penning de Vries.

NUS, National University Singapore.
Professor Roy E. Sidle, Department of Geography.

PROMIC, Programa Manejo Integral de Cuencas.
Roberto Mendez and **Ana V. Heredia**.

TMI, The Mountain Institute.
D. Jane Pratt, President.

UNESCO, United Nations Educational, Scientific and Cultural Organization.
Dr Mike Bonell, Chief of Section, Division of Water Sciences.

UNU, United Nations University.
Libor Jansky, Ph.D., Senior Academic Programme Officer, Environment and Sustainable Development.

World Bank.
Norman B. Piccioni, Sr. Agric. Economist LCSES.

The results of the survey were summarized according to three main topics: 1) major issues that require further investigation and in-depth analysis; 2) major constraints – past and future; and 3) challenges, needs and opportunities for future effective watershed management. A summary of the responses is presented in the following.

Major issues that require further investigation and in-depth analysis include: pathways of water, sediment and nutrients in response to land management; appropriate sustainable natural resources management options; cross-scale biophysical and socio-economic issues; the dynamics of natural resource use intensification; and multi-institutional approaches to acting together in watershed management projects.

The above suggests that there is a need to establish linkages among central governments, local governments and civil organizations, together with a more coordinated and effective international aid effort. It is also necessary to find ways of: appraising the ecosystem services of catchments and the damage to on- and off-site environments from the viewpoints of farmers and society; creating options for catchment development in which all stakeholders gain (including through intersectoral or downstream–upstream transfers); and dealing with trade-offs and conflict. Staff require careful on-the-job training, particularly in dealing with people, and the role of youth in watershed management should be investigated in greater depth.

In its response, the World Bank stresses that "…finding the right way to address the policy framework and the sets of incentives that affect natural resources in watersheds (water, land, forests, etc.) is key. Also, issues of governance (local vs. central; upstream users vs. downstream users; community organization; mechanisms for water allocation and property rights) are central themes. The challenge is not a conceptual investigation of these issues, but rather the political will to move in the right direction."

Major constraints for the present include reconciling the needs of resource-based planning with "people-first" objectives, the weak national research systems in developing countries, and the need to develop central and/or local government/community commitment and the political will to allocate appropriate staff. Watershed management is about managing conflicts. Thus, lack of governance is a major constraint.

In addition, process-based concepts and models are lacking across many spatial scales. There is insufficient understanding of the reasons why some major catchment development programmes are working well while others are not – in other words there is an inability to replicate successes. Lack of sustainable financial and institutional mechanisms was identified as an additional "Achilles heel" of watershed management projects.

Major constraints for the future include the present-day constraints continuing. Additional constraints for the future are related to limited access to freshwater, with worsening of the environmental situation as water quality and flooding become more important in highly settled areas; upstream–downstream issues are most important where water supply limits productive land use.

There is also a need to improve project design and management in order to increase the participation and commitment of key actors. A major constraint for catchment development is often the willingness/capacity of national governments to act, e.g. with respect to land tenure and payments for ecological services of catchments, including that of water supply.

Challenges include adapting decision support tools for different biophysical and socio-economic conditions, and documenting experiences and lessons learned in order to become the leading organization in this field.

Needs include a specific focus on water and sustainability as they apply to protection of human health and the environment, capacity building of youth through training and rural school curricula appropriate to their environments, and demonstrations of the usefulness of methodologies for science-based project design and monitoring and evaluation.

Opportunities include recognition of watershed management's significant role as one of the most important mechanisms to address global climate change and the high negative impact of desertification in a sustainable way. There is also increasing public understanding of the importance of managing watersheds. Information collected during the 1990s will make it possible to assess performance more effectively and compare methodologies and approaches based on actual results.

FAO experiences

The second step of the study was to conduct stocktaking of FAO experiences with watershed management development projects/programmes during the 1990 to 2000 period. The process included review of project terminal and evaluation reports, proceedings of seminars, conferences and workshops, personal and group consultations, and other information sources. The results of the stocktaking exercise are presented in the following according to major topics.

Evolution of watershed management methodologies/approaches over the past decade, 1990 to 2000

The top-down approach, which was prevalent during the 1970s and 1980s, has given way to the grassroots, bottom-up approach. However, it appears that neither of the extremes is the recipe for success. The correct, sustainable approach is somewhere in between. The proper mix would include factors such as biophysical, social, cultural, financial and political considerations for all concerned stakeholders.

The emphasis of watershed management has changed from development of upland water and soil resources to all-encompassing management of upland natural resources, communities and associated infrastructure, with diffusion of the focus and prioritization of objectives. Community development has become a part of many integrated watershed management projects, with subsequent lower priority being set for management of soil and water resources. Technology for soil and water conservation on sloping lands has changed from mostly physical methods to emphasis on biological and biophysical treatments.

To some extent, the transfer of technology has shifted from a major emphasis on training professionals to training the local inhabitants who are directly involved in implementing development activities. Some of the more recently developed technologies are being used for planning and decision-making; e.g. Geographic Information Systems (GIS), global positioning systems (GPS), satellite imagery, management decision-making tools, advanced monitoring and evaluation, and participatory models.

FAO's role in sharing experiences and lessons learned in watershed management

Owing to the significant decrease in FAO field projects and the associated decrease in FAO field personnel, national meetings and technical backstopping, the sharing of technology and experiences at the national and local levels has decreased. At present, the sharing of experiences and lessons learned consists primarily of attendance, and sometimes presentations, at high-level conferences.

There is a need for networking of watershed management technology on the global scale. FAO is lagging behind as other organizations set up their own systems. This is an excellent opportunity and time for FAO to take the lead role in fulfilling this gap.

The International Year of Mountains, 2002 provided FAO with a forum to share its experiences in upland watershed development. Regional and national conferences and workshops have also provided fora for information exchange between FAO and national-level professionals. The regional participatory watershed management training project in Asia (1996 to 1999) provided a forum for information exchange between FAO and participating countries. Implementation of the second phase of this project could provide the mechanisms for a sustainable network in Asia, with links on the global scale.

The existing FAO conservation guides are being formatted on CD-ROM for distribution. However, some of these documents were prepared several years ago and may need revision to reflect the current trends and status of technology development and transfer in watershed management. The most recent FAO conservation guide that specifically addressed watershed management was prepared in 1996. Periodic articles on state-of-the-art watershed management topics in journals such as *Unasylva* have provided a mechanism for disseminating information on the global scale.

Decentralization seems to have created a technology transfer gap between FAO headquarters and regional offices. With respect to forestry and watershed management, the flow of technical information between the regions and the relevant central office is lacking. This particular initiative has shed some light on this issue. The causes are most likely multiple and the solutions complex. A detailed problem analysis with subsequent solutions is warranted.

Participatory processes in the planning and implementation of watershed management activities

Global experience has shown that there is no universal model for participatory planning and implementation of watershed management activities. There is a process that would, in most cases, have similar steps. However, this process – which should include all levels and steps of

the participatory process, e.g. planning, design and implementation with all concerned stakeholders – has not been well defined. Bits and pieces of the process have been identified by various projects. The complete participatory process for watershed management needs to be mapped out in a logical manner, tested and refined.

Experience has shown that empowerment of the main stakeholders in watershed management projects/programmes to plan and implement appropriate activities is essential if a project/programme is to have any chance of sustainability. For example, regardless of good intentions, it is not enough for a project to form a community conservation committee at the grassroots level – in isolation from local governments – plan and start interventions, provide technical, financial and other required inputs to the end of the project and then expect the government to make the project sustainable by providing the required inputs into the future. This is a recipe for failure.

Participatory research methods such as participatory rural appraisal, which have been developed and employed on a wide scale in watershed management projects, have sometimes been a good instrument for initiating the participatory process. However, owing in part to the inherent nature of rapid data collection, subjective questions and answers and limitations on statistical analyses and the subsequent extrapolation of findings, the data generated by these rapid survey methods have limitations for use as baseline data for future assessment of project success. In addition, these participatory appraisal methods are only one part of the participatory process. Participatory appraisal methods, if used, should be conducted in proper sequence as part of the overall participatory process.

Participatory approaches and institutional considerations

The pendulum is swinging in support of empowering people with regards to the conservation of natural resources. There are several reasons for this, one being that past endeavours by governments to solve natural resources degradation problems on their own have for the most part been unsuccessful in terms of sustainability. Second, most national governments do not have the human or financial resources for the countrywide mitigation of natural resource degradation. Throughout the world there are examples of successful, sustainable resource conservation being carried out by local communities that have been empowered to manage their land-based resources.

Change is also occurring, albeit slowly, in governments. New policies are being implemented that permit and encourage people's management of their natural resources, e.g. land tenure, user rights, water rights, crop tenure, formal recognition of community groups and committees, privatization of communal lands, rights to the income generated from these conservation activities, etc.

The participatory process requires an active, well-trained field-level extension service in sufficient numbers to carry out watershed management activities on a large scale. The extension component is usually a weak link in the development process.

Gender issues

Review of past FAO projects revealed that gender issues have been a part of watershed management projects. However, the extent to which these issues were addressed has varied and the recommended changes have not always been made. FAO has promoted the involvement of men and women in implementing watershed management activities since the early 1970s. Through time, the importance of directly involving women in these activities has grown. The degree of success of women's involvement has varied for many reasons, including the following:

- *Inadequate project design:* All of the projects reviewed from the 1990 to 2000 period included component(s) for women. However, most of the inputs provided for these activities were minimal compared with other interventions. In addition, the designs addressed only parts of the gender issues in rural environments. Consequently, most of these activities were inadequate in terms of addressing key gender issues.

- *Cultural and social constraints:* Experience has shown that cultural and social constraints are limiting factors regarding rural women's involvement in project activities. Regardless of the level of inputs, these issues have to be considered and project activities designed to fit the norms for a particular rural setting.

- *Policy and legal constraints:* If there is no supporting policy and legislation, the involvement of women in watershed management projects will continue to be limited.

As the empowerment of people movement moves forward, the inclusion of women in the decision-making process is a prerequisite to sustainable development in rural environments.

Impacts of watershed management technologies

Watershed management technologies have proven to be effective for mitigating erosion on sloping land, stabilizing landscapes, providing clean water, and stabilizing – and in some instances improving – agrarian production systems on the small to medium scale. With modification, these existing technologies can be used successfully in most terrestrial environments inhabited by humans. The degree of success of watershed management interventions is primarily a matter of the will of the people and the scale of the activities.

Regarding the *upstream* effects, examples exist throughout the world where upland resource conservation activities have been successful on the micro and macro scales; e.g. micro- to meso-scale activities in Honduras, the Philippines, China, Thailand, Burundi, Nepal, Pakistan, Sri Lanka, India, Bolivia, Peru and other countries, and the macro-project in Santa Catarina, Brazil.

Regarding the effects *downstream*, the impact of upland watershed management activities on downstream water quantity, quality and siltation remains a controversial issue, partly because of economies of scale, and partly because of difficulties in predicting with reasonable accuracy the results of these activities. Until the magnitudes of natural and human-induced erosion and subsequent sedimentation can be quantified with reliability in a watershed, the controversy will remain regarding upstream effects on downstream infrastructures. The same applies to the quantifiable affects of land use on the hydrologic cycle and water supply and quality.

In the meantime, downstream infrastructures such as hydroelectric and/or irrigation dams are being constructed for hundreds of millions of dollars. However, in the past, when watershed management activities were to be carried out to mitigate downstream siltation of these structures, at best a few million dollars were provided to treat all of the contributing upland areas. In many catchments, the upland areas are in degraded condition before the dam is constructed, so implementing small-scale watershed management interventions is like putting a band aid on gangrene; furthermore, the results of poverty-level inputs are poverty-level outputs.

Sustainability and replicability of watershed management technology

The interpretation of *sustainable* in the context of watershed management interventions is a matter of perspective. Many interventions at the community, household and farm levels have continued after the project terminated. For example, woodlots were still being managed years after projects ended in Pakistan, Nepal, Myanmar, Thailand, India and the Philippines. The same applies to terracing works that have stabilized hillsides and improved agriculture production in China, Nepal, Thailand and Honduras; biophysical gully erosion control treatments that have stabilized gully cutting on sloping lands – structures that were built 15 to 20 years ago are in place and functioning as an energy modifier on the landscape, which was the original intention; and simple low-tech water supply interventions that continue after projects finish. The development process has provided many examples of low-tech and low-cost upland interventions being more sustainable than high-tech, high-cost ones.

Two key factors regarding the sustainability of watershed management interventions are financial and institutional stability/instability. As stated by some of the contributors to this assessment exercise, the "tragedy of the commons" continues to be a problem. Experience has shown that the political, social and user rights issues on common lands must be solved before interventions are sustainable.

The technical solutions available for managing soil and water resources are *replicable*, with modification to fit most landscapes inhabited by humans. These techniques are being used throughout the world. The degree of replication depends to some extent on the degree of technical skills and investment required to implement a technique. For example, high-tech, high-cost torrent/landslide control is replicable to most sites. However, the scale of these interventions is limited by the technical and financial resources available. Whereas, low-tech, low-cost interventions at the community and farm levels have potential for replication on the large scale if local technical skills are available and people are willing to implement the activities.

Important scale factors for upscaling from site, to watershed, to basin, to region include institutions, finances, and cooperation and coordination of all concerned parties. Important factors for out-scaling from plot or demonstration site to local farms and communities include biophysical considerations, finances, and the capacity of local institutions.

Development status of institutional/organizational arrangements, policy and legislative mechanisms

Watershed management is an integral part of natural resources management in many countries; more so today than ten years ago. Some countries give it more attention than others. In Asia and the Pacific and in Latin America it has been institutionalized into existing forestry and agriculture line agencies. The degree of institutionalization varies, from one or more professionals in watershed management such as in Bhutan or the Lao People's Democratic Republic, to watershed management units or divisions such as in Myanmar, Nepal, Honduras and the Philippines. Institutionalization of watershed management in Africa has been slow to develop. The reasons for this lag are beyond the scope of this exercise.

Policy and legislation that support participatory watershed management remain major issues. Governments have been slow to respond to the need for changes in existing and new policies and legislation that enhance upland inhabitants' opportunities for sustainable participation in natural resource conservation interventions. However, some progress has been made, for example: 1) the granting of user rights for communities and households on government lands in Asia, Africa and the Americas; 2) many countries' enactment of tree crop tenure rights that permit individuals or groups to harvest and market products from trees that they themselves have planted (Nepal, Bhutan, Pakistan and other countries); and 3) formal recognition of local watershed resource conservation development groups/committees.

Training and education

Watershed management training and education programmes have progressed significantly during the past decade. The results of a study by Brooks (FAO, 1992) of the Asia and Pacific region indicate that there are many talented professionals. The study also pointed out that there are excellent education institutions in the region. None of the respondents to the global survey stated that there was a dearth of well-trained professionals. The Brooks study pointed out the need for training/education of all the key actors, from policy- and decision-makers to field-level technicians and villagers who are implementing watershed management activities.

The regional FAO watershed management training in Asia project (FAO, 2000) indicated the need for training in participatory methods and interpersonal skills at all administrative, professional and technician levels.

The major training constraint that surfaces in all the study reviews is the need for more emphasis on well-designed training programmes for local government staff and for the villagers who are directly involved in implementing field-level activities (FAO, 1996; Dent, 1996; FAO, 1999).

Evaluation of FAO projects

Eight FAO projects with a watershed management theme that were implemented during the 1990 to 2000 study period were evaluated in the context of the stocktaking part of this study. Terminal and evaluation reports were reviewed and evaluated according to the following criteria:

- scale of operation;
- participatory approach;
- project design;
- major constraints;
- sustainability indicators;
- training;
- technology;
- government capacity.

The results of the project evaluation indicate that all of the projects had a community- or group-level participatory component. Project design was unsatisfactory in two projects, with satisfactory performance for the others. None of the projects were rated highly satisfactory. The major constraints varied, but were common to the constraints that have been identified in this overall assessment exercise. Evaluation of project training components indicated a trend towards more emphasis on the training of local-level technicians and villagers. All of the projects had social and biophysical technical components. However, indicators of the performance of these technologies were insufficient for evaluation. Government capacity ranged from unsatisfactory to satisfactory. In some projects, government performance was not clearly defined. Sustainability indicators were not clearly defined in most of the projects. In addition, these indicators were not of sufficient scope and detail in any of the projects to provide clear evidence of sustainability.

Analysis of the results of the FAO project evaluation identified some points that may need attention for the improvement of future projects. These points are the following:

- Project design is lacking: e.g. overdesign in terms of expected outputs; unclear objectives; and less than comprehensive design (i.e. a design that includes the required inputs for all of the key actors in the project [FAO, 1991]).
- Performance indicators need to be comprehensive and clearly defined.
- There is a need for monitoring and evaluation procedures at the project and agency levels that clearly link performance with objectives.
- There is a need for sustainability indicators that are clearly defined and linked to project objectives.

Comparison of major watershed management development issues: 1986 and 2002

During 1985/1986, FAO conducted a study on the problems of watershed management in Asia and the Pacific (FAO, 1986a). One of the outputs of this study was identification of major issues and constraints with respect to implementing watershed management development projects and programmes. These major issues and constraints were used as a baseline for comparison with the major issues and constraints that were identified in the current study. The results of the comparison are presented in Table 2.

TABLE 2

Comparison of major issues and constraints, 1986/2002

	1986	2002
Policy, legislation and regulations	The concept of watershed management (WM) had not been introduced into upland strategies or national development policies	WM has become an integral part of upland strategies in many countries
	Coherent policies to promote good WM were inadequate	Some improvements in policy, but it remains a major issue
	Inadequate coordination policies	Coordination remains a key issue
	Legislative and regulatory measures emphasized policing for enforcement	In some countries, enforcement is now being given less importance than empowerment
Institutions and organizations	WM activities were implemented through forest and agriculture departments promoting the formation of separate WM units within government technical sectors	Experience indicates that this approach is preferable to multi-agency responsibility: separate WM departments are not necessary to achieve success; and well-trained WM staff are needed at all levels
Problem identification, programme planning and project implementation	Diagnostic methods were needed for rapid assessment of biophysical and social parameters	Rapid rural appraisal method developed and used globally
	Scope of WM activities was often not clearly defined	Failure to define scope of WM activities remains an issue although further diffusion of objectives and activities has occurred, with inclusion of integrated rural development
	WM planning methods overemphasized biophysical elements and inadequately considered social and cultural issues	Social and cultural issues have become an integral part of WM planning
	Inadequate economic analysis of WM programmes	Economic analysis models remain inadequate
	Absence of operational guidelines to overcome conflicts between project objectives and administrative organizations	Little progress on making operational guidelines
Monitoring and evaluation	Monitoring often started after, rather than before, projects started	Pre-project monitoring is still rarely carried out
	Monitoring was often inadequate to evaluate achievements and outputs	The advent of verifiable indicators in project design has improved monitoring and evaluation
	Social and cultural factors not covered	Project design considers social and cultural factors
Training and education	Professionals and technicians in WM lacked broad perspective	Good progress, but they still lack people skills
	Curricula copied from external sources, with limited application to local conditions	Many institutions have modified curricula to fit local conditions
	Emphasis on university training, with lack of training for field workers	Emphasis now on training field workers, but training of local people is lacking
	WM was mostly ignored in primary and secondary education	Conservation of natural resources is taught in many elementary and secondary schools throughout the world
	Hardly any planning for development of technical personnel in most countries	Still inadequate technical personnel planning

TABLE 2 - continued

	1986	2002
Research and demonstration	Relationships between technical and social benefits of WM were not clearly understood	Remains an issue
	Causes and effects of watershed degradation in highly populated watersheds were not fully understood	Remains an important issue
	Scarcity of well-designed demonstration watersheds	Demonstration watersheds established, but of little use because of unreplicable levels of inputs and other factors
	Need for linkages among research, demonstration, extension and educational organizations	Remains an important issue
Awareness raising	Inadequate public awareness campaigns	Public awareness campaigns are an integral part of conservation education worldwide
	NGOs were not being used effectively for awareness raising	NGOs are involved in all aspects of WM
Extension	Extension networks were one of the weakest links in WM	Still an issue, although there is more resource conservation and WM extension in many countries
	Majority of extension workers had inadequate training in conservation extension	Training of extension workers is common in many countries
	Weak linkages among extension, research and training	Remains an issue
People's participation	Large deficiencies in methods used to ensure participation	Participatory processes widely used. However, the total process, including all stakeholders, has yet to be well defined
	Unsatisfactory legal, institutional and organizational approaches to involving local residents in project planning and implementation	Remains an issue, and is a key topic being considered by development practitioners
	Land tenure was a major constraint to community and farmer participation	Significant progress, as rural people have gained more user rights, land tenure and crop rights
	Community-owned land was rarely well managed	Remains a key issue in most of Asia. Reasons for poor management of community land have been documented, but little implementation progress
Investments	WM is a long-term process needing long-term investments	Donors and governments are aware of the need for long-term commitments
	It was seen as unfair to expect upland communities to bear costs of WM when most benefits were enjoyed by lowland people	Remains controversial, but note recent movement towards payment to upland dwellers for environmental services provided to lowlanders

Source: 1986 issues paraphrased from FAO, 1986b, Chapter 6 – Issues and constraints.

Some of the issues and constraints identified in 1986 remain important today. Some of the institutional, administrative, project planning and research issues listed in the 1986 study have been identified in this current study (Table 2). Progress has been made on several issues and constraints. For example, policy and legislative reform is occurring. Improvements have been made in training and education, awareness, extension, people's participation, and monitoring and evaluation (Table 2).

CASE STUDIES

A literature search was conducted for case studies that had been prepared for projects with watershed management as a major component. Several case studies were reviewed (Dachanee, Lakhaviwattanakul and Kalyawongso, 1996; Hoang and Nguyen, 1996; Lim Suan and Rosario, 1996; Rice, 2000; and Warren, 1998). The following two case studies were selected for presentation in this paper: the Begnas Tal and Rupas Tal Watershed Management Project (BTRT), Nepal (Bogati, 1996) and the Project Land Management II in Santa Catarina, Brazil.

BTRT, Nepal

The Begnas Tal (lake) and Rupa Tal (BTRT) watershed management project was funded and implemented from 1985 to 1994 by the international NGO, Cooperative for Assistance and Relief Everywhere (CARE). A case study of the project was conducted as part of the FAO regional project on participatory watershed management training in Asia.

The BTRT watershed area comprises about 173 km^2 of land area that includes two main lakes and three minor lakes. The area is about 10 km east of Pokhara in western Nepal. The population is about 31 000. The terrain is hilly with gentle to steep slopes. The area is rural with an agrarian economy. The nearby town of Pokhara is the major population centre of the area.

In the project area, seven village development committees (VDCs) were established and used as the primary mechanism for implementing participatory methods. The local people were involved in planning, implementation, follow-up and maintenance of individual and community watershed resource activities. Watershed management technicians who were part of the external support served as technical facilitators. Community development conservation committees (CDCCs) were organized to ensure people's participation in interventions that were relevant to their particular needs. Every household in the community was represented on the CDCC. The participatory process began with formation of a CDCC, which in turn identified its problems, prioritized its conservation needs and presented these to the VDC and the project office for consideration. At the end of 1994, 100 CDCCs were in operational status. As the project progressed, the need was recognized for a third level of communication and decision-making at the community level. Consequently, a community development board (CDB) was formed at the village level to facilitate communication between the VDC and the CDCC. All members of the VDC and the chairperson of the CDCC are members of the CDB. The end result of this process was a participatory communication pathway of CDCC to CDB to VDC to facilitating agency.

Agricultural diversification interventions have minimized the risk of crop failure and enabled farmers to earn income throughout the year. The average farmer now grows about six kinds of fruits, five different fodder crops, and cereal crops.

Following initial education and implementation by the project, with people's participation, management of natural forests was handed over to the local users. The end result is denser forest lands.

Several conservation farmers adopted improved agriculture practices, which they share with their neighbours. They have set up demonstrations on their farms, and have converted many followers. Homestead agroforestry plots and kitchen gardens provide sources of income. Cash crops such as coffee, pineapples, oranges, cardamom, broom grass, vegetables and other fruits are sold at local markets.

Local women are active in forest management and conservation farming activities, and are fully involved in the decision-making process. Three major factors that facilitated active participation of women were: a clear prospect of benefit sharing; support from their families; and the small size of the CDCC.

Overall, the project was considered a success. The participatory model developed in the BTRT area was used by other development projects in Nepal; e.g. the FAO Shivapuri watershed management and fuelwood project. According to Bogati, the participatory model and many of the activities that were implemented during the life of the project have continued after the end of international assistance.

The major reasons for success of the project included:
- clear and transparent decision-making procedures by project management;
- clear and simple guidelines and flexible operational procedures to facilitate people's participation in watershed management;
- well-defined programmes, budgets, plans, implementation procedures and benefit sharing mechanisms;
- integration of a wide range of diversified watershed management activities, and guarantee of benefits;
- strong motivation among project staff.

The main lesson learned by the project are as follows:
- Interest groups for women should be formed for income-generating activities.
- Indigenous technology for the conservation of watershed resources should be evaluated before external technology is imposed.
- Training on leadership skills for local users is needed.
- Training of local users on maintenance of activities is needed.
- Mid-level field technicians should be oriented in project goals, and receive refresher training in watershed management subjects.

Santa Catarina, Brazil

The Land Management Project in Santa Catarina was implemented from 1995 to 1999 with World Bank funding. The project objective was to safeguard farmers' incomes and natural resources by increasing agricultural production and income for about 81 000 mostly small-scale farmers, by promoting the adoption of sustainable, modern forms of land management and soil and water conservation, and mitigating existing upland land degradation.

Project interventions centred on the introduction of land management methods that would improve soil and water conservation and the disposal of animal, human and pesticide wastes in 520 of Santa Catarina's 1 700 micro-catchments. The major components included agriculture

extension, research, incentives to share the costs for implementing new methods with farmers, support for reforestation of critical parts of the landscape, rural access road improvement, land-use planning and mapping, environmental monitoring, training assistance to State parks and biological reserves, and project administration.

The overall project performance was rated as successful. Owing to the good performance of the project and the apparent sustainability of activities, a second project is being considered, which incorporates the successful components and lessons learned from the original project.

A case study was conducted on the Lajeada Sao José micro-watershed (FAO, 2002), which was one of 520 micro-catchments included in the project. This micro-watershed was chosen for study to illustrate the positive effects of improved land management on land degradation, agricultural production, water quality, and upstream and downstream beneficiaries. The watershed is about 7 744 ha in size, with elevation of about 659 m and slopes ranging from 0 to 20 percent. Total population of the watershed is estimated at 28 375, with a distribution of about 1 057 people in the upland rural area and 27 300 in the downstream urban area.

Improved land use and management (zero and minimum tillage, crop rotation, cover crops, green and organic manure, level terracing and forestation) produced on-site benefits such as reduced soil erosion. Crop production increased (maize by 40 percent, soybean by 21 percent, beans by 3 percent and tobacco by 32 percent) with subsequent increases in farm income. Owing to the downstream environmental monitoring of stream flow, the project was able to determine some of the offsite benefits of the land management interventions. One important benefit was the reduction in suspended sediment levels by 69 percent. This reduction represented a savings in water treatment costs for domestic supply of about US$2 445 per month. This study illustrates that investment in upland watershed management-related interventions can produce downstream economic return.

Some of the important lessons learned during implementation of the project at the study watershed are as follows:

- Active participation and organization of land users are essential factors for success.
- Participatory methods need to be promoted at the micro-watershed level.
- Formal extension to and education of farmers is necessary.
- Existing farmers' organizations need to be strengthened.
- Farmers are most interested in activities that improve farm-level production.
- Environmental education of upstream and downstream inhabitants is essential.
- Decentralization of research and extension is needed.

CONCLUSIONS

Watershed management projects and programmes are being implemented throughout the world. It is considered by many to be one of the important development sectors now, and will continue to be so in the future.

As the trend continues towards empowerment of rural people to manage their natural resources, the integrated, multiple-use concepts of watershed management at the community and farm levels with linkages to local and State governments will become more viable.

The watershed management development approach is not perfect in any sense. It continues to evolve with time, with ever-changing development needs. As described here, some of the major constraints that were identified in 1986 are still prevalent today. However, some of those earlier constraints have been removed, or are being given attention by the key actors in development. New approaches such as payment for environmental services are being implemented and tested. The role of national and local NGOs is becoming more important as the participatory approach is being expanded at the community and farm levels. However, the effectiveness of NGOs in implementing sustainable watershed management activities has yet to be determined.

According to Sayer and Campbell (2001), the integrated management of natural resources requires three key elements:

- Management needs to be adaptive.
- Movement along the research–management continuum is essential.
- There must be provision for negotiation among all stakeholders, with interventions that are based on (an outcome) of this process.

Sustained improvement of the well-being of poor people in developing countries, such as farmers, will require natural resource management research that gives more emphasis to: 1) management risks; 2) reduction of dependence on external inputs; 3) avoidance of long-term depletion of production potential; and 4) more careful control of environmental externalities (Sayer and Campbell, 2001).

In the 1990s, the watershed management development sector, to some extent, became ambiguous in context. The basic principles of multiple use management of renewable and non-renewable natural resources, with emphasis on soil and water resources, gave way in some projects to a more holistic, integrated rural development and agriculture production systems approach, with less importance to upland conservation of soil and water resources.

RECOMMENDATIONS

Analysis of the results of this review and assessment study suggests that a paradigm shift is warranted to refocus the watershed management development sector and improve the performance of future projects and programmes. Some of the important paradigm components and recommended changes are listed in Table 3.

TABLE 3

Preliminary recommendations of the FAO stocktaking exercise

Present scenario	Future scenario
1. Treating the symptoms of watershed degradation (i.e. deforestation, soil erosion, siltation, decreasing production) (WRDP-WMIC, 1998).	Identifying and treating the underlying causes of watershed degradation (i.e. lack of knowledge, poverty, population increase, demand for resources, improper land use). More focus on prevention rather than cure.
2. Priority focus on off-site/downstream costs and benefits of watershed management (i.e. downstream infrastructure risk, decrease in floods and sedimentation, increase in water quantity and quality for downstream users).	At minimum, equal priority to on-site costs and benefits of watershed management (i.e. improving and maintaining upland agriculture, forest, and rangeland productivity, water quantity and quality).
3. Inadequate project designs that often overestimate government capacity and assume policy changes will occur.	Project design that provides for adequate government capacity and assures policy changes.
4. Top-down research and development, and transfer of technology to local stakeholders that is driven by donors and education and research institutions.	Emphasis on stakeholder participatory learning and technology development process that builds on indigenous technologies and addresses local research needs.
5. Diffuse focus of watershed management, which often maximizes production of resources/commodities other than water and soil.	Sustainable multiple-use management of watersheds that combines water resources development with compatible economic land-based production systems (i.e. trees, crops, livestock, fish, recreation).
6. Encroachment of integrated rural development approach with multisectoral steering committees and line agencies (which, for the most part, has been a failure) into the integrated watershed management concept.	Multiple-use management of natural resources (renewable and non-renewable), with emphasis on water and soil resources in upland watersheds and with development responsibility given to the relevant line agency.

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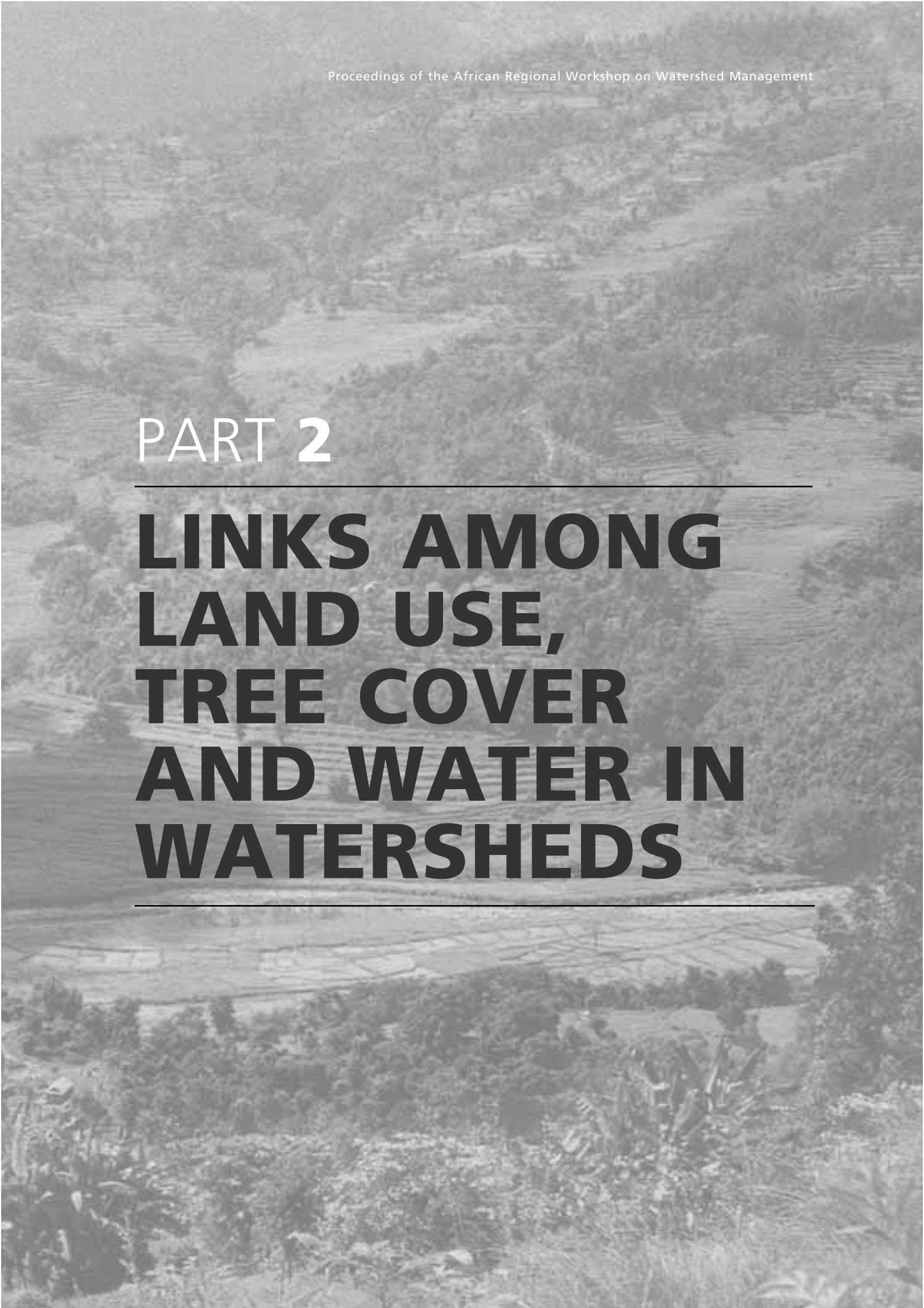

PART 2

LINKS AMONG LAND USE, TREE COVER AND WATER IN WATERSHEDS

CHAPTER 3
LAND–WATER RELATIONSHIPS IN RURAL WATERSHEDS

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Some forms of land use have a negative impact on the availability and quality of water resources. Sustainable land-use practices can reduce or mitigate this negative impact, and justify the need for a watershed approach in which considerations of water resources are adequately addressed in terms of land use.

The Land and Water Development Division of FAO has recently embarked on a programme to develop and promote instruments and mechanisms to share benefits and costs arising from upstream land use in rural watersheds. The programme has four main elements:

- improving understanding of land–water relationships in rural watersheds;
- collecting evidence through case studies on impact valuation and watershed cooperation mechanisms;
- developing guidelines for use at the decision-making and technical levels;
- disseminating findings through policy guidance, technical assistance, seminars, etc.

Preliminary results of the programme and the case studies used in preparation of this report can be accessed on the Internet at: www.fao.org/ag/agl/watershed.

This paper presents a review of current practices and knowledge on land-use practices related to water protection, and reviews the need for further research and knowledge synthesis and dissemination, as well as the implications in terms of watershed management policies.

THE PROBLEM

It is usually admitted that land use has an impact on the hydrological regime and quality of water downstream. The relative importance of such impact varies with the type of land use, the size of the watershed, climate, soil characteristics, topography, geology, etc., and is well documented (Bosch and Hewlett, 1982; Bruijnzeel, 1990; Calder, 1999). Yet, in the past, the relative importance of all these factors and the need to consider the specificities of each situation have not been fully understood by the public and decision-makers, leading to misconceptions about the main causes of floods and droughts in particular. The media, some NGOs, government officials, and in some cases even scientists have often convinced the public that deforestation is among the main causes of changes in water regimes, leading to increased floods and reduced dry season flows in rivers. Many agencies have funded conservation and reforestation programmes in response to these concerns (Kaimowitz, 2004).

A better understanding of the factors determining these impacts is needed in order to avoid misleading generalizations. Valuing of these impacts is also required in order to assess the potential for developing mechanisms to share benefits and costs between upstream and downstream water users. Several types of sharing or compensation mechanisms are possible, and a review of current experience and practices is needed to assess their potential.

This study is based on the following three assumptions:

- In watersheds, there is a distinction between on-site and off-site impacts of land-use practices.
- Land users in upstream watersheds tend to adopt practices that optimize their return.
- In the absence of upstream–downstream cooperative mechanisms, land users will seek to optimize direct (on-site) benefits only.

As we will see in the following, these assumptions are important to understanding the potential and limitations of watershed management approaches when seen from a downstream perspective.

BIOPHYSICAL IMPACTS OF LAND USE ON WATER

A large number of experiments and surveys have been conducted in the past 40 years, particularly in the field of forest hydrology. Comprehensive reviews of these experiments have been provided by Bosch and Hewlett (1982), Calder (1999) and Bruijnzeel (1990; 2004) for moist tropical forests. In particular, studies have focused on the impact of land use (especially forest cover) on rainfall pattern, river runoff, floods and low flows, sediment transport and water quality. These impacts are reviewed briefly in the following.

Impact of forest cover on rainfall

For a long time scientists have been looking for evidence of the positive impact of forest cover on rainfall, but research on how forest cover affects rainfall remains inconclusive (Kaimowitz, 2004). The higher evaporation rate and greater aerodynamic roughness of forests compared with agriculture and pasture lead to increased atmospheric humidity and moisture convergence, but so far observation of enhanced rainfall in forested areas could not be attributed to forests themselves. Orographic effects and the impact of trees on the way rain gauges capture rainfall explain the observed differences (Bruijnzeel, 2004). For the moment, one cannot discard the possibility that land-use change can cause significant changes in rainfall patterns. The discussion is not made easier by the fact that rainfall is highly variable in space and time. In conclusion, the impact of forest cover on precipitation, if proven, seems to remain marginal compared with other factors responsible for rainfall variability, short- and long-term cycles and climate change. Clearly, in this field, natural factors (and possibly climate change) have a much more important impact on rainfall than any possible change in land use.

Impact of land-use change on the hydrological regime

Changes in land use may have an impact on the hydrological regime of a river basin. In some cases, the impact is evident. Forest clearing, for instance, has an impact on the infiltration rate

and recharge of aquifers. In many other cases, however, the relation between land use and the hydrological regime is not so clear. A debate still exists, for instance, on the impact of wetland management on flow regimes: some research tends to prove that it has a negative impact (increased peak flows, reduced base flow), while other research notices an increased water storage capacity, leading to reduction in peak flow (Bullock, 1992).

Research shows that land use affects the infiltration of water into the soil, and any change in land use that compacts the soil or diminishes porosity will increase runoff and peak flow during rainfall events and, arguably, flooding (Kaimowitz, 2004). However, such findings hold mostly for small areas. At the large scale, the extent, intensity and distribution of the storm effect are likely to have a much larger impact on runoff than land-use change is. Most studies attempting to relate large-scale flooding events with land-use change have remained inconclusive.

In the forestry community, the tendency has often been to isolate forests from other types of land use and to assess the impacts of forested land on the hydrology of watersheds. In most cases, questions related to the improvement or conservation of a river's hydrological regime cannot be expressed only in terms of extent of forest cover, and a much more comprehensive approach is needed. In a downstream perspective, all types of land use need to be considered, including forested land, rangeland, agricultural land, urbanized areas, roads and badlands.

Another tendency among foresters is to take for granted the positive role of forests in terms of water resources and to ignore any possible negative implications. While it is clear that a good vegetative cover contributes to stabilizing the land and reducing the erosion of rainfall, forested land also shows significantly higher evapotranspiration rates than rangeland or agriculture, leading to an overall reduction in the amount of water available in rivers. Where water resources are scarce, countries increasingly tend to consider forests as a water user and consider afforestation programmes as part of their integrated water resources management plans (Gallart and Llorens, 2001).

Forest operations can also play a significant negative role in the hydrology of small watersheds. Forest roads are considered to be among the most dangerous types of land disturbances in terms of erosion, and the way forest exploitation is conducted can have devastating impacts on soil and erosion.

Erosion and sediment load of rivers

Everyone agrees that sedimentation can adversely affect reservoirs, waterways, irrigation systems and coastal zones. A change in the sedimentation load of a river can also affect the river's biology and have implications in terms of fish production or biodiversity.

While there is a relation between the rate of erosion and the amount of sediment transported by the rivers, this relation is far from being simple. Erosion and sediment transportation are a natural process and vary widely, according mainly to the geology and climatic conditions. At the farm level, there is clear evidence that land-use practices can have a significant impact on the rate of erosion, either positively or negatively. Changes in land cover, from forest to agriculture for instance, usually induce an increase in soil erosion. On the other hand, good agricultural practices can substantially reduce the erosion hazard.

However, the impact of such land-use practices on the overall sediment yield of river basins is very difficult to assess. It is generally admitted that the bulk of sediment load of rivers originates from specific locations within the watershed, and that most of the sediments are brought into the river during extreme climatic events. In addition, research has shown that the routing time of sediments inside a river basin is relatively slow, and that over the life span of a reservoir very few sediments of the upper watershed travel more than 100 to 200 km. Thus, the impact of land-use practices on the sedimentation rate at one point in a large river, if any, will be felt only several decades later. A major difficulty consists in distinguishing between natural and human-induced sediment load.

Chemical and organic water pollution

In regions of intensive agriculture, inappropriate application of fertilizers and pesticides may result in parts of these chemicals being washed out of the field and sent to the rivers or aquifers, where their concentration may cause pollution problems for water users downstream. Although rather localized in nature, cattle feedlots, which are now recognized as a major cause of pollution, are also usually considered as non-point-source pollution, and are included in this category.

The category of non-point-source pollution is usually the easiest to assess as it introduces radical changes to the chemical composition of the water. However, the complexity of the degradation process of some chemicals, mostly pesticides and toxic trace elements, combined with measurement problems, represents a serious constraint to the quantitative assessment of this sort of pollution. Non-point-source chemical and organic pollution of water resources are mostly concentrated in industrialized countries, but an increasing number of regions in developing countries where intensive agriculture is practised are faced with similar problems. As is the case, for instance, in peri-urban or commercial agriculture.

In all cases (impact on rainfall, flow regime, sediment load and chemical pollution), the relation between land use and its impact on water degradation is complex and not straightforward. While processes can be described in general terms, as they are presented above, each case is unique. Assessing and quantifying the impact of land use on water quality in a given river requires a thorough analysis of the situation and a clear understanding of the physical processes.

The type of problem, the scale of the watershed, the distinction between natural and human-induced hazard, the chemical processes, and the distinction between point-source and non-point-source pollution are all elements that need to be fully understood in order to ensure that adequate response be given to a specific problem. Some myths that have been used to justify watershed management programmes clearly need to be revisited.

Scaling up non-linear processes

Scale is probably the most important parameter in assessing the impact of land use on water. Table 1, drawn from a review of numerous case studies, is an attempt to classify the potential impact of land use on different aspects of water regime and quality as a function of basin scale. It was discussed during the electronic conference on land–water linkages in rural watersheds organized by FAO in 2000 (FAO, 2002). Only in very small watersheds can we expect to see

a significant impact of land use on water regime and water availability. This is owing in large part to the variability of the hydrological regime of watersheds, due to variable precipitations. Sediment load, for instance, will depend much more on the intensity of extreme rainfall events than on land use. As the size of the watershed increases, the impact of land use on most of the characteristics of the hydrological regime becomes insignificant compared with that of natural factors. On the other hand, the impact of land use on water quality can be observed at larger scales. Cumulative effects of pollution, for instance, can result in an impact that can be observed even in large river basins.

TABLE 1
Potential impact of land use on aspects of river regime

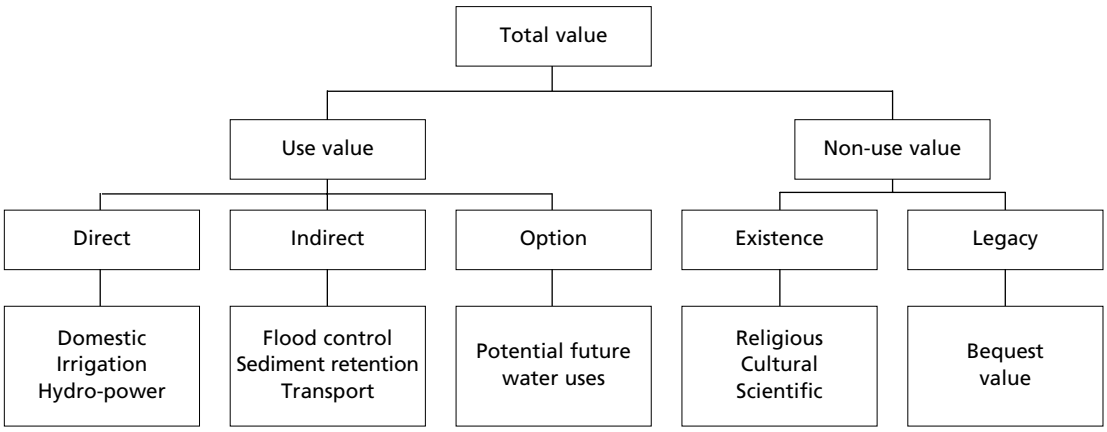
OBSERVABLE IMPACT OF LAND USE ON:	WATERSHED SIZE (km^2)		
	Small (0.1–10)	Medium (10–100)	Large (100 and greater)
Average flow	X	-	-
Peak flow	X	-	-
Base flow	X	-	-
Groundwater recharge	X	-	-
Sediment load	X	-	-
Pathogens	X	-	-
Nutrients	X	X	X
Salinity	X	X	X
Pesticides	X	X	X

VALUING THE IMPACTS OF LAND USE

Valuing the impact of land use implies the capacity to value water. While it is practically impossible to assess the full value of water, as it implies considerations of value judgement – particularly on the non-use values of water (existence, legacy, see Figure 1) – it is relatively easy to assess the value in terms of use of water, in particular domestic uses, irrigation and hydropower.

The most frequent cases of valuation of water are those related to domestic water use of hydroelectricity. In the Sao José watershed in Brazil, a problem arose when suspended sediments and chemicals from agriculture led to excessive treatment costs. Through negotiation with farmers, a decision was taken to adopt improved agricultural practices: soil conservation measures, and the introduction of no-tillage and organic farming. The reduction of treatment cost was estimated at US$2 500 per month. A total investment of $103 000 was proposed, which would be paid off in four years (Bassi, 2002).

FIGURE 1
Assessing the value of water



MECHANISMS TO SHARE BENEFITS AND COSTS OF LAND USE

Mechanisms are needed to link upstream land users with downstream water users. Several options are possible. *Payment for watershed services* (FAO, 2004a) is a subset of the principle of payment for environmental service, by which a value is assigned to some types of land use in a watershed where beneficiaries can easily be identified (as in the case of the Sao José watershed described above). Other mechanisms include incentives, technical advice, agreements on the marketing of agricultural products, etc. Of interest to many farmers, particularly in Latin America and southeastern Asia, is the possibility of providing land titles or land-use rights in exchange for the adoption of sustainable land-use practices in watersheds.

IMPLICATIONS FOR WATERSHED MANAGEMENT PROGRAMMES

Watershed management has evolved with time, from a purely natural resources management approach (essentially top-down) to a community development approach in which people's participation is at the centre of the planning and development process. In the former approach, emphasis was put on the management of land, soil and water conservation, and on afforestation. The watershed was a logical planning unit, as erosion and sedimentation control was considered an important objective of the programmes. Such programmes have been successful, particularly in areas with low population density and where important and valuable infrastructure downstream of the treated areas required protection. They were usually associated with structural interventions (dykes, check dams, etc.) and are still valid today.

Such approaches, however, are not adapted to areas with substantial population density, where conservation requires meeting the needs of local populations. In such cases, to be successful, any attempt to improve the management of natural resources needs to satisfy the immediate and mid-term needs of the population of the watersheds. Community watershed development programmes have shown the need to adopt a participatory approach, empowering local populations, developing local capacity and institutions, and fostering cooperation among resources users.

As a result, watershed management programmes evolved from an approach where the focus was mainly on natural resources conservation to an approach with the focus on people's priorities. One major implication of this shift in priorities is that the beneficiaries of watershed management activities are the farmers themselves (on-site benefits), rather than the downstream populations (off-site benefits). The watershed boundaries become less relevant as planning units (except in cases where micro-watersheds correspond to a social division of the landscape) and are replaced by a socio-administrative division of the land that is of greater relevance to the local population. The downstream impact of watershed management programmes becomes therefore much less relevant.

CASE STUDY: GALLITO CIEGO, PERU

The case of Gallito Ciego watershed in Peru shows how a good impact assessment can positively influence investments in watershed actions and avoid non-productive actions. A hydroelectric dam was built on the river, with a storage capacity of 573 million m^3 for a watershed area of 3 480 km^2. Annual rainfall varies in the watershed between 40 and 1 300 mm, and average runoff is 816 million m^3/year. After construction of the dam, a problem of rapid siltation of the reservoir appeared, threatening the investments and hydroelectric potential. One of the possible options that were considered was to invest in soil and water conservation actions to reduce the rate of siltation of the reservoir. However, a careful study of the land-use situation in the watershed showed that such an option would not be feasible for the following reasons:

- On the watershed scale, cultivated land was relatively small, and improvement in agricultural land use would have had no significant effects on erosion and sediment transport.
- Most sediment transport occurred during extreme climatic events.
- The area of most severe erosion was beyond human control.

The study concluded that any attempt to reduce reservoir sedimentation could only be successful if it focused on structural measures in the river bed (check dams, riverbank protection), and that there would be little scope for watershed management activities (FAO, 2004b).

CONCLUSIONS

Good land husbandry practices are a key ingredient to the sustainable management of natural resources in rural watersheds. Their impact on the hydrological regime and quality of water downstream may be significant, and deserves careful attention. However, care should be taken to avoid generalization about the impact of land use on water. In particular, misconceptions of the role of forests and the link between erosion and sedimentation may lead to ineffective investments in watersheds.

Watershed management programmes must be considered as one element of water conservation strategies. Land use may not have a significant impact on water downstream, particularly when dealing with problems of sedimentation or floods. In such cases, and based on estimates of the value of the services they provide, structural measures may be required in the watershed.

In other cases, watershed management programmes involving land users can be justified on the basis of downstream benefits. The impact of land use on water can have significant downstream benefits or costs, particularly regarding water quality and downstream users' drinking-water facilities. In such cases, it could be worth investigating mechanisms that explicitly recognize this upstream–downstream linkage and allow downstream users to provide upstream land managers with some sort of compensation for good land-use practices.

In many cases, it is impossible to assess the total value of water-related services, in part because of the difficulties in assessing non-use values. The easiest cases are those related to the need to treat water for drinking purposes, for which a number of examples exist of agreements between water utilities and land users upstream (Landell-Mills and Porras, 2002; FAO, 2004a). In other cases, companies using water downstream may be interested in being portrayed as environmentally conscious, providing incentives or subsidies to land users in watersheds, even in the absence of clear links between land use and water.

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CHAPTER 4
WATERSHED MANAGEMENT– CAN WE INCORPORATE MORE EVIDENCE-BASED POLICIES?

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ACRONYMS

CAMP	Catchment Management and Poverty Alleviation (project)
CLUWRR	Centre for Land Use and Water Resources Research
DFID	Department for International Development, United Kingdom
FAWPIO	Forest and Water Policy – Improving Outcomes
IIT Delhi	Indian Institute of Technology
IRC	International Water and Sanitation Centre
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
NFPP	Natural Forest Protection Programme
NGO	non-governmental organization
NRI	Natural Resources Institute
SFA	State Forestry Administration
SFRA	stream flow reduction activity
SLCP	Sloping Land Conversion Program
WfW	Working for Water

Unsound land and water (and power) policies are arguably wasting billions of dollars of development funds on unachievable targets (see Box 1). The impacts are worldwide and of a massive scale. Solution will require confronting complex and messy real-world situations and recognizing that land and water policies and practices at the international, national and local levels are generally driven, dominated and exploited by the vested interests of sectoral, powerful and wealthier groups: government departments, departments and divisions of international and national development organizations, non-governmental organizations (NGOs), the research community, and industry.

BOX 1

ROOT OF THE WATER PROBLEM

In his article on the world's water problems ("Ten questions the west must answer", H_20 supplement, 23 August), John Vidal writes: "If we learned not to cut down forests, we'd find that there was more water for everyone." This illustrates a widely held misconception, which is arguably leading aid organizations to waste billions of dollars on afforestation programmes.

Hydrological studies show that most forests will evaporate significantly more water than shorter vegetation, and reduce water for recharging aquifers or supplying rivers.

In countries such as South Africa, the true role of forests in relation to water is well understood. The South African Water Act, rather than promoting forests, effectively imposes a "stream flow reduction activities" tax on high water-consuming land uses such as plantation forestry and sugarcane.

In the United Kingdom, highlighted by Mr Vidal as one of the most water-stressed countries in Europe, the impact of forests is also becoming better understood. Both water and forestry interests now accept that upland coniferous afforestation will reduce annual stream flows by, typically, 20 percent.

In the lowlands of England, recent studies at Sherwood Forest indicate much greater impacts. Compared with grassland, oak forest will reduce long-term recharge by about 50 percent and pine forest by about 75 percent – under pines, only in a year of high rainfall (such as 2000) will the "water pulse" pass the root zone to reach the aquifer.

While there may be many reasons to promote forests, they need to be considered in relation to the adverse effects on water resources.

I. Calder, letter to *The Guardian,* 4 September 2003.

POLICIES BASED ON MISPERCEPTIONS

Examples of policies based on misperceptions may include the following.

Southeast Asia: Possibly half a million livelihoods have been lost because of logging bans imposed on the basis of myth-based perceptions of forest and flood interactions.

India: Watershed development projects that were implemented with unsound understanding of land and water interactions are resulting in perverse outcomes: for poorer people, less access to water from common property water pans; unsustainable rates of groundwater depletion; and catchments reaching closure with serious downstream and environmental impacts.

China: Afforestation under the Natural Forest Protection Program (NFPP) and the Sloping Land Conversion Program (SLCP) has been driven and promoted by the State Forestry Administration (SFA) partly on the basis of what could be regarded as very optimistic perceptions of the benefits of forests to the water environment. These programmes may again be leading to perverse outcomes: detriment to rural livelihoods, disadvantage to minority ethnic groups, reduced downstream and transnational water flows and reduced food production (Calder, forthcoming). Li Zibin, Vice-Minister of China's National Development and Reform Commission states that "…China had reconverted 7.86 million ha of farmland to woods, and planted trees on 11.33 million ha of bare hills and land between 1999 and the end of 2004" (*China Daily*, 2004). In this period, China's grain production fell from 512.3 million to 430.7 million tonnes. Although other factors may be affecting grain yields, the removal of 7.86 million ha of farmland is clearly a massive land-use change for any country, and must surely be a significant factor in the reduced grain production in China.

India: Power policies in India, where farmers receive subsidized or free electricity, have led to situations where there are no economic controls on groundwater pumping for irrigation. Water tables are exceeding 200 m depth in some states, preventing poor people from obtaining access to groundwater through handpumps and forcing them to buy water from tankers.

A big challenge (problem or opportunity) for the development community now is how to implement IWRM concepts in a wider resource management context where there are:

- increasingly severe and conflicting demands on the land and water resources to supply food, water and timber, together with conservation, amenity, recreation and environment products;
- sectoral conflicts among the water, land, power generation and irrigation sectors;
- concerns that upstream management of land and water in watershed development projects generally ignores downstream impacts, particularly transnational and coastal interests.

Implementation of the well-meaning IWRM concepts will require confronting the complex and messy real-world situation in which it is important to recognize that land and water policies and practices at the international, national and local levels are generally driven, dominated and exploited by the vested interests of sectoral, powerful and wealthier groups, often at the expense of the poorer segments of society.

THE SCIENCE PERCEPTION AND FUTURE RESEARCH NEEDS

Two of the many myths or conventional wisdoms relating to forestry and water (see Hamilton, 1987; Hamilton and King, 1983; Bruijnzeel, 1990; Calder, 1998; 1999; 2002; 2004) are reviewed here as a means of investigating the disparity between the "science" and the "public" perceptions and to identify the remaining gaps in our knowledge. The "conventional wisdoms" considered are:

- forests increase runoff;
- forests regulate flows.

Forests increase runoff?

In recent years, a new understanding has been gained of evaporation from forests in dry and wet conditions based on process studies. These studies, and the vast majority of the world's catchment experiments, indicate decreased runoff from areas under forests as compared with areas under shorter crops.

The studies indicate that in wet conditions interception losses will be higher from forests than shorter crops, primarily because of increased atmospheric transport of water vapour from their aerodynamically rough surfaces.

In dry (drought) conditions the studies show that transpiration from forests is likely to be greater because of the generally increased rooting depth of trees as compared with shorter crops, and their consequent greater access to soil water.

Thus, in both very wet and very dry climates, evaporation from forests is likely to be higher than that from shorter crops. Consequently, runoff will be decreased from forested areas, contrary to widely accepted myths.

The few exceptions that lend some support to the myth are:

- cloud forests, where cloud-water deposition may exceed interception losses;
- very old forests; Langford (1976) showed that following a bushfire in very old (200 years) mountain ash, *Eucalyptus regnans,* forest covering 48 percent of the Maroondah catchment – one of the water supply catchments for Melbourne in Australia – runoff was reduced by 24 percent. The reason for this reduction in flow has been attributed to the increased evaporation from the vigorous regrowth forest that had a much higher leaf area index than the former very old ash forest.

Conclusion: Notwithstanding the exceptions outlined above, catchment experiments generally indicate reduced runoff from forested areas as compared with those under shorter vegetation (Bosch and Hewlett, 1982).

Caveat: Information on the evaporative characteristics of different tree species/soil type combinations is still required. In both temperate and tropical climates, evaporative differences among species and soil types are expected to vary by about 30 percent.

Forests regulate flows/increase dry season flows?

Although it is possible, with only a few exceptions, to draw general conclusions with respect to the impacts of forests on annual flow, the same cannot be claimed for the impacts of forests on the seasonal flow regime. Different, site-specific, often competing processes may be operating, and the direction, let alone the magnitude of the impact, may be difficult to predict for a particular site.

From theoretical considerations it would be expected that:

- Increased transpiration and increased dry period transpiration will increase soil moisture deficits and reduce dry season flows.
- Increased infiltration under (natural) forest will lead to higher soil water recharge and increased dry season flows.
- For cloud forests, increased cloud-water deposition may augment dry season flows.

There are also observations (Robinson, Moore and Blackie, 1997) indicating that for the uplands of the United Kingdom, drainage activities associated with plantation forestry increase dry season flows, both through the initial dewatering and – in the longer term – through alterations to the hydraulics of the drainage system.

Observations from South Africa indicate that increased dry period transpiration reduces low flows. Bosch (1979) demonstrated from catchment studies at Cathedral Peak in Natal that pine afforestation of former grassland not only reduces annual stream flow by 440 mm, but also reduces the dry season flow by 15 mm. Van Lill, Kruger and Van Wyk (1980), reporting studies from Mokobulaan in the Transvaal, showed that afforestation of grassland with *Eucalyptus grandis* reduced annual flows by 300 to 380 mm, with 200 to 260 mm of the reduction occurring during the wet summer season. More recently, Scott and Smith (1997), analysing results from five of the South African catchment studies, concluded that percentage reductions in low (dry season) flow as a result of afforestation were actually greater than the reduction in annual flow. Scott and Lesch (1997) also report that on the Mokobulaan research catchments under *Eucalyptus grandis,* the stream flow completely dried up by the ninth year after planting. The eucalypts were clear-felled at age 16 years, but perennial stream flow did not return for another five years. They attribute this large time lag to very deep soil moisture deficits generated by the eucalypts, which require many years of rainfall before field capacity conditions can be established and recharge of the groundwater aquifer and perennial flows can take place.

Studies in India draw similar conclusions. Sikka *et al.* (2003) investigated the impacts on both flood flows and low flows of converting natural grassland to eucalypt plantation in the Nilgiris region of south India. The detailed and long-term (1968 to 1992) paired catchment experiments in the Nilgiris, where the responses from a control catchment under natural grassland were compared with those from a catchment with 59 percent eucalypt cover, which were monitored over a period encompassing two rotations of the eucalypt crop, indicate very significant reductions in low flows during the dry season. Expressed in terms of a "low flow index" (defined as the ten days average flow being exceeded for 95 percent of the time of the flow record), the low flows were reduced by approximately one half during the first rotation, and by one quarter during the second rotation of the eucalypt crop.

Bruijnzeel (1990) discusses the impacts of tropical forests on dry season flows, and concludes that the infiltration properties of the forest are critical in how the available water is partitioned between runoff and recharge (leading to increased dry season flows).

Conclusions: Competing processes may result in either increased or reduced dry season flows. Effects on dry season flows are likely to be very site-specific. It cannot be assumed that it is generally true that afforestation will increase dry season flows.

Caveat: The complexity of the competing processes affecting dry season flows indicates that detailed, site-specific models will be required to predict impacts. In general, the role of

vegetation in determining the infiltration properties of soils, as it affects the hydrological functioning of catchments through surface runoff generation, recharge, high and low flows, and catchment degradation, remains poorly understood. Modelling approaches that are able to take into account vegetation and soil physical properties, including the conductivity/water content properties of the soil and possibly the spatial distribution of these properties, will be required to predict site-specific impacts.

EXAMPLES OF ONGOING RESEARCH ON THE ROLE OF FORESTS AND WATER

Two examples are given of ongoing interactive research in South Africa and India that are addressing questions of policy related to land-use change involving forestry and the water environment. Interactive, in this context, implies that the eventual users, or stakeholders, of the research interact closely with the researchers in both the design stage (by helping to define the objectives of the research and ensuring that the necessary resources are mobilized) and the implementation phase (by monitoring and steering the research programme). Experience of using this model for the management of applied environmental and hydrological research programmes has shown that it has a number of benefits:

- The users, through close involvement with all phases of the research, assume ownership of the programme, and are more likely to both "believe in" and take up eventual research findings.

- Best use is made of existing knowledge and data resources by building on the collective resources of all the stakeholders.

- The interaction between users and researchers through stakeholder group meetings not only facilitates linkages and information flows between the users and the researchers, but also facilitates linkages and information flows among the users themselves. This in itself has often been seen as an important output of the interactive research programme. Increasingly, it is being recognized that successful integrated land use and water resources management requires not only a sound science base, but also understanding, commitment and collaboration among the different organizations responsible for and affected by integrated management.

- The formation of a representative stakeholder group with a diversity of interests and perspectives is more likely to achieve the ultimate goal of integrated land-use and water resources management by ensuring that all aspects of development affecting water resources, basin economics, ecology/conservation, socio-economics and the sustainable livelihoods of basin inhabitants are considered and represented.

It is also believed that if stakeholder groups can be formed with representatives comprising both the science and the public perceptions this may, through a process of "action learning", provide a means of reconciling disparate views.

The two examples considered in the following subsections demonstrate the continuing need to improve our understanding of the biophysical linkages between forests and the water environment, particularly in relation to the impacts on seasonal flows. These examples also illustrate the different degrees of "connectivity" between science and policy in the different countries.

South Africa, Catchment Management and Poverty Alleviation (CAMP)

The Government of South Africa has recognized that not only is there usually a high cost in terms of lost water associated with fast-growing commercial plantations, but there may also be dangers associated with "escaping" plantation trees. The government is addressing these issues through policy instruments that include legislation and government-funded programmes:

- The National Water Act (Government of South Africa, 1998) declared commercial forestry as a "stream flow reduction activity" (SFRA) and, as such, requires that it is managed through the issuing of water-use licences and is subject to water resources management charges.

- The multi-billion rand Working for Water (WfW) programme (DWAF, 1996) is being implemented for the control and eradication of alien invading tree species. The expectation is that without this programme the invaders would eliminate indigenous plant species and seriously reduce water resources. The programme also has a major poverty alleviation component, through specifically targeting the poorest in society for employment.

The SFRA legislation and WfW programme highlight a number of issues relating to forest and water management; these issues are probably not specific to South Africa. They include how to devise and implement forest and water policy instruments, such as SFRA and WfW, which will meet the requirements of integrated water resources management (water resource, basin economics and conservation) while also meeting the demands of major international and donor organizations (such as the World Bank and the United Kingdom's Department for International Development [DFID]) that policies should have an equity dimension and support and enhance (particularly the poorest) people's livelihoods.

These questions are being addressed within the Catchment Management and Poverty Alleviation (CAMP – Figure 1) project, which is supported by DFID in South Africa, the United Republic of Tanzania and Grenada, under the direction of a stakeholder group comprising forest, water and poverty interests: members from both United Kingdom and South African universities and research institutes, the South African Department for Water Affairs and Forestry, the WfW programme and an NGO. The South African focus of the study was chosen to be the Luvuvhu catchment in Limpopo province, which drains into the Limpopo River at the border with Zimbabwe and Mozambique (Figure 2). The Luvuvhu catchment illustrates the acute problems posed for water- and land-use management related to forestry activities: there is potential for a considerable increase in the area of commercial forestry, it is currently affected by alien invader tree species, it is water-short, and it has high levels of poverty.

The project is investigating how different scenarios of forest cover, which may result through application or non-application of WfW and SFRA instruments, will affect the hydrological regime and water availability, which will, in turn, affect economic production and people's livelihoods. The linkage between water availability and people's livelihoods has been assessed through a survey carried out at a number of communities (Figure 2).

FIGURE 1

The CAMP project is investigating how two forest and water-related policy instruments, the WfW programme and the charging of landowners for SFRAs, will affect water resources, catchment-scale economics and livelihoods

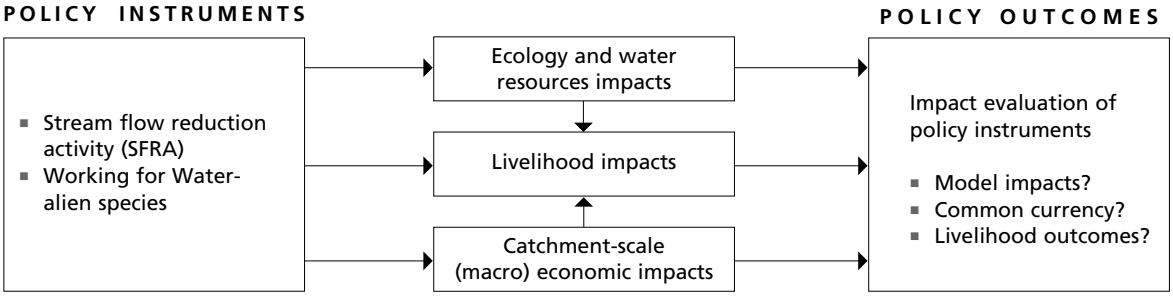
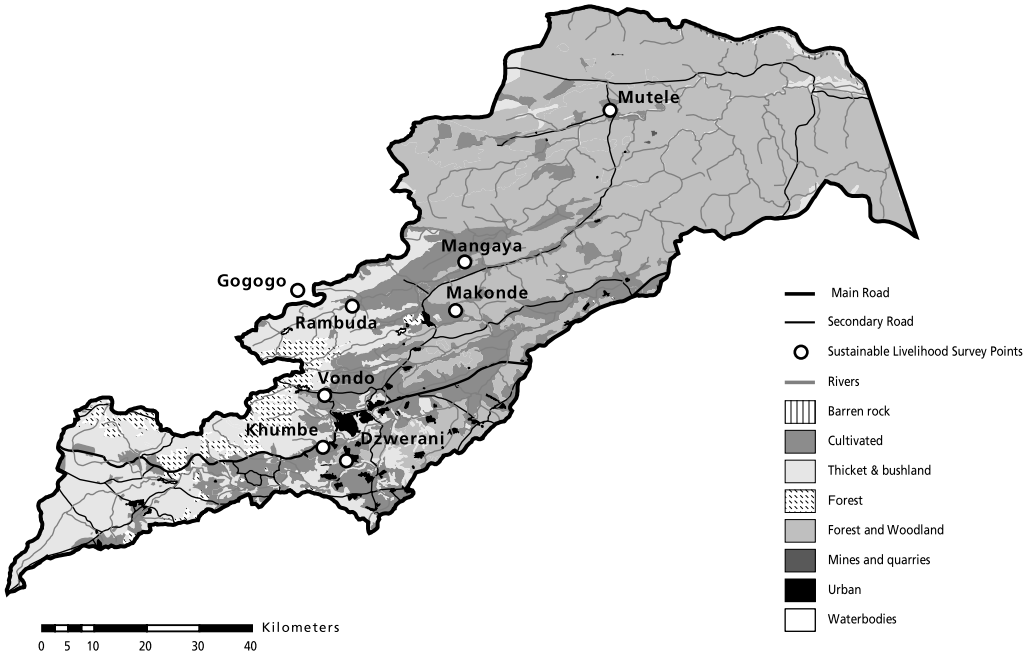


FIGURE 2

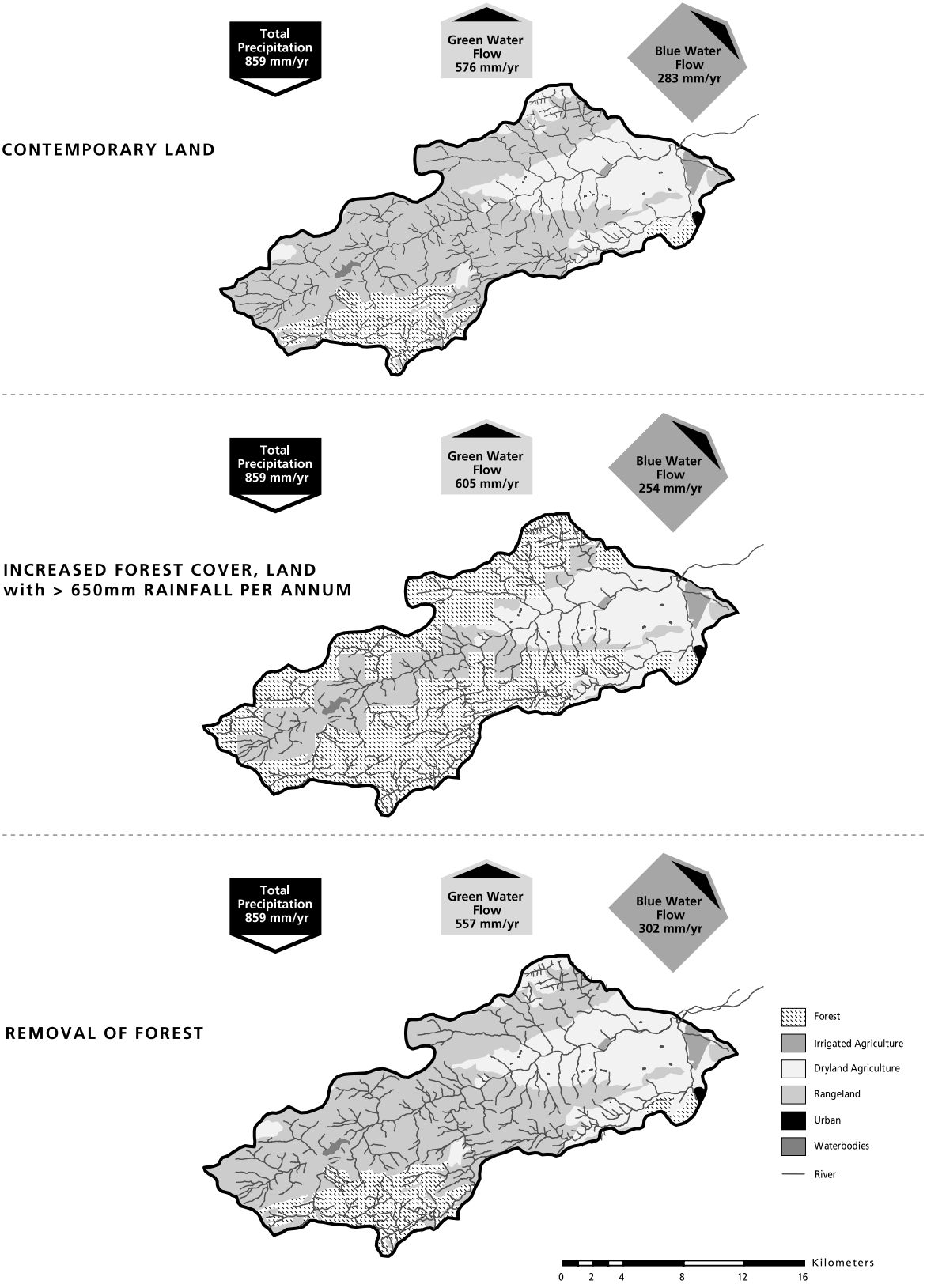
Land use and communities where livelihoods assessment was carried out on the Luvuvhu catchment, Limpopo Province, South Africa



Changes in river flow and evaporation as a result of changing land cover are being assessed through the use of two land-use-sensitive hydrological models, the Hydrological Land Use Change model (HYLUC – Calder, 2003) and the Agrohydrological modelling system (ACRU – Schulze, 1995). Both models have been used extensively in forestry-related studies (Calder, 1999; Jewitt and Schulze, 1999) and have been configured for use in the Luvuvhu. In these models, the nomenclature adopted by Falkenmark (1995; 2003) is used to highlight the role of land use in hydrological functioning, with respect to flow out of the catchment, termed "blue water", and evaporation, "green water" (Figure 3).

FIGURE 3

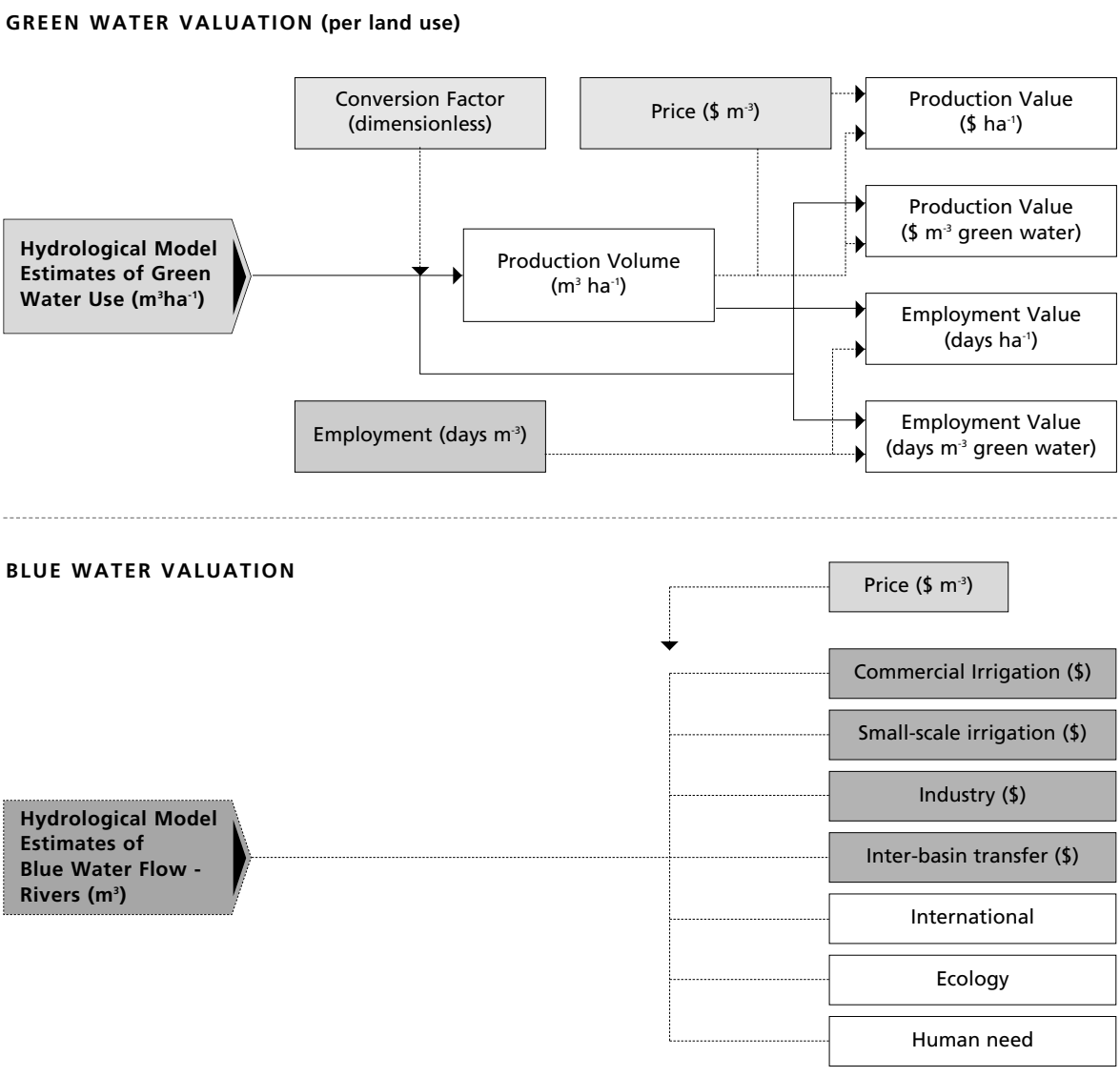
Example of how changes in forest cover on the Tengwe subcatchment of the Luvuvhu affect green and blue water flows (expressed in units of depth of water over the catchment)



A framework has been devised for understanding the linkages between water flows and the economic and livelihood values of water when it is used in its green or blue forms (Figure 4). This framework is currently being calibrated for the Luvuhu, and will be used to analyse the economic and livelihood benefits of the different forest cover scenarios (later studies will investigate combinations of different forest and irrigation scenarios).

FIGURE 4

Framework for evaluating blue and green water flows in terms of production value and employment (surrogate for livelihood) value



The analysis carried out so far has demonstrated a somewhat unexpected linkage, or rather lack of linkage, between water availability and livelihood benefit. The livelihood survey indicates no statistically significant relationship between poverty (calculated in terms of income rather than expenditure) and greater access to water (whether provided through reticulated supply or through being in a higher rainfall area). The implication, from the data available at present, is that provided the statutory provision of 25 litres of water per capita per day is being met, further provision of water will not greatly increase livelihood benefit. Evidence also suggests that while there may be food security gains from increased water provision (e.g. for irrigation of kitchen gardens), the poorest in society are less likely to benefit; wealthy households with greater access to home-based reticulated supplies will benefit most (Moriarty, Butterworth and Van Koppen, 2004; Hope and Gowing, 2003).

India – Watershed development, forest and water policies

The public perception of the beneficial role of forests in relation to the water environment is very strong in India, and this is reflected in government policy. This public perception persists despite the many locally conducted scientific studies that present a different view (see e.g. Sikka *et al.*, 2003).

Policy drivers: The Government of India has long recognized water as one of the most limiting resources to development. In 1987, a National Water Policy was published, and this has recently been renewed and updated (Government of India, 2002). A focus of this policy is on improving water supply to meet the identified water allocation priorities:

- drinking-water;
- irrigation;
- hydropower;
- ecology;
- agro-industries and non-agricultural industries;
- navigation and other uses.

The National Water Policy also promotes watershed management and increasing forest cover as a means of conserving water. Forestry is regarded as less water-demanding in drought-prone areas:

> 3.4 Watershed management through extensive soil conservation, catchment-area treatment, preservation of forests and increasing the forest cover and the construction of check-dams should be promoted. Efforts shall be to conserve the water in the catchment.
>
> 19.1 Drought-prone areas should be made less vulnerable to drought-associated problems through soil moisture conservation measures, water harvesting practices, minimization of evaporation losses, development of the ground water potential including recharging and the transfer of surface water from surplus areas where feasible and appropriate. Pastures, forestry or other modes of development which are relatively less water demanding should be encouraged. In planning water resource development projects, the needs of drought-prone areas should be given priority.

The Policy also recognizes the need for maintaining an information system on water:

> 2.1 A well developed information system, for water related data in its entirety, at the national/ state level, is a prime requisite for resource planning. A standardized national information system should be established with a network of data banks and data bases, integrating and strengthening the existing Central and State level agencies and improving the quality of data and the processing capabilities.

Watershed development projects: Since the 1990s, some US$500 million per year have been spent on watershed development programmes (Kerr, 2002) that have the general aim of alleviating poverty by improving the quality and quantity of water resources. The water component of these programmes has mainly concentrated on improving water supply through the construction of new surface water reservoirs (usually termed "tanks" in India), or the desilting of existing tanks, and the construction of rainwater harvesting structures, e.g. check dams and contour bunding, which are designed to increase the recharge of water to aquifers. There is a limit to what can be achieved through "supply-side" measures. This limit is reached when surface and groundwater storage schemes, and the exploitation of water from these schemes, are such that there is no flow of water out of the catchment and the catchment becomes, using the International Water Management Institute's (IWMI) terminology, a "closed" system. Many catchments in India are already "closed" or rapidly approaching this state (see e.g. Batchelor, Rama Mohan Roa and James, 2000; James, 2002; Batchelor, Rama Mohan Roa and Manohar Rao, 2003).

As catchments approach closure, two dis-benefits are evident: the cost-effectiveness of engineering constructions reduces to nil; and flows out of the catchment, which may be required for ecological purposes and for the benefit of downstream users, are lost. When virtually all the resource is utilized, in this closure state, there can be no overall benefit obtained through the construction of more storage structures or more measures for increasing aquifer recharge. Upstream users can only capture waters at the expense of reduced availability to downstream users within the catchment. When supply-side options are exhausted, improvements in economic and livelihood benefits can only be achieved through higher-value usage of the existing, nearly fully utilized resource and improved "demand" management.

The beliefs of the rural development offices and NGOs entrusted with implementing these watershed development programmes – that irrigation, soil water conservation measures and forestry are all "good things", promoted by government policy, and that more will therefore necessarily be better for the watershed – may have contributed to the present state of affairs of near closure on some catchments. Large-scale promotion of these measures within watershed development projects without the promotion of a monitoring and water information system, as required by government policy, has meant that the detection and recognition of these adverse impacts have been slow or have not even occurred yet.

Clearly, it is important that the gap between the institutional and the science perceptions of the role of forests and water be closed, as considerable amounts of development funds are currently being expended in the erroneous belief that tree planting will increase groundwater recharge within watershed development projects (Calder and Gosain, 2003; Calder, forthcoming). Equally if not more serious is the concern that the present focus on forestry programmes for improving water resources may be diverting attention away from the more

urgent need for increased demand management measures for controlling the abstraction of groundwater for irrigation use. In some southern Indian states, groundwater tables, which, perhaps three decades ago were within 10 m of the surface and accessible by hand-dug wells, now exceed 100 m.

A perverse outcome of many watershed development projects is that it is often the richer farmers, with access to boreholes with electric submersible pumps, who are benefiting (in the short term) from increased groundwater access. Poorer downstream villages that traditionally have relied on common property resources – water in the village tank and water from village hand pumps – have often been disadvantaged by both increased use of upstream soil and water conservation measures and structures that have resulted in less flow into the village tank. An unexpected outcome of the widespread promotion of these measures is that water that was previously regarded as common property, water in the village tank, is effectively being transferred into private property, the property of landowners, who benefit from the increased infiltration on their land through increased growth of their crops or forest and who can benefit from the increased groundwater recharge beneath their land by reaching it through boreholes with electrically powered submersible pumps. It is now recognized that in many parts of India the increased use of submersible pumps has lowered groundwater tables to depths that are in accessible to hand pumps. Local people who formerly had free access to groundwater through hand pumps are now having to purchase their water supplies from tankers. It would be expected that in these situations where, in contrast with South Africa, there is no per caput free right to water of any quantity, increased access to water by the poor in India would have major livelihood benefits.

At present, there is no effective demand management of groundwater abstraction for irrigation, and as electricity for farmers is either provided free or is heavily subsidized by the government, farmers have little incentive even to reduce the cost of pumping water. This has serious resource implications not only for water and lowering water tables but also for electricity production. Pumping water for irrigation from ever-increasing depths has led to groundwater pumping accounting for a major proportion of all the electricity generated in some southern Indian states.

The interactive research project that has been set up to address these issues with collaborators, government stakeholder departments and NGOs (including IIT Delhi, the Department of Science and Technology, Winrock International and state government departments and NGOs in Himachal Pradesh and Madhya Pradesh) was initiated in January 2003 and is expected to help close the gap between science and public perceptions.

CONCLUSIONS

It is concluded that to move towards a reconciliation of the different perceptions and to put in place better policies and management systems, in which policy is better connected with science and which avoid perverse policy outcomes, further efforts will be required to:

- understand how the belief systems underlying the science and public perceptions have evolved within different stakeholder groups, and understand how these beliefs may be influenced to enable a more science-based policy development process;

- develop management support tools, ranging from simple dissemination tools that can demonstrate the impacts of land-use decisions on the water environment, to institutions and local people and to detailed, robust and defensible hydrological models that are needed to help implement the new land and water policies;

- understand better the impacts of land and water-related policies on the poorest in society. It is argued that many present policies may not be benefiting the poor significantly and may even in some situations be resulting in perverse outcomes. Research conducted in the Luvuvhu catchment in South Africa indicates that, where in the country there is a right to free water for each inhabitant (25 litres/caput/day), increasing this entitlement, at a large cost to the government, may not significantly increase the livelihood benefits to the poorest people. It is believed that richer people would be most able to benefit from increased supplies. In India, where water policies are such that there is no free entitlement, it is suggested that the implementation of present forest and water (and irrigation) policies, which are again very expensive to donors and government, is also mainly benefiting richer communities;

- understand better and recognize how different land and water-related policies may be affecting the ownership of water resources. Watershed development policies that promote increased infiltration of water through structural (e.g. check dams, bunding) or non-structural (e.g. afforestation) measures may be transferring what would have effectively been a common property resource – the water running into a communally owned village tank (reservoir) or the river (a government-owned resource) – into an effectively privately owned resource of the landowner, who can afford the installation of electrically pumped groundwater supplies, or forest owner, whose forest consumes extra quantities of water compared with most non-irrigated land uses;

- develop guidelines for best practice in land and water management based on cross-region experiences of research and policy developments. This could include the development of better management tools and the sharing of knowledge through "bridging research and policy" networks. (A programme of research: Forest and Water Policy – Improving Outcomes [FAWPIO], which incorporates many of the items outlined above, is currently under discussion with development organizations.)

ACKNOWLEDGEMENTS

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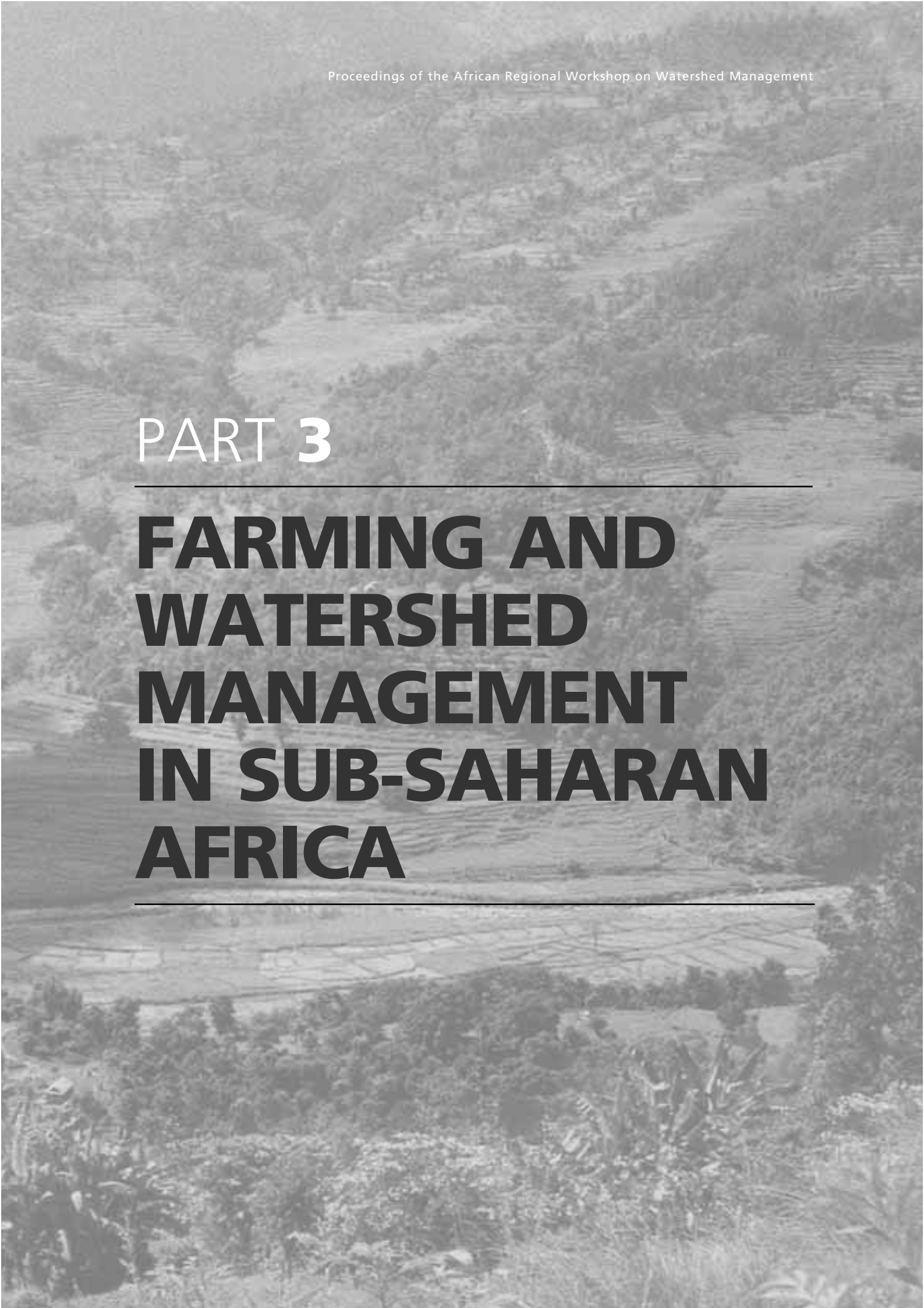

PART 3

FARMING AND WATERSHED MANAGEMENT IN SUB-SAHARAN AFRICA

CHAPTER 5
RUNOFF AND EROSION CONTROL UNDER IMPROVED FALLOWS IN WESTERN KENYA

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ACRONYMS

BD	bulk density
C losses	soil carbon losses (g C m^{-2})
CT	conventional tillage
CC	continuous crop
IF	improved fallow
IF-Tc	improved fallow sp. *Tephrosia candida*
IF-Ss	improved fallow sp. *Sesbania sesban*
NT	no-tillage
PCA	principal component analysis
RP	soil resistance to penetration (kg cm^{-2})
RS	soil resistance to shear (kg cm^{-2})
SC	sediment concentration (g l^{-1})
SL	soil loss (g m^{-2})
SOC	soil organic carbon
WSA	water-stable aggregates

Food security and flooding have become issues of much concern in western Kenya in recent years. Changes in land use have greatly altered the vegetative cover and thereby the natural protection of the soil provided by plants and crops during heavy rainstorms. Accelerated soil erosion is the major land degradation process in Africa (Cooper *et al.*, 1996), and many small-scale farmers are experiencing low soil fertility and decreasing yields. At the onset of the rainy season, when the soil surface is bare, detachment of soil particles by raindrops and transport by runoff carry away the more fertile topsoil, depositing it further down slope or in water bodies. Thus, there is a need to find alternative land management systems that replenish soil fertility, provide an early plant cover and enhance the infiltration of rainwater.

The World Agroforestry Centre (ICRAF) has for several years been undertaking research in planted nitrogen-fixing shrubs (improved fallows) to replenish soil fertility. Many authors (Ingram, 1990; Niang *et al.* 1998; ICRAF, 2000; Mutuo, 2004) have shown that cropping improved fallows in the short rainy season greatly enhances soil fertility, and thereby crop production. Furthermore, these practices produce large amount of biomass, which can be left on the soil and provides a cover during the onset of the rainy season. These improved systems have been tested for various soil types in regions of Africa, Asia and Central America.

However, less is known of the role that improved fallows play in enhancing and improving infiltration and soil health, and thereby in reducing and controlling runoff and soil erosion.

Soil health is a term often used in literature to describe the status of the soil. Soil organic carbon (SOC) is acknowledged as one of the most important soil parameters to maintain good soil health (Doran, Sarrantonio and Liebig, 1996). However, a considerable challenge exists to maintain adequate SOC levels for cultivated soils, especially in the tropics, where carbon losses through cultivation, decomposition and erosion often exceed carbon inputs. The main sources of SOC input in the tropics are returned biomass (above- and below-ground biomass) and manures, which are often less than required to maintain adequate SOC levels (Nandwa, 2001). Agroforestry has shown to be a good management option to produce sufficient biomass to maintain or increase SOC (ICRAF, 2000; Mutuo, 2004).

Another land management practice that has received much attention elsewhere in the tropics is no-tillage (NT). No-tillage has been shown to build up SOC and thereby stimulate soil aggregation (Arshad, Franzluebbers and Azooz, 1999; Franzluebbers, 2002). Soil aggregation has been directly linked to soil erodibility by many authors, and is accepted as the most important physical property of soil when discussing soil erodibility and erosion (Le Bissonnais, 1996; Barthès *et al.*, 2000; Barthès and Roose, 2002). The potential improvement in soil properties is dependent on soil texture. The larger potential for improving soil properties on fine textured soils can be attributed to the chemical connections formed between clay particles and organic matter. However, Franzluebbers (2002) found runoff to reduce under NT for both sandy and clayey soils.

Thus, the objectives of this study were: 1) to examine runoff and soil and carbon losses for various improved fallow species for a sandy loam and a clay soil; and 2) to assess the impact of NT in these systems.

METHODS

Site description

The results presented in this paper were collected between June and August 2002 on two farms in western Kenya: Sophia farm and Nyabeda farm. Sophia farm is located in Busia district with sandy loamy soils and an annual rainfall of 1 500 mm, whereas Nyabeda farm is located in Siaya district with clay soils and an annual rainfall of 1 800 mm. Soil texture, initial soil carbon content and annual rainfall are listed in Table 1.

TABLE 1
Soil texture, carbon content (0 to 20 cm) and rainfall for the study sites

Site	Soil texture			Soil carbon content	RainfalL
	Sand (%)	Silt (%)	Clay (%)	g/kg^{-1}	mm/year^{-1}
Sophia	76	6	17	6.9	1 500
Nyabeda	34	28	38	25.0	1 800

Experimental design and management

The experiment was established in September 2000 when improved fallows (IF) were planted. The design was a completely randomized block design with three replicates. The following improved fallow species were tested: *Tephrosia candida* and *Sesbania sesban,* with continuous maize (*Zea mays*, hybrid 513) intercropped with beans (*Phaseolus vulgaris,* roscocco glp2) as the control. The fallows were harvested 18 months after planting, in February 2002. The beans were harvested in June 2002 and the maize in July/August 2002. During the maize season, no striga was seen for the IF plots, whereas the control plots experienced striga. However, the striga was not assessed in this study.

Rainfall simulations and soil sampling

Rainfall simulations were carried out at harvest of the first maize after fallowing (July/August 2002), and all treatments were tested. The rainfall simulation campaign consisted of three events with the objectives of pre-wetting the soil and simulating on a wet and a very wet soil with medium and high rainfall intensities. Two distinct rainfall intensities were chosen, which represent a medium and a high-intensity rainstorm in the two respective areas. The medium intensity was 50 mm hr^{-1}, and the high intensity was 90 mm hr^{-1}. The duration was 45 minutes for the pre-wetting phase, and 30 minutes for the wet and very wet runs.

Rainfall was simulated with the Orstom rainfall simulator over a 4-m^2 plot. (See Asseline and Valentine, 1978, for a detailed description of the Orstom rainfall simulator.) Runoff was collected from a marked 1-m^2 plot. In this study, runoff was collected every minute, and a sample was kept every second minute to determine sediment concentration and soil loss. Soil resistance to penetration and shear stress were measured adjacent to the frame before each rainfall simulation using a penetrometer CL 700A (kg cm^{-2}) and a torvane CL 600 (kg cm^{-2}) produced by Gravquick, Esbjerg, Denmark. Each measurement was replicated six times.

Soil samples were collected for bulk density, soil aggregate analysis and soil carbon content. Soil was sampled in June 2002 (before the harvest of beans) at 0 to 5 and 5 to 10 cm using 98-cm^3 cores with three replicates for each plot. The three replicates were then bulked to one sample per replicate. Water-stable aggregates (WSA) were determined by wet sieving after shaking. (See Boye and Albrecht, forthcoming, for a detailed description of this method.) Total carbon content of soil and sediment samples was determined by the CNS Carlo Erba micro-analyser method. In the absence of carbonates, all carbon was considered organic.

Data analysis

The data were statistically analysed using ANOVA for a completely randomized block design. Statistical significance was determined at the 95 percent confidence level. A contrast analysis was run to test the effect of tillage practice in association with improved fallows on soil properties, runoff and soil and carbon losses. The control was continuous maize under conventional tillage (CC CT), and the improved system was improved fallow under no-tillage and conventional tillage (IF NT and IF CT).

A principal component analysis (PCA) was carried out with the ADE4 statistical package (Thioulouse *et al.,* 1997), in order to identify the dominant factors explaining soil carbon losses for the three land-use systems and two tillage practices. The variables were soil carbon content, percentage water-stable aggregates, soil bulk density and soil resistance to penetration and shear stress.

RESULTS AND DISCUSSION

Improvement in soil properties after fallowing

In this study, changes in soil properties after fallowing were highly affected by soil texture ($p \leq 0.001$) and treatment (see Table 2a). Generally, soil properties (SOC and WSA) improved under IF at the Nyabeda site (clay soil), whereas little or no improvement was seen at the Sophia site (sandy loam). On the clay soil, cropping improved fallows, increased soil organic carbon by 16 to 38 percent and reduced bulk density by 8 to 11 percent (only significant for IF-Tc, $p \leq 0.074$ and $p \leq 0.040$, respectively). WSA increased by 11 to 14 percent under IF for the clay soil (only significant for IF-Ss, $p \leq 0.10$). For the sandy loam, IF-Tc increased SOC by 38 percent, whereas no improvements were seen for IF-Ss plots and for bulk density (BD) and WSA. These results are in line with the hypothesis that stipulated larger improvements in soil properties for the clay soil. When farmland is rested from cultivation there is a build-up of SOC and soil aggregation (Ingram, 1990; Niang *et al.,* 1998; ICRAF, 2000; Mutuo, 2004); however, time is a crucial factor when examining the processes of restoring degraded land. The results from this study show that SOC and soil aggregation increased after fallowing for the clay soil, but did not change significantly for the sandy loam. However, the trends indicate that with time larger improvements are likely on these soils.

Soil bulk density decreased for IF-Tc for the clay soil, which confirms the results of Zeleke *et al.* (2004). They found incorporation of biomass to decrease bulk density (BD) for a clay and a sandy soil. In this study, changes in BD were not significant for the clay soil. Soil resistance to penetration (RP) and shear stress (RS) were not clearly influenced by soil texture and treatment in this study, which is contrary to the results of Boye and Albrecht (forthcoming) and Zeleke *et al.* (2004). Boye and Albrecht found IF to reduce RP and RS for a sandy loam and IF to increase RP and RS for a clay soil compared with the continuous maize plots. Similar results were found by Zeleke *et al.*

Table 2b lists the effects of no-tillage in association with improved fallows in improving soil properties. For the clay soil, SOC significantly improved and BD decreased under IF-Tc NT and CT compared with the control (CC CT). However, NT in association with IF-Ss did not significantly enhance SOC and WSA. IF-Ss CT increased WSA and decreased BD for this site. For the sandy loam (Sophia), IF in association with NT did not influence soil properties, but IF-Tc CT increased SOC. Similar studies in western Kenya have reported SOC and WSA to increase under NT for a clayey soil, but found no improvement in soil properties for a sandy loam (Boye and Albrecht, forthcoming), which corroborate these findings. NT has in many instances resulted in improved soil structure. This has been attributed to the stabilization of the surface by increased SOC contents and the accumulation of crop residues at the surface (Ingram and Fernandes, 2001; Van den Bygaart *et al.,* 2002) and by the lack of mechanical disturbance and its consequences on biological activity (Beare, Hendrix and Coleman, 1994).

TABLE 2a

Changes in soil properties after improved fallowing

Site	Treatment	Soil carbon	Bulk density	Water-stable aggregates	Resistance to precipitation	Resistance to shear stress
		g/kg^{-1} 0–5 cm	g/cm^{-3} 0–5 cm	g/kg^{-1} 0–5 cm	kg/cm^{-2} 0–10 cm	kg/cm^{-2} 0–2 cm
Sophia	CC CT	6.9	1.33	245.2	0.76	1.18
	CC NT	8.0	1.33	217.2	0.70	1.01
	Tc CT	10.6	1.29	235.9	0.81	1.46
	Tc NT	9.9	1.27	233.3	0.60	1.11
	Ss CT	8.3	1.25	341.3	0.54	1.32
	Ss NT	7.9	1.33	229.7	0.59	1.11
Nyabeda	CC CT	25.7	1.10	193.6	0.76	1.09
	CC NT	24.8	1.00	196.1	0.73	0.78
	Tc CT	35.1	0.92	214.6	0.81	1.05
	Tc NT	34.8	0.94	216.0	0.84	1.11
	Ss CT	28.3	0.95	228.8	0.64	0.96
	Ss NT	30.3	1.00	214.2	0.65	1.07
Sophia	LSD (0.05)	1.8*	0.09	26.3	0.32	0.48
Nyabeda	LSD (0.05)	4.1**	0.09*	26.5	0.15	0.32

* = significant at 0.05.
** = significant at 0.01.

However, time is a crucial factor. Rhoton, Shipitalo and Lindbo (2002) found improvement in soil physical properties of 17 percent after four years, and a 70 percent increase in SOC and WSA after 14 years. In this study, the recent time since conversion (18 months) can explain the relatively slow improvement in soil properties, but the degraded status of these two soils also influences the effect of NT practices. The trends in this study and in those of Boye and Albrecht (forthcoming) indicate that, with time, these systems can improve soil properties.

Effect of improved fallows on infiltration, and soil and carbon losses

The effect of improved fallows on infiltration was influenced by soil texture ($p \leq 0.001$) and treatment. Larger improvement in infiltration was found for the clay soil (Nyabeda), where IF increased infiltration by 35 to 38 percent. For the sandy loam, IF increased infiltration by 21 to 54 percent (only significant for IF-Ss). The improvement in infiltration can partly be attributed to improvement in soil structure during the fallow phase. In this study, there was a trend to larger SOC and WSA and reduced soil bulk density. However, for the sandy loam, the improvements were not significant. Several studies have found a close relationship between runoff and improved soil structure, e.g. soil organic carbon, soil aggregation and bulk density

TABLE 2b

Significance levels of contrast analyses to test the effect of tillage practice in association with improved fallows in enhancing soil properties

Site	Contrast	Soil carbon	Bulk density	Water-stable aggregates	Resistance to precipitation	Resistance to shear stress
		g/kg^{-1} 0-5 cm	g/cm^{-3} 0-5 cm	g/kg^{-1} 0-5 cm	kg/cm^{-2} 0-10 cm	kg/cm^{-2} 0-2 cm
Sophia	CC CT vs. Tc NT	NS	NS	NS	NS	NS
	CC CT vs. Tc CT	0.025	NS	NS	NS	NS
	CC CT vs. Ss NT	NS	NS	NS	NS	NS
	CC CT vs. Ss CT	NS	NS	NS	NS	NS
Nyabeda	CC CT vs. Tc NT	0.003	0.021	NS	NS	NS
	CC CT vs. Tc CT	0.002	0.012	NS	NS	NS
	CC CT vs. Ss NT	NS	NS	NS	NS	NS
	CC CT vs. Ss CT	NS	0.028	0.039	NS	NS

(Le Bissonnais, 1996; Barthès *et al.,* 2000; Barthès and Roose, 2002). Increased infiltration can also be attributed to reduced crusting on the IF plots. Crusting processes increase runoff through sealing of the soil surface (Bryan and De Ploey, 1983; Le Bissonnais, 1996; Le Bissonnais *et al.,* 1998; Rao *et al.,* 1998), and are often prevailing on degraded sandy soils. In this study, the soil surface of the sandy loam crusted quickly (within 5 to 10 minutes), increasing runoff rate and depth. Zeleke *et al.* (2004) also found incorporation of biomass to reduce soil strength, which Boye and Albrecht (forthcoming) also report for two soils in western Kenya.

The enhanced infiltration and soil structure under IF reduced soil loss. Soil loss (SL) was smaller for the clay soil (Nyabeda) compared with the sandy loam (Sophia) under IF (100 percent), whereas SL was similar under CC. The smaller SL for the clay soil was largely caused by smaller runoff rate because sediment concentration (SC) generally did not vary across sites. For the clay soil, SC was significantly reduced by IF (55 percent), whereas SC was not influenced by treatment for the sandy loam. A similar trend was seen for SL. IF reduced SL by 80 percent for the clay soil and by 70 percent for the sandy loam (only significant for IF-Ss). The soil loss values found in this study are in the same range as those reported elsewhere for simulated rainfall conditions (Merzouk and Blake, 1991; Meyers and Wagger, 1996; Boye and Albrecht, forthcoming).

NT in association with IF-Ss significantly reduced infiltration for the clay soil, whereas sediment concentration and soil loss were significantly reduced for both IF species (Table 3b). For the sandy loam, sediment concentration and soil loss were significantly reduced by IF-Ss CT, whereas no-tillage and IF-Tc did not influence SC and SL for this soil type. These results confirm those of Meyers and Wagger (1996) and Rhoton, Shipitalo and Lindbo (2002), who found long-term, no-tillage practices to reduce runoff.

TABLE 3a

Effect of improved fallows on infiltration, sediment concentration, and soil and carbon losses

Site	Treatment	Infiltration	Sediment concentration	Soil loss	Carbon losses
		%	g/l-1	g/m-2	g/m-2
Sophia	CC CT	44	1.8	43	1.97
	CC NT	51	1.7	31	1.40
	Tc CT	47	1.5	32	1.14
	Tc NT	68	2.4	30	1.15
	Ss CT	73	1.0	5	0.19
	Ss NT	74	2.1	18	0.65
Nyabeda	CC CT	65	3.2	66	2.29
	CC NT	61	2.8	34	1.01
	Tc CT	88	0.9	3	0.11
	Tc NT	86	1.4	6	0.27
	Ss CT	83	1.4	7	0.28
	Ss NT	87	1.3	5	0.20
Sophia	LSD (0.05)	24	0.6	25	0.93*
Nyabeda	LSD (0.05)	18*	0.9**	22**	0.79**
Site	LSD (0.05)	19***	0.7***	21**	0.79***

* = significant at 0.05
** = significant at 0.01
*** = significant at 0.001

In recent years, much focus has been given to soil carbon losses on the plot, slope and landscape levels. Several studies have found selective detachment and transport of SOC and fine particles, resulting in depletion of SOC for *in situ* soil and enhanced SOC for depositional areas (Watung, Sutherland and El-Swaify, 1996; Wan and El-Swaify, 1997; Jacinthe, Lal and Kimble, 2002; Owens *et al.,* 2002; Lal, 2003). On the slope scale, the most important way to reduce C losses is to reduce and control runoff and soil loss. This study has shown the potential for IF to increase infiltration and reduce soil loss for a clay soil and a sandy loam. Associated soil carbon losses were significantly reduced by IF-Ss for both sites and by IF-Tc for the clay soil (Table 3b). NT significantly reduced soil carbon losses for IF-Ss and for IF-Tc (only for the clay soil). Tillage practice did not influence soil carbon losses within treatment for the two sites.

TABLE 3b

Significance levels for contrast analyses to test the effect of tillage practice in association with improved fallows in reducing infiltration, sediment concentration, and soil and carbon losses

Site	Contrast	Infiltration	Sediment concentration	Soil loss	Carbon losses
		%	g/l^{-1}	g/m^{-2}	g/m^{-2}
Sophia	CC CT vs. Tc NT	NS	NS	NS	NS
	CC CT vs. Tc CT	NS	NS	NS	NS
	CC CT vs. Ss NT	NS	NS	NS	0.034
	CC CT vs. Ss CT	NS	0.020	0.025	0.008
Nyabeda	CC CT vs. Tc NT	NS	0.009	0.002	0.002
	CC CT vs. Tc CT	0.046	0.002	0.001	0.001
	CC CT vs. Ss NT	0.054	0.006	0.001	0.002
	CC CT vs. Ss CT	NS	0.010	0.002	0.002

A principal component analysis (PCA) of soil carbon losses shows C losses to be predominantly controlled by soil texture and treatment. The eigen values show that the first factor (F1) explains 40 percent of the variance and is opposed by soil carbon content, BD and water-stable aggregates (Figure 1a). The second factor (F2) explains 28 percent of the variance and is explained mainly by soil resistance to penetration (RP) and shear stress (RS).

The points on the factorial map of treatments are clustered mainly into two groups, one group placed to the right of the diagram, representing the clay soil (Nyabeda), and one group placed to the left of the diagram, representing the sandy loam (Sophia) (Figure 1b). For both sites, the points for CC are placed towards the upper part of the diagram (larger C losses), whereas the points for IF are placed towards the lower part of the diagram (smaller C losses). Cropping IF prior to maize reduced C losses by 79 to 83 percent (0.19 to 0.24 vs. 1.15 g C m^{-2}) for the clay soil and by 32 to 75 percent for the sandy loam (0.42 to 1.15 vs. 1.69 g C m^{-2}, only significant for IF-Ss). Similar C losses have been reported by Boye and Albrecht (forthcoming) for western Kenya, however, they found no effect of treatment on C losses for a sandy soil. Similar C losses have been reported by Jacinthe, Lal and Kimble (2002) for long-term experiments.

FIGURE 1a
Correlation circle of variables

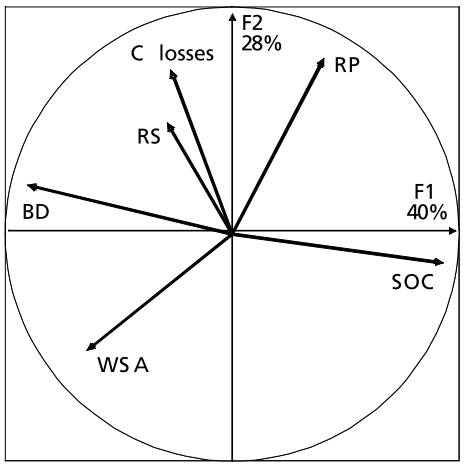
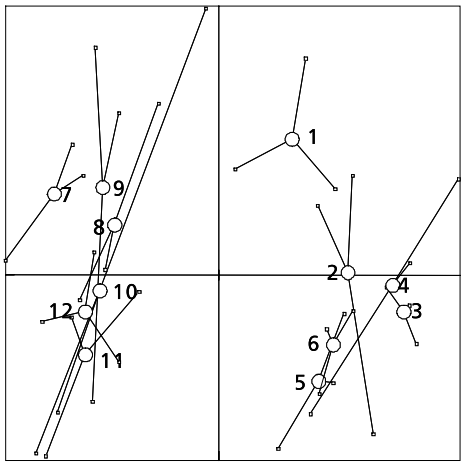


FIGURE 1b
Factorial map of treatments



Nyabeda: 1. CC-T, 2. CC-NT, 3. IF-Tc T, 4. IF-Tc NT, 5. IF-Ss T, 6. IF-Tc NT.
Sophia: 7. CC-T, 8. CC-NT, 9. IF-Tc T, 10. IF-Tc NT, 11. IF-Ss T, 12. IF-Tc NT.

CONCLUSION

The results from this study show that improved fallows have the potential to improve soil properties and thereby reduce runoff, and soil and carbon losses. The improvement in soil properties was larger for the clay soil compared with the sandy loam, hence larger infiltration and lesser soil and carbon losses for the clay soil. The larger control found for the clay soil can be attributed to the significant improvement in soil properties, e.g. SOC, WSA and BD, which was found here. Despite the slow improvement in soil properties for the sandy loam, infiltration increased for the IF plots, and soil and carbon losses reduced, however only significantly for IF-Ss. Improved fallows reduced crusting for the sandy loam, which can explain the larger infiltration found for the IF plots on this soil type. No-tillage in association with improved fallows enhanced soil properties and infiltration, and reduced soil and carbon losses for the clay soil. The effect of no-tillage on the sandy loam was less clear, however, there was at trend for improved soil structure on this soil type, but long-term experiments are needed to address the impact of improved fallows and no-tillage in relation to runoff, soil and carbon losses.

ACKNOWLEDGEMENTS

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CHAPTER 6
RESULTS FROM TEN YEARS OF WATERSHED AND WATER RESOURCES RESEARCH IN SEMI-ARID SOUTHERN ZIMBABWE

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ACRONYMS

AREX	Agricultural Research and Extension Services
CEH	Centre for Ecology and Hydrology
DFID	Department for International Development, United Kingdom
HOF	Hortonian overland flow
IES	Institute of Environmental Studies
SOF	saturated overland flow
START	System for Analysis Research and Training

The semi-arid areas of Zimbabwe located in natural regions IV and V receive low and erratic rainfall, such that dryland crop production is not reliable. The rains are unevenly distributed in both time (Figure 1) and space, resulting in frequent crop failures that occur in three out of every five years. This makes life difficult for communities living and farming in such areas, forcing them to rely on water stored underground or in surface storage during wet seasons.

Watershed and water resources research commenced in the early 1990s in semi-arid southern Zimbabwe. The objectives of the studies were to determine the effect of land management on groundwater recharge (Bromley *et al.,* 1999; Butterworth *et al.,* 1995; Lovell *et al.,* 1998) and surface water resources (Mugabe and Hodnett, unpublished). It also determined runoff generation and groundwater recharge mechanisms (Bromley *et al.,* 1999; Butterworth *et al.,* 1995; Lovell *et al.,* 1998; Mugabe and Hodnett, unpublished). Similarly the studies determined the extent to which water use can be stretched without depleting surface water resources (Mugabe and Hodnett, unpublished; 2003).

STUDY SITES

The research on watershed and water resources concentrated on two headwater micro-catchments (~ 5 km^2) of the Runde catchment (Figure 2), which were fully instrumented to enable measurements of all components of the hydrology, including rainfall, runoff, soil moisture and groundwater recharge.

FIGURE 1

Annual rainfall recorded at Chiwi, as deviation from long-term mean and cumulative deviation from mean annual rainfall

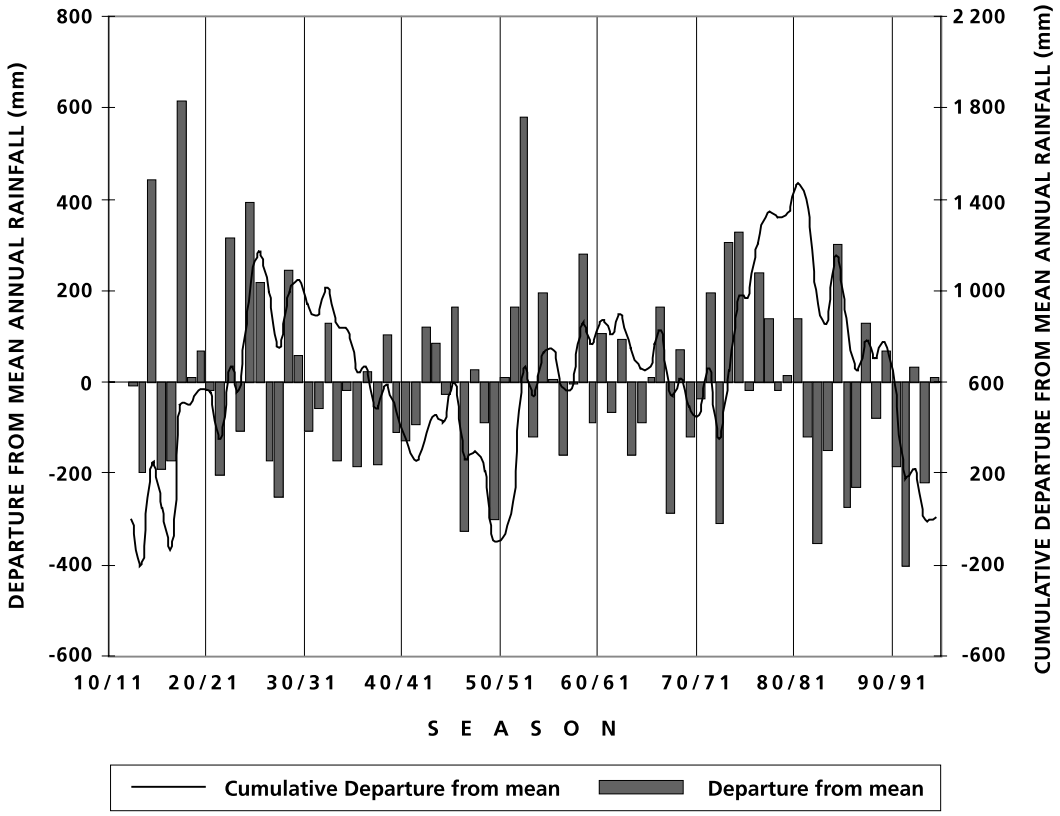
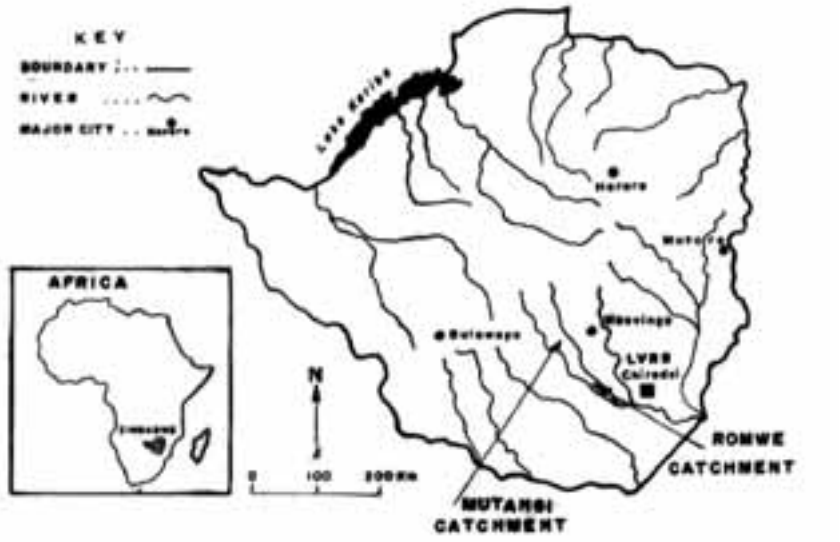


FIGURE 2

Location of Romwe and Mutangi communal areas.



RESULTS FROM THE CATCHMENT AND WATER RESOURCES RESEARCH

Runoff

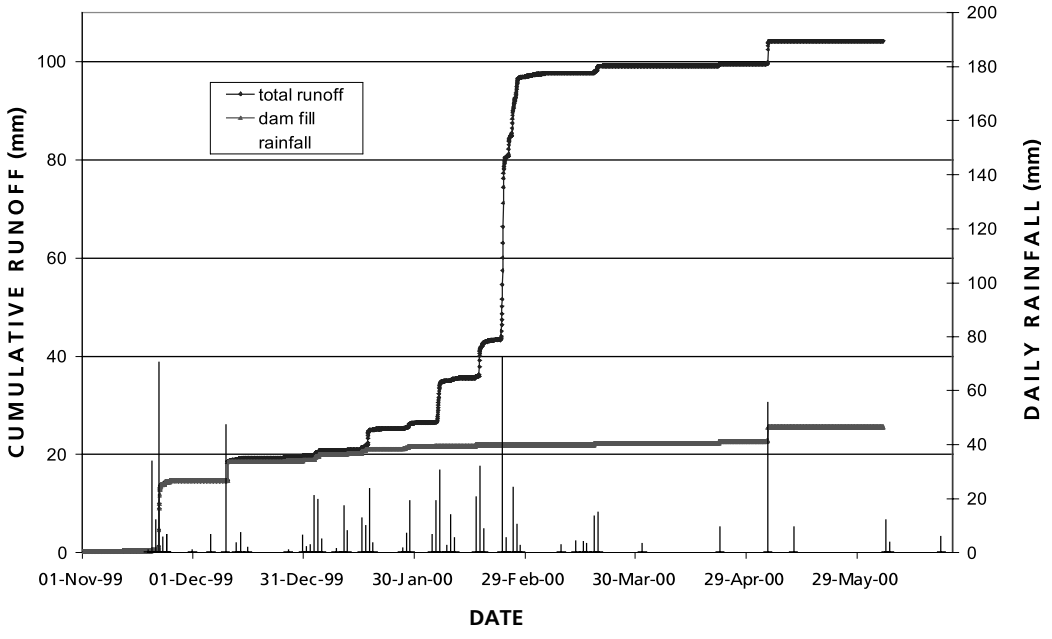
At the catchment scale, runoff from the semi-arid areas is generally a small part of the water balance, and is highly variable – even within small catchments. The grey soils at Romwe catchment (4.6 km^2) generated more runoff than the red soils (Table 1).

TABLE 1
Rainfall and runoff from the red and grey subcatchments in the Romwe micro-catchment (4.6 km^2)

SEASON	RAINFALL (mm)	RED SOILS		GREY SOILS	
		Runoff (mm)	Runoff conversion efficiency (%)	Runoff (mm)	Runoff conversion efficiency (%)
1994/5	738	9	1.2	48	6.5
1995/6	990	46	4.6	203	20.5
1996/7	1 140	64	5.6	335	29.4
1997/8	798	67	8.3	206	25.8
1998/9	1 084	22	2.0	151	13.9

Of the runoff studied in Romwe, between 20 and 30 percent is captured by the small dams that are found in these semi-arid areas (Figure 3), while the remainder leaves the catchment (Mugabe and Hodnett, 2003; unpublished).

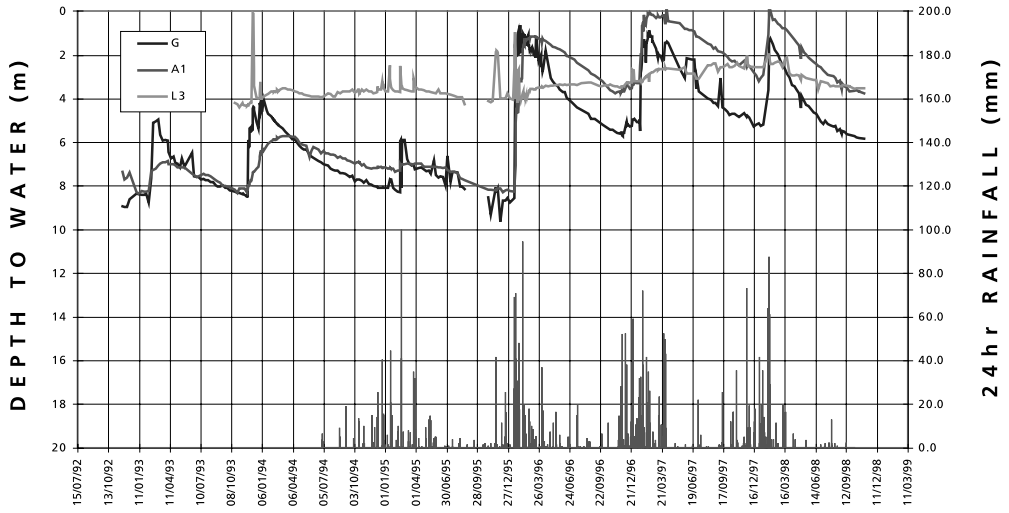
FIGURE 3
Cumulative total runoff and dam fill, and daily rainfall during the 1999/2000 season



Effect of rainfall on groundwater levels

Long-term trends in groundwater levels reflect the effect of cycles in rainfall. Figure 4 shows there is more fluctuation of the water table in the red soils than the grey soils. Piezometer G is located on a grey soil (G), while A1 and L3 are located on a red soil.

FIGURE 4
Long-term water table hydrographs for three Piezometers



Groundwater recharge and runoff generation mechanisms

Research in the Romwe catchment area shows that groundwater recharge is not uniform throughout the catchment, but is erratic and episodic (Lovell *et al.,* 1998; Butterworth *et al.,* 1999a, b and c). Drainage from the unsaturated zone during the 1994/1995 seasons on both red clay and grey duplex soil types was associated with a single rainstorm. Drainage through the soil profile in 1994/1995 was highly spatially variable on both the red clay and the grey duplex soils. In the red clay soils, subcatchment drainage was observed at nine out of 16 sites, and in the grey duplex clay, subcatchment drainage occurred at only four out of 20 sites. Locations of high drainage were in areas where surface water was concentrated through redistribution during rainstorms (Butterworth *et al.,* 1999b). In particular, high drainage was observed above contour bunds, along lines of surface water drainage and along storm drains (where infiltration of water was enhanced by the construction of infiltration pits by farmers). If surface redistribution of rainfall had not occurred during this year, there would have been no deep drainage to groundwater through the soil matrix below fields with either soil type (Butterworth, 1997).

Research at Mutangi catchment shows that some runoff appears to be generated by Hortonian overland flow (HOF), mainly in the early wet season before ploughing creates a rougher soil surface (Mugabe and Hodnett, unpublished). The dominant process of runoff in this catchment was saturated overland flow (SOF), which occurs when the soils become saturated from below (Mugabe, no date) along the catena. The sodic soils along the stream channels

appear to generate most of the runoff because of their small capacity to store water before saturation. The ridge soils are coarse sands, with a large capacity to store rainfall. The transitional (slope) soils have an intermediate capacity to store water. If there is a sequence of daily events that completely fills the storage available for both the sodic and the transitional soils, and begins to saturate the ridge soils, subsequent events can produce very large amounts of runoff (> 50 percent of the daily rainfall). The occurrence of such runoff events depends very heavily on the distribution of rainfall. Dry spells between rain events create storage, thereby reducing the risk of runoff from the next events (Mugabe, no date).

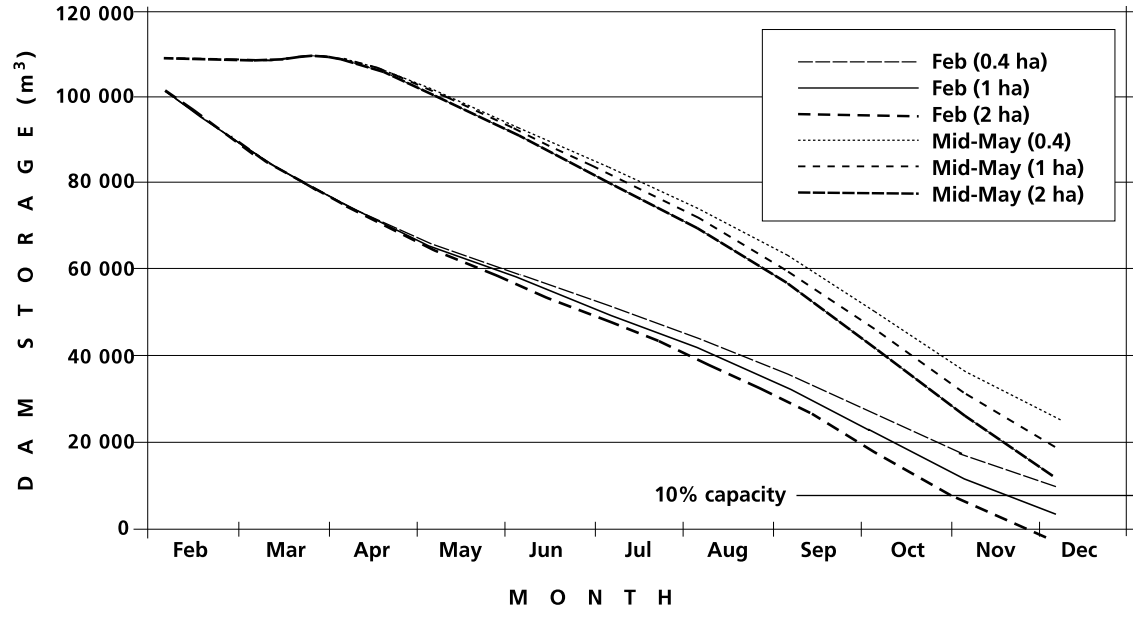
Can current water use be increased without drying the dam?

The amount of water available for irrigation depends on the amount of water stored in a dam at the beginning of the irrigation season, and the evaporation and seepage losses. Six scenarios were run to determine the effect of increased abstraction on dam water level if the dam last filled in February or in mid-May (Figure 5).

The scenarios illustrated in Figure 5 show that garden size (water use) can be increased by up to five times without the danger of drying up a dam if the dam was last filled up in May. When the dam was last filled in February, water use can only be increased 2.5 times. This highlights the importance of knowing when the dam was last filled up, and the amount of water in the dam at any given time, in determining the amount of water (garden size) to use in a season. Most dam users do not have this information, and often do not know how much water their dams hold at full capacity.

Modelling results using historical rainfall data show that water use from small dams can be safely increased by up to ten times without drying up the dam in 78 percent of cases (Mugabe, no date).

FIGURE 5
Reservoir storage when last full in February and in mid-May for three garden sizes



CONCLUSION

The following conclusions and recommendations can be made from the research:

- At the catchment scale, runoff from the semi-arid areas is generally a small part of the water balance.
- Long-term trends in groundwater levels reflect the effect of cycles in rainfall.
- Runoff generating processes can be SOF or HOF, depending on the quantity, distribution and intensity of the rainfall.
- Of dam water balance in the semi-arid areas, only 3 percent is used for productive purposes, and the remainder is lost as evaporation.
- Water use from small dams can safely be increased by up to ten times without drying up the dam in 78 percent of cases.
- The amount of water available for productive purposes depends on when the small dams were last filled – the later in the season this is, the more water is available for gardening.

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CHAPTER 7
CONSERVATION FARMING – A STRATEGY FOR IMPROVED AGRICULTURAL AND WATER PRODUCTIVITY AMONG SMALLHOLDER FARMERS IN DROUGHT-PRONE ENVIRONMENTS

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ACRONYMS

C	control
CF	conservation farming
Fert	fertilizer
HIV/AIDS	human immunodeficiency virus/acquired immune deficiency syndrome
Ripp	Magoye ripper
SIWI	Stockholm International Water Institute
SSA	sub-Saharan Africa (SSA)
TFSC	Tanzania Farm Service Centre

The frequent crop failures and yield reductions due to drought observed in the last years in many parts of Africa are not just a consequence of climatic variability but, to a large extent, a consequence of land degradation due to inappropriate agricultural practices. Land degradation, reducing rainfall infiltration, crop water availability and crop water uptake capacity, lead to agricultural droughts where the crop suffers from water scarcity despite adequate amounts of rainfall. Unlike meteorological droughts, agricultural droughts can often be managed through integrated soil and water management practices that focus on maximizing crop water access and uptake. Conservation tillage systems that have in common non-inversion of soil with the purpose of harvesting water and building soil quality can, together with improved soil nutrient management, result in substantially improved yields by mitigating droughts and dry spells.

One of the most important natural resources is soil, especially agricultural soil. However, the soil resource can fulfil its functions only in the presence of another precious resource – water, in particular rainwater. There are close interactions between these resources, as only a healthy soil can take up and store sufficient amounts of rainwater and make it available to plants over a prolonged period. These interactions among soil, water and plants (crops) are influenced by human activities, and are in many cases disturbed. Soil quality (soil structure, soil organic

matter, soil life) is lowered in most cases by tillage operations; soils degrade and the ability to take up and store rainwater suffers. A great percentage (> 50) of rainwater is lost by runoff and evaporation, and crops suffer from water stress after only a few days without rain.

Food security and poverty reduction, the main objectives of all development efforts, can only be achieved if sustainable land and soil management practices are applied on a large scale. This calls for a drastic change, first of all of tillage practices. Tropical soils should be disturbed as little as possible, and protected by a cover of mulch or crops (wherever possible by cover crops) the greatest part of the year. Ploughing and intensive hoeing should be replaced by ripping, direct planting or pitting. These conservation farming techniques, complemented by the breaking of hardpans, contribute to a better water infiltration and reduce losses of precious rainwater as runoff. Conservation farming is therefore integrated soil and water management. It is an *in-situ* water harvesting strategy.

Semi-arid and dry subhumid regions constitute some 40 percent of the arable lands in sub-Saharan Africa, and host some 40 percent of the population. Rainfall is highly erratic, with large spatial and temporal variability resulting in frequent periods of particularly dry spells. The correct ecological term for these regions is savannah.

Water is the major limiting factor in savannahs, even on soils with a poor nutrient status, which means that the increase of rainwater productivity needs to gain priority before the application of mineral fertilizers. However, it is more often the poor distribution of rainfall over time that causes water scarcity than low overall rainfall. This is not always well understood, and in the normal jargon these regions are generally denoted "drylands". However, they are not all that dry (generally receiving at least 600 mm of rainfall). There is generally enough water, but it is there at the wrong time and such a large proportion is lost to the crop as evaporation and runoff. This indicates a window of opportunity to improve yield levels through improved water management.

The objective of this paper is to give evidence that conservation farming in sub-Saharan Africa is an important water harvesting strategy with beneficial impact on yields in water scarcity-prone semi-arid and dry subhumid areas.

RAINWATER PRODUCTIVITY

Dry spell mitigation

Rainfed farming in savannah agro-ecosystems is a highly risky business owing to the extreme temporal and spatial variability of the rainfall. Rain is generally concentrated in one or two short rainy seasons, followed by distinct dry seasons exceeding six months of the year. The high rainfall variability results in a high risk of occurrence of meteorological droughts – here defined as a cumulative rainfall below the minimum water requirement to produce a crop (i.e. resulting in complete crop failure – in general when seasonal rainfall is < 250 mm). Statistically, meteorological droughts occur in between one and two seasons in a decade. They are difficult if not impossible to manage (there is simply no freshwater resource to manage) and form a natural part of the savannah reality. Most important therefore is to focus on meteorological dry spells – short periods of two to four weeks of no rainfall, resulting in crop growth reduction.

If occurring during stress-sensitive growth stages, such as flowering, a severe dry spell can result in complete crop failure. Meteorological dry spells are very common in savannah farming systems, occurring almost every rainy season. These dry spells are manageable, but generally require management practices such as storage water harvesting systems for supplemental irrigation (SIWI, 2001).

However, crop water stress may increase dramatically as a result of poor land management. Water stress causing dry spells and agricultural droughts is caused primarily not by low rainfall but by poor rainfall partitioning, resulting in large losses of water (from the perspective of the cultivated crop) in the water balance (as evaporation, runoff and drainage).

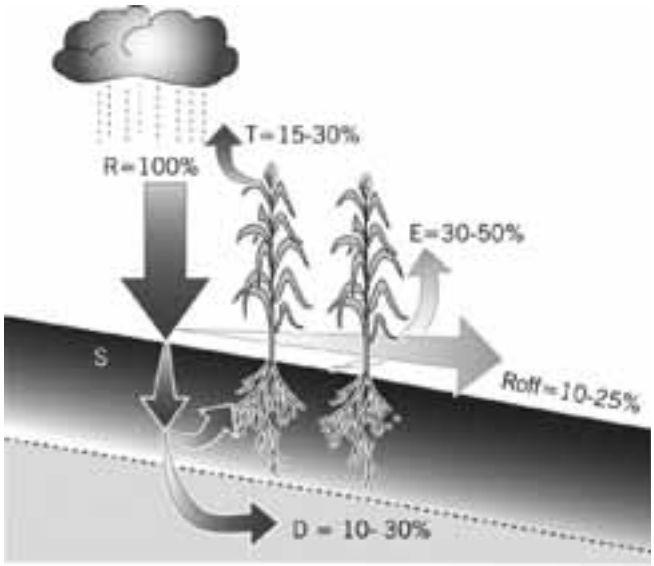
Water balance analyses from rainfed farming systems in savannah environments of sub-Saharan Africa indicate that only some 15 to 30 percent of rainfall on average is used for productive crop growth (Rockström, 1999). On smallholder farms subject to land degradation – both in terms of structural degradation impeding rainfall infiltration, water holding capacity and plant water uptake potential and in terms of soil fertility decline – less than 10 percent of the rainfall takes the productive flow path as crop transpiration (Rockström, Jonsson and Barron, 1998). Yield levels in such degraded farming systems, which are systematically subject to management-induced dry spells, oscillate around 0.5 to 1 tonne of grain per hectare. This is the common yield level generally observed among smallholder farming in eastern and southern Africa. It suggests that: 1) there is a large management-induced crop water scarcity; and 2) there is a large potential for upgrading rainfed savannah farming through improved soil and water management.

Conservation farming – a water harvesting strategy

Conservation farming aims at reversing a trend that is persistent in many production systems – i.e. the reduced infiltration capacity of soils due to compaction and crust formation, and reduced water holding capacity due to oxidation of organic materials (due to excessive turning of the soil). From this perspective, conservation farming is a form of water harvesting, where runoff is impeded and soil water is stored in the root zone of the crop. This means that conservation farming constitutes a very interesting approach to achieve improvements in water productivity, and "crop per drop" increases, in line with the newly launched global dialogue on water for food and environmental security (Anonymous, 2001).

We know that for large parts of the developing world subject to rapid population growth, yield levels of staple foods need to at least double over the next generation in order to keep pace with population growth. We also know that a majority of these countries are in savannah environments. Generally, it is assumed that water requirements increase linearly with increased food production, i.e. that a doubling of yields would result in a doubling of crop water use. Empirical research shows that water requirements range in the order of 1 000 to 3 000 m^3/tonne of grain (Falkenmark and Rockström, 1993), which explains why agriculture is the world's largest direct water using sector. However, there is strong evidence showing that water productivity can be improved (i.e. improvement in the amount of crop produced per drop of water) through management (Rockström, Barron and Fox, 2003).

FIGURE 1
Rainfall partitioning in the semi-arid tropics in sub-Saharan Africa



Two key factors need to be improved in order to increase water productivity in agriculture. These are:

- increased crop water availability (through improved rainfall infiltration and water holding capacity, and reduced soil evaporation losses through minimum or no-tillage and soil cover);
- increased crop water uptake capacity (improved root depth and canopy development in order to maximize productive transpiration flow).

An aim of conservation farming is to improve both of these key water productivity-enhancing factors. One major goal is to change the partitioning of rainfall in favour of infiltration, soil moisture storage and plant water uptake. Rockström and Falkenmark (2000) have in a recent study shown that a doubling, and in many cases even a quadrupling, of crop yields in African savannahs is feasible from a hydrological perspective if such measures are accomplished.

Rainwater productivity can be increased further by timely farm operations such as timely planting and weeding. Planting is often delayed by up to several weeks owing to tillage operations. Adoption of reduced or no-tillage systems permits farmers to plant directly after the onset of the rains, thus exploiting the entire rainy season. Timely weeding is as important, as weeds compete for water. A permanent ground cover by crop residues and cover crops suppresses weed growth and reduces the labour requirements for weeding.

FARMER EXPERIENCES WITH CONSERVATION FARMING IN THE UNITED REPUBLIC OF TANZANIA

Approach and methodology

Farmer-designed conservation farming trials have been carried out since 1998 in semi-arid and dry subhumid (rainfall depth averaging 700 to 1 000 mm yr^{-1}) parts of Arusha and Arumeru districts, in northwestern Tanzania. The trials involved eight to ten farmers each year in three villages; Sakila (subhumid), Ngorobob and Mkonoo (semi-arid). The basic tillage implements involved are ox- and tractor-drawn subsoiler, ox-drawn Magoye ripper, and hand hoe.

The trials included four principal production systems: 1) ripper/subsoiler; 2) a ripped broad-bed system; 3) a manual pitting system; and 4) the conventional ploughing system. These four systems were then combined and site-adapted regarding: 1) intercropping (lab-lab or cowpea depending on location); 2) fertilization (manure, Mijingu rock phosphate and Urea); 3) traction (oxen or tractor); 4) crop rotation; and 5) crop varieties. The main crop in all experiments is maize (*Zea mays*). Common to all sites was the use of a standard plant density of 80 x 30 cm, and fertilization (for all treatments expect the non-fertilized control). The experiment was a randomized block design with two repetitions per farm site (i.e. two blocks with six treatments each). Each production system was repeated 16 to 20 times each rainy season (the variation depends on the varying number of farmers involved in the trials).

Subsoiling was carried out with either tractor or ox-drawn subsoiler. Subsoiling was carried out during the dry season to a depth of 40 to 50 cm for tractor subsoiling and 25 to 35 cm for ox-drawn subsoiling. The subsoiling was followed by ripping, which was done to establish permanent planting lines, along the contour at 75-cm spacing.

The pitting system was very similar to the zai-pitting found in the Sahel. A hand hoe was used to dig planting holes with dimensions of roughly 20 x 20 x 20 cm. Most important was that the depth exceeded the conventional ploughing depth (which in this region is 12 to 13 cm).

The conventional system (control) was similar in all locations, based on post-onset ploughing with mouldboard plough. All conservation farming treatments were dry-planted, and crop residue was left on the fields as mulch (except for maize leaves, which were taken for fodder). Weeding control was done manually, following the normal practices in the area. However, one additional weeding operation was carried out after harvest in order to reduce weed infestation from weed seeding.

The trials started effectively with the long rains (March to June/July) of 1999. Despite a bimodal rainfall pattern, the short rains (generally from mid-October to January) are so poorly distributed with low cumulative rainfall that most farmers do not even attempt to cultivate rainfed crops. The trials have been ongoing for four years, and in this paper, yield data from the long rains of 1999 to 2002 are presented.

Yield results

Table 1 shows the average yield results from the long rains of 1999 to 2002 for the eight to ten participating farmers for each year. The average conventional ploughed maize yield is

1.3 tonnes/ha^{-1}, which is a factor three times lower than the ripper treatments (yielding on average 3.8 to 4.0 tonnes/ha^{-1}).

Conservation farming systems yielded on average 2.2 to 2.4 times higher yields than the present conventional practice based on mouldboard ploughing. This large and persistent difference can be attributed to the combined effect of improved water (through conservation tillage) and soil fertility management (through spot application of fertilizer and manure). The water effect of conservation farming can be assessed by comparing the ripped system with the control receiving fertilizer, which resulted in a significant yield increase of an average 40 percent. The soil fertility effect alone is indicated by the 70 percent yield increase between the controls with and without fertilizer application. It is interesting to note that addressing water alone – i.e. by adopting conservation farming without soil fertility management (represented by Ripp-fert) results in roughly the same yield level as if the farmer addresses soil fertility alone (represented by conventional + fert). This suggests two important issues. First, that water is not necessarily the only, and often not even the major, limiting factor for crop growth, even in this semi-arid savannah environment. Second, it clearly shows that it is only when combining water and soil fertility management that a synergy effect is achieved, which is manifested in large yield increases.

Similar results have been achieved in semi-arid Babati district, Tanzania, where tractor subsoiling of maize resulted in an immediate (first-season) 2.8-fold increase in maize yields during the favourable rains of 1995/1996 (from 1.7 to 4.8 tonnes/ha^{-1} for fertilized maize and

TABLE 1
Maize grain yield of farmer trials in Tanzania for long rains 1999 to 2002

TREATMENT	N	AVERAGE YIELD (kg/ha)	SD (kg/ha)	TREATMENT EFFECT		MULTIPLIER	
				Control	C+fert	Control	C+fert
Ripp	39	3 874	1 781	0.0000***	0.0023***	2.4	1.4
Ripp+CC	39	3 633	1 809	0.0000***	0.0000***	2.2	1.3
Ripp-fert	27	2 539	1 513	0.0024**	0.4727	1.6	0.9
Pitting	39	3 523	1 515	0.0000***	0.0198*	2.2	1.3
C+fert	39	2 783	1 217	0.0000***	0.0000***	1.7	1.0
C	41	1 621	885				

Notes: Treatment effects are shown compared with C (control; conventional mouldboard ploughing without fertilizer application = farmer's current practice) and with C+Fert (conventional mouldboard ploughing including fertilizer application equal to the fertilization of the CT treatments). Ripp = Magoye ripper, Ripp + CC = Magoye ripper plus lab-lab cover crop, Ripp-fert = Magoye ripper without fertilizer application. Pitting = manual hand hoeing of planting pits, plus fertilization.

from 1.3 to 3.7 tonnes/ha^{-1} for non-fertilized maize), and a 25 percent increase in yields during a drought season (short rains 1996/1997) (Rockström and Jonsson, 1999).

The results of on-farm trials with subsoiling, cover crops and minimum-tillage conducted in the neighbouring Hanang and Karatu districts confirm these findings. Yields of maize and wheat could be more than doubled during three consecutive years (1999 to 2001). The highest increment was observed in the dry year 1999, where the annual rainfall was only 233 mm and 451 mm compared with an average of 800 mm, and crops failed completely on conventionally tilled fields in Karatu district (TFSC, 2000; 2001; 2002).

YIELD AND WATER PRODUCTIVITY

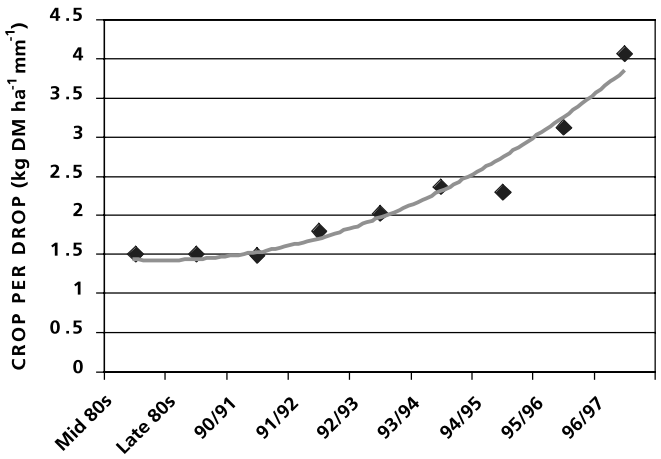
Rainwater productivity

The animal-drawn ripper-based conservation farming system resulted in increased rainwater productivity (an average WP_R of 2 400 m^3/tonne compared with 3 800 m^3/tonne for the conventional [non-fertilized] farmers' practice). According to the farmers participating in the trials, conservation farming resulted in practically zero surface runoff. This suggests that the reduction in water consumption per unit crop under CT is a result of a reduction in soil evaporation and/or deep percolation. Rainwater productivity was increased by fertilizer application in both systems (conventional = 1 750 m^3/tonne; ripping = 1 400 m^3/tonne). Using cover crops instead of fertilizer in ripped fields gave similar results to conventional farming with fertilizer (1 600 m^3/tonne versus 1 750 m^3/tonne). Data suggest a synergistic effect of rainwater harvesting and fertilizer application, indicating that fertilizer use efficiency is increased by conservation farming (i.e. improved soil moisture status).

The subsoiling trials discussed above in Babati district in western Tanzania using tractor-drawn subsoiling and ripping resulted in similar water productivity improvements (Figure 2). Over a

FIGURE 2

Development of rainwater use efficiency (kg DM grain mm^{-1} ha^{-1}) of maize in Babati district, Tanzania before introduction of conservation tillage (mid-1980s to 1990/1991) compared with after introduction of conservation tillage (1991/1992 onwards)



Source: adapted from Rockström and Jonsson, 1999.

period of seven years, a progressive improvement of WP_R could be observed from an average of 1.5 kg grain per millimetre of rainfall (6 600 m^3/tonne) in the 1980s (based on conventional disc ploughing by tractor) to approximately 4.5 kg grain per millimetre of rainfall (2 500 m^3/tonne) in the mid- to late 1990s after adoption of deep tillage and non-inversion technologies (adapted from Rockström and Jonsson, 1999). It is assumed that this is primarily owing to a reduction in surface runoff, improved water infiltration and storage and a more profound root system.

FARMER EXPERIENCES WITH CONSERVATION FARMING IN MADAGASCAR

In Madagascar, the French research organization CIRAD has been working since 1994 on the development of direct planting practices for smallholder farmers. The objectives are to maintain soil fertility, prevent soil erosion and increase yields of food crops, as well as producing forage for livestock (cattle). A key issue is the maintenance of a permanent soil cover by crop residues and relay cropping of forage plants (oats, etc.) or associations with permanent species such as *Desmodium uncinatum* or *Trifolium semipilosum*, Kikuyu grass or *Pennisetum clandestinum*. Crop yields, labour productivity and household incomes could be increased significantly with a steady upward trend.

Figure 3 shows data of on-farm trials of six successive years. Data are derived from three different regions in the semi-arid parts of the Madagascar highlands; three on-farm plots (= repetitions) were installed at two different sites in each region, in total 18 on-farm plots. Soils are sandy alfisols (*sols ferrugineux tropicaux*) with 70 percent sand and 15 percent clay. Annual rainfall varied between 480 and 850 mm. By stopping ploughing and direct planting, bean yields could be raised from 200 to 400 kg/ha to 800 to 1 700 kg/ha in unfertilized plots and from 400 to 600 kg/ha to 1 800 to 2 000 kg/ha in fertilized plots. Rainwater productivity was simultaneously raised from 0.1 to 0.2 kg of grain per m^3 of water to 0.38 kg maize grains and 0.58 kg of maize and cowpea grains (intercropping).

DEVELOPING RAINWATER HARVESTING TECHNIQUES IN THE KORDOFAN PROVINCE OF THE SUDAN

In the Sudan, food security in dryland agriculture is threatened by low average rainfall and frequent droughts. Owing to population growth, more and more traditional pastureland is used for cropping. Since 1998, the National Agricultural Research Institute has been conducting on-farm trials with rainwater harvesting methods in the Kordofan province, with the objective of increasing yields and reducing the risk of crop failure due to drought. The land is almost flat, with gradients of 1 percent only. Soils are sandy to sandy clay loams. Rainfalls are erratic, with annual means varying between 140 and 624 mm (1998 to 2002). Prolonged dry spells during the cropping season are frequent.

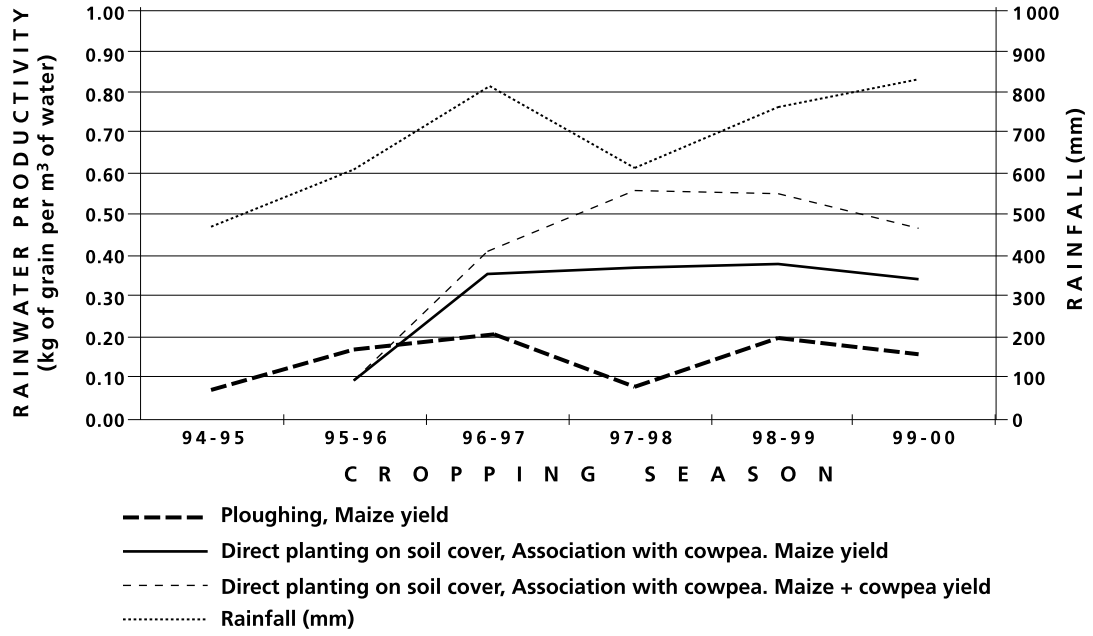
Traditionally farmers till or scratch the land only superficially with hand tools. The main crops are sorghum, millet, watermelon and groundnut. With the first rains, the soil surface gets crusted, resulting in runoff and high losses of precious rainwater.

The rainwater harvesting techniques tested consist of parallel earth bunds, about 40 cm high, built at 10 m distances. The upper half of the strip between bunds serves as a runoff area, the lower half is planted with sorghum. The sorghum is planted in ripped (by chisel or tine) rows, outlets for

excess water are placed to ensure even water distribution, while cowpea or groundnuts and Roselle are planted on the inner side of the earth bunds (as soil protection and an additional source of food and income). With this simple technique, sorghum yields can be tripled or quadrupled in normal years, and total crop failure can be prevented in dry years (Figure 4). The rainwater productivity is a rough estimate, based on total rainfall in the growing season, and crop yields.

FIGURE 3

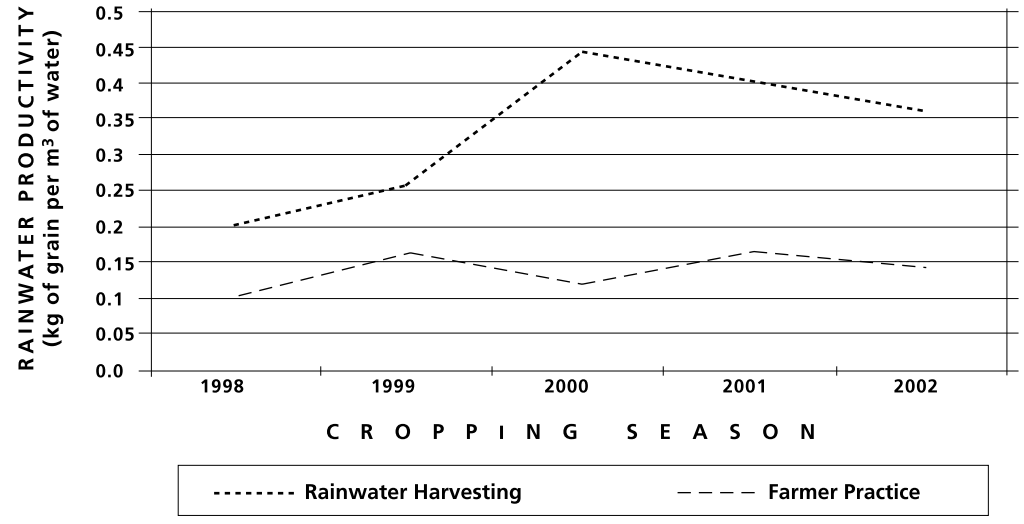
Development of rainwater productivity under direct planting through soil cover in Tulear, highlands of Madagascar



Source: O. Husson, personal communication

FIGURE 4

Impact of rainwater harvesting on sorghum yields in Obeid, Kordofan province, the Sudan



Notes: Data from researcher-managed on-farm trials 1998 to 2002. "Farmer practice" refers only to tillage and not to other management aspects, which equal those of "Rainwater harvesting". Data on farmer practice 1998 and 2002 interpolated. Complete crop failure due to drought in 2002
Source: O. Alfadni, personal communication.

CONCLUSION AND DISCUSSION

Conservation farming systems are not new and have, during the last decades, been adopted at a large scale in several countries in Latin America, in parts of Asia and in North America. Common to this wide adoption is that most success has been experienced in relatively wetter hydroclimatic zones, with limited success in drier, savannah agro-ecosystems. This paper addresses the water harvesting advantages of conservation farming systems, which form an entry point to conservation farming development in relatively drier savannah environments. It is interesting that commercial farmers in semi-arid and dry subhumid regions of, for example, Tanzania and Zimbabwe have adopted conservation farming practices, resulting not only in higher and more stable yields but also in significantly reduced labour and fuel needs (Oldreive, 1993). Only very limited adoption has been experienced among smallholder farmers in savannah agro-ecosystems.

On-farm trials in savannah agro-ecosystems among smallholder farmers in Tanzania show that yield levels of maize can effectively be more than doubled over consecutive years, with varying rainfall levels, through the adoption of conservation farming practices. A cornerstone in these practices is the *in situ* water harvesting effect of ripping and subsoiling, which instead of turning the soil at shallow depth (as done by ploughing) opens a deep planting furrow, which effectively collects rainwater.

Mouldboard ploughing is still perceived among farmers, extension agents, development officers and most researchers as a *sine qua non* in every crop producing system. The very notion of abandoning the plough in favour of various techniques of reduced tillage was initially not easy to convey. However, the obvious benefits of reduced tillage, especially in years with extended dry spells, rapidly turned disbelief into a strong local ownership of the adaptive process of designing site-specific conservation farming systems. This highlights again that farmers are open-minded and prepared to make fundamental changes to their land-use practice if they can see the benefits in doing so.

Rainwater productivity is increased by a soil cover of crop residues and cover crops. However, this is difficult to achieve in dry savannahs, where rainy seasons are followed by long dry seasons, biomass growth is overall low and livestock and humans compete for the use of post-harvest biomass remaining in the fields. A challenge in savannah regions is, therefore, to develop integrated crop–livestock production systems. This requires further research and development activities together with farming communities.

Conservation farming systems provide farmers with an effective tool to maximize rainfall infiltration into the soil and to build up water holding capacity and crop water access. They do not provide farmers with a solution to mitigate dry spells, even though the length of dry spells and their effects can be reduced somewhat thanks to an increase in soil moisture availability. An interesting, unexplored avenue is to integrate conservation farming practices as a form of *in-situ* water harvesting with external water harvesting systems where runoff water upstream from cropland is harvested and stored for supplemental irrigation. Together, such practices could enable farmers to increase and stabilize food production, and thus improve rural livelihoods in the long term.

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CHAPTER 8
ABOVE-GROUND TRANSFORMATIONS IN AGROFORESTRY SYSTEMS IN WATERSHEDS: CASE OF COCOA AGROFORESTS OF CENTRAL CAMEROON

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ACRONYMS

CFA	Communauté financière africaine
MT	median tree
NMT	non-median tree

Local knowledge passed down from ancestors to descendants indicates that a considerable proportion of the forest margins of central Cameroon was previously covered by forest savannah. These forest savannahs have since been occupied by pioneer settlers who have developed traditional agroforestry systems. These agroforests are simultaneous land management systems, in which tree components occupy the same area as crops and, sometimes, animals. Similar to home or forest gardens, the agroforests possibly constituted the first transformation of original vegetation into a consciously managed agroforestry system. To date, their value is based on their flexibility, both economically (i.e. flexible demand on labour) and ecologically (i.e. diversity of species and different harvest periods for products) and in terms of the adaptation of products to local and national markets as well as household needs (Minchon, Mary and Bompard, 1989).

Many of these traditional agroforestry systems experienced their second transformation approximately 30 to 50 years ago with the onset of cocoa plantations (Tonka, 2003). There was a move towards transforming forest savannah to cocoa agroforests. Indigenous trees in these cocoa systems continued to serve as medicine, fruit and food sources, with the vast majority set aside as shade trees for the cocoa crops. In this second transformation, the health and productivity of the cocoa crop was the main concern and driving force behind the management of these agroforestry systems.

The decline of the cocoa sector, which began in 1989, came to a head in 1995 with the quasi-liberalization of the production chain for cocoa. The devaluation of the Communauté financière africaine (CFA) franc in 1994 led to the doubling of Cameroon's external debt, therefore the Government of Cameroon was forced to reorganize the sector by withdrawing subsidies to farmers. The combined crises of a failing international market, rigorous national policies, social pressures, low inputs and low yields at the farm level meant that farmers could no longer fully observe technical guidelines (Bernard, 2000), maintain the cocoa plantations and depend almost entirely on the cocoa crop for their livelihood. This period saw a gradual disenchantment by farmers with cocoa as a dominant livelihood strategy. In addition, cocoa is not directly used in indigenous culinary and health strategies.

These circumstances led to the third transformation, characterized by both the increasing diversification of the use of cocoa systems by integrating and managing greater numbers of indigenous fruit and medicinal trees, and the development of smallholder plantations. Both strategies were geared towards more profitable land use and greater food and health security. This third and latest transformation of agroforestry systems was accompanied by the spread of smallholder plantations and mixed systems, the latter being characterized by variations in three important above-ground factors:

- tree species diversity;
- spatial and horizontal disposition of trees;
- spatial and vertical stratification of the systems.

While the smallholder plantations tend to follow the lines of intensification (using less complex methods of monocultures, high-yielding varieties, regular spacing and single strata), the cocoa agroforests are characterized by a more complex and dynamic arrangement in which economic, ecological and management questions are less predictable. Two transformation processes are currently evident, smallholder monocultures and annual crop agroforests; the latter are by far the more complex, and therefore are analysed in this paper. Numerous factors are undergoing change in this current process of transformation of agroforestry systems. Even for annual tree crop-based agroforests such as the cocoa systems, tendencies are towards simplification of system structure, regularization of inter-tree distances, integration of more uniform and high-yielding trees, and greater domestication of the agricultural landscapes, largely for socio-economic reasons.

It is likely that other processes such as the environmental consequences of these transformations will tend to be less obvious, hence these tendencies and trends will form the basis for this research. The work was carried out in order to capture these latest transformations in agroforestry systems as they unfold, and to raise some pertinent research questions regarding the potential links that may exist between the visible above-ground transformations and the less visible systems, watershed properties, as part of a potential future research agenda for the region.

The study focused on the characterization of spatial, quantitative and qualitative aspects of indigenous trees within cocoa agroforests in the study sites. The following three specific hypotheses guided this above-ground characterization study:

1. The degree of variation in the horizontal inter-tree distances of indigenous trees is a measure of irregularities in their horizontal spatial distribution, and a cause of sparseness and/or clustering in different parts of the system.

2. The height distribution of the indigenous trees largely determines the vertical stratification of the agroforest system.
3. The knowledge of the species and the extent of their use by local communities is a strong determinant of management requirements and therefore of what practices are likely to be retained, eliminated, substituted or replaced.

The legitimacy of these hypotheses can be found in observable characteristics in the cocoa systems and in current scholarly knowledge on the potential effects of trees and tree systems on components of the hydrological cycle (interception, percolation, transmission, retention, discharge, evapotranspiration), as well as the ways in which these influence the water budget of a farming system on a watershed. Trees on farms can have these effects in their influence on water-related properties of the soil (Stevenson and Cole, 1999; van Noordwijk *et al*., 1999) such as organic matter content or their hydraulic conductivity (Angers and Caron, 1998).

According to the hypothesis, the greater the variations in inter-tree distances, the more irregularly the soil surface of the farming system is likely to be covered, resulting in sparsely covered or exposed areas and densely covered or choked up sections. This creates a patchwork of tree cover as a result of both farmer intervention and natural processes that stem from the need to provide shade to cocoa crops.

In tree-based systems with minimal undergrowth, the more developed the stratification or height class distribution (light and heavy crown) of the trees, the more developed the system's mosaic or overlapping characteristics. An increase in raindrop interception (achieved mostly by trees in the highest stratum) results in a reduction in impact velocity. This leads to less surface crusting of the soil, greater percolation and infiltration to the soil, and reduced runoff resulting in a potential increase in groundwater.

Farmers are able to influence the properties of soil in the cocoa systems in the choice of trees to introduce. Deciduous, broad-leaved and fruit producing trees create larger amounts of biomass that is added to the soil. Similarly, the even distribution of these trees over the farm surface will result in fewer disparities in such factors as organic matter accumulation, soil surface exposure and wetting and drying cycles of the soil. These factors affect the hydraulic conductivity of soils (Angers and Caron, 1998), however; the overall water retention and discharge within a cocoa system can be indirectly managed. This is achieved through factors affecting reception and infiltration, soil retention, evapotranspiration and discharge to groundwater, resulting in reduced variation across agroforests in important watersheds throughout the African humid tropics.

RESEARCH METHODS

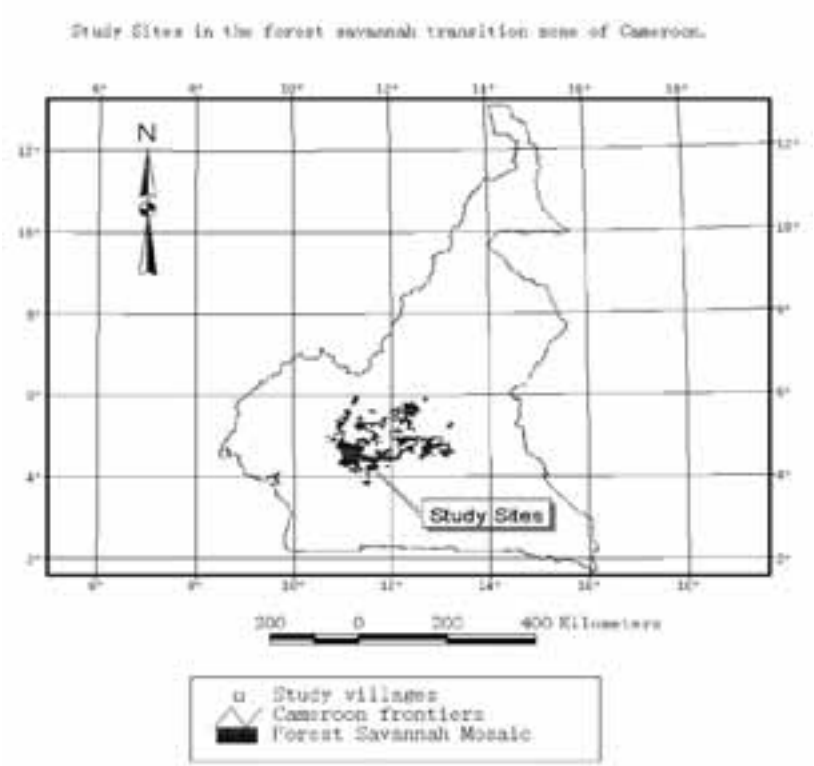
Research site and sampling design

Thirty cocoa farms were selected systematically within the forest savannah study site (Figure 1). The general characteristics of the forest savannah showed little or no variation in dominant tree or herbaceous species; therefore, no vegetation-based stratification was deemed necessary. Instead, stratification was carried out at the community level where three villages, each between 2 and 3 km apart, were selected for the study. The basic rule was that no two farms

were to constitute a contiguous block. Ten farms were selected per village by randomly selecting numbers from a list of all cocoa producers within that village.

Within each cocoa farm, a median was estimated with the help of the farmer, and all trees within 8 to 10 m on either side of the median were characterized. This study transect (20 m wide), cutting across all 30 farms, covered a total distance of more that 1 000 m, thus constituting a total study surface area of more than 20 000 m^2 or 2 ha.

FIGURE 1
Forest savannah zone where study was carried out.



Data collection

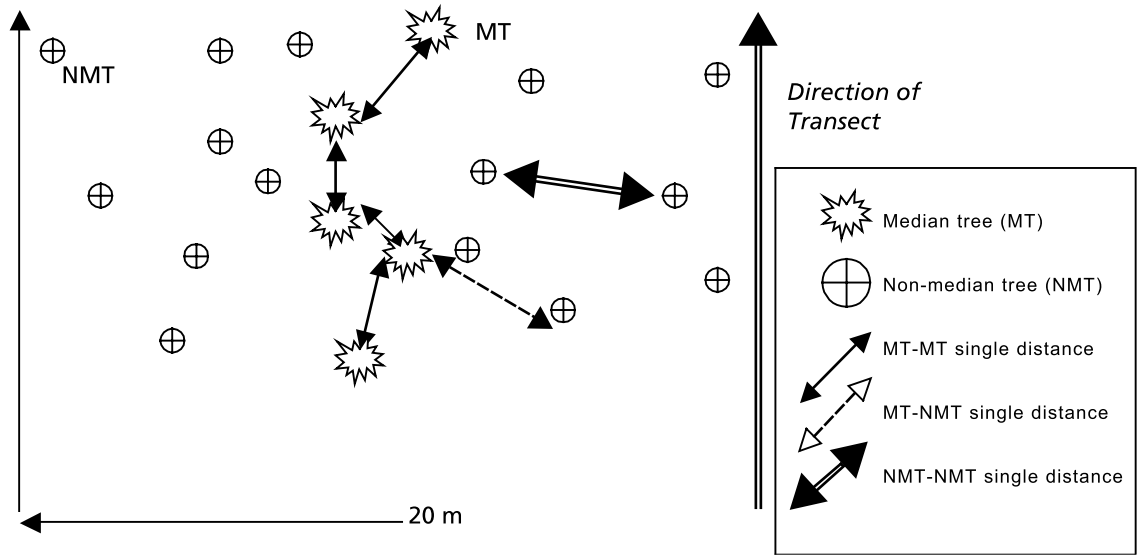
A research team consisting of three people (including the farm owner) carried out the data collection. In order to maintain the median of the cocoa farms or subplots, a series of median trees were identified throughout the length of the farm (Figure 2). Non-cocoa indigenous trees within this median were referred to as median trees (MTs). All other trees on the left and right of the MTs were referred to as non-median trees (NMTs). The following measurements were then taken within these transects:

- Tree heights were estimated using an improvised "thumb method". A stake 1.8 m tall was placed against the tree and used as a yardstick for measurement. Two or three people independently estimated the height of the tree by mentally counting the number of yardsticks that would correspond to the height of the tree. This number could not differ by

more than 2. The two or three readings were then averaged and multiplied by 1.8 m to get the estimated tree height.

- Single horizontal distances between MTs of heights greater than 3 m were measured using a measuring tape.
- Single horizontal distances between NMTs of heights greater than 3 m were also measured using a measuring tape.
- All trees that were measured were also identified by their local name. Those not known by the farmer were recorded as "unknown".

FIGURE 2
Cocoa farm transect characteristics



Data analyses

An analysis of variance in inter-tree distances was carried out using GENSTAT (Edition 6). Tree height classes were sorted using Microsoft™ Excel, and a diagrammatic representation of a compressed "unit" cocoa agroforest was generated. Additional quantitative analysis was carried out using Excel. The main results are presented in the following.

RESULTS AND DISCUSSIONS

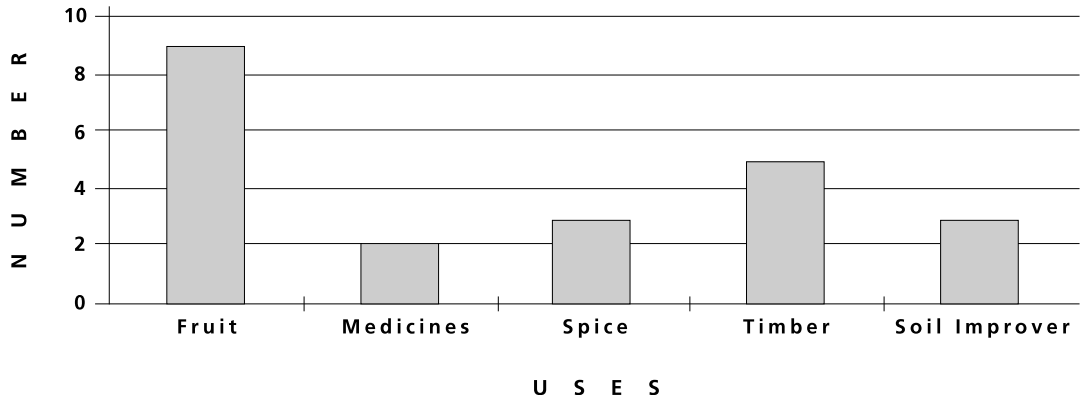
Table 1 shows that a relatively wide range of indigenous trees were encountered on the study site farms; however, farmers generally use only trees that they know, while others remain to provide shade for the cocoa crop.

TABLE 1
Trees species that are unknown, known and used by farmers

ITEM STUDIED	RESULT
Total number of different species of trees encountered	162 (100%)
Number of species unknown to the farmers	96 (59%)
Number of species known but not used	44 (27%)
Number of species most used by the farmers	22 (14%)

With the present transformations in the cocoa system, more than half of the indigenous trees are unknown to the farmer and remain in the agroforest only to provide shade for the cocoa crop. Indications are that as the value of the cocoa crop continues to be uncertain, trees within this category are most likely to be replaced. Of the 22 most used species the vast majority were indigenous and exotic fruit species (Figure 3). Farmers claimed that "duplicates" for these trees occurred in the woodlands nearby. Their performance in terms of form, height and productivity was generally poor. Trees were too tall and impossible to climb. Fruits were generally small for the species, and management was non-existent. Indications are that these fruit trees were not fully valued by the farmers as they generally performed badly in the cocoa systems. Therefore, with the introduction of even a mildly more profitable alternative land use, farmers may not hesitate to transform the system further at the expense of these trees.

FIGURE 3
Uses of most-used species



Therefore, unless new steps are sustained in the diversification and intensification of the cultivation of high-value trees, the cocoa systems and the trees in them are likely to see increasing instability in the years to come.

In terms of the spatial arrangement of the trees, the irregularity was very marked (underlined by variations in inter-tree distances). As Table 2 indicates, the distances between all the categories of MTs and NMTs varied considerably ($p < 0.001$). This is a strong indication of the potential for clustering in some parts of the farm and/or sparse distribution in others, which was supported by direct observations on the farms. Generally, the horizontal spatial distribution is irregular for all the trees, irrespective of species.

TABLE 2
Extent of variations in inter-tree distances in cocoa agroforest

Parameters	Results for inter-tree distances between MTs (MT-MT)	Results for inter-tree distances between NMTs (NMT-NMT)	Results for inter-tree distances between MTs and NMTs (MT-NMT)
Values (n)	234	506	351
Mean	7.466	7.008	8.387
Probability	(< 0.001)	(< 0.001)	(0.001)
Standard error	3.702	3.448	4.180
Coefficient of variation	49.6	49.2	49.8

In light of the current transformations in new plantations within the zone of study and elsewhere, there is a tendency towards conscious regularization of inter-tree distances in order better to manage space, tree growth and maintenance activities. This is very marked, particularly in new oil-palm-based plantations.

In terms of vertical stratification, a clear and consistent structure could not be discerned in the agroforests. One precondition for optimum use of vertical space is the three-tier model proposed for the "ideal" agroforest (Minchon and De Foresta, 1997). These cocoa agroforests show a great dominance within the 10 to 20 m height class.

The 10 to 20 m class shown in Table 3 is so large that in order to analyse it correctly, it required further division into subclasses. When related to the three-tiered model, two classes (5 to 10 m and 20 to 25 m) appear dispensable. According to the farmer, these two intermediate classes often constituted points of increased disease spread from tree to tree and from stratum to stratum. It is possible that the greater efficiency achieved by the ongoing transformations of improved space management and pest management may require these intermediate strata to be thinned out.

TABLE 3
Tree height class distribution in the cocoa systems

Stratum according to Figure 2	Tree height class	Number of indigenous trees	Proportion of system
Stratum A	5 m	30	3%
T1*	> 5 m < 10 m	99	11%
Stratum B	> 10 m < 15 m	198	25%
Stratum B	> 15 m < 20 m	240	29%
T2*	> 20 m < 25 m	187	21%
Stratum C	> 25 m	89	11%
Totals	**6 classes**	**843 trees**	**100%**

Notes: * T1 is intermediate between strata A and B; T2 is intermediate between strata B and C.

Figure 4 is a cross-section representing all the cocoa agroforests that were studied and showing the "smallest denomination" of these trees. Clearly, T1 and T2 are strata requiring elimination if the ideal three-tier structure is to be attained. Stratum B has also been found to be too dense, and may need to be thinned out. On the other hand, stratum C may be too thin.

CONCLUSIONS

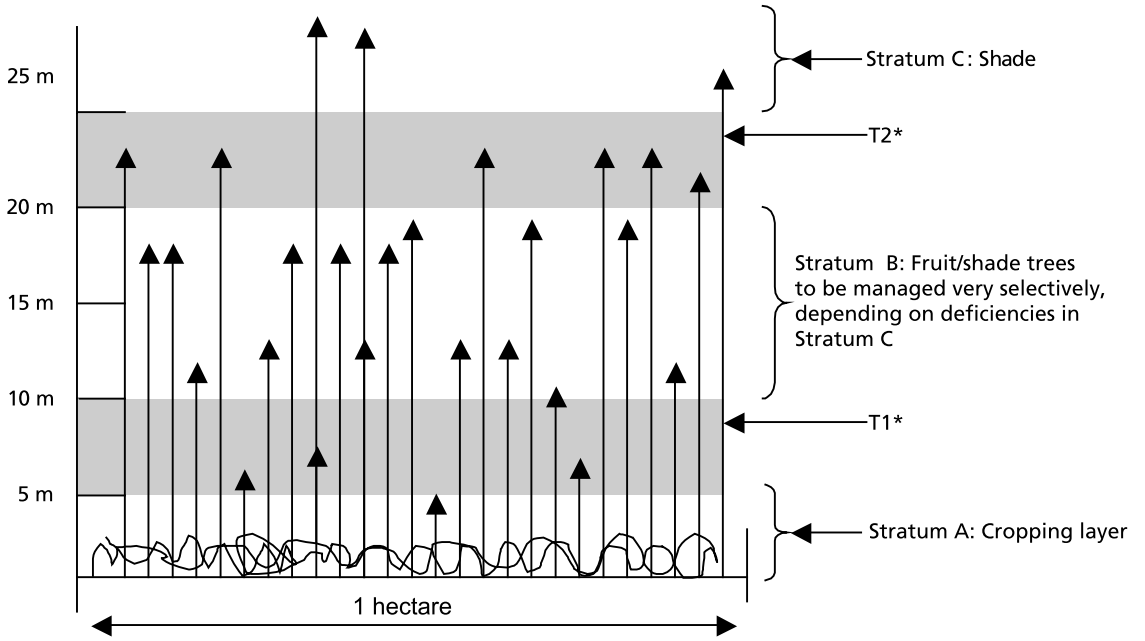
The results of this research raise a number of important management questions that can be directed towards two main areas. The first is in terms of the hypotheses given at the beginning of the research, and the second in terms of the potential effects of these transformations on the watershed functions of these agroforests.

When reviewing the original hypotheses, the results show conclusively that there are highly significant variations in inter-tree distances within all height classes in traditional cocoa agroforest systems. This variation leads to considerable irregularity in the spatial arrangements of the more dominant components in these agroforests. The questions that are therefore raised are:

- How will such variations relate to vital watershed functions of these increasingly rampant and ubiquitous agroforests?
- How should they be managed in the coming years?

Second, the results show quite conclusively that vertical stratification in these agroforests is a function of the height class distribution within the system. Furthermore, although the maturity and productive form of some indigenous trees are known, heights of trees in systems such as those studied are equally influenced by competition (due to environmental factors) with other trees. Therefore, to develop and maintain a model structure with potential benefits for space

FIGURE 4
Compressed unit cocoa agroforest



* T1 is intermediate between strata A and B; T2 is intermediate between strata B and C.

management would require intensive management of the agroforest. However, the management of such a system creates potentially contentious and critical issues. The farmer should be responsible for making decisions regarding thinning, eliminating, substituting or replacing trees within the agroforest system. The potential costs and benefits involved and the trade-offs necessary need to be evaluated to enable the farmer to take calculated decisions with balanced or more acceptable outcomes. This appears to be a classic case of the application of optimum pessimism: success results in moderate benefits and failure in moderate losses. Current possibilities would suggest a non-specific (generic) decision providing a range of options to farmers, with associated possible outcomes and different levels of risks. In a society where the level of production of cocoa for individual farmers may mean the difference between destitution and survival, care needs to be taken to unite better the environmental and livelihood objectives. Similarly, the level of management given to the cocoa may rely directly on the value given to the product by individual farmers. The value of a tree is directly related to accumulated knowledge relating to that tree by the farmer, thus playing a large role in the management decision-making process. Therefore, gaining additional knowledge relating to the indigenous trees within an agroforest system is beneficial in the management process.

In order for the potential effects of these transformations on the watershed functions of agroforest systems to be assessed, substantial medium- to long-term research must be carried out in order fully to support such theories. Important factors will need to be addressed relating to watershed functions that are relevant to the main components of the hydrological cycle. These factors can significantly influence the water budget of any agroforest system.

Additional and relevant research, modelling and management (at the local level) may be necessary to reach equilibrium in balancing both the costs and benefits accruing from agroforest systems. These can provide optimum benefits both for the environment and for the livelihoods of farmers. Current knowledge regarding the effects of trees and tree systems on components of the hydrological cycle (i.e. interception, retention, discharge, evapotranspiration, soil moisture storage, water deficit) that apply to existing situations is needed to support and justify future efforts.

The results of this study clearly indicate that transformations in agroforestry systems within the region are increasingly characterized by trends in spatial distribution of trees in agroforests from irregular to regular distribution. This was shown by a decrease in the variations between inter-tree distances and changes from complex to simpler vertical stratification (i.e. multi- to fewer strata). However, the issues relating to trends in tree diversity, an expanded knowledge base and indirect values of trees on farms are more varied and less conclusive. What is certain is that as transformations continue in agroforests, driven by economic considerations, transformations also occur in the biophysical processes within the system. Greater understanding of these processes is still required. Furthermore, these economically driven transformations tend to simplify the system from complex and dynamic to ordered, less complex and more predictable or "domesticated" systems. Tree domestication activities carried out by the World Agroforestry Centre tend to support a more ordered and predictable system, closely resembling traditional agroforests in both diversity and stratification. Questions remain to be answered relating to the optimum balance between sustainable livelihoods for farmers and an equitable environmental balance.

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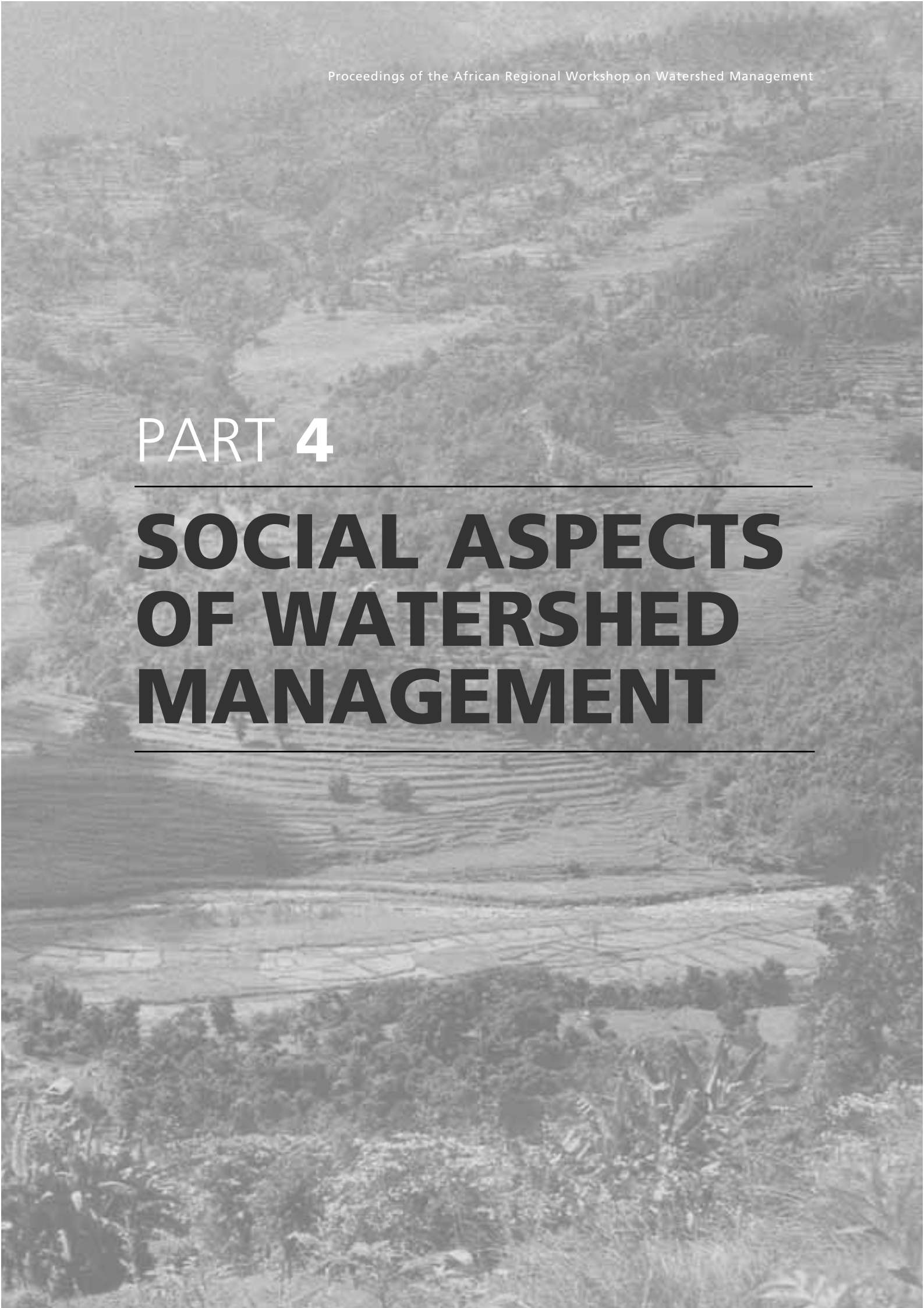

PART 4

SOCIAL ASPECTS OF WATERSHED MANAGEMENT

CHAPTER 9
THE SOCIOLOGICAL APPROACH IN WATERSHED MANAGEMENT: FROM PARTICIPATION TO DECENTRALIZAION

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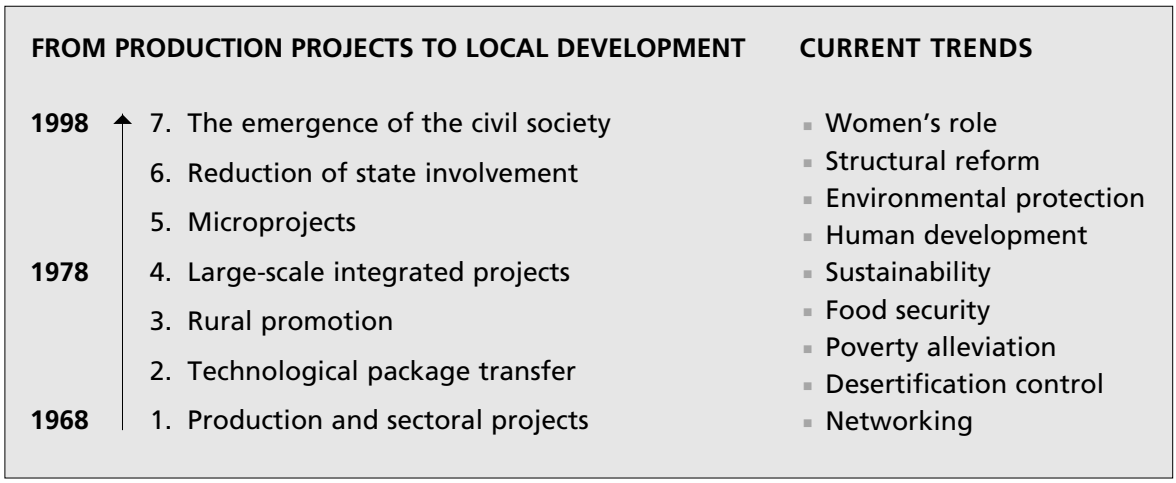
Rural development over the past 20 years has been marked by a gradual shift from the intervention-based method to an approach promoting rural people's involvement in their own development. Initially, projects sought to respond to very low levels of crop production due to countries' failure to make the most of their resources. They dealt with these production problems by introducing technical packages and extension support measures, sometimes using rural promotion and education methods. Because the economic and social environment was ill-suited to the changes introduced and given the populations' growing needs, these projects had to fill the gaps in terms of equipment and management, often becoming difficult-to-manage, large-scale integrated projects. At the same time, the NGOs, which worked more closely with the people, opened the way for village-level micro-projects, where the people could take responsibility for their own development. Although these experiments were limited in scope, they proved their usefulness at a time when there was pressure from within and without for governments to stand back to allow the civil society to emerge. Current trends suggest an increased awareness of the human dimension, women's role, environmental protection, sustainability and food security.

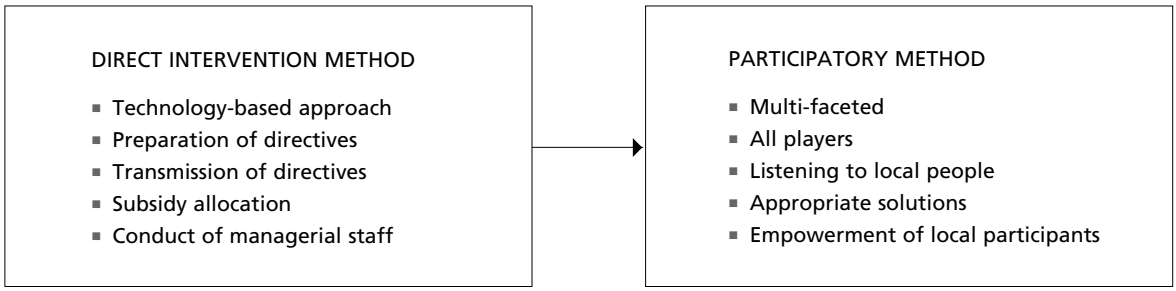
Development programmes and projects have gradually evolved to cover the many aspects of the problems to be dealt with. They have sought to reflect better the complexity of the situations encountered, the numerous causes of the problems and the various solutions proposed. The major change in the last ten years was to design these programmes and projects along participatory and decentralized lines so that more attention could be paid to the people's requirements, the problems on the ground could be better understood and the groups concerned could be helped to improve their situation. However, it must be pointed out that priority with respect to development measures has been given to those regions with a high production potential (e.g. irrigated plains) and, consequently, large parts of watersheds, often subject to migration, received less support. The exception to this rule was erosion control measures, but even these were carried out only to protect dams whose water was earmarked for the rich farmers on the plains.

THE GLOBAL APPROACH AND THE PEOPLE'S ROLE

One of the improvements introduced in recent years is the global approach. Although evaluations of the constraints encountered in and the potential of rural areas revealed the

complexity of the situations, they also highlighted the need to take account of the many aspects of the problems to be dealt with. A systemic analysis showed that all human activity may be considered as an element in a complex system; a system where various elements are interrelated and can be exchanged (goods and information) within and outwith the system in accordance with regulatory mechanisms, thereby providing a result while at the same time ensuring that the overall system is sustainable.





Under these holistic arrangements, the human factor has a vital role in rural systems. If we look at mountain dwellers, we find that they develop survival strategies based on the assets available to them (land, water, inputs, labour and expertise) and are able to obtain results that can be used not only to sustain their system but also, in the best-case scenario, to expand it.

Of course, farmers receive funds in the form of aid and subsidies, as well as non-farm income from family members. Understanding the strategies used by small farmers, as well as how small farming systems work or why they fail, could shed light on the constraints they face and the measures to be taken to overcome them. Such measures could include improving the factors of production (e.g. fertility improvement, improved water management, land management, equipment and mechanization, etc.) and the marketing of farm surpluses (labelling, marketing organization, etc.). This requires decisions to be made by the persons in charge, their families and other persons concerned directly or indirectly with these improvements.

All these partners are also involved in a number of rural systems all governed by the same rules of operation (e.g. marketing systems, the banking system, the political system, etc.). While each system may be an entity in itself, all the systems are inter-related and may also be inter-dependent. The hydrological system is intrinsic to the watershed, a truly complex system. The same may be said of social systems, which may be local, regional, national and even international. They all involve a number of flows and relationships among the various components which, despite the complexity of the task, must be taken into account so that an accurate evaluation of the environmental situation can be made and the most appropriate solutions recommended.

Similarly, the changes in the design and implementation of development programmes in recent years have made it necessary to review the principles and relationships among the players in the rural process, especially the partnership between the people and the outside experts. Indeed, evaluations of the measures taken, often on the initiative of the authorities and outside experts, have highlighted problems concerning the maintenance and sustainability of the measures taken after project completion. The situation is further aggravated by pressure from international donors for government disengagement. The new responsibility-sharing system is part and parcel of a general trend towards decentralization, now taking place in most countries. It also draws on a very strong movement promoting the involvement of grassroots communities in the sustainable management of their resources.

PARTICIPATION AND LOCAL DEVELOPMENT

Although people's participation is recognized as a necessity and has been introduced in many programmes and projects as well as in most national and international plans, it is not always evident that it is being implemented. Some of the problems with involving the people in projects lie with the outside experts who have difficulty changing their method of operation – a management-based and top-down approach – and do not fully understand the reality of the situation in which the people find themselves. The people, on the other hand, find it difficult to enter into a new type of relationship as they continue to see themselves as the recipients and the outside experts as the providers of material assistance. However, what slows things down most often is failure to recognize the local people and their associations as true partners.

What has been seen so far of the participatory system makes one wonder how to deal with the various situations brought about by the use of this approach, even when it is properly implemented. There has been a shift from the top-down approach, based on the provision of services, to one giving priority to individual demand. We have also witnessed governments everywhere disengaging. This could leave vacuums which could adversely affect the less well-prepared communities. By giving priority to the local people – a good step in itself – we now have a situation where more people are making decisions without being able to see the broader picture. So as not to succumb to some of the dangers of the participatory approach, such as dilution, decentralization will have to be strengthened; in other words, the intermediate levels, i.e. the regions and provinces, will have to be given the means to provide the interface between national requirements and local expectations.

SOCIAL RELATIONS AND PARTNERSHIP

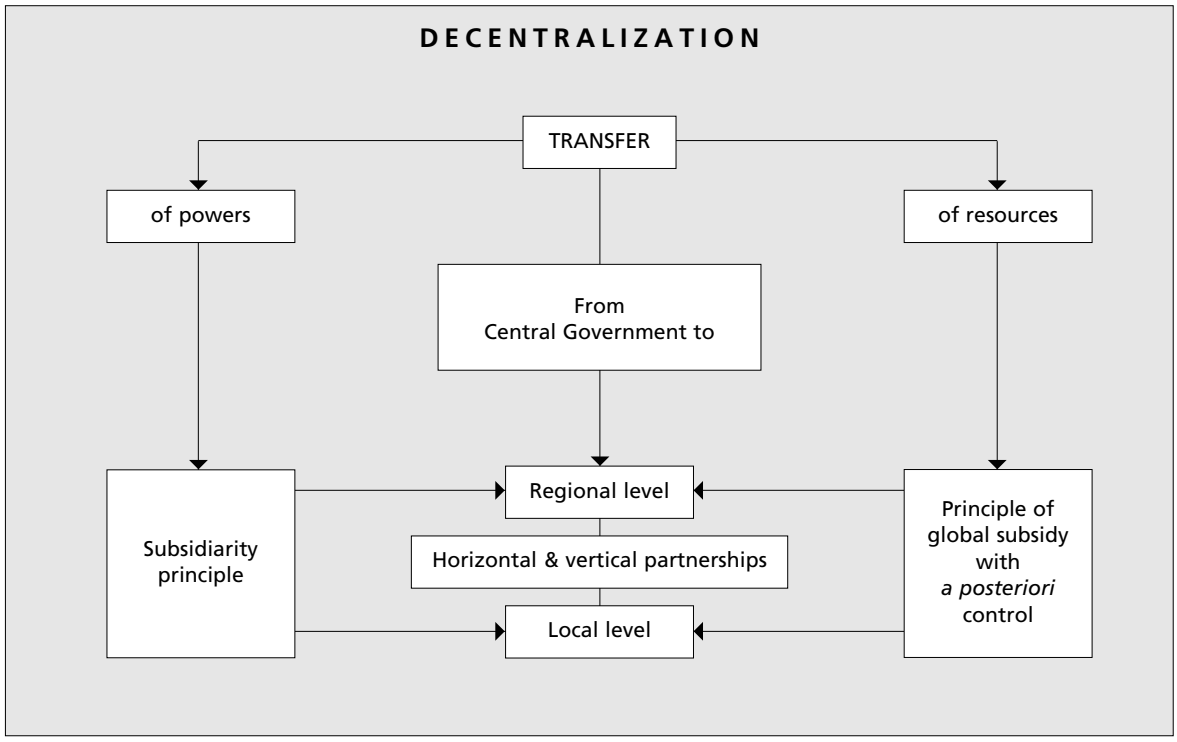
A policy based on local player involvement needs to recognize the demands of local communities and small regions. Conversely, national policies will have to be made more region-friendly. In other words, they will have to take into account the regions' agro-ecological, social and cultural characteristics. However, these two dimensions can only be implemented if accompanied by strong support measures designed to improve information sharing, strengthen the capabilities of people at all levels and organize the countryside. The major challenge here is how to deal with the contradiction between acknowledging local community initiatives and the need to incorporate these initiatives into a comprehensive approach.

With decentralization, the State becomes the mobilizer and facilitator of local development initiatives proposed by the communities. The basic idea behind economic reforms and decentralization is to give free rein to initiatives so that they can cater to special interests, without the local elites once again using their role as representatives of the people to organize, run and take over decentralization. A contractual and partnership approach would seek to establish new relations among the rural development players rather than vertical relations based on strategies that ignore local and regional processes.

Centralized government institutions must be replaced by new institutions capable of creating suitable conditions for dialogue between farmers' organizations and other rural development players. At the same time, these new institutions must work towards the creation, conversion and strengthening of intermediate associations, which will have a central role for the following three reasons: 1) they will provide guidance for the government in drawing up the various policies that must go hand in hand with decentralization; 2) they will collate and regionalize the demands and requests of the rural people; and 3) as they eventually become sufficiently mature consultative partners, they will be able to build partnerships with other rural development players.

This organizational effort by the intermediate associations would help to globalize the decentralization process and the rural development measures based on an ongoing dialogue among all rural development players. In this way, the regional interface would gradually become the point at which mediation and arbitration take place, through the establishment of consultation and participatory arrangements for all levels of the rural communities. The principles of subsidiarity (based on the transfer of decision-making to the most appropriate level) and global subsidy with *a posteriori* control will apply in the case of actual decentralization, i.e. the devolution of power to the regional and local levels.

FAO has developed a RED-IFO analytical model based on experiences gained through its support to countries and projects with a view to strengthening decentralization processes. A CD-ROM and methodological documents are available. FAO has also provided support in the field in various areas and sectors. Significant watershed projects were carried out in Morocco, Tunisia and the Sahelian countries. Their aim was to promote new ways of sharing tasks and responsibilities among governments and their decentralized services, and civil society and its representative organizations (municipalities, farmers' organizations, grassroots groups, etc.). The following diagram shows how this works.



CONCLUSIONS AND RECOMMENDATIONS

The following suggestions are proposed in an attempt to highlight the importance of expanding the use of the sociological approach in tackling upland watershed problems and implementing relevant development measures.

Raising awareness of the people's role in the watershed approach. In order fully to recognize human dimensions in water and land management, it is vital that the partners concerned, in intervention structures and in the village communities, are made aware and are convinced of the advantages of this approach, i.e. the mobilization of the rural communities and their greater involvement in development programmes and projects.

The proposed measures are:

- to launch information campaigns so that all the parties concerned are aware of the principles, methods and advantages of participation and take part in the participatory processes;
- to prepare specific material that may be used by government experts and the people's organizations better to understand the socio-human problems and to promote participation.

Strengthening the capabilities of local organizations. Even when they do exist, rural people's organizations in many developing countries are not fully participatory. Governments often look upon them as their political tools. These organizations do not have qualified managers or local leaders, which makes it difficult for them to become involved in their own development. Efforts need to focus on promoting and strengthening civil society organizations and making them independent.

The proposed measures are:
- to use various types of organizations such as small informal groups, traditional community associations, cooperatives and trade unions to deal with water problems in mountain areas, and to reach all sectors of the rural population concerned. This would involve amending laws and regulations and ensuring that training is provided for those persons who will take over responsibility and for the members of the organizations;
- to pay particular attention to and introduce special measures for the most deprived groups and women, bearing in mind their essential role in socio-economic life and in farming and non-farming activities. This entails giving women equal access to natural resources and services, and equal rights and opportunities to develop and use their skills;
- with regard to the funding of local organizations, to encourage governments to adopt methods designed to help these organizations to become self-sufficient, so that they will not need to have much recourse to aid and subsidies.

Decentralization of decision-making by all players concerned, including those outside of watershed areas. It has been observed that decentralized systems encourage local initiatives and participation. Rural people are probably more likely to support development initiatives that reflect their own views and requirements. So that the hand-over of decision-making powers at the local level may take place according to the rules, appropriate mechanisms must be available to facilitate dialogue and cooperation among the parties concerned.

The proposed measures are:
- to change administrative and budgetary procedures to facilitate the hand-over to the local level of the powers and tasks involved in decision-making, tax collecting and expenditure;
- to set up local planning consultation bodies, which will comprise representatives of the people's organizations, NGOs and the authorities to help in decentralizing decision-making about the future of high mountain areas.

Promoting dialogue, partnership and alliances among players. In many developing countries, governments, development bodies and NGOs help to promote and support village community groups and people's organizations. Promoting the sharing of information and dialogue among all the parties can encourage cooperation at the local level with a view to participatory development.

The proposed measures are:
- to establish national and local-level networks whose task would be to facilitate dialogue and cooperation among the players in these mountain areas;
- at the legal, administrative and technical levels, to facilitate the establishment of bodies made up of civil society organizations in order to help improve the partnership among all the various players.

CHAPTER 10
CATCHMENT PROPERTY RIGHTS AND THE CASE OF KENYA'S NYANDO BASIN

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ACRONYMS

CAPRI	Collective Action and Property Rights programme
ICRAF	World Agroforestry Centre
NEC	National Environment Council
NEMA	National Environment Management Authority
NSWCP	National Soil and Water Conservation Programme
RWSTF	Rural Water Services Trust Fund
Sida	Swedish International Development Cooperation Agency
WRMA	Water Resource Management Authority
WSRB	Water Services Regulatory Board

Attention to watershed management is increasing across the developing world. In India, for example, more than US$500 million is invested in watershed projects every year. There are compelling reasons to believe that this interest will continue to grow. Water resources are becoming increasingly scarce. Tunisia, Kenya, Rwanda, Burundi, Algeria, Somalia and Malawi were already considered water scarce in 1990; by 2025 they will be joined by the Libyan Arab Jamahiriya, Morocco, Egypt, Comoros, South Africa and Ethiopia (as measured by the availability of 1 000 m^3 of renewable water per person per year) (www.cnie.org/pop/pai/water-14.html). Concerns about water scarcity in South Africa have led to the Working for Water programme to remove fast-growing invasive trees from critical catchment areas and areas of valuable biodiversity (www.dwaf.pwv.gov.za/wfw). Across the developing world, ever-greater numbers of people are exposed to flood risks. Soil erosion continues to degrade agricultural potential, while dams, reservoirs and irrigation infrastructure continue to be clogged with sediment.

Integrated water management and ecosystem approaches are now generally recognized as vital to durable solutions to these challenges. In India, for example, the most successful watershed and catchment management programmes involve multiple stakeholders – community groups, NGOs, government agencies – a mix of new techniques and social organization, and give balanced attention to improving resource management and farmers' livelihoods (Kerr, Pangare and Pangare, 2002).

A particular area where more integrated approaches are required is in property rights reform. Insecure property rights to cropland are often cited as the major cause of soil erosion, sedimentation and low crop production (see review in Gebremedhin and Scott, 2003). An obvious policy prescription for dealing with catchment degradation, therefore, is to enhance tenure security on cropland. While more secure tenure may well reduce plot-level erosion, it is possible that less erosion at the plot level will not translate into significant changes in sediment loss at the catchment scale. Catchments are comprised of different types of land, put to different uses and held under different types of property rights. Crop agriculture may or may not be a large contributor to erosion within a catchment. In most catchments, there are other land uses, especially roads and footpaths, which occupy small areas of land but account for large percentages of total erosion (Ziegler, Sutherland and Giambelluca, 2001). In addition, catchments invariably comprise micro and macro sinks where eroded soils accumulate, as well as filters that reduce lateral flows of water, pollutants and sediment (Van Noordwijk *et al.,* 1998; Swallow, Garrity and Van Noordwijk, 2002). It is important, therefore, to take a wider perspective on property rights.

The objective of this paper is therefore to present a catchment perspective of property rights. Following Tiffen and Gichuki (2000) and DENR (1998), we define a *catchment* as "the area of land from which rainwater can drain, as surface runoff, via a specific stream or river system to a common outlet point which may be a dam, irrigation system or municipal/urban water supply offtake point, or where the stream/river discharges into a larger river, lake or the sea" (DENR, 1998: p. 29). On the other hand, a *watershed* is a "whaleback land unit" that forms the upper area of one or more catchments, with hydrologic linkages to lower parts of those catchments (Tiffen and Gichuki, 2000). We use the term *property rights* to refer to claims to use or control resources that are recognized as legitimate by an entity or entities larger than the individual, and the social and/or legal mechanisms that define and protect those claims. The key elements of *catchment property rights* therefore are the claims to use or control the resource stocks, flows and filters that comprise catchments, the individuals and groups that exert those claims, the statutory and non-statutory entities that support those claims, and the institutions that define and protect those claims and enforce duties on others.

The remainder of the paper consists of three components. The second section presents an analytical framework for watershed property rights that builds on a simple model of watershed function and the concepts and approach of legal pluralism. The third section applies that framework to the case of the Nyando river basin in western Kenya. The final section presents conclusions.

AN ANALYTICAL FRAMEWORK FOR ANALYSIS OF CATCHMENT PROPERTY RIGHTS

A watershed model of sources, sinks, flows and filters

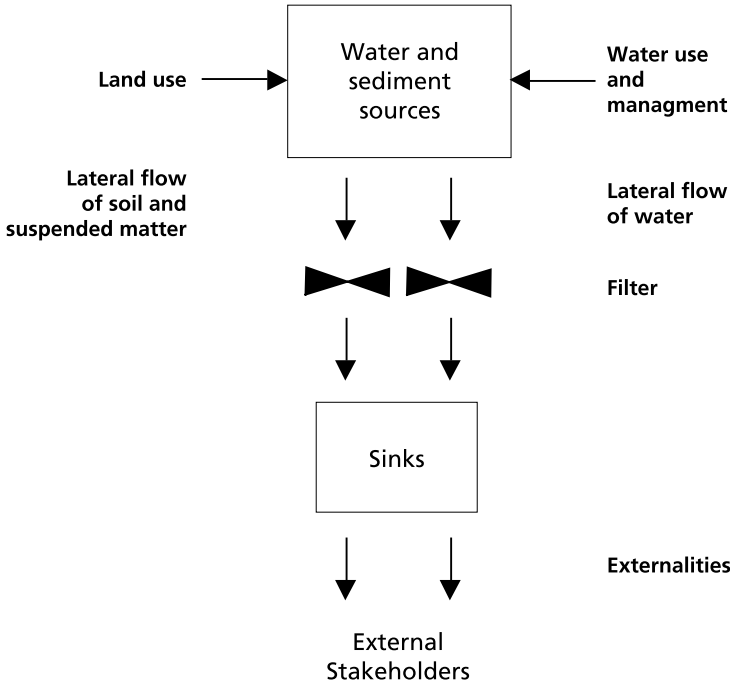
Van Noordwijk *et al.* (1998) and Swallow, Garrity and Van Noordwijk (2002) propose that watersheds be conceptualized as containing four main components: sources, sinks, flows and filters. *Sources* are units of land that yield more soil or water to downstream land units than they accumulate from upstream sources, while *sinks* are units of land that accumulate more soil or water from upstream sources than they yield to downstream sources. Both sources and sinks exist at multiple scales. At a landscape scale, natural forests tend to be net sinks of

sediment and water. At a smaller scale, natural forests usually have undulating land surfaces that contain small areas of source and sink.

Flows refer to lateral flows of organisms, soil, water, air and specific substances carried in such flows. Lateral flows of water are a defining characteristic of hydrologic catchments.

Closely related to the concept of lateral flow is the concept of *filter*. A filter is an element of a landscape that intercepts or modifies a lateral flow. Filters can decouple flows of dissolved particles from a flow of water, or act on flows of air or organisms. Filters have profound effects on the way that people cope with externalities and the scaling up and scaling down of catchment management. There are filters in the landscape at all scales, from field edges, to rice paddies, river vegetative strips and wetlands.

FIGURE 1
Simplified graphical model of sources, sinks, flows and filters in a hydrologic catchment



Source: Modified from Swallow, Garrity and Van Noordwijk, 2001.

Figure 1 presents a graphical model of a catchment that is comprised of sources, sinks, lateral flows and filters. Overall catchment management depends crucially on the particular portions of the catchment that can be identified according to source, sink, filter and flow. Landscape portions that are particularly important include the following:

1. *Water sources:* Catchments usually have discrete water sources, such as springs, that may be subject to multiple use by multiple users. Such sources may be the cause of severe gulley erosion if poorly managed.

2. *Soil erosion sources:* Land areas that are particularly prone to high rates of erosion generally include footpaths and roadsides, which are often public property. Croplands and grazing lands, which may be private or common property, are more variable as sources of sediment.
3. *Pollution hotspots:* Particular commercial farms, such as horticulture farms or agro-industries, may be associated with particularly high discharge of pesticides, fertilizers or industrial residues.
4. *Wetlands:* Wetlands tend to be very important sinks and filters of sediment and nutrients. They also tend to be subject to multiple use, multiple users and conflicting property rights. Wetlands often have important values for preserving biological diversity.
5. *Waterways and constructed canals:* Waterways and canals serve as channels for carrying flows of water and suspended pollutants. Natural waterways are often viewed as public or common property, while canals may be private or group property.
6. *Riparian areas:* Riparian areas along watersheds or water reservoirs are important as potential or actual filters of soil and water (Tabacchi *et al.,* 1998). Riparian areas tend to be declared public areas, and are often used by large numbers of people with divergent interests (Swallow, Garrity and Van Noordwijk, 2002).
7. *Field and farm boundaries:* Field and farm boundaries can be important filters of water and sediments. Depending on the land tenure system, such boundaries may be subject to intense private investment in trees, vegetative fences or stone structures, or intense competition and multiple use.

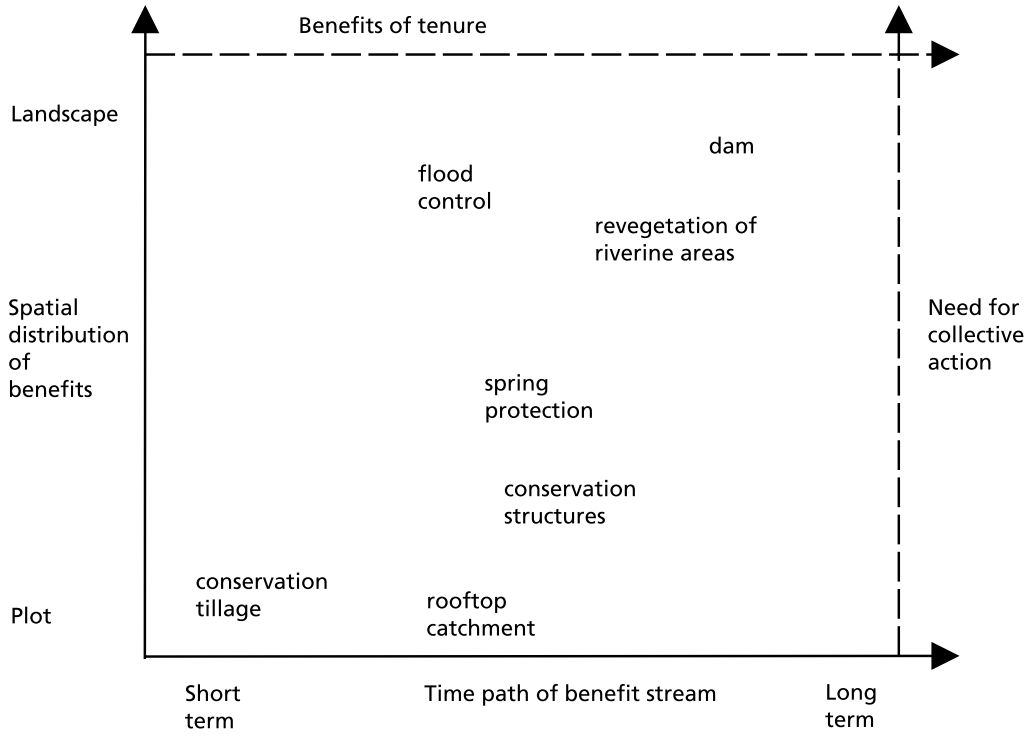
Importance of property rights and collective action over catchment components

The Collective Action and Property Rights programme (CAPRI) offers a simple conceptual framework to depict the importance of property rights and collective action for the adoption and management of different types of agricultural technologies and natural resource investments (Knox, Meinzen-Dick and Hazell, 1998). The key components of the framework are: 1) time duration of investment, which implies the value of long-term security of land tenure; and 2) spatial distribution of effects of investment, which implies the benefits to be obtained from collective action for resource management. Knox, Meinzen-Dick and Hazell (1998) indicate watershed/catchment management as a resource investment that requires both secure property rights and strong collective action. In Figure 2 we use the CAPRI framework to offer some hypotheses about the importance of secure property rights and effective collective action for the watershed components.

A legal pluralism approach to watershed property rights

Conventional treatments of property rights start from the presumption that there is a single legal source of authority that defines and enforces a single set of rules and laws about how people may access, use and manage resources and the benefits that derive from those resources. In contrast, the legal pluralism approach recognizes that there tend to be multiple sources of authority and institutions affecting people's access and use of resources and does not judge the legitimacy or superiority of any particular authority or institution (Meinzen-Dick and Pradhan, 2002).

FIGURE 2
The spatial distribution and time duration of investment in key catchment components



Source: Modified from Knox, Meinzen-Dick and Hazell, 1998.

Analysis of property rights through the perspective of legal pluralism begins with an understanding of how individuals obtain access to and control over resources. The "law" that governs access to and control of resources is not confined to rules and regulations enacted by State organs, but also includes norms and rules of behaviour that are generated by various forms of social organization, including villages, ethnic groups, associations or the State. Various types of law may be important in influencing property rights, including statutory law, religious law, customary law, project law, organization law and a range of local norms. Different types of laws are likely to be supported or sanctioned by different social authorities, which will tend to have different types of strengths and weaknesses. People with claims or complaints regarding watershed resources are likely to appeal to different types of law and social authorities to support those claims (Meinzen-Dick and Pradhan, 2002).

CATCHMENT PROPERTY RIGHTS IN THE NYANDO RIVER BASIN OF WESTERN KENYA

The Nyando River basin covers an area of 3 500 km^2 of western Kenya, and has within it some of the most severe problems of agricultural stagnation, environmental degradation and deepening poverty found anywhere in Kenya. The Nyando River drains into the Winam Gulf of Lake Victoria and is a major contributor of sediment, nitrogen and phosphorus to Lake

Victoria.[1] About 750 000 people reside within the Nyando basin, most of whom live in Nyando District in Nyanza Province and Nandi and Kericho districts in Rift Valley Province. The incidence of consumption poverty is high, ranging from an average of 58 percent in Kericho District, to 63 percent in Nandi District and 66 percent in Nyando District. At the administrative location level, the locations of Nyando District include both those with the lowest poverty rate in the sugar belt of Muhoroni Division (36 percent) and those with the highest poverty rate in Upper Nyakach Division (80 percent) for the entire basin (Central Bureau of Statistics, 2003). HIV/AIDS prevalence varies among 28 percent in Nyando District, 7 percent in Nandi District, and 12 percent in Kericho District.

Land-use and property rights vary across the basin. The upper part of the basin is comprised of gazetted forests, commercial tea production and small-scale agriculture on steep hillsides that were degazetted as forests during the last 40 years. Mid-altitude areas are a mixture of smallholder farms (with maize, beans and some coffee, bananas, sweet potatoes and dairy) and large-scale commercial farms (mostly sugar cane). The flood-prone lakeshore area is mostly used for subsistence production of maize, beans and sorghum, combined with commercial production of sugar cane and irrigated rice. There are clear differences in land use between long-settled areas and resettlement areas. The irrigated areas are owned by smallholder farmers and the moribund National Irrigation Board.

Sources, sinks, filters and flows in the Nyando basin

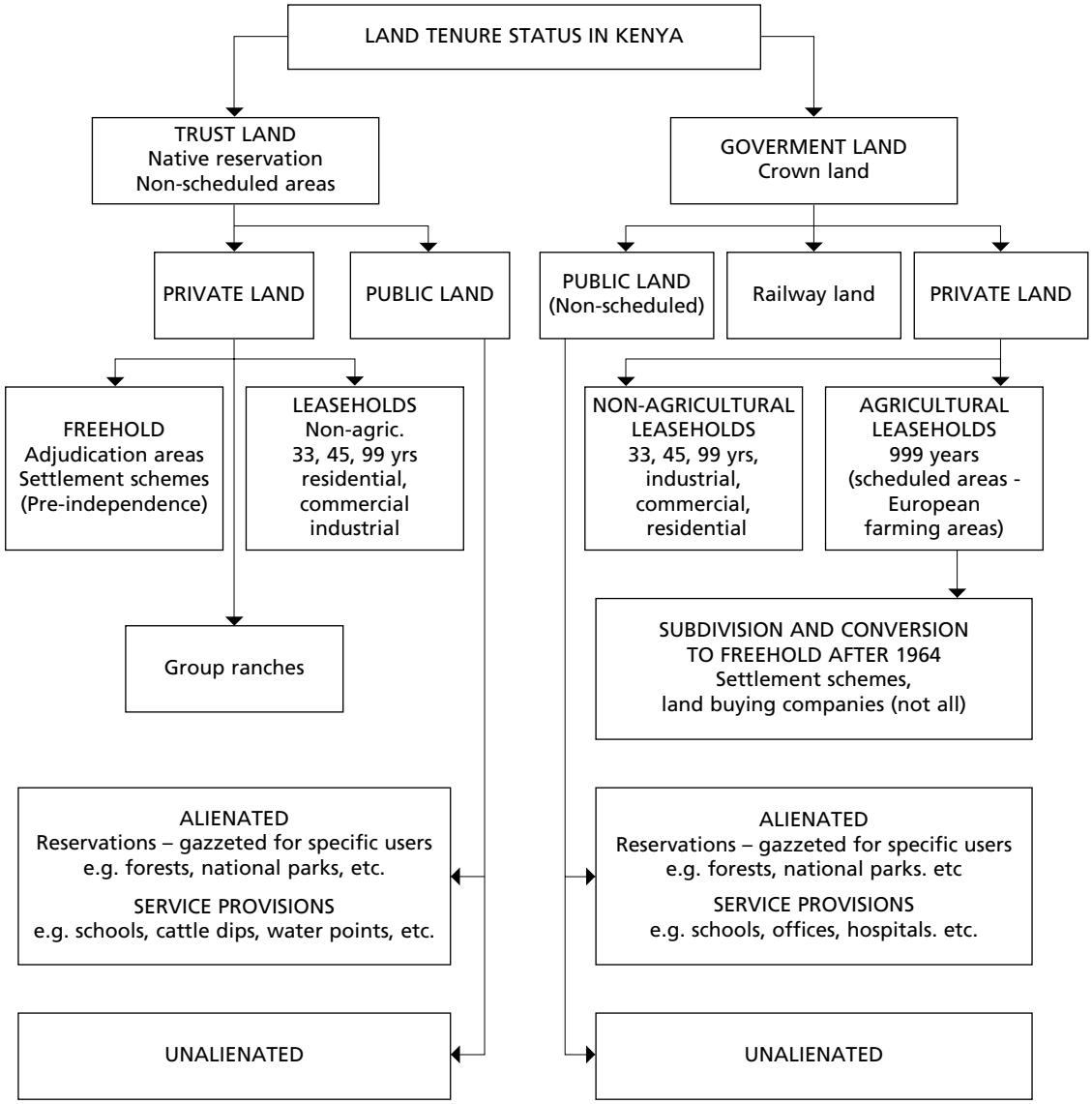
Scientists from the Lake Victoria Environment Management Programme, Water Quality Component and ICRAF have conducted several studies of water quality, land use and soil degradation across the Nyando basin during the last few years. Many of these results are summarized in a proceedings volume edited by Mungai *et al.* (2004). An analysis of sediment cores from the outlet of Nyando River into Lake Victoria shows a historical trend towards higher levels of sedimentation, with strong peaks in sediment deposition during high rainfall events associated with El Niño. Increased nutrient and sediment loads in the Nyando are linked to both point and non-point sources of pollution. Key point sources are sugar processing and agrochemical factories, while non-point sources are the thousands of small farm families who operate throughout the basin. ICRAF scientists estimate that about 61 percent of the land in the basin is sediment "source" area, with average net erosion rates of 43 tonnes/ha per year, while 39 percent of the land in the basin is sediment sink area that accumulates about 45 tonnes/ha per year. Sediment source areas are further distinguished into areas with relatively high erosion rates (fast erosion) and relatively slow erosion rates (slow erosion). Fast erosion is concentrated in hill slopes in the flood-prone Kano plains and some of the steep hillsides in the upper and mid-altitude parts of the basin. The remaining upland forests and wetlands and some of the sugar cane and smallholder farming areas in the mid-altitude zone appear to be net sediment sinks (Walsh, Shepherd and Verchot, 2004). Most of the riparian areas that could be important filters have been systematically deforested over the last 40 years.

1. The myriad problems of Lake Victoria – heavy loading of nutrients, loss of indigenous fish species, invasion by aquatic weeds, bans on fish exports to the European Union – have prompted a number of research, development and networking activities during the last decade.

Statutory land tenure in the Nyando basin

Land and water in the Nyando basin are held under a surprisingly wide variety of statutory property rights arrangements. Figure 3 presents the various types of land tenure as a classification tree, showing that there are at least six types of private tenure, including three types of private tenure on former crown land (large agricultural leaseholds [former white-owned farms], subdivided agricultural leaseholds and non-agricultural leaseholds) and four types of private tenure on trust land (freehold land in adjudication areas, freehold land in settlement schemes, non-agricultural leaseholds and group ranches). At the present time, these different tenure types are administered under a number of statutes, including the Government Lands Act, the Trust Lands Act, the Registration of Titles Act, the Land Adjudication Act and the Registered Land Act.

FIGURE 3
Land tenure characterization in Kenya



Source: Authors' analysis of the legal statutes and key informant interviews.

Land degradation problems appear to be most severe in subdivided agricultural leaseholds and in freehold land in adjudication areas. In the former, there are problems associated with poor land-use planning during the transition from large-scale to small-scale farms in the 1960s and early 1970s. The land buying companies that purchased land on behalf of groups of shareholders did not consider the productive capacity of the land, the terrain or the need for public utilities. Their main interest was to allocate some land to all of their members. Land buying companies have been formed along ethnic lines, thus creating clusters of different cultures living next to each other on the same landscape. This had the effect of weakening traditional systems. As a result, people in these areas find statutory laws more functional. A contrasting situation is found in the areas that were designated as native reservations in the colonial era. Natural growth in the populations in the native reserves has led to high population pressure in those areas and to overuse of all land resources.

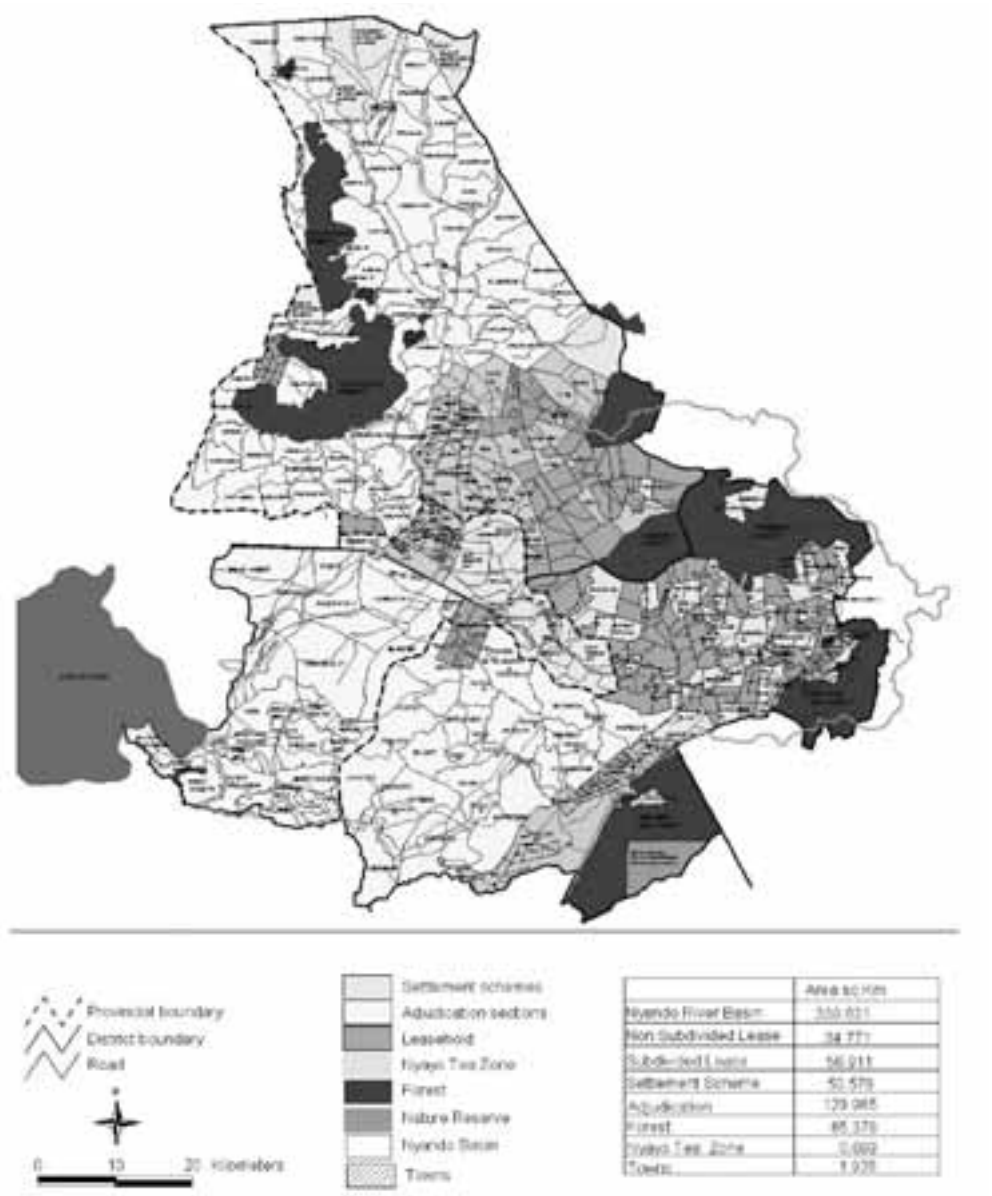
Figure 3 also illustrates that there are at least five types of public land in the Nyando basin. In both government land and trust land areas, there is land that is not alienated to any specific user. This type of public land is very vulnerable and is often subject to abuse because of *de facto* open access. This is the land that is supposed to form the land bank from which the custodians of land draw when a development need arises. In the Nyando basin this bank is almost empty. There is also land that is alienated for specific public purposes such as forests, parks, government institutions, and public utilities such as schools and hospitals. The use for which it is alienated determines the custodian of such land. These are less vulnerable. Preliminary studies indicate that many very important areas for catchment management have been formally designated as private property and not left as public lands. These include spring heads, the catchment areas immediately around spring heads, riparian areas, some wetlands, and water harvesting structures. While private property generally offers the tenure security that is desirable to provide incentives to prevent degradation, inappropriate privatization can also cause problems, such as when the layout of plots results in many holdings cut across steep hillsides, or when key watershed points (e.g. spring heads) that have spatial benefits that go beyond the individual household are privatized and put under the control of one household.

Figure 4 presents a map of land in the Nyando river basin that distinguishes the main types of private and public forms of land tenure. This map is based on data provided by the Ministry of Lands and the Forest Department offices in the relevant provincial and district offices.

Multiple statutory sources of authority for land, water and tree management in the Nyando basin

The *Ministry of Lands* is responsible for land adjudication, survey, registration, settlement, land administration and land-use planning under the statutory land tenure system of Kenya. Currently, there are more than 20 statutes that are used for land administration, which makes the process confusing and expensive. Formal land administration in Kenya is very centralized, with lands, survey, physical planning, settlement and adjudication handled by relatively independent departments of the Ministry. At the local level, the functions of the Ministry of Lands are handled by a number of boards and committees. Land Control Boards are responsible for approving or denying land transactions on freehold land. Liaison committees receive and resolve contentious issues on development applications that have not been approved by the local authorities. Plot allocation committees deal with issues of

FIGURE 4
Land tenure adjudication in the Nyando basin of western Kenya.



Sources: Map produced by the ICRAF GIS laboratory on the basis of data compiled by the authors from data supplied by the Kenya Ministry of Lands and Ministry of Forestry.

allocation of public land to public or private individuals and entities for development purposes. Local adjudication committees and arbitration boards facilitate the process of adjudication of land.

The Environment Management and Coordination Act Cap 8 of 1999 attempts to provide an appropriate legal and institutional framework for the management of the environment. It creates the National Environment Council (NEC), the National Environment Management Authority (NEMA), the Provincial and District Environment Committees and the Public Complaints Committee, the National Environment Action Plan Committee, the Technical

Advisory Committee on Environment, and the Establishment of Standards and Enforcement Review Committee. It also establishes the National Environment Trust Fund and the National Environment Restoration Fund and provides for Deposit Funds.

The *National Environment Management Authority* was established in July 2002 and made responsible for coordinating and supervising all matters related to the environment. NEMA is responsible for preparing environment action plans, and protecting and conserving the environment, including key water resources rivers, lakes, wetlands, hillsides, hilltops and the coastal zone. It establishes guidelines and procedures for environmental impact assessment of policies, programmes and projects likely to have significant environmental impact. It enforces quality control standards and can issue environment restoration orders, environmental easements and environmental conservation orders (Buigutt, 2004).

Department of Forestry: The Forest Act Cap 385 of 1962 (revised 1982 and 1992) is implemented by the Forest Department of the Ministry of Environment and Natural Resources. According to this act, "a forest area means an area of land declared under section 4 to be a forest area". The act addresses the preservation, protection, management, enforcement and utilization of forest resources on forest reserves, which must be reserved through a gazette notice as forestland. This limits forest development by the government to specific regions. Degazettement of forest lands is periodically undertaken to make way for new settlements. Concerns about the continual loss of forest lands and forest functions led to the drafting of a new Forestry Bill. This new bill attempts to expand the definition of forest to include all types of woody vegetation. It also attempts to address issues of gazettement and degazettement and provide for greater community involvement in forest management. The Forestry Bill was rejected by parliament in early 2004.

The Ministry of Agriculture is the leading agency in agriculture matters and the Agricultural Act Cap 318 of 1963 is the principle legislation. The act provides for the development of agricultural land use in accordance with accepted practice of good land management and husbandry. It provides for the conservation of soil and its fertility. It also empowers the Minster of Agriculture to make preservation rules to regulate, control and prohibit the clearing of land for cultivation, grazing or watering of livestock with a view to protecting land against floods, landslides, formation of gulleys and destruction from roads and other infrastructures. Soil and water conservation has been given some level of priority by the Ministry of Agriculture and the Office of the President. The National Soil and Water Conservation Programme (NSWCP) was supported by the Swedish International Development Agency (Sida) for the 25 years that ended in the year 2000. For the last 12 years, the NSWCP implemented a catchment approach to conservation, which was generally considered to be successful (Pretty and Shah, 1999). Until a realignment of the government structure in early 2003, the Ministry of Agriculture was responsible for supporting irrigation development.

The *Lake Basin Development Authority* was set up by an act of parliament (Lake Basin Development Authority Cap 442) to plan for the development of the Lake Victoria basin area of Kenya and to initiate project activities that would boost economic growth and human welfare in the region. A controversial component of the Lake Basin Development Authority was its largely unsuccessful support to the conversion of wetlands into irrigated agriculture.

The *Ministry of Water Resources Management and Development*: Until 2002, the focus of water management in Kenya was on the provision of water for domestic use, agriculture, livestock development and industrial utilization. A number of organizations were involved in the provision of water and sanitation services, including the Ministry or Department of Water, the National Water Conservation and Pipeline Corporation, local authorities, local communities, self-help groups, NGOs, projects in the private sector, regional development authorities and the Office of the President (for water development in the arid and semi-arid lands). There was very little focus on water resource management, and systems of water monitoring fell into relative disrepair. In the late 1990s, concerns about increasing water scarcity, low coverage of water services and declining water quality led to a new water policy, new legislation and a set of reforms of the water sector.

The Water Act 2002 vests all water resource in the State, and provides for the formulation of a National Water Resource Management Strategy and the establishment of the Water Resource Management Authority (WRMA), the Water Services Regulatory Board (WSRB) and the Rural Water Services Trust Fund (RWSTF). The Water Act provides an elaborate structure for water resource management based on catchment areas that are defined by the WRMA in accordance with the NWRMS. The WRMA formulates a Catchment Management Strategy and appoints a Catchment Advisory Committee for each catchment. Water Users' Associations are recognized as the primary authority for water management in rural areas. The Water Act 2002 also creates the Water Services Regulatory Board (WSRB), which concentrates more on the utilization (services providers) of water than the conservation of water. The WRSB is represented in the catchment by Water Service Boards that oversee water service providers. Once all of these new authorities are functional, the Ministry of Water will focus on the provision of information and the implementation of policy.

Multiple social authorities for land, water and tree management in the Nyando basin

The Nyando river basin is comprised of two major language groups – Luo and Kalenjin – with small minorities of other ethnic groups. Luo-speaking people reside primarily in the low and mid-altitude parts of the basin, while Kipsigis Kalenjin and Nandi Kalenjin reside primarily in the upper parts of the basin. The Ogiek is a small ethnic group whose customary habitat is the forests in the upper parts of the basin. Resettlement of the large farms in the "white highlands" has led to the co-existence of distinct clusters of Kipsigis Kalenjin with people of other ethnic groups, including Kikuyu, Kisii and Luhya. One spatial settlement pattern was one of the factors that contributed to politically motivated "tribal clashes" in 1992, 1994 and 1997.

The Luo ethnic group is well known in Kenya for the strength of its customary authorities and the large number of prohibitions and restrictions on individual land use. Polygamy is common, and polygamous households have a complex system of duties and obligations. Clans and subclans are very important sources of social authority; village committees are unlikely to succeed if they do not deliberately include representatives of all clans or subclans.

Women have very little independent access to land under Luo customary law, with the exception of the small home garden (*Orundu*) that even junior wives are entitled to (Onyango, 2002). Lack of control over land also severely constrains women's access to water sources, as

almost all water sources are established in private lands. Women thus have full responsibility for the provision of water for the domestic needs of their households, with almost no authority to manage their water sources.

Land management at the village and farm scales is also affected by the activities of a number of important projects and programmes. Perhaps most important of these are the focal area development committees and common interest groups that have been established, with support from the Ministry of Agriculture, under the National Soil and Water Conservation Programme, the National Agriculture and Livestock Extension Programme, the Lake Victoria Environment Management Programme, and ICRAF. Focal area development committees are elected by local communities to coordinate local contributions to extension and development plans developed by the communities and extension agents. Common interest groups form within these communities to address issues of common interest – often including spring protection, water pan construction, soil fertility enhancement, fuel energy conservation and income diversification. Hundreds of such community groups have been established over the last 15 years. In one part of the Nyando basin, ICRAF and the Ministry of Agriculture have been supporting coordination among neighbouring focal area development committees (Swallow *et al.,* 2003).

At the village level, rights and access to water are also affected by both customary authorities and area-based projects. In this area of rural Kenya, water service projects have been supported by the Ministry of Health, the Ministry of Water and the Ministry of Agriculture, as well as a number of NGOs.

CONCLUSIONS

This review illustrates the surprisingly large arrays of formal land tenure types and sources of statutory and customary authority over land and water management in the Nyando basin. While it appears that this complex land tenure system creates many problems for watershed management, insecure private rights to cropland is not one of the most compelling problems. High rates of erosion in the lower part of the basin are associated with private uncultivated areas that are overused for grazing and wood collection. High rates of erosion in the upper part of the basin appear to be associated more with the private allocation and farming of steep hillsides. Gulley formation and low-quality water in the mid-altitude areas are associated with springs that are used commonly, but located on private land. Deforestation and cultivation of riparian areas are associated with privatization of riverine areas, together with ineffective enforcement of rules on the use of those areas. Lack of public infrastructure for water management is partially associated with the lack of public or collective land on which to locate water storage structures.

The Government of Kenya is currently undertaking a review of its land tenure and land policy. Whatever emerges from that review, however, it is unlikely that there will be a large reallocation of land from private individuals to the government. What is more feasible is that public and collective interests in key components of the watershed are exerted through new instruments such as environmental easements. However, that approach will require engagement with key statutory and social authorities. Catchment authorities or environment committees will be most effective if they are able to operate with the support of social authorities such as clan elders, water and land management projects and local authorities.

The Nyando case is complex, perhaps more so than most other watersheds in Africa. Nonetheless, it illustrates the importance of linking science with policy and institutional design: better scientific understanding of the catchment hydrology can lead to a policy and programme focus on small discrete parts of the catchment. The Nyando case also shows the need to understand the complex linkages between property rights and watershed management problems. And, finally, it illustrates the need to involve multiple social and statutory authorities in watershed management, including the various government institutions whose responsibilities and mandates often overlap and conflict.

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CHAPTER 11
MANAGING MICRO-CATCHMENT RESOURCES: INSTITUTIONAL ARRANGEMENTS FOR WATER USE IN CHIWI DISTRICT, ZIMBABWE

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ACRONYMS

CASS	Centre for Applied Social Sciences
CEH	Centre for Ecology and Hydrology
CIFOR	Center for International Forestry Research
CPR	common pool resources
CPRM	common property resource management
DDF	District Development Fund
DNR	Department of Natural Resources
IES	Institute of Environmental Studies
IH	Institute of Hydrology
LWF	Lutheran World Federation
PRA	participatory rural appraisal
VIDCO	Village Development Committee
WADCO	Ward Development Committee

The last two decades have witnessed a paradigm shift in conservation and natural resource management in most post-colonial African countries from costly State-centred control towards community-based approaches. Within this management framework, there is renewed debate on the role of institutional arrangements[1] for common pool resource (CPR) use. Research on CPR institutions has tended to concentrate on visible and formal institutions (Murphree, 1991; Murombedzi, 1994; Ostrom, 1990), yet there are other hidden and informal institutions, such as social networks, that are important for appropriating natural resources (Sithole, 2001). This study examines the role of both formal and explicit and informal and implicit institutions in water use and management.[2]

1. Rules and regulations governing resource use (Ostrom, 1990).
2. This study was part of a broader micro-catchment management project undertaken by the Institute of Environmental Studies, University of Zimbabwe, and funded by the United Kingdom Department for International Development (DFID).

A diversity of theoretical and empirical material on the complexity of common pool use and management exists. Two strands identified in the literature are of relevance to this paper. First, there are theories suggesting that groups of interdependent CPR users have a strong stake and desire to manage CPR resources collectively (McCay and Acheson, 1987; Ostrom, 1990). Two perspectives exist under this paradigm. One assumes that economic incentives drive self-interested behaviour in CPR management (Ostrom, 1990), while the other suggests that CPR management is motivated by social capital or moral economy providing social bonds for the attainment of collective outcomes (Cleaver, 2000; Mosse, 1997). One of the suggestions made by the CPR theory is that the minimum condition for functioning CPRs includes the need for clearly defined boundaries for resources and resource users (Ostrom, 1990).

The second strand is the new ecology, in which empirical evidence generated from rangeland management (Peters, 2000; Scoones, 1996) shows that flexible boundaries can be more efficient than fixed boundaries. This strand further delves on the politics of resource access and control among diverse social actors (Mearns, Leach and Scoones, 1997). This approach recognizes that communities are not bounded, homogenous entities, but rather socially differentiated and diverse.

Empirical evidence from this study shows that there are fuzzy and overlapping resource units and uses. The use of water resources occurs both within and across administrative and other geographical boundaries. Local controls include explicit as well as implicit norms and taboos that are often voluntarily observed or tacitly enforced through spiritual belief censure, such as in the case of natural springs that are regarded as sacred. A common pitfall is to interpret less intense and passive management systems as lack of management, and to recommend switches to more intense management systems without taking cognizance of transaction costs, net benefits and sustainability considerations.

THE STUDY AREA

The case study was conducted in the Romwe micro-catchment located in Chiwi District, southern Zimbabwe. Chiwi District is characterized by low rainfall, ranging from 450 to 600 mm per annum, poor soils for agricultural production, and severe droughts (Nemarundwe, 2003). Because of the dryness of the area, water is a key resource in the livelihoods of households within the micro-catchment. The households in the physical catchment fall into three traditional villages, presided over by a village head known as the *sabuku* (kraalhead). These villages are Sihambe, Tamwa and Dobhani. Besides the three villages in the physical catchment, seven other traditional villages use natural resources found in Romwe. These seven villages are Chikanda, Matenhese, Ndabaningi, Munikwa, Joni, Magomo and Puche, and are referred to as the social catchment villages.

RESEARCH METHODS

A number of research methods were used in an attempt to cross-check information obtained from different sources. These include key informant interviews with traditional leaders, well owners, well users and members of water committees. Participatory rural appraisal (PRA) techniques, such as resource and institutional mapping, group discussions with separate groups of women and men and participant observation, were also used. During the PRA workshops,

women and men were divided into separate groups to ensure equal participation in discussion and also to help capture perceptions of the different groups, where relevant. These groups had between 30 and 40 participants because an open invitation had been sent out to all village residents. The fieldwork was conducted over 18 months, with field visits in two-week blocks. In addition, a full-time research assistant was based in the village. The research was conducted by two team members, a sociologist and the research assistant, who holds a diploma.

RESULTS: WATER RESOURCES MAPPING

Two broad categories of water sources were identified. These are community- and privately owned water sources. Community-owned water sources include boreholes, Barura dam, streams and deep wells. There are 36 privately owned deep wells in the catchment with various uses and users. These have different institutional arrangements from those of community water sources.

Community-owned water sources

Different villages use community-owned water sources for various purposes and during different times of the year. The boundaries of water resource use shift depending on the type of the water source and the use of that particular source, as seen in the case of Barura dam (Figure 1). A variety of rules and regulations apply to the different community-owned water sources. Some rules are generic, while others are specific to the type of water source.

Boreholes: Although a borehole may be located in one village, neighbouring villages are allowed access to it by the village in which it is located. In years with good rains (more than 650 mm per annum), rules relating to the use of boreholes apply equally to local people and outsiders. These rules are enforced more vigilantly during times of water scarcity. Examples of rules that have been agreed by the community relate to general hygiene around the boreholes. Brick moulding is not allowed at the borehole, and the hand pump should not be hit against the ground. In low-rainfall years, communities may institute rules that regulate the amount of water collected, the frequency of collection, the uses to which the water is put and the number of villages that can use a particular borehole. During times of water shortage, farmers are not allowed to use borehole water for watering fruit or other trees. In all cases, these rules are not written down, but community members seem to know them well and appear to follow them.

Borehole management committees have been set up with the assistance of external agencies such as the Institute of Hydrology, the Lutheran World Federation and the District Development Fund. In theory, their mandate is to enforce the rules regulating access to boreholes, but in practice these committees have been found ineffective. For instance, the Chidiso borehole committee failed to repair a borehole during a four-year period, yet only a bolt costing less than US$5.00 was needed. All users of a particular borehole are expected to pay a yearly contribution (e.g. Z$5 for Tamwa borehole).[3] The money is used for repairing the borehole if it breaks down. However, it is difficult to mobilize all the users, as some people are less frequent users than others.

3. As of June 2001, the official exchange rate is Z$55 = US$1.

Barura dam: The three physical catchment villages use the dam mainly for irrigating crops in the community garden, watering their livestock, brick moulding and laundry. Social catchment villages shown in Figure 1 use the dam mainly in the dry season. The various committees (dam, agronomy, conservation committees) related to the dam in one way or another indicate the different stakeholder groupings at the dam. The different committees, in consultation with the farmers, set rules that regulate the way farmers use the dam. Rules regulating dam use include that livestock should use designated gates in order to control erosion, yearly subscription fees should be paid on time, and cattle grazing, brick moulding and laundry should not be done near the dam. While members of the social catchment villages use the dam for watering livestock and other domestic uses, they are not accorded the right to use it for fishing or collecting large volumes of water. Because water is considered hupenyu (life), there has been no case of denying another village access to water during drought, although rules are enforced more stringently.

Closed deep wells: There are closed deep wells that are used as community water sources. These have been developed and protected with labour contribution from community members through the traditional work parties (*nhimbe*). Rules relating to access to these wells are set by the kraalheads in consultation with advisers. The rules prohibit the use of water for activities such as brick moulding and gardening, and also prohibit people from doing laundry near the well. In practice, there is no evidence that these rules are enforced. The study found that some rules are not enforced because of the transaction costs involved, such as getting shouted at, the time needed to track offenders and the fear of being bewitched.[4] There are also close social ties in the catchment as the majority of the families are related in one way or another, and thus there is fear that penalizing another person may work against the long-established social capital.

Open deep wells: The open deep wells found in the catchment are not protected and are used as an open-access resource. Some of the wells are natural, while others were abandoned when their owners moved to settle in an area outside Romwe. The wells are used mainly for brick moulding and house construction, but not for drinking purposes. People therefore have free access to these open wells.

Mawunga stream: During the dry season, households water their livestock in Mawunga stream. Some mould bricks along the Mawunga stream as well. This stream is accessible to almost everyone in the adjacent villages. Use of the stream tends to be determined by the distance of the household from the stream. For example, those who live near the stream do gardening, while those who live far away use the stream for watering livestock only. Local Department of Natural Resources (DNR) representatives theoretically enforce rules on the use of streams, e.g. observing the mandatory 30 m distance[5] from the stream bank if one wants to establish a field or vegetable garden. This rule is ignored by most of the users because the soils close to the riverbanks are very fertile and it is easy for them to water their crops. Despite backing by statutory instruments, of late, DNR rules and regulations are ignored by the community, partly owing to inefficient monitoring by representatives and staff members of the department.

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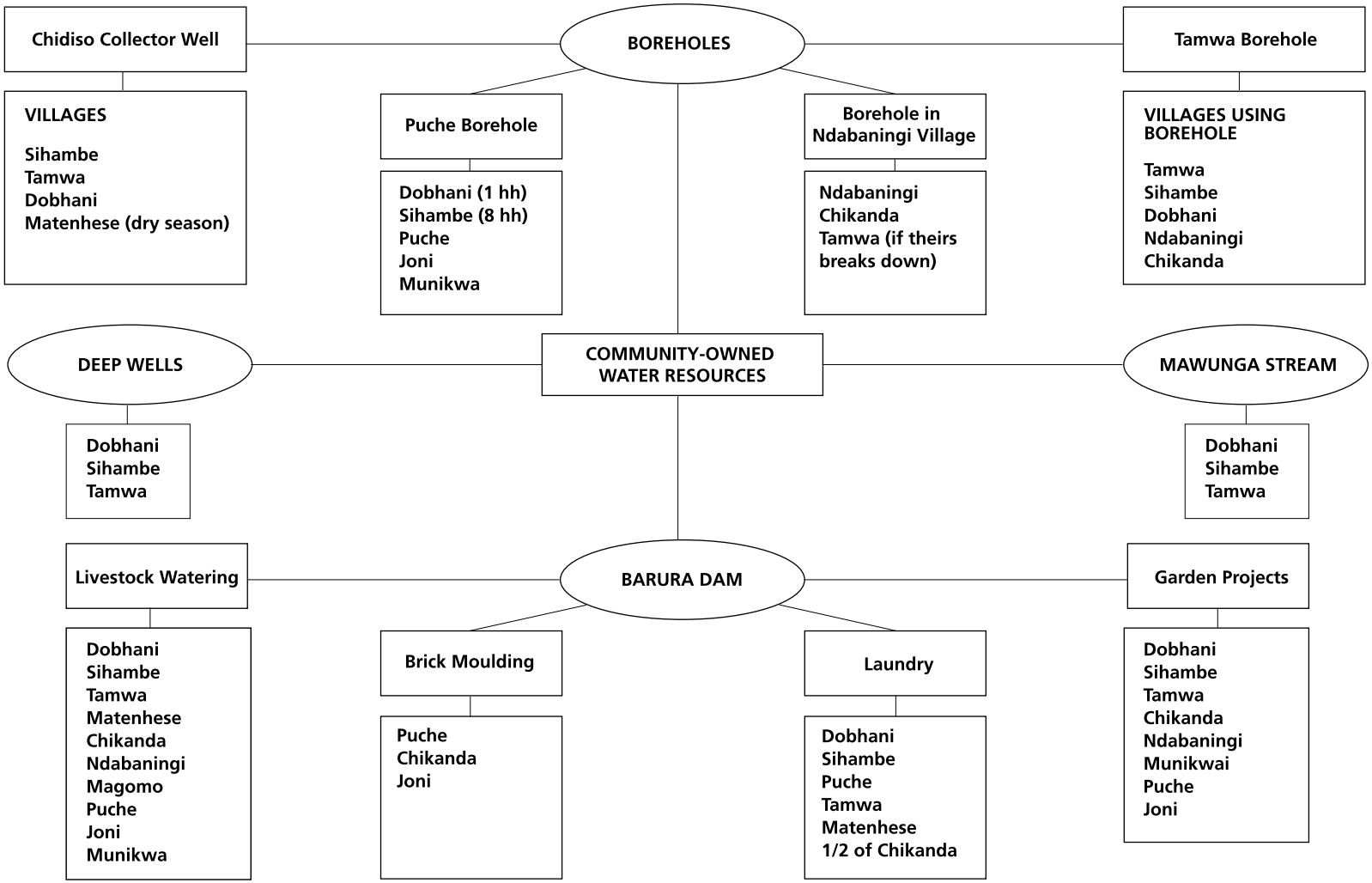
4. Nemarundwe (2003) details how witchcraft is a strong social control mechanism in the Romwe catchment.
5. Farmers are not supposed to use the land within 30 m of the stream in order to curb soil erosion.

FIGURE 1

Community-owned water sources and user villages



Source: Nemarundwe and Kozanayi, 2003

Privately owned water sources

Wells: Privately owned water sources are mainly deep wells dug by specific households, through mobilizing their own labour, hired labour or assistance from neighbours. The wells are dug close to homes or in the fields. Ownership ranges from zero to three wells per household. In some cases, the wells are inherited, together with fields, from parents and grandparents. Exclusive use of a well by a single household is highly unlikely. Wells are often open to use by other households, following a basic set of norms. The well owners attach certain conditions to the use of wells. Permission has to be sought from a well, and someone may be granted access to water for domestic purposes, such as drinking, cooking and laundry. Where larger amounts are needed, e.g. for beer brewing, permission has to be sought for that specific activity. Wells in crop fields are more accessible to the whole village, while wells near homesteads are usually fenced.

When identifying a well from which to collect water, individuals consider the following: distance to the well, closeness of their relationship with the well owner, and people whose wells they helped to construct. Cases of denial of access come into play if the person wanting to collect water never assisted the well owner to dig the well, is renowned for being unhygienic, or collects water from the well for purposes other than those for which he or she originally sought permission.

In times of drought, when water is limited, well owners may set a limit to the number of households that can fetch water from their wells, the frequency of fetching water, the purposes and volumes of water to be collected per day. For instance during drought, other households may be allocated 20 litres of water per day for domestic use only. The individual owners institute rules governing access to privately owned wells, but these are not written down. The rules are well articulated by community members because they are communicated informally to potential well users. The local village health workers also set some of the rules, such as those relating to general hygiene. The health workers make frequent visits to different wells to monitor cleanliness around wells and ensure the wells are properly protected. Bans on access to water are generally resented in the community. A well owner who denied others access to his well found a dead dog in the well two days after he had locked the gate to it. People also believe that wells at which punitive rules are in force often dry up or collapse, even if they have a strong lining made of cement.

The foregoing discussion emphasizes what well owners "give" to other community members, and not what they themselves "get" from the other community members. The process of water access is reciprocal, thus well owners also derive benefits from people who use their wells.

Benefits that can be realized by well owners include the following:

- *Access to arable land:* there is general land shortage in Romwe, but land is comparatively abundant in the social catchment villages. Residents from Romwe often lease land from farmers in neighbouring villages. The leasing arrangements are not fixed, but are negotiated on an annual basis. Some well owners allow people access to their wells in order to benefit through access to arable land.
- *Access to draught power:* some well owners do not own sources of draught power, and therefore give access to their wells to fellow farmers who have draught power in anticipation that when the rainy season begins, they will be assisted with draught power at a reasonable price.

- *Access to labour:* well owners may get assistance from those who are allowed to collect water in the form of help in the fields to weed, harvest and process farm produce. Based on cultural norms of reciprocity, the water collectors reciprocate the access they are given to a well in one way or another.
- *Social capital:* people who share the same water points have a higher chance of engaging in other projects together because they can easily mobilize each other. The flow of information is also fast among people who share the same water source.

***Natural springs* (Zvitubu):** Only two privately owned natural springs were identified. Given that springs are natural features, private ownership of springs is an example of privatization of a potentially common pool resource. Individual claims are made over springs partly because they are localized and can easily be defended, and partly based on claims of inheritance from ancestors. Water from natural springs is used for drinking, watering livestock, laundry, brick moulding and vegetable production for sale and home consumption. The owners determine the kind of access to and use of the spring by other community members. There are some rules that have been inherited from generation to generation and enforced by kraalheads and chiefs. The most common rules are: no bathing at the springs, no laundry and no soap should be used at the spring. Livestock should also not drink from the same point of the spring as people because springs are normally left unfenced and would be trampled by livestock, thus spoiling the water and also making the spring dry up. Generally, people observe the rules that have been laid down, because they ensure the availability of clean water.

DISCUSSION

Both implicit and explicit institutional arrangements govern communal and privately owned water sources in Romwe. The rules and regulations are generally not written down, but community members appear to know them well. In most cases, these institutional arrangements are defined only in a very general way, giving conditional access based on appropriate use. The importance of this non-specificity is that it allows for flexibility in resolving particular cases (Berry, 1993; Cleaver, 2000). Some authors have argued that it is important to codify rules and regulations for resource use, for instance, through community organizations (Clarke, 1994; Mandondo, 2000; Matowanyika, 1991). Codification should, however, only be done when community needs and priorities justify switches to more managerially costly and intensive management systems. It should be demand-driven rather than prescriptive or supply-led.

Calls for codification overlook the fact that the existing system allows for flexibility in determining who has access to water resources at a given time. To support this latter view, Platteau (1995), using evidence from Africa on land, suggests that formalizing landholdings through registration increases conflicts over land rights. This is more so for groups who customarily had informal access to natural resources such as land and, in our case, water. Customary rights over common pool resources in local communities and the value of flexibility in these arrangements should be recognized.

At Romwe, private water source institutional arrangements are products of social networks of actors created through the family, extended family and kinship ties. Thus, interpersonal relationships are important in determining the degree of compliance with existing rules and

regulations governing access to water resources. The multiple uses of a water source also involve a balance between allocating water for domestic and other uses. In most cases, priority is given to water for domestic use over irrigation or gardening activities. A good example is the Chidiso borehole, where originally two pumps were allocated for domestic and irrigation purposes but, after frequent breakdowns, the irrigation pump is often used for domestic purposes. This balance also allows for flexibility, and people do not rigidly stick to the original uses of a particular water source.

Findings of this study contradict the literature on collective resource use, which assumes that economic incentives drive self-interested behaviour in CPRM (Ostrom, 1990). This study found that social capital rather than economic incentives facilitate CPRM. The social capital provides social bonds that are key for the attainment of collective outcomes for resource management. Compliance to the unwritten rules can be attributed to this social capital. The penalty for lack of adherence is to be refused access to a given water source. Furthermore, there is a high level of complexity in water management, yet the design principles attempt to simplify this complexity.

There is also reciprocal access to water resources with neighbouring villages, as seen in the case of Barura dam. This overrides the traditional and administrative boundaries in favour of flexible social boundaries. In a way, this challenges Ostrom's (1990) design principles, one of which suggests that resource use boundaries should be clearly defined. This fuzziness of resource use boundaries also challenges recommendations for exclusion management, as espoused in the Land Tenure Commission report (1994)[6] and the new Traditional Leaders Act of 1999. Similarly, the uncertainty associated with water resource use and availability suggests the need for flexibility in resource management. Findings of this study concur with the new ecology empirical evidence that shows that flexible boundaries can be more efficient than fixed boundaries (Scoones, 1996). Resource access is a process of negotiating resource user boundaries, as well as access to the various sources of water.

In conclusion, this study has shown that there are many implied rules and controls governing access to water in micro-catchment areas. Development practitioners and researchers sometimes assume that if rules are not written down, they do not exist. These unwritten rules are part of the social fabric, and play an important role in determining access to water. The resilience of these rules, even though not written down, is sustained by their capacity to accommodate change.

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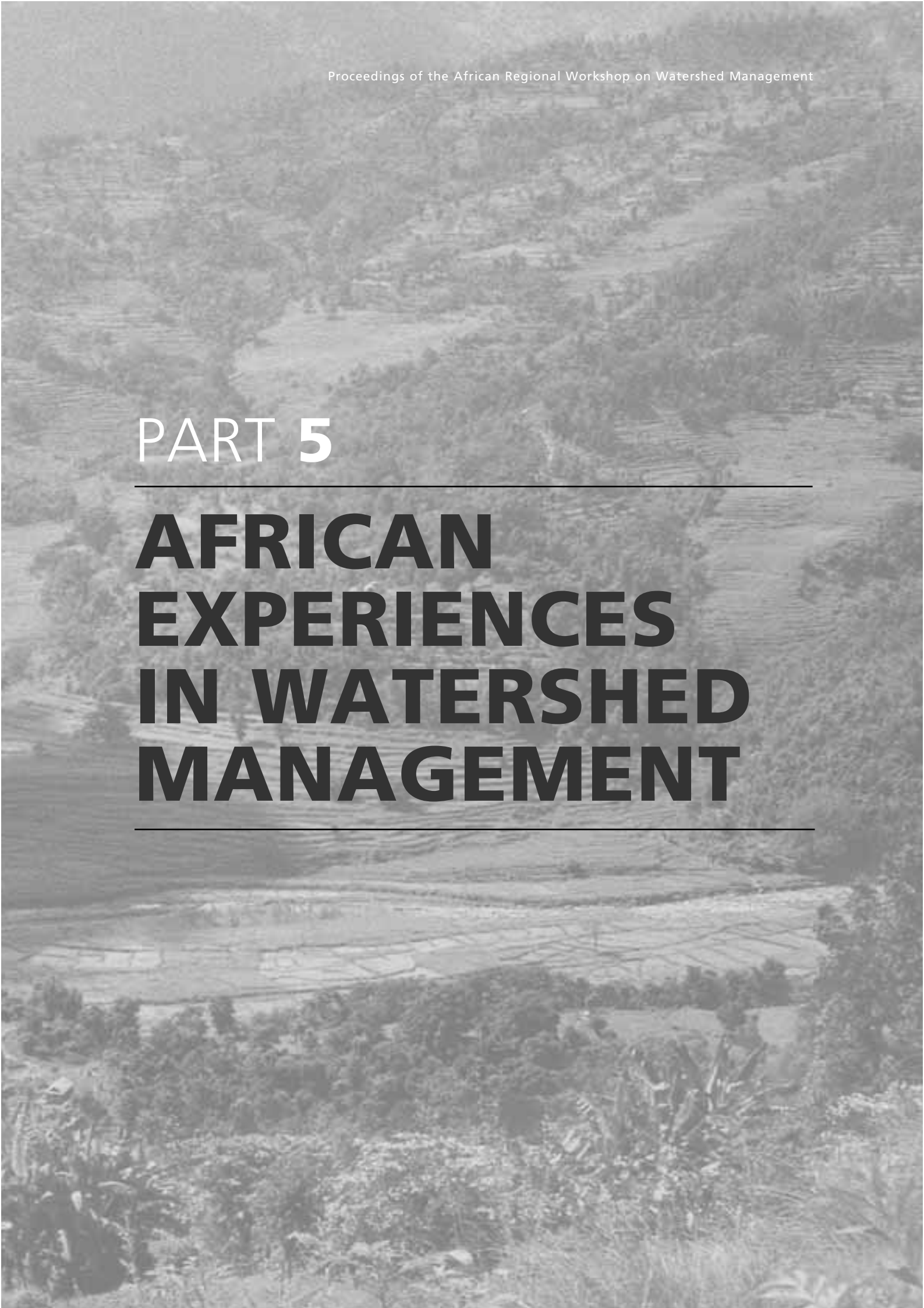

PART 5

AFRICAN EXPERIENCES IN WATERSHED MANAGEMENT

CHAPTER 12
PROCESSES THAT WILL INFLUENCE RESOURCE ALLOCATION IN THE REPUBLIC OF SOUTH AFRICA

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ACRONYMS

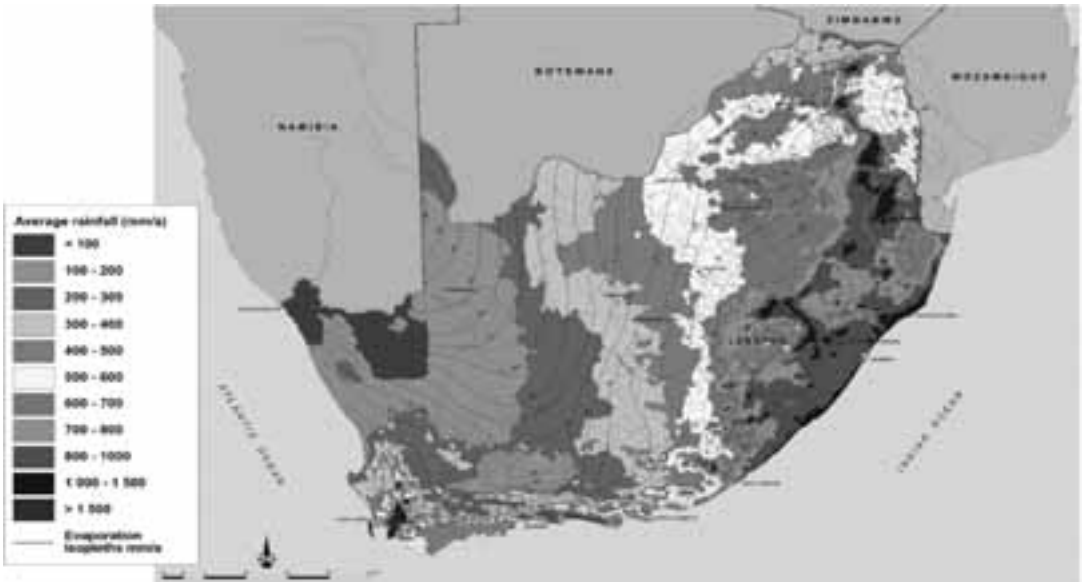
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
DWAF	Department of Water Affairs and Forestry
EWR	Ecological Water Requirements
ISP	Internal Strategic Perspectives
NWA	National Water Act
NWP	National Water Policy for South Africa
NWRS	National Water Resource Strategy
WMA	Water Management Area

South Africa is located in a predominantly semi-arid part of the world. The climate varies from desert and semi-desert in the west to sub-humid along the eastern coastal area. The average rainfall for the country is about 450 mm per annum, which is well below the world average of about 860 mm/annum; however, evaporation is comparatively high. As a result, South Africa's water resources are, in global terms, scarce and extremely limited. The country has no truly large or navigable rivers, and the combined flow of all the rivers in the country amounts to approximately 49 000 million m^3 per annum, less than half of that of the Zambezi River, the closest large river to South Africa. Groundwater plays a pivotal role, especially in rural water supplies. Because of the predominantly hard rock nature of South African geology, only 20 percent of groundwater occurs in major aquifer systems that could be utilized on a large scale.

Owing to the poor spatial distribution of rainfall, as shown in Figure 1, the natural availability of water across the country is also highly imbalanced. This situation is compounded by the strong seasonality of rainfall, as well as high within-season variability over virtually the entire country. Consequently, surface runoff is also highly variable. As a result, stream flow in South African rivers is at relatively low levels for most of the time. The sporadic high flows that do occur limit the proportion of stream flow that can be relied on to be available for use. To aggravate the situation, most urban and industrial development, as well as some dense rural settlements, have been established in locations remote from large watercourses, dictated either by the occurrence of mineral riches or by political dispensations of the past. As a result, in

several river basins, the requirement for water already far exceeds its natural availability, and widespread and often large-scale transfers of water across catchments have already been implemented in past decades.

FIGURE 1
Rainfall and evaporation map of Southern Africa.



EVOLUTION OF WATER USE AND WATER LAW IN SOUTH AFRICA

Background

South Africa was under Netherlands rule from the time of Van Riebeeck to the United Kingdom occupation early in the nineteenth century. All land was held in leasehold, therefore the State had ownership of all water and had absolute control over its applied use. Irrigation was from direct diversion of rivers. The responsibility for water resource development was in the hands of private enterprise.

During United Kingdom occupation in the early nineteenth century, freehold land tenure was introduced. Under English law, the natural rights appertaining to the land belonged to the owner. The riparian principle, namely that all owners of land along rivers had common rights to the water in such rivers, became established. Special water courts were created to apportion water and to determine individual rights. The Irrigation and Conservation of Water Act (No. 8 of 1912) was eminently suited to promoting irrigation development in accordance with these principles. With this, the State concentrated on the construction of works to benefit irrigation.

But the country developed, and it was realized after the Second World War that the 1912 act was obsolete in that it did not make provision for the growing needs of industry and other users in what had turned out to be a water-deficient country. As the result of a Commission of Enquiry,

which reported in 1952, a new Water Act (No. 54 of 1956) was promulgated, which was the first attempt in South Africa to regulate the use of public water for all demand sectors of the economy to the best national advantage. Unfortunately, the concept of State control was reintroduced (portion in excess of existing users' rights). The principle of private ownership was still enforced, and access to water for production purposes was still tied to landownership (the riparian system).

The National Water Policy

Since the advent of a democratic South Africa in 1994, government policy has focused strongly on equitable and sustainable social and economic development for the benefit of all people in South Africa. However, many existing laws – including the law relating to water – were not at all appropriate in achieving these objectives. The National Water Policy (NWP), adopted by Cabinet in 1997, was introduced in response to the new direction set by government and as part of a thorough review of existing water law.

The NWP was preceded in 1996 by the development of 28 Fundamental Principles and Objectives for New South African Water Law. Principle 7 is particularly relevant and states that:

> The objective of managing the quantity, quality and reliability of the nation's water resources is to achieve optimum, long-term, environmentally sustainable social and economic benefit for society from their use.

This became the cornerstone for the priorities for water resource management in South Africa.

Three fundamental objectives for managing South Africa's water resources, which are firmly grounded in the provisions of the Bill of Rights of the Constitution of South Africa (No. 108 of 1996), arise from these principles. These objectives are to achieve:

- equitable access to water;
- sustainable use of water;
- efficient and effective water.

Important proposals to facilitate achievement of the NWP objectives include the following:

- Water will be regarded as an indivisible national asset. National government will act as the custodian of the nation's water resources, and its powers in this regard will be exercised as a public trust.
- Water required to meet basic human needs and to maintain environmental sustainability (the reserve) will be guaranteed as a right, while water use for all other purposes will be subject to a system of administrative authorizations.
- The responsibility and authority for water resource management will be progressively decentralized through the establishment of suitable regional and local institutions. These will have appropriate community, racial and gender representation to enable all interested persons to participate.

Implementation of the NWP proposals will fundamentally change the ways in which South Africa's water resources are managed.

The National Water Act

The National Water Act (NWA) (No. 36 of 1998) derives directly from the Fundamental Principles and Objectives for a New South African Water Law and the NWP proposals for managing water resources. The NWA is the principal legal instrument relating to water resource management in South Africa and contains comprehensive provisions for the protection, use, development, conservation, management and control of South Africa's water resources. These legal provisions enable the proposals in the NWP to be implemented. The NWA was therefore enacted in recognition of the following:

- the water cycle, and water's scarcity and uneven distribution;
- although water belongs to all the people of South Africa, some were excluded from its use in the past;
- water is a national asset, and the national government should therefore be its custodian;
- the ultimate aim of water resource management is to achieve sustainable use;
- the quality of water should be protected to ensure sustainability;
- the need for integrated management of all aspects of water resources and the delegation of management functions to the regional or catchment level.

However, the NWA is not the only instrument through which the objectives of the NWP will be achieved. It is supported by other legislation such as the Water Services Act (No. 108 of 1997) and the National Environmental Management Act (No. 107 of 1998).

The National Water Resource Strategy

The implementation of the NWA is a progressive process that will subject the country to gradual water reform for a long period. An important initial step was the development of the first edition of the National Water Resource Strategy (NWRS). The NWRS describes how the water resources of South Africa will be protected, used, developed, conserved, managed and controlled in accordance with the requirements of the policy and law. The central objective of managing water resources is to ensure that water is used to support equitable and sustainable social and economic transformation and development.

The NWA is a national framework for managing water resources, developing catchment management strategies and giving information on the Minister's intentions for water resources management. The NWA is also utilized to identify development opportunities, as well as constraints.

Catchment Management Strategies

A vital element of the NWRS is the progressive decentralization of the responsibility and authority for water resource management to Catchment Management Agencies (CMAs) and, at the local level, water user associations. The initial functions of the agencies include the important responsibility of developing a Catchment Management Strategy (CMS) for each Water Management Area (WMA). This strategy may not be in conflict with the NWRS, and must give effect to the NWRS's provisions and requirements, providing the

framework for managing the water resources of the area. In particular, it must determine the principles according to which the available water will be allocated among competing user groups.

Internal Strategic Perspectives

The first step towards the CMS, which is the writing up of the so-called Internal Strategic Perspectives (ISPs), has already been done, and ISPs for a number of WMAs are already available in the public domain.

The Department of Water Affairs and Forestry's (DWAF) regional offices have to manage the water resources in their areas of jurisdiction until they can hand over some of these management functions to established and fully operational CMAs. In accordance with the NWA, the Minister of DWAF will retain ultimate responsibility for the management of the water resources.

In light of this responsibility, DWAF's corporate perspective on how the water resources should be managed needs to be formally put on paper. This is with a view to maintaining consistency when answering requests for new water licences, and informing existing water users (including authorities) on how DWAF will manage the water resources within the area of concern and which decision support information still needs to be collected.

SOUTH AFRICA'S WATER SITUATION AND STRATEGIES TO BALANCE SUPPLY AND DEMAND

Background

Although South Africa's water resources are limited and highly variable, they will be sufficient to support social and economic development for the foreseeable future, provided that they are judiciously managed and wisely allocated and utilized.

An important basic concept relating to water resources management that needs to be explained is the portion of the available water, in respect of both quantity and quality, in each WMA that is under the direct control of the DWAF Minister in terms of his or her national responsibilities. This includes the reserve water necessary to meet international obligations, provision to meet realistic future requirements, transfers between WMAs and water of strategic importance.

Once these obligations are met, the balance is allocated to the various other users in the catchments.

The reserve

In the NWA (and therefore also the NWRS), the highest priority is afforded to the provision of water for the purposes of the reserve. The first objective is to ensure that sufficient quantities of water of appropriate quality are readily available to provide for basic human needs.

The second objective is the provision of water for safeguarding and sustaining healthy ecosystems, including fauna and flora. This can also be termed the Ecological Water Requirements (EWR). Owing to the complex interdependence among species in nature, and our extremely limited knowledge of the wide spectrum of habitat and water requirements, only provisional estimates of the EWR are presented in the NWRS.

In simple terms, it can be said that the EWR is the water that should be left in a river (or wetland or estuary) for the healthy ecological functioning of the system. This water is not available for abstraction and therefore limits the available yield from the system. Allowance for EWR has been made in all yield numbers quoted in the NWRS.

Water required for international rights and obligations

Four of South Africa's rivers are shared with other countries. These are the Limpopo, Inkomati, Pongola (Maputo) and Orange (Senqu) rivers, which together drain about 60 percent of the country's land area and contribute about 40 percent of its total runoff (river flow). Approximately 70 percent of South Africa's gross domestic product (GDP) and a similar percentage of the population are supported by water supplied from these rivers, making their judicious joint management of paramount importance to South Africa.

Water use of strategic importance

Electricity is fundamental to the functioning of modern society, and the abstraction and storing of water for use at power stations operated by Eskom, as the organization entrusted with generating the bulk of the country's electricity, is therefore regarded as being water use of strategic importance.

Reservation for transfer between WMAs

The allocation of reserves for transfer between WMAs is also regarded as water use of strategic importance, and is established by the Minister in the NWRS.

Contingency to meet projected future growth

As part of the reconciliation of supply and demand, projections were made of the future requirements for water, together with an indication of the resource potential that could still be developed. The best strategies for the future reconciliation of requirements and availability will be combinations of various possible interventions. Only under certain conditions will further developments and transfers of water prove to be desirable. It is therefore not generally practical for reservations to be made of specific quantities of water to allow for future growth. However, there are certain instances in which the limited resources still available must be reserved (e.g. where known quantities of water need to be reserved for specific uses or transfers; where general reserves that are not quantifiable at present need to be made for future priority uses; and where dam sites need to be reserved for specific purposes).

This will ensure that optimal development choices are not foregone and developments are not allowed in one area that will unwittingly prejudice another.

STRATEGIES FOR WATER RESOURCES MANAGEMENT

Background

Strategies, objectives, plans, guidelines, procedures and institutional arrangements are necessary to implement the provisions of the NWA. This paper has alluded to some of these, such as the reserve and other water use under the direct control of the Minister and water management institutions. We need briefly to explain some of the other important provisions.

Protection of water resources

It was indicated in the preceding section on the evolution of water use and water law that the fundamental objectives for managing South Africa's water resources are to achieve equitable access to water resources, and their sustainable and efficient use. In the section on the strategies needed to balance supply and demand, it was concluded that the country's water resources will be sufficient to support development for the foreseeable future.

Equitable access has both a short-term and a long-term dimension. It is important that the needs of current and future generations are considered in the management of water resources.

To give effect to the interrelated objectives of sustainability and equity, an approach to managing water resources has been adopted. This introduces measures to protect water resources by setting objectives for the desired condition of resources, and putting measures in place to control water use to limit impacts to acceptable levels.

The approach comprises the following two complementary strategies:

- *Resource-directed measures:* These measures focus on the quality of the water resource itself. Resource quality reflects the overall health or condition of the water resource, and is a measure of its ecological status. Resource quality includes water quantity and water quality, as well as the character and condition of in-stream and riparian habitats, and the characteristics, conditions and distribution of the aquatic biota. The class of a resource, the reserve and its resource quality objectives are intimately related to one another. The reserve includes the quantity and quality of water to meet basic human needs and protect aquatic ecosystems. Resource quality objectives provide numerical and/or descriptive statements about the biological, chemical and physical attributes that characterize a resource for the level of protection defined by its class. Resource quality objectives must take account of user requirements and the class of the resource. Accordingly, the determination of the management class of a resource, and the related reserve and resource quality objectives (jointly, a resource-directed measures determination) will usually be undertaken as an integrated exercise.

- *Source-directed measures:* These measures contribute to defining the limits and constrains that must be imposed on the use of water resources to achieve the desired level of protection. They are primarily designed to control water use at the source of impact.

Water use

Concerning equity of access, the NWA replaces the previous system of water rights and entitlements (many of which were based on the ownership of riparian land) with a system of administrative, limited-period and conditional authorizations to use water.

"Schedule 1 use" (relatively small quantities of water) and "use under a general authorization" (limited, but conditional, water use without a licence) were introduced in the NWA. These were primarily intended to reduce the administrative effort of authorizing each individual water use in the country. However, a licence is required for any water use that exceeds a Schedule 1 use, or that exceeds the limits imposed under the general authorizations.

It is important to note (as previously stated) that the reserve has priority over all water uses and that the requirements of the reserve must be allowed for before any water use is licensed.

CONCLUSION

Many challenges face South African water resource managers in ensuring that water supports the transformation of society and the economy, and neither the resources nor the time required to address them should be underestimated. However, building on the outstanding foundation provided by the NWA, the NWRS will guide the achievement of the common vision of an equitable and sustainable society.

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CHAPTER 13
PUTTING INTEGRATED WATER RESOURCE MANAGEMENT INTO PRACTICE – GHANA'S EXPERIENCE

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ACRONYMS

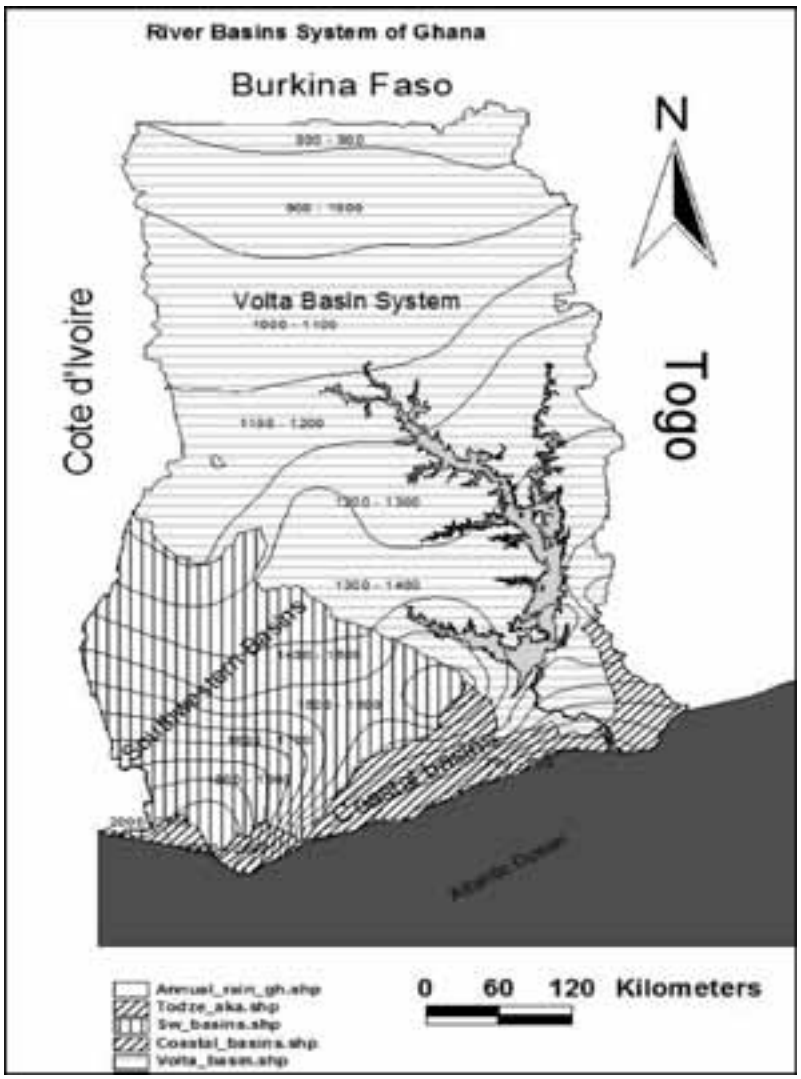
CWSA	Community Water and Sanitation Agency
DAs	District Assemblies
EPA	Environmental Protection Agency
FC	Forestry Commission
GWCL	Ghana Water Company Limited
HSD	Hydrological Services Department
IDA	Irrigation Development Authority
MC	Minerals Commission
MDAs	Decentralized Ministries, Departments and Agencies
MES	Ministry of Environment and Science
MLF	Ministry of Lands and Forestry
MM	Ministry of Mines
MOFA	Ministry of Food and Agriculture
MRT	Ministry of Roads and Transport
MSD	Meteorological Services Department
MWH	Ministry of Works and Housing
NDPC	National Development Planning Commission
VLTC	Volta Lake Transport Company
VRA	Volta River Authority
WRC	Water Resources Commission
WRI	Water Research Institute

BACKGROUND

Water resources of Ghana

Ghana is well endowed with perennial rivers and groundwater, although seasonal shortages are quite common. The mean annual rainfall ranges from 2 150 mm in the extreme southwest of the country, reducing progressively eastwards and northwards to 800 mm in the southeast and about 1 000 mm in the northeast of the country (Figure 1).

FIGURE 1
Rainfall distribution in the major river basins of Ghana



Source: Map produced in Arcview GIS with background shapefiles from Ghana Country at a Glance.

Ghana is drained by three main river systems; the Volta basin, the southwestern basins and the coastal basins river systems, which respectively cover 70, 22 and 8 percent of the total area of Ghana (Figure 1). The Volta River system is shared with Côte d'Ivoire, Burkina Faso, Togo, Benin and Mali. Two river basins in the southwestern system are also transboundary – the Bia River is shared with Côte d'Ivoire, while the lower reaches of the Tano river form part of the boundary with Côte d'Ivoire. The total annual runoff of the river basins is 56.4 billion m^3. The Volta, southwestern and coastal systems contribute 73.7, 29.2 and 6.1 percent, respectively, of the annual runoff originating from Ghana (Ministry of Works and Housing, Ghana, 1998).

The groundwater resources of the country are found in two main rock formations: 1) the sedimentary formation made up of mainly Voltaian origin, which occupies about 43 percent of the total area of the country, with yields of 1.0 to 12.0 m^3/ha at depths of 20 to 80 m; and 2) the

non-sedimentary formation made up mainly of the crystalline basement complex of pre-Cambrian origin, which occupies 57 percent of the total area of the country with yields of 1.5 to 32.0 m^3/ha at depths of 20 to 100 m. The quality of groundwater resources in Ghana is generally good except for some cases of localized pollution with high levels of iron and fluoride, as well as high mineralization with total dissolved solids, especially in some coastal aquifers (Water Resources Commission, 2000).

HISTORICAL PERSPECTIVES OF WATER RESOURCES MANAGEMENT IN GHANA

Customary land and water conservation practices

Customary laws and practices in Ghana have existed over the years and covered the areas of water conservation, pollution control, protection of catchments and protection of fisheries. Kinship, reverence for ancestors and belief in the spiritual power of the earth combined to give land tenure and customary environmental protection their peculiar character.

Basically, the people believed that the earth has a spirit of its own, which can be helpful if propitiated or harmful if degraded. Even though the earth was regarded as possessing a spirit, the ancestors were believed to be the immediate spiritual custodians of the land and its resources. It was the ancestors, on behalf of the earth deity, who constantly kept watch to see that the land is judiciously used (Opoku-Agyeman, 2001).

As well as the earth deity, the natives also believed in river gods, tree deities and sacred groves. People were forbidden to hunt in certain periods of the year or to fish on Tuesdays, and were to refrain from farming along riverbanks, which were considered the resting abode of the river gods and children.

These laws were enforced through various sanctions usually dictated by fetish priests and priestesses. Today, however, it is difficult to identify any features of customary law beyond the priority given to water for domestic use, which is common throughout the country.

Pre-independence common laws

As early as the 1900s, the government recognized the need to control the use of water. The first attempt comprehensively to regulate the use of water, other than for domestic use, was the enactment of the Rivers Ordinance (CAP 226 of 1903). Section 10 of this ordinance states that it shall be unlawful to pump, divert or by any means cause water to flow from any river, for purposes of irrigation, mines or factories or to generate power, without a licence from the Minister. There was no follow-up to this ordinance, neither were regulations made, and the ordinance was overtaken by time and other enactments. The other enactments that followed contained specific provisions that enabled agencies to perform certain specific functions, and some of these provisions were water-related. For example, the Forestry Ordinance of 1927 made provisions for catchment protection and control of water abstraction in forest reserves; the Land Planning and Soil Conservation Ordinance of 1953 had sections for checking soil erosion and for the control of watercourses.

Post-independence common laws

A priority of government in the immediate post-independence era was to establish agencies and institutions with specific roles for water supply, irrigation and environmental management. Some legal enactments related to water management in post-independent Ghana are listed in Table 1.

TABLE 1
Legal enactments for setting up major water-related agencies

INSTITUTION	RESPONSIBLE MINISTRY	LEGAL ENACTMENT
Meteorological Services Department	Communications	Administrative
Hydrological Services Division	Works and Housing	Administrative
Water Resources Research Institute*	Environment, Science and Technology	NLCD 293 of 1969
Institute of Aquatic Biology*	Environment, Science and Technology	NLCD 293 of 1969
Irrigation Development Authority	Agriculture	SMCD 85 of 1977
Ghana Water and Sewerage Corporation	Works and Housing	Act 310 of 1965
Volta River Authority	Mines and Energy	Act 46 of 1961
Volta Lake Transport Company	Transport and Communication	Registered under Company Code of 1970
Environmental Protection Agency	Environment, Science and Technology	Act 490 of 1994
Forestry Commission	Lands and Forestry	NRCD 239 of 1974

* Two institutions now merged as Water Research Institute.
Source: Ministry of Works and Housing, Ghana, 1998.

These attempts were sector-specific. Each sector agency managed, controlled and regulated its own activities with respect to water management, with little coordination and control. For example, the Ghana Water and Sewerage Corporation (GWSC), now the Ghana Water Company Limited (GWCL), developed, managed and controlled drinking-water supply and, to a very limited extent, sewerage services; the Volta River Authority uses raw water to produce electricity; the Irrigation Development Authority (IDA) develops and manages irrigation and associated land use for agricultural production; and the Environmental Protection Agency (EPA) concerns itself primarily with the environmental implications of water treatment and usage.

Subsequent water sector reviews identified institutional gaps regarding the coordination and integration of the various sector policies for water use in the country.

Water sector reforms

Since the late 1980s and early 1990s, the water sector in Ghana has undergone various reviews. These reviews enabled the government to undertake a number of reforms. Among which are: 1) a rural water and sanitation strategy based on community ownership and management; 2) the restructuring of the urban water sector to bring in private sector participation in urban water delivery; 3) preparation of the national environmental action plan; and 4) strengthening of water resources information agencies, etc. For example, in the rural water delivery subsector, the Community Water and Sanitation Agency (CWSA) has been established with the mandate to act as a facilitator for the delivery of water and sanitation facilities and hygiene education to rural communities, and to oversee the accelerated provision of potable water and hygienic sanitation facilities in a congenial environment in rural areas. The Ghana Water and Sewerage Corporation (GWSC) has been turned into a limited liability company, Ghana Water Company Limited (GWCL), to facilitate partnership with the private sector in urban water supply.

A major milestone event towards reforming water resources management was the Water Resources Management (WARM) study that was initiated in 1996 and carried out through consultative workshops with the participation of a broad spectrum of stakeholders in the public and private sectors, women's representatives, researchers, media personnel and the general public. The WARM study gives an overview of the major water resources issues. The recommendations presented in "building blocks" reports take a cross-sectoral perspective, identifying common issues and strategies that will promote an integrated approach to water resources management. The findings and recommendations of the WARM study provided the elements to set up an institutional framework for IWRM on a sustainable basis.

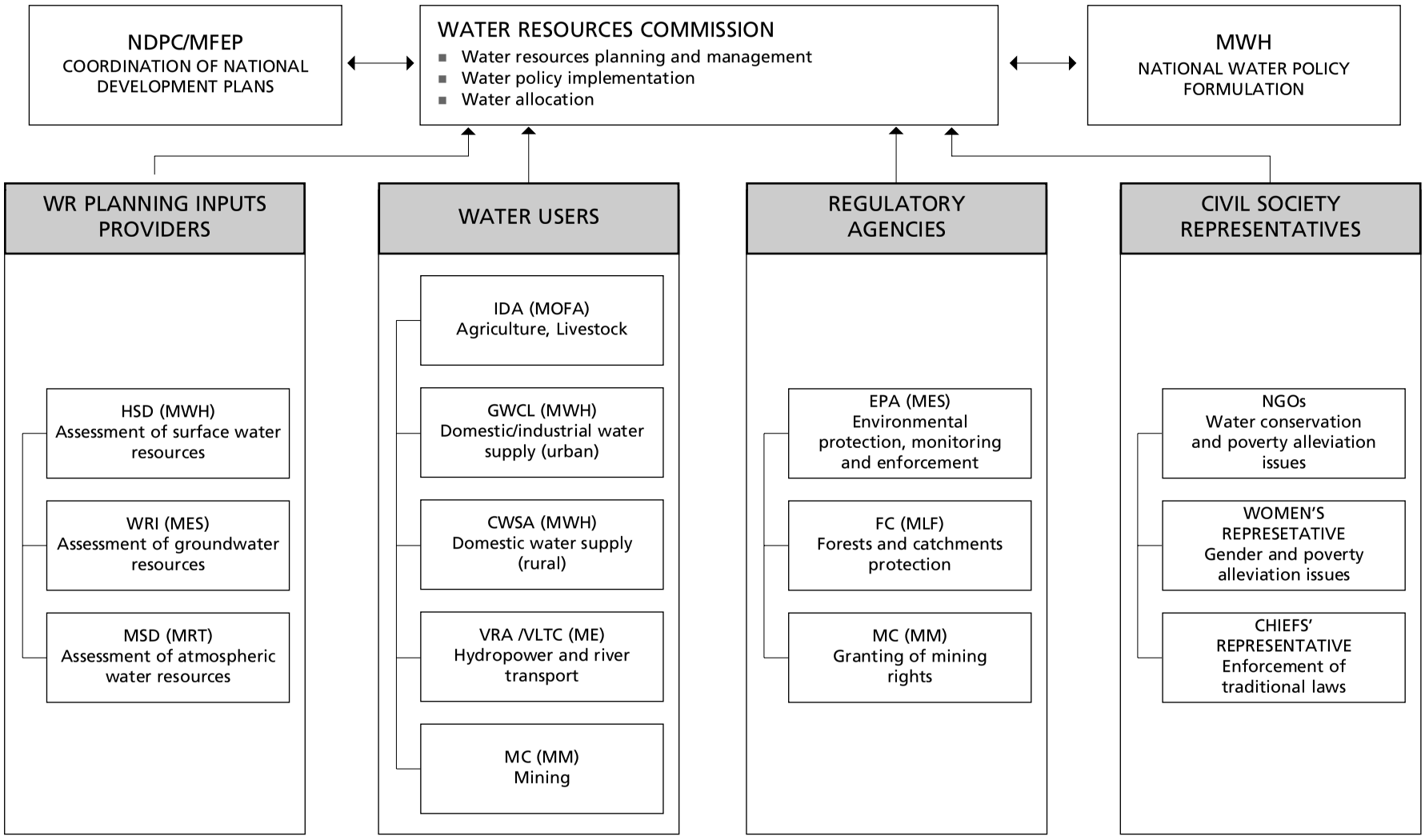
COORDINATION OF WATER RESOURCES MANAGEMENT AND POLICIES AT THE NATIONAL LEVEL

In 1996, a significant step was taken by government to address the diffused state of functions and authority in water resources management and to put them into an integrated form. The Water Resources Commission (WRC) was established by an Act of Parliament (Act 522 of 1996), with the mandate to regulate and manage the country's water resources and coordinate government policies in relation to them. The commission is comprised of the major regulators and users in the water sector, and provides a forum for the integration and balancing of different interests. The composition of WRC is made up of technical representatives of key institutions involved in water utilization and water services delivery, i.e. Hydrological Services, Water Supply, Irrigation Development, Water Research, Environmental Protection, Forestry, and Minerals. Traditional chiefs, NGOs and women are represented in order to take care of civil society interests. The institutional representation and linkages at the strategic level are shown in Figure 2.

At the ministerial level, a Water Directorate is being created at the Ministry of Works and Housing to coordinate policies effectively and monitor donor support in the water sector

FIGURE 2

Institutional framework for IWRM in Ghana



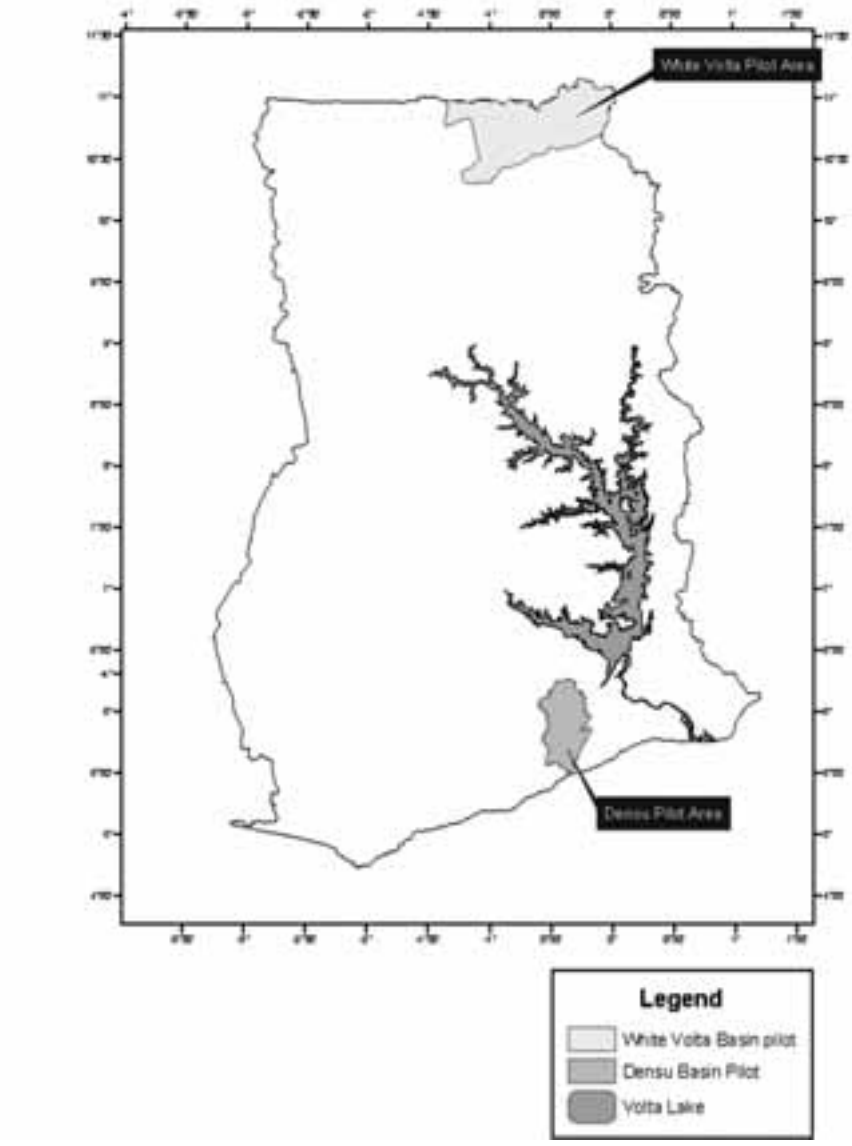
Source: Water Resources Commission, 2000.

STRATEGIES FOR IWRM IMPLEMENTATION

Pilot interventions

Since its establishment, WRC has developed short- and medium-term strategies for the management of water resources in Ghana. As part of these strategies, two river basins have been selected for pilot studies. These are the Densu basin in the south, which is a major source of potable water supply to parts of Accra, the national capital, and the White Volta basin in the north, which is shared with neighbouring Burkina Faso (Figure 3).

FIGURE 3
WRC pilot basins

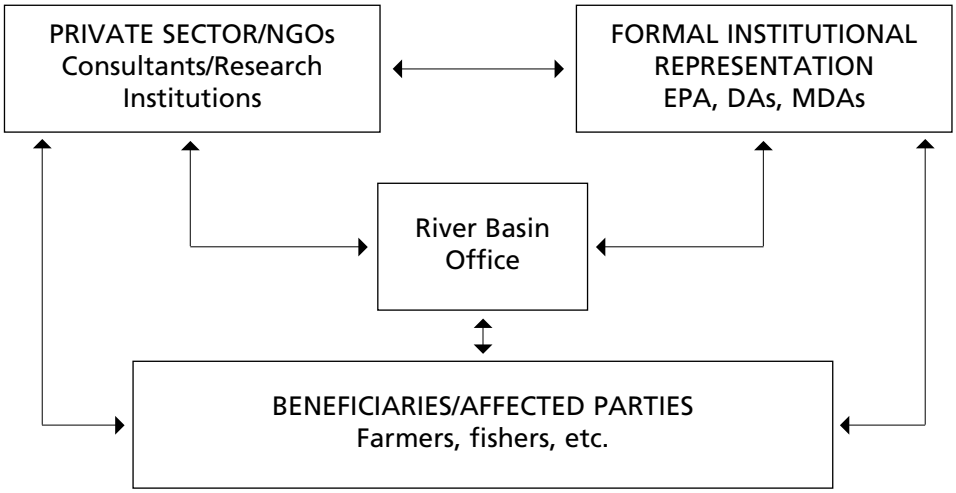


Source: K. Odame-Ababio, 2002.

The main components of the pilot interventions include institutional development and capacity building, coordination of the water sector at the river basin level, participation of stakeholders, regulation of water use, allocation of water resources, and management of international water resources.

Through the pilot interventions, WRC is exploring ways to institutionalize its functions and how most appropriately to use the decentralized local government structure, i.e. the Regional and District Assemblies. Within the districts, a number of planning-related bodies exist, which are being targeted and harnessed as units for IWRM at the river basin level. Institutional linkages at the basin level are shown in Figure 4.

FIGURE 4
Institutional framework at the river basin level



Source: Adapted from Water Resources Commission, 1999.

A Densu Basin Office and a Basin Board have been established after a number of stakeholder consultations and workshops, and will be inaugurated soon.

The framework for the setting up of the White Volta Basin Board was formulated at a workshop held towards the end of 2002. Most of the initiatives on transboundary issues, particularly with Burkina Faso, will be pilot tested in the White Volta Basin.

Institution of water use charge

The cost of managing water resources in the WRC context comprises four elements:

- activities to promote rational use and conservation of water resources;
- maintaining a hydrological database to ensure efficient service delivery;
- strengthening the institutions for IWRM;
- funding research that would be beneficial to the overall management of water resources.

A Water Management Fund (WMF) has been created to cover such expenses. The passage of the Water Use Regulation LI 1692 towards the end of 2001 gave a boost to the sustainable financing of water resources management activities.

The planned income of this fund will come from a raw water charge, a licence fee, an application fee, and penalties and fines for offences as prescribed under LI 1692. The fund has been developed through a number of stakeholder consultative meetings. For an average household, the raw water charge translates to an increase of tariff for potable water supply in the order of about 0.7 percent.

Allocation of water

Water allocation is one of the main tasks of WRC. The commission is in the process of licensing all the major commercial users, such as the mining industry, irrigation schemes, Ghana Water Company Limited and the hydropower industry. The smaller users, such as community groundwater schemes established by the Community Water and Sanitation Agency and managed by the District Assemblies, would normally fall below the threshold to attract the payment of raw water charges, but would be licensed through the registration of the drilling companies. A database of water users is being created using Arcview GIS. In this way, WRC will ensure that the bulk of water abstraction in Ghana will be under licence in order to help in the assessment of the resource, and abstraction charges can be collected to contribute to the implementation and sustainability of IWRM.

A decision support system (DSS)

A major output of the water allocation pilot will be the development of appropriate planning tools, including a decision support system (DSS) for efficient water allocation. The development of the DSS will involve a substantial amount of information collection and storage, hydrological and socio-economic assessments and modelling of future scenarios. A Water Resources Information Systems (WRIS) project has been initiated to improve the capacity of data generation and research institutions for the improvement of data collection networks and assessment techniques. This is being pursued with regard to equipment, processing, storage, retrieval and dissemination in order to improve the adequacy, accuracy and regularity of data.

WRC, with the help of institutions and organizations with relevant expertise, will develop the DSS, which will be tested when implementing the first basin action plan for Densu.

Communication strategy

Public awareness and education campaign plans with different components according to the segments of the public to be addressed have been developed by WRC and are being implemented. A comprehensive communication strategy for the commission is also being developed.

CONCLUSIONS

IWRM implementation is still at its formative stage in Ghana. The creation of WRC in 1996 was a significant step taken by the government to address the diffused state of functions and authority in water resources management in Ghana. WRC is learning from the experiences gained in other places in Africa, and is using pilot studies to develop appropriate tools to ensure sustainable water resources management.

The lessons from pilot studies will be replicated in other river basins in the country, taking account of the differences in industrial development, cultural traditions and natural resources of each river basin. This implies that the approach to planning, monitoring and enforcement will have to be adapted to the actual situation on the ground.

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CHAPTER 14
WATER SECTOR REFORMS IN ZIMBABWE: THE IMPORTANCE OF POLICY AND INSTITUTIONAL COORDINATION ON IMPLEMENTATION

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ACRONYMS

CC	Catchment Councils
COP	Catchment Outline Plans
SADC	Southern African Development Community
SCC	Sub-Catchment Councils
ZINWA	Zimbabwe National Water Authority

Over the past decade, a large number of African countries have undergone or are in the process of implementing water sector reforms. The reforms have generally been driven by international calls for more efficient and sustainable water management approaches. The need for a global water management review has gathered momentum since the United Nations Convention on Sustainable Development – the Earth Summit – held in Rio de Janeiro in 1992.

The modern focus of water management efforts has been to consider the environment as a legitimate user. In the process, efforts towards pollution control have intensified, with the "user pays" principle being adopted by many countries. Water management functions have also been decentralized to the catchment or watershed scale where stakeholders have a larger say in the management of water in their own areas. Ghana, Zimbabwe, South Africa, Zambia, Swaziland, Malawi, Uganda, Kenya and the United Republic of Tanzania are typical examples of African countries where water sector reforms are being implemented. The formation of basin commissions, as evidenced by river basin commissions in the Southern African Development Community (SADC), is also in line with a watershed approach to water management that is involving all riparian countries.

One way of promoting more efficient and sustainable utilization of water is through stakeholder involvement in water management at the catchment scale. The idea behind this approach is to enhance greater participation at the catchment level, thereby increasing the sense of ownership among users and promoting sustainable and efficient use and environmental protection.

WATER SECTOR REFORMS IN ZIMBABWE

Two different processes drove the water sector reforms of 1994 in Zimbabwe (Pazvakavambwa, 2002), ahead of other sub-Saharan countries in Africa. The first factor was the general global concern pressing for a more efficient and sustainable approach to water management.

The second factor was water legislation that was perceived to be inconsistent with present trends in Zimbabwe. More water users were applying for water rights, yet the existing legislation was not sufficiently flexible to accommodate more players. This was evident in highly committed areas, where almost all available water had already been allocated and therefore new users could not be accommodated. The 1976 Water Act was intended to protect the interests of commercial farmers, but these constituted less than 1 percent of the country's population of 13 million (Manzungu, 2002).

WATER LEGISLATION IN ZIMBABWE

The Water Act governs the use of water in Zimbabwe. Until the recent revision of the Water Act (1998), the prevailing act was the Water Act of 1976. In general, the Water Act of 1976 was a good piece of legislation that brought any form of water use under control and aimed at the systematic allocation of water among users. According to the act, anyone was entitled to access to water, as long as the water was for primary use (basic human sustenance). Any use of water from which the user would derive a benefit was deemed commercial use, and required a water right. All water rights were issued in Harare by the Water Court, which was based at the Administrative Court of Zimbabwe.

The following were the main weaknesses of the Water Act (1976):

- The issue of all water rights was centralized at the Water Court in Harare.
- A water right was issued in perpetuity on a first-come-first-served basis. This meant that when water resources were fully allocated, no further water rights would be issued, regardless of the need.
- In the event of water shortage, the process of reallocation was very long and complex.
- A water right would not be revised, even if the right holder was not exercising his or her water rights. The water rights could only be revised if the holder volunteered to do so.
- The process of acquiring a water right was very long. Once granted, there was no requirement to pay for the possession of the water right or to contribute towards general water service provision.
- The act was silent on water quality and factors relating to the environment.
- There was little consideration given to groundwater supplies. The Secretary of Water had to be informed if a deep borehole was drilled, but there was no control on the amounts of groundwater pumped, or the number and spacing of such boreholes.

The Water Act (1976) was amended several times, and global modern trends pushed for a review of existing approaches to water management in Zimbabwe. This led to the complete overhaul of the Water Act (1976), which was replaced with the Water Act (1998), conforming to global trends and addressing pressing national issues.

The Water Act (1998)

The Water Act (1998) was signed into law after considerable consultation with stakeholders. The new act is founded on economic efficiency, environmental sustainability and equity of use. The following are its main features:

- Water rights have been replaced with water use permits. The permits are issued for a limited period and can only be renewed subject to water availability and evidence of efficient use.
- The priority principle has been done away with.
- Water can no longer be privately owned.
- Water is to be viewed from the complete hydrological perspective, i.e. groundwater and surface water are treated as part of one hydrological system.
- Stakeholder-driven institutions have been formed that will have more say on water allocation and general water management on a day-to-day basis.
- There is greater consideration of the environment, with environmental water use now recognized as a legitimate user.
- There is more control over pollution, with the "polluter pays" principle being introduced.

Water management has been decentralized to stakeholder-managed Catchment Councils (CCs) and Sub-Catchment Councils (SCCs). Under the present arrangements, a new framework for water management has been formed to:

- involve stakeholders in water management;
- replace water rights with water permits, which expire after a set period;
- create more efficient water allocation processes;
- develop catchment water use plans, with the full participation of stakeholders;
- treat the environment as a legitimate user;
- form new stakeholder-driven institutions to facilitate more efficient water management.

As a result of these developments, CCs and SCCs were formed as key institutions to manage water affairs on the ground on a day-to-day basis. The Zimbabwe National Water Authority (ZINWA) was formed with the primary role of taking over the commercial functions of the Department of Water Development.

Summary of institutions formed

ZINWA was formed to provide water services on a commercial basis. All fees charged for commercial water services are retained by the water authority for the provision of water services. Services of a statutory nature, provided by ZINWA, will be funded through the Water Fund, as directed by the minister responsible for water.

CCs were established for the management of the seven demarcated catchment areas in Zimbabwe. A CC consists of representatives of lower-level catchment management institutions.

The main responsibilities of CCs are to:
- prepare a catchment management plan, in consultation with the stakeholders, for the river system;

- grant permits for water use;
- regulate and supervise water use;
- supervise the performance of SCCs;
- resolve conflicts within their areas of jurisdiction.

SCCs were formed to facilitate water management on a smaller scale. SCCs consist of representatives of the various water users within the sub-catchment. Representatives from each SCC form the CC, thereby representing their constituents at the sub-catchment scale.

The main functions of SCCs are to:
- regulate and supervise the implementation of permits, including groundwater use;
- monitor water flows and use, in accordance with allocations by the CC;
- provide representatives for the CC;
- promote catchment protection;
- monitor water discharge;
- assist in data collection and participate in catchment planning;
- collect rates and fees for all permits issued.

The Water Act (1998) has also paved the way for better institutional coordination to facilitate more efficient water management. For instance, approval from several institutions is a prerequisite before a water permit can be issued.

The theory behind the Water Act (1998) is commendable, however, when transformed to the reality on the ground, the practice is not always so successful.

Why have water sector reforms not performed as expected?

While the framework for a perfect water management system exists, the situation on the ground does not reflect this common belief. The reform process has not taken off as expected owing to a combination of factors ranging from conflicting policies and weak institutional linkages, to insufficient funding. The reasons given in the following subsections help to explain why a properly developed legal framework can only function with the support of other critical pillars, such as technical and institutional support.

Donor withdrawal: The water sector reforms in Zimbabwe were largely donor-driven. Several donors pledged to support the reform process. This was very positive, considering that a particular donor would be supporting at most two catchments. There was therefore an opportunity for maximum interaction between the donor organizations and the beneficiary catchments.

However, by the time the CCs were to be fully launched, only one donor remained available to support two of the seven catchments, and that donor was in the process of withdrawing its support. A number of stakeholders began to lose confidence in the whole reform process, and they too began to pull out.

CCs were not yet financially self-sufficient, and this sudden withdrawal of donor support in both financial and technical areas was unexpected.

Without a good financial base, CC activities were doomed to fail, with participation restricted to voluntary work. Volunteers tended to be those who had already established themselves in water management, and therefore had interests to protect. Representation therefore continued to be skewed.

Other national programmes: The launching of the water reform process coincided with the land reform process in Zimbabwe. The water sector reforms were aimed at promoting equitable and sustainable utilization with more participation of stakeholders and the introduction of the user pays principle. The land reform programme aimed to redistribute land and to encourage greater utilization of the national land resource. On paper, these two policies complemented each other.

There was a great amount of movement, especially in the commercial sector, with established farmers moving away and new farmers coming in. This process happened so quickly that the water sector lost track of who was utilizing water. The problems were more complex in cases where there were more settlers on a property for which a permit had previously been issued to one user. The reallocation of such a permit to more users resulted in many conflicts. Moreover, new settlers were more interested in consolidating their claim to the new properties than in attending water management meetings. Water issues were therefore thrown aside as the land reform exercise attracted greater attention.

Financial stability: The water sector reforms intended to implement the user pays and polluter pays principles. In this respect, permit holders would pay a fee, which was to contribute to water services provision. The Water Fund was created through the Water Act (1998) to facilitate the collection of levies, fees, government contributions and any other support towards water service provision. This was to be deposited into a common pool from where the minister would identify areas of greatest need for the benefit of the water sector. The government would also contribute to the Water Fund, using public funds allocated from the main government budget. The Water Fund had a potential to realize substantial revenue to be used to improve the provision of water services, as directed by the minister responsible for the provision and management of water.

Inflows into the Water Fund have been minimal, with a contributing factor being the cessation of donor contributions. Unease ensued, resulting in many established farmers not paying for their permits, as they were uncertain as to their continuing occupancy on their land with respect to the new land reforms. Increased government responsibilities meant that less and less money was allocated to the Water Fund from the national budget. Similarly, new farmers were reluctant to pay for water use, as water rights had not been paid for previously. Most of the new commercial water users believed that water is a God-given resource, and therefore there is no need to pay for access to it.

The diminishing sources of contributions into the Water Fund therefore meant that there was very little money available to support water service provision and management.

Weak institutional linkages: The new Water Act provided a better framework for stronger institutional linkages. It is now a requirement that a number of institutions be consulted before permits for water use can be issued. However, there is little evidence to prove that this is bearing fruit. Not all institutions give priority to water issues. Some continue with their

previous approach to water management where their support cannot be fully guaranteed unless they are certain of deriving substantial and direct benefits from their participation.

Lack of capacity within key institutions: Key institutions, especially ZINWA, are not adequately staffed to cope with the sudden demands for the provision of expert services. The staffing levels of ZINWA fall short of expected levels, as does the level of expertise. The result is that ZINWA cannot provide sufficient personnel to provide commercial services, nor can it provide statutory functions with funding sourced from the Water Fund. With staffing levels inadequate and depth of expertise questionable, it is uncertain if sufficient funds from the Water Fund would have made much difference to this situation.

Other key institutions, such as the Department of Natural Resources, Agricultural Research and Extension Services (AREX), the Ministry of Water and Rural Development and the Ministry of Lands and Resettlement, are also experiencing inadequate staffing levels that have a negative impact on the whole process.

Remuneration for participants: CC and SCC representatives have not been paid directly for their input into water affairs. They were only compensated for travel and subsistence. When finances became scarce, the frequency of meetings was reduced, and user groups were merged to cut down on expenses. This meant that stakeholders could not meet as often as was desirable to discuss water management issues. This new approach was designed to cut down costs, however, consideration was not given to the main objective of providing more efficient water management at the catchment level.

Lack of enforcement of legislation: The new Water Act has been described as technically sound with a solid base for sustainable and efficient utilization of water resources. However, some vital sections of the act have not been fully enforced, hence, its founding principles cannot be supported. The Water Fund is collecting insufficient revenue adequately to support statutory functions. ZINWA is not financially viable, as the four main accounts that were created (raw water account, clear water account, engineering services account and water levy account) are not self-sustaining, hence the new institution has to rely on the government for financial support. In the process, key and experienced staff have left the organization owing to the working environment.

Similarly, Catchment Outline Plans (COPs) have not been developed in accordance with Section 12 of the Water Act (1998). COPs are to be developed by stakeholders, and should serve as a guide on water management within their catchment areas, as well as on the interventions to take in the event of scarcity, and therefore excess demand. Water quality issues and environmental aspects are also covered in the COPs. The reasons for non-development of the COPs range from a lack of capacity for their development, financial constraints and general lack of coordination among stakeholders.

In the meantime, water permits cannot be issued in the absence of approved plans, and the objectives of the reform process cannot be fully realized.

Different levels of appreciation of water: Water management representatives are from local authorities, industry, commercial farmers, communal farmers and other interested parties. While all representatives were expected to sit at the same table to discuss water affairs, it was

clear that the priority of each group was to protect its own interests. Communal farmers were the weakest and most disadvantaged sector, with the least appreciation of water for commercial use. They were not given equal access to the resource, despite management being conducted through SCCs, which were believed to involve such vulnerable user groups.

Political interference: Politics always plays a role in the success or failure of any process. In this case, there was a marked political influence in the pricing of water. In a bid to retain popularity, politicians aimed to keep the price of water as low as possible. Politicians frustrated the implementation of the pricing policy, which cannot afford to subsidize water service provision to maintain standards in good water service delivery. Defaulters of payments for water permits were protected against disconnection through the political influence of politicians. Political influence is also a factor in project choice and implementation where development is driven by political balance rather than economics. It has been noted by Shwatuk (2002) that the government was adding to its expenditure on military interventions in other countries when there were no public funds available for reticulation and sanitation systems.

LESSONS LEARNED THAT COULD BENEFIT OTHER COUNTRIES

A recommendation is made that those countries that have still to implement water sector reforms – and therefore meaningful watershed management systems – fully learn from the Zimbabwean experience. The following issues are of major interest:

- Stakeholders will have different agendas, and it will take time for them to sit down to develop a management plan openly and honestly.
- Financially powerful stakeholders will always want to dominate the process, while protecting their own interests.
- Political influence should always be kept at minimum levels.
- Management systems that are financed from stakeholder involvement are more likely to succeed than externally supported programmes.
- Implementation of reforms should not take too much time, as problems will be experienced, no matter how much time was put into preparation.
- Reforms are costly and time-consuming. Stakeholders will need to be convinced of the immediate and long-term benefits of their participation before they fully commit themselves to the process.

CONCLUSION AND RECOMMENDATIONS

The water sector reforms in Zimbabwe were initiated to deal with an increasingly complex and unsustainable water management structure. Global momentum was also pressing for change in the general approaches towards watershed management, especially in sub-Saharan Africa. The Water Act (1998) in Zimbabwe provided an excellent framework for good and sustainable watershed management where all major stakeholders were given an opportunity for input. However, without sound technical, financial and political backing, any good policy or legislation will prove difficult to implement. The introduction of conflicting policies has proved to be detrimental and retrogressive, as evidenced by the land reform process, which despite possible good intentions has created greater confusion in water management circles.

Such setbacks imply that it would take much longer to realize set targets within the water sector. Population pressure and an increase in commercial activities will increase the demand for water use, hence creating a potential for more conflicts and more stakeholder interest.

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CHAPTER 15
WATER EROSION AND SILTING IN THE NIGER RIVER BASIN IN THE CONTEXT OF WATERSHED MANAGEMENT

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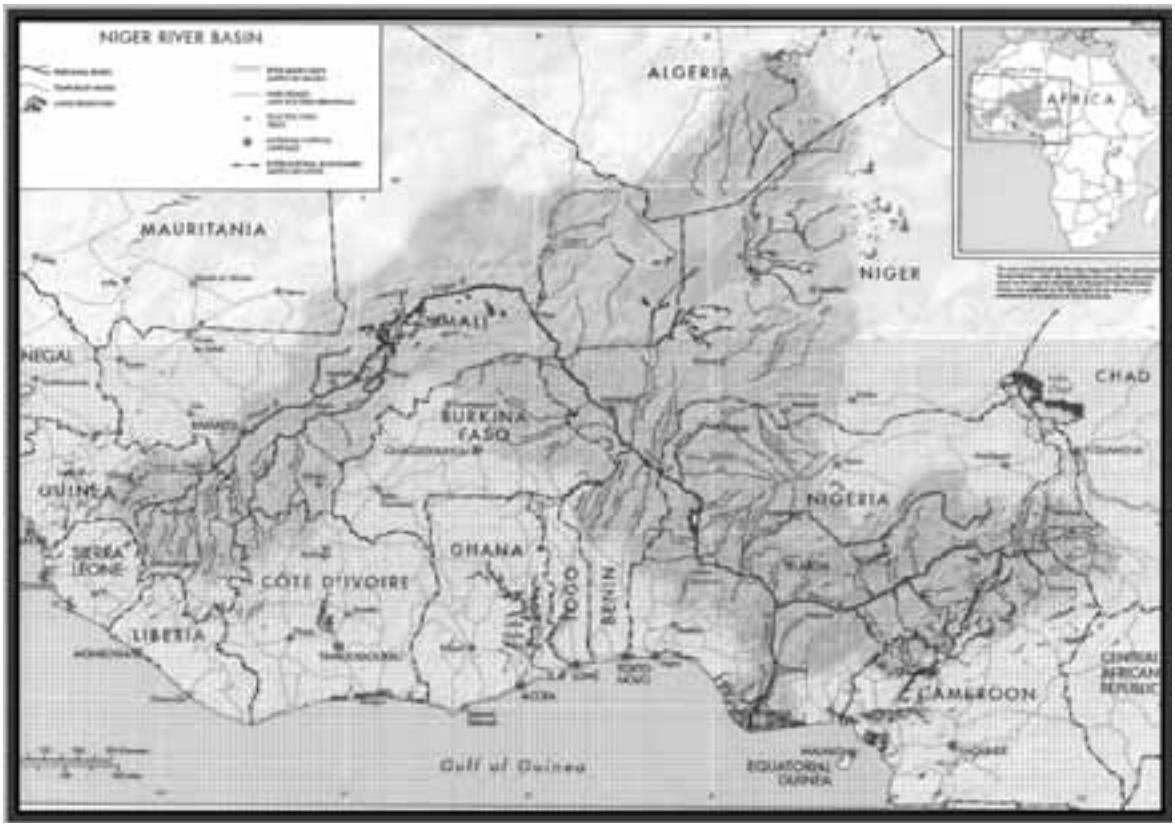
Located in the heart of West Africa, the Niger River basin is an important asset for the nine ABN countries (Bénin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, the Niger, Nigeria and Chad). Niger water is essential for ecosystems, life and socio-economic development.

The Niger is the third longer river in Africa (4 200 km²: see Figure 1). With a total surface of 2.2 million km², its basin is the ninth largest in the world. Moreover, the Niger is an important linkage between West and Central Africa and among the nine ABN countries, some of which are among the poorest in the world.

FIGURE 1
Map of the Niger River basin



The Niger River crosses four climatic zones (humid tropical, dry tropical, semi-arid and arid zones). Ranging from 4 000 mm in the Guinea Gulf to 200 mm in the Sahel, rainfall is very variable in time and space. The basin is affected by a widespread environmental degradation process and by a deterioration of the natural resource base. Major environmental threats include: unsustainable agricultural and ranching practices; bush fires and deforestation; pollution from different sources; water and aeolian erosion of rangelands; silting of water courses; and the proliferation of aquatic plants (water hyacinth, water lettuce, etc.).

Land degradation is a major threat for land productivity and food production. This process affects the whole basin, but the Sahelian part (corresponding to the mid-watershed) is severely affected. The local fragile ecosystem is exposed to intense desertification, soil erosion and silting of water courses. Climate aridification and sediment decrease, which are associated with an increasing demand for agricultural land, have significantly contributed to the destruction of vegetation cover. Stream flow and ecosystems are seriously threatened, as well as socio-economic activities.

The combatting of hydrological erosion and silting is a major political, economic, social and environmental issue and major justification for this programme. The initiative is expected to develop in two phases: the five-year first phase focuses on the mid-Niger watershed, corresponding to the northern Niger, stretch, and the right bank upstream from Nyamey (Burkina Faso, Mali, the Niger).

This paper presents the programme, and in particular its approach, and political and institutional arrangements for integrated management of the Niger River basin.

The general long-term objectives of the programme are to protect the natural resources of the basin and to conserve its hydrological potential in order to foster development, decrease food insecurity and poverty and preserve local ecosystems. Specific objectives for phase 1 are as follows:

1. to strengthen the institutional capacity at the subregional and national levels in collaborative management of basin shared resources;
2. to alleviate the effects of desertification and to slow down the silting process;
3. to assist national governments in developing programmes against hydraulic erosion and in raising funds;
4. to promote participation and involvement of affected local populations and communities.

The programme was conceived as a response to the urgent need for scale actions against silting.

Natural resource degradation in the basin is largely caused by human factors; the programme adopts a participatory, gender sensitive approach, aimed at strengthening local stakeholders' responsibility and at involving them in rehabilitation actions.

The programme includes a regional component working at the basin level and three national components working with each of the concerned countries.

The regional component aims at strengthening ABN at the regional and national levels. It includes two sub-components: development of an operational framework for combatting

siltation; and institutional strengthening of ABN and ABN member state watershed management agencies. This component is expected to consolidate capacity in designing, coordinating, implementing, monitoring and evaluating watershed management activities. It also includes the development and implementation of a capacity building programme, targeting ABN member state officers; the creation of a research and development network; the systematization and diffusion of results achieved; and the operation of a programme management and coordination unit.

Programme national components focus on priority actions in environmental protection and combatting siltation in Burkina Faso, Mali and the Niger. These national components are of special interest because they are geographically closer to the intervention sites and play a significant role in developing inter-governmental collaboration. They were designed as investment projects. The three national components share common development objectives, but each of them enjoys a significant degree of autonomy. Their activities are based on the participatory approach and aim at raising the awareness and commitment of local stakeholders in different stages of the implementation process. Each national component includes actions aimed at:

- supporting the implementation of the programme's action plans for hydraulic erosion control, combatting siltation and reclaiming agroforestry and rangeland;
- strenghtening local populations' and stakeholders' technical, organizational and financial capacity to ensure ownership and sustainability of watershed management works;
- implementing a monitoring and evaluation system at different levels and a "light" and autonomous coordination body.

The programme is expected to have multiple impacts, including dune stabilization in 3 000 to 5 000 ha, management/protection works on rangeland and catchments, agroforestry rehabilitation of 13 500 ha of degraded land, enhancement of watershed management capacity among local institutions and people, and institutional strengthening of ABN.

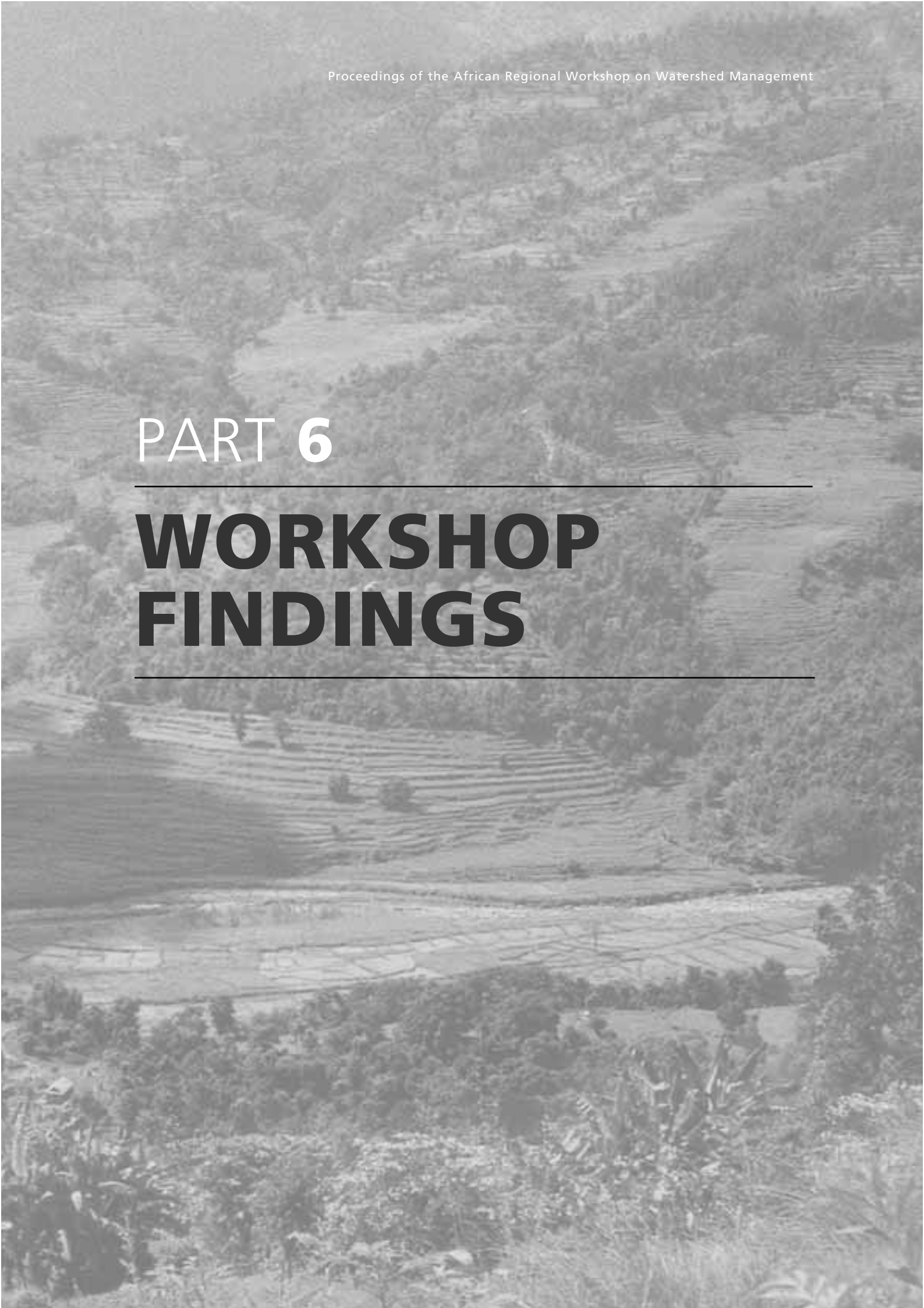
Other expected results include: development of a toolkit for identification, planning, coordination and monitoring and evaluation; creation of a management plan for hydraulic erosion protection and combat against siltation; improvement of agroforestry and range management systems; sustainable use of natural resources; rehabilitation of stream flow and ecosystems; enhancement of food security and livelihoods of local people; income generation and diversification; rural employment; and women's empowerment (through vegetable production in irrigated gardens, other income-generating activities and literacy).

The implementation strategy is based on the following:

- twofold intervention in policy implementation (inter-regional component) and field programmes (national components);
- awareness raising on soil degradation and siltation risks and processes, in society at large;
- participatory approach and local capacity building;
- collaborative research and collaborative management;
- development of subregional and national expertise.

The programme is being implemented in coordination with a GEF project on rehabilitation of the Niger River basin. Important synergies exist between the two initiatives.

A regional committee and national committees in each country supervise the programme. Implementation of field action is being entrusted to local collaborative management bodies. The programme is in the process of developing a monitoring and evaluation system focusing on both performance and outcomes. This will provide information useful for project management and reporting to donors. The project also aims at developing human capital, through learning activities, facilitated by experienced trainers. Human capital development will be extended to focus in particular on local men and women with the aim of incorporating gender issues in watershed management.



PART 6

WORKSHOP FINDINGS

CHAPTER 16
CONCLUSIONS OF WORKING GROUPS

WORKING GROUP 1: UPLAND–LOWLAND LINKAGES

Working group 1 investigated the interactions between uplands and lowlands in watersheds, and the way in which these are addressed in watershed management programmes. It reviewed the current state of knowledge, existing approaches and techniques, and conflicts between interest groups and policies, and for each of these it analysed gaps and lessons learned. Special attention was given to the issues of scale and water quality. The group drafted recommendations for better understanding and integration of upstream–downstream linkages in watershed management programmes.

Knowledge

There is a serious lack of understanding of the processes of upland–lowland linkages, mainly because of the complexity of these processes, the large variety of local situations and the difficulty in generalizing findings. Appropriate tools to improve knowledge are not available, and when results are available within the research community, it is difficult to transfer these to decision-makers, planners and other stakeholders. Knowledge transfer and exchange between practitioners from developed and developing countries and among specialists from developing countries is also a limitation.

Some lessons have been learned from past experience in managing knowledge of upstream–downstream relations. First, there is a need to recognize the critical role of communication, extension and education in conveying the right messages to all stakeholders in watershed management. A good understanding of the processes, based on local experience and solid science, is needed to ensure successful planning. In this respect, the possibility to exchange experiences and expertise enhances the capacity to understand and plan at all levels. Proper linkages between researchers and practitioners from developed and developing countries are crucial.

Approaches and techniques

Watershed management programmes suffer from focusing too much on short-term interventions. There is often confusion about the objectives and intended beneficiaries, resulting in projects that try unsuccessfully to address both upstream and downstream objectives in an unbalanced way. Clarity in stating the objectives of the programmes and linking the planned interventions to these objectives can only be beneficial.

While watershed management programmes have evolved considerably over past decades, there are still cases where not enough attention is given to the populations of watersheds, resulting in the introduction of unsustainable practices. Only when populations are associated to watershed management planning and implementation, and when they can understand the

short- and long-term benefits for themselves of the proposed actions can sustainable watershed management approaches be developed. The same applies to water: only a comprehensive approach to water-related problems within a watershed can bear successful results. However, there is a need to recognize that water-centred and people-centred approaches are not always compatible in watershed management programmes, and the two objectives may need to be addressed in different ways. If farmers in watersheds are requested to modify the way they use their land for the sake of water protection, there need to be clear incentives for them to do so. In order to succeed, people-centred watershed management programmes must always focus on income and productivity.

Lessons from past experiences have shown that watershed management programmes must be comprehensive and involve all stakeholders. Project failures are due in large part to the application of top-down approaches and rigid principles that are not adapted to local conditions. The excessive emphasis on short-term visions for watershed management programmes is also a cause of failure. The absence of water rights and land property rights has been identified as a major constraint to the successful application of programmes for upstream–downstream linkages. There is also a need to link biophysical and socio-economic considerations in planning for watershed management programmes.

Conflicts among interest groups

The working group identified conflict among interest groups as one of the main issues in addressing upstream–downstream linkages in watersheds. The lack of appropriate institutional mechanisms to promote negotiation among interest groups within a watershed is often the first cause of misunderstanding and incomprehension among these groups. Another key issue is the groups' own lack of understanding of the implications of their behaviour, particularly in terms of its water-related impacts. In addition to the problem of institutional set-up, it is notable that the legislative framework in which upstream–downstream negotiations or collaboration could take place is usually absent. In most cases, land tenure is not well defined, which has serious consequences for any long-term intervention within the watershed. Depending on the geographical expanse of the watershed, there are also logistical problems in attempting to involve all stakeholders in watershed management programmes, with consequences for the level of engagement and participation in watershed management programmes by local communities.

Several mechanisms exist to overcome some of the problems related to conflicts among interest groups in watersheds. They are diverse, and their applicability varies from place to place. In some cases, appropriate legislation and regulations can go a long way in improving the sustainability of land management within watersheds. In others, local agreements between farmers in watersheds and water users downstream may prove useful. In other cases, particularly in Latin America, payment schemes for water-related services have been initiated. While it is still too early in most cases to evaluate the sustainability of such agreements, they are a promising approach and deserve to be monitored closely.

In working to improve relations among interest groups, all efforts should be made to rely on existing local structures and institutions. Where water users' associations exist, they can play a leading role in establishing a platform for negotiations between upstream and downstream communities.

Policies

While the research and practitioner community struggles to improve its understanding of the processes involved in upstream–downstream relations in watersheds, the little that is known of these interactions is not conveyed to policy-makers in an appropriate format. Policy-makers have difficulties in accepting the high level of uncertainty associated with watershed processes, and usually rely on simple, straightforward models, often with misconceptions about these processes. As a result, watershed-related investments are often based on wrong assumptions, resulting in poor or inexistent results. Part of the fault lies with professionals who do not see the importance of clarifying their findings and conveying them to policy-makers in a format that they can use in their decision-making processes. Enhanced interactions between politicians and practitioners are necessary to fill the knowledge gap on upstream–downstream linkages and improve the way in which policies are developed and applied.

Another classical problem arises from the sectoral nature of policies, in particular those related to land use, agriculture, irrigation and forestry, which leads to conflicting approaches to land management. In addition, the development agenda in poor countries is often driven by considerations dictated by developed countries, with little or no regard for the specific needs. There is little scope for decision-makers from developing countries to exchange their experience and approaches on watershed and related policies.

Scale issues

The group identified scale as one of the most important factors influencing upstream–downstream relations. A lack of clarity about the scale and possible impact of a given intervention is often the cause of inadequate policies and programmes, as most processes are highly scale-dependent. Countries are often confronted with problems arising from the upscaling of successful approaches and the lack of perception of the impact of local actions at larger scales. As a result, many programmes do not achieve expected outcomes because they lack upscaling mechanisms, while both technocrats and policy-makers do not appreciate the scale issue.

Water quality

Issues related to water quality have been discussed in the context of sub-Saharan Africa. While the problems of pollution are relatively limited in extension, they still represent a real threat in specific cases. In particular, the group considers that the impact of horticulture or other intensive agriculture on water quality is not properly understood, and there is a lack of standards and regulations for water quality management in intensive agriculture. A better understanding of the role of forests and how they affect water quality is also needed; it was recognized that well-managed watersheds can contribute substantially to improve the quality of water in watersheds and downstream.

Recommendations

In order to overcome the shortcomings related to knowledge, it is recommended that countries and institutions develop comprehensive training programmes at all levels on upstream–downstream interactions, and promote research in contentious issues, particularly the role of trees in water protection; that appropriate networks be developed to facilitate exchange of knowledge and information; and that watershed management programmes systematically include components on communication and education of stakeholders.

On the technical side, it is recommended that watershed management programmes be planned with a medium- to long-term vision and that they involve all stakeholders in an appropriate manner. Programmes should be comprehensive and flexible, so that they adapt to local conditions, and should link biophysical and socio-economic considerations. The watershed context should be used to set up sound development projects and programmes.

Watershed management is an ideal tool to enhance and improve interactions among interest groups within watersheds. Potential mechanisms to link these groups should be systematically explored and tested in order to reduce conflict and enhance collaboration. Such mechanisms should involve all relevant stakeholders in a practical way, and rely on improved institutional, legal and technical capacities. There is a need for wider dissemination of the existing tools to address conflict resolution in watersheds.

In terms of policies, watershed management programmes must be designed within the framework of country-specific poverty reduction and rural development strategies, clearly showing the integration between these programmes and high-level strategies. The exchange of knowledge and experiences in watershed management among countries should be facilitated, and countries and their financial partners should set up policies for the long-term funding of watershed management programmes. A better perception of land–water linkages within watersheds should be promoted, in particular among decision-makers. The role of the research community is crucial in providing decision-makers with clear and straightforward messages that capture the complexity of the processes, while providing them with opportunities for direct investment in the sector. A better linkage between science and policy is required. Renewed efforts should be made to address better the question of upscaling strategies in watershed management programmes.

With regard to water quality, there is a need to improve understanding and reporting on the extent of the problem, raise awareness about the possible impacts of intensive agriculture (particularly horticulture) on water quality and health, develop comprehensive strategies for water quality management in watersheds, and develop knowledge about the effects of forests on hydrological processes and water quality.

WORKING GROUP 2: POLICY AND INSTITUTIONS IN THE CONTEXT OF INTEGRATED WATERSHED MANAGEMENT

Over the last 20 years there have been some useful changes in national and transnational policies and institutions that affect watershed management. Most African countries have adopted new policies and laws on water and the environment that create useful legal foundations and

institutional frameworks for improved watershed management. There have also been some limited efforts to establish transnational agencies to deal with the continent's many transnational river basins. Successful implementation of new national laws and institutions is limited, however, by lack of information and resources. To some extent, watershed management is being affected by the same challenges that affect other aspects of governance in Africa, especially the challenges associated with decentralization and limited resources. Achievements and failures in transnational watershed management are shaped by the overall political context of inter-country relations. The working group noted achievements and gaps in a number of these key areas and articulated recommendations that can help to redress the situation.

Water policies and watershed management institutions

Since the mid-1990s, most African countries have adopted water policies and water acts that define the roles of various stakeholders in integrated water management. Most of the new water acts provide for new multi-layer water management institutions and greater recognition of water rights, human reserves and ecological reserves. Some local organizations are aware of the provisions of these acts. Most African countries have also enacted new legislation for environmental management and have established new institutions to implement that legislation. Negotiation platforms for shared resource use and management have emerged in some places.

However, the implementation of new institutional arrangements remains incomplete in most countries because of lack of funding, inadequate human resources, and inadequate involvement of local organizations and communities. Legal authority, rights to resource use and the responsibilities of different stakeholders are not clearly spelled out in some of the new laws. National water and watershed policies and laws tend to be sectoral, while effective watershed management requires multisectoral coordination.

Decentralization and involvement of local organizations

In some countries, there has been effective political decentralization, including decentralization of watershed management. Communities in some pilot implementation areas have become more involved in watershed and water resource management. However, it is important to recognize that managing decentralization is a long-term, complicated and inherently political process. In practice, it has proved to be easier to devolve powers to lower units of government and user groups than to ensure that these units have the capabilities, values, incentives and accountability necessary to fulfil their new functions.

There is now greater recognition of the needs, including water needs, of disadvantaged groups living in rural and urban areas (especially women, the elderly and youth). This has come about partly because of the poverty reduction planning processes that have been implemented in many African countries. In practice, however, local elite groups often dominate devolution processes, while many poorer resource users remain unfamiliar with their rights to obtain access to and utilize resources. Efforts to raise awareness among disadvantaged communities tend to be very partial and ad hoc.

Transnational water resource management

Africa has more transboundary river basins than any other region of the world. In the past, this has mostly been a constraint to investment, management and development. In the future, however, this constraint could be turned to advantage, with the possibility of joint management yielding a variety of social, economic and ecological benefits. Across the African continent there are a number of promising initiatives in improved transboundary basin management. These initiatives need to be greatly enhanced and sustained.

The working group noted the following transnational partnerships in different parts of Africa: the Nile Basin Initiative, the Lake Victoria Development Programme of the East African Community (EAC), Nkomati River Basin Agreement (Swaziland, Mozambique, South Africa), and the Niger Basin Authority. There are also some new transnational projects that have injected additional momentum to these initiatives, such as the Lake Victoria Environment Management Programme. In addition, there have also been some useful efforts to promote international networking on water and watershed management issues, such as WaterNet, SearNet, and the Network of Peasant Farmers' and Agricultural Producers' Organizations of West Africa (ROPPA –Réseau des organisations paysannes et de producteurs de l'Afrique de l'Ouest). There is potential to learn from successful cases of international cooperation and networking. However, there are still gaps in sustained finance for transboundary watershed management. Greater coordination is needed among countries and donors.

Information and knowledge base for improved watershed management

Effective watershed management at all levels is constrained by the poor information base and poor understanding of watershed management principles and practices. The general public and civil society organizations have not been very actively involved in watershed management programmes, in part because of low general awareness and concern for water and environmental challenges. Very few data have been compiled on watershed management programmes across the continent.

Investment

Too few resources are available for effective watershed management at all scales. Additional public resources are needed, especially at the transnational and basin levels. In addition, all countries need to understand better how to create regulatory and institutional environments that will attract additional private sector investment and participation.

Recommendations

National policies: National governments should review and harmonize the sectoral policies that affect water and watershed management within their countries (e.g. water, environment, agriculture, industry, administration, national planning). Harmonization of policies needs to recognize and address the uniqueness of watersheds and the challenges of watershed management (cultural values, hydrology, climate, geology, size/area, etc.). There is a need for

innovation of new policies that will provide new sources of finance to support watershed management for the range of situations found across Africa.

National institutions: The resource and information base of the institutions that are mandated to implement watershed management should be strengthened. Watershed resource management regimes need to be built up from local organizations to sub-watershed, watershed and basin management agencies, and watershed management councils and authorities need to go beyond water allocation to address watershed resource conservation and enhancement. There is also need for integrated planning and financing for water storage and supply, and watershed management that links local interests and concerns from water quality to conservation. Resources and finance need to be committed for the long periods that are necessary for effective watershed management.

Transnational institutions: National water laws need to be harmonized among countries sharing transnational basins and water sources.

Networking and information sharing: The flow of communication and awareness creation among stakeholders needs to be increased at all levels regarding policy and institutional requirements for effective watershed management. National-, regional- and continental-level watershed management networks need to be established and strengthened. Data and information about watershed resources should be collected more systematically and disseminated more transparently to concerned stakeholders. Data collection should be made a central responsibility of water management authorities/agencies at all levels, from the sub-basin to the transnational basin.

WORKING GROUP 3: WATERSHED MANAGEMENT EXPERIENCES: LESSONS LEARNED AND THE WAY FORWARD

Environmental services of watersheds: who should pay what?

A sufficient supply of clean water is a basic requirement for sustainable watershed management. Agriculture and industry must take into account upstream and downstream users in terms of their needs and how each user affects other users (e.g. the effects of upstream use of chemicals on downstream water users).

Effective environmental conservation practices have to be at the catchment level, and build up from the small scale. Putting people first has gained greater attention, but how far should this policy be followed at the environment's expense? While environmentalism has also gathered momentum, it question of trade-offs between livelihood and environmental concerns has arisen, especially in the context of poverty alleviation and food security.

One place to start is by examining mechanisms for the payment of environmental services in a watershed context. This would help with the maintenance and development of watersheds. Generally, urban consumers abstract the most, and should therefore pay the most. However, although urban centres pay for this water, these payments are not systematized. Added to this lack of systematization, very little of the revenue is ploughed back into the development and conservation of the watersheds that yield water for urban use. Yet, urban water users have an

important role to play in water issues and can lend a loud voice to watershed maintenance and development. Payments for environmental services can also play a more direct role by inculcating self-discipline for more judicious water use.

Water issues are economic issues

There is also need for an effective mechanism for conflict resolution among land and water users, and among water users at various points on the watershed. For this, there must be an integrated management approach regarding the quality and quantity of water at every level in order to avoid a skewed picture of reality. All actors with an economic interest in the watershed should be involved, and there should be economic benefits accruing to all. Unfortunately, socio-economic issues of this nature are often politicized and easily hijacked by politicians. To safeguard the process from becoming the prey of politicians, accurate information on water supply and quality is fundamental. Currently, this kind of information is lacking.

Technology transfer

Technology transfer regarding the benefits and impacts of watershed management activities needs more attention. A first step is to raise awareness, especially among women and youth, who have prime responsibility for family water provision. Planning has to be participatory. Positive experiences should also be disseminated and, where possible, replicated.

The knowledge gaps in resource assessment are very evident. Capacity building in geographic information systems (GIS) and Global Positioning Systems (GPS) would help in establishing a low-cost planning system for land and natural resource use, water assessments and waste treatment. Where possible, Web networks should be created, and greater use of existing electronic fora encouraged. Sometimes people are not aware of the existence of these online fora and networks, which include capacity building for integrated water resource management (Cap-Net), an international online forum. These water networks should in turn be linked to national programmes and to the International Water Management Institute's (IWMI) country-level efforts. Creating the networks is the easier part: getting them to work is more difficult.

Water basin management and natural resource management (NRM) are two sides of the same coin. Regional planners should be involved in this initiative with the right constituent of participants beyond top management; consultations at the technical level are also needed. In Latin America and the Caribbean, regional technical fora are already ongoing, including information and database sharing and exchange. Europe also has interactive networks with online discussions on various water management topics. Southern Africa, Nigeria and Morocco also have networks. Most of these initiatives fall under the Global Water Programme, and bring together institutions, researchers and technical experts.

An important consideration with respect to technology transfer is effective communication strategies, especially among and to technocrats. Equally important are the identification of benefits to primary stakeholders; the assessment of environmental benefits; the identification of factors affecting water supply; the incorporation of cultural values; and alternative livelihoods to ease the population pressure in and around watersheds. A word of caution,

however: in assessing benefits, the focus has often been heavily skewed in favour of conservation and biodiversity and/or industry, agro-industry, urban needs and mining, while the needs of the poor and smaller users are ignored.

Methodologies and measurements aside, technology transfer for development must also include people's perspectives and inputs. Watershed management has overemphasized research-based knowledge at the expense of Africa's indigenous knowledge. African societies are largely characterized by a strong tradition of "self-provisioning" and the evolution of community knowledge. There is a need to make an inventory of rural conservation technologies, evaluate their benefits and sustainability, and incorporate them into extension. Indigenous knowledge has to be acknowledged. Recognizing it also enhances the dignity of the people.

An integrated multisectoral approach

Poverty alleviation strategies and watershed management have to be linked in a multidisciplinary approach for conflict management. Policy and environment are closely intertwined. However, for the most part, there is no coordination in policy at the national level, and the arena is often marked by various sectors working at cross-purposes and even in competition, rather than complementing one another (e.g. agriculture, environment, water, planning, land, natural resources). Moreover, most African governments are driven by the foreign aid agenda and "stand-alone" poverty alleviation strategies. Yet present and potential conflicts can only be resolved by economically viable and environmentally sustainable projects and solutions. Governments have to take on board the maintenance of watershed infrastructure, especially in rural watersheds, bearing in mind that most rural communities lack the capacity to maintain such infrastructure adequately.

Furthermore, views on pollution tend to be too static, whereas the field and the issues involved are very dynamic. Local governments tend to be the main culprits in water pollution through irresponsible waste disposal in waterways and floodplains. Safe water and sanitation are a Millennium Development Goal of the United Nations (MDG) for 2022. An additional issue is migration, which is a socio-economic reality that has an impact on the environment, but which is usually ignored.

Scale and focus

This raises the question of the right scale and the right focus: should it be the household or the community? Small- or large-scale? About maintenance and conservation or about livelihoods and rights? Whatever the answers to these questions, the underlying guiding principle is that irrespective of scale, resources should never be jeopardized and the welfare of any single group should not be the overriding factor. Any interventions at a local scale should always be viewed on the "big picture" screen.

Environmental impact assessments (EIAs) should be enforced, and programmes and projects linked to them. Sometimes however the enforcers themselves are the culprits, as is the case of local governments and pollution. One possible solution is punitive payments in which the heaviest polluters pay the heaviest penalties to mitigate pollution.

Compared with industry, agro-industry and local authorities, resource-poor farmers have few options and are, more often than not, subject to the principle of "can't pay won't pay". Land tenure and ownership for rural dwellers is also an important factor. Land degradation is sometimes driven by poverty and lack of tenure.

Pollution payments would call for an integration of the quality and quantity of water used, but the point of departure is who has a right to use the water? What is the quality of the water received and the water discharged? When rights are merged with quality and quantity, users can be self-regulating and free to purify and recycle their own wastewater.

For pollution payments to be equitable, full costs and benefits must be factored in. In practice, however, penalties lag far behind the economic benefits derived from pollution. Large users (urban centres, industries, agro-industries, mining) can easily pay for heavy pollution, and the penalties are not high enough to deter them. Small users suffer the most. The evolution of agriculture must also be taken into account. Agriculture is no longer wholly biological, but is also a contributor to pollution.

The way forward

For the future, an integrated vision is needed that incorporates all the actors, each of whom must have an economic interest in the watershed. Planning should be participatory and involve the young, the old and, especially, women. Access to watershed services should not be based solely on who can afford to pay, but also on efficient use and equity.

Because development approaches in Africa are primarily driven by the agenda of foreign aid and poverty alleviation programmes, development outcomes should be linked to national and regional poverty reduction strategies. There should be domestic, regional and international links, with the strategies of EAC, the Southern African Development Community (SADC) and the Economic Community of West African States (ECOWAS) linked with those of the New Partnership on Africa's Development (NEPAD) and the MDGs.

As a result of the fragmented approach, most programmes target watershed sanitation and/or poverty alleviation as "stand-alone" problems. Yet there is a need to link the general framework for watershed management with ongoing and upcoming sectoral programmes. Ideally, a watershed management approach should avoid project-specific programmes. Assessment tools and models also need to be simplified and continually modified in order to adapt them to local realities, ensure that "toolkits" are in line with changing dynamics, especially on pollution, and facilitate the projection and modelling future scenarios.

There should also be simple indicators that reflect the impact of interventions on people's livelihoods. However, cost–benefit analyses should cover the entire watershed in order to identify the greatest benefit and the greatest number of people: a local cost could well translate to a regional benefit. It must also be borne in mind that when enhancing resources, the tendency has largely been to overlook the benefits to local people.

Youth should be identified as a discrete group with their own issues, rights and perceptions; not all youth are children, even though the general trend is to lump them and children together.

It is therefore important to incorporate the impacts on youth welfare, especially because they are the future managers and custodians and so have an even higher stake in the sustainable management of natural resources.

The environment should be viewed through the lens of biodiversity and cultural context, as well as in terms of local flora and fauna. Agencies must work with a dynamic concept of pollution. A more flexible approach to capacity building is also necessary and should include vocational education for children, who can work elsewhere outside the watershed, and aid to technology transfer. Identifying alternative livelihoods would help to reduce the pressure on forests and other natural resources.

CHAPTER 17
WORKSHOP SUMMARY

WHAT IS SPECIAL ABOUT WATERSHED MANAGEMENT COMPARED WITH OTHER RESOURCE MANAGEMENT?

- Watersheds are integrators of people, resources and sectors.
- Watersheds link people that may never see each other, and may have vastly different wealth, livelihoods and socio-economic status.
- Watersheds include multiple resources – usually including forests, wetlands, fisheries, agricultural land, grazing land and water, and sometimes including minerals and important reservoirs of biodiversity.
- Good planning needs to be based on clear understanding of land use, hydrologic systems and interactions.
- Investments are long-term and generate benefits and costs that extend across large distances.
- Interventions that make good sense for individuals or communities may not be good for the total society that depends on the watershed.
- There is a large range of watershed management situations across the African continent, in terms of hydrology, policy, culture, governance, investment and the spatial distribution of poverty within watersheds.

WHAT IS SPECIAL ABOUT WATERSHEDS IN AFRICA?

- In general, levels of poverty are higher in Africa than in other regions of the world, and many African countries are experiencing increasing poverty. This poverty has multiple impacts on watershed management: both resource users and governments have short time perspectives; there are few resources available for investment by resource users and governments; and public investments are heavily dependent on the priorities of donors who emphasise short-term poverty alleviation rather than long-term infrastructure, resource conservation and technical capacity.
- Most countries share important river basins with other countries, and most important water resources are shared among two or more countries.
- There is heavy dependence on the priorities and programmes of multilateral finance organizations and donor agencies.
- Most countries have declining water storage in catchments, wetlands, lakes and reservoirs.
- Some countries have extremely low levels of investment in constructed water storage (water pans, dams, reservoirs), although there is large variation from country to country.
- There is a wide range of situations regarding water availability, forest cover and water quality.
- The national and regional institutions involved in watershed management generally have low and variable capacity, especially regarding integration across disciplines.

WATERSHED GOVERNANCE

- Many countries have recently enacted new policies for water and environmental management. However, there is a need to harmonize these policies across countries and with other more sectoral policies. More important, there is a need to develop the institutional capacity, financing mechanisms and enforcement mechanisms to implement these policies fully.
- There are new commitments to regional harmonization in some parts of the region.
- There is a need for nested management regimes that link local organizations to subcatchment, catchment and basin authorities and agencies. While several countries have recently enacted legislation that supports such nested regimes, there are few examples of those regimes actually working efficiently and effectively.
- Africa faces fundamental and special challenges of dealing with the consequences of transnational watersheds and river basins. Fortunately, there have been a number of early efforts to obtain better transnational water resource management (e.g. the Niger River basin, the Lake Victoria Development Programme of EAC, the Nile Basin Initiative, the Fouta Djallon, etc.).

EXPERIENCES WITH WATERSHED MANAGEMENT

- There are some cases of successful case studies in improved catchment management at the local level (e.g. Morocco), and examples of land-use practices that have beneficial effects on watershed properties (e.g. agroforestry practices, conservation agriculture).
- There is good evidence that the poor can benefit greatly from even small additional amounts of water during the dry season.
- There has been relatively little upscaling of successful watershed management to the national and regional levels. Institutional arrangements and financing mechanisms need to be put in place to scale these up to much larger areas.
- There is generally poor coordination and harmonization of organizations and agencies involved in watershed management.

UPSTREAM–DOWNSTREAM LINKAGES

- Smallholder water harvesting has good potential for increasing the availability of water for domestic and small-scale productive uses.
- There are weak controls on water abstraction and forest conversion in the headwater areas of many catchments.
- Deforestation and soil degradation in headwater areas are increasing the risk of floods in some small river basins.
- Policy-makers and farmers in many semi-arid areas have major concerns about the impacts of invasive trees on river flows and groundwater reserves.
- Many water and watershed management interventions are put in place without due regard to their downstream impacts.
- Water quality and groundwater resources have been underemphasized.

KNOWLEDGE AND INFORMATION

- There are large knowledge gaps among technicians, the general public and policy-makers about cause and effect relations in watersheds.
- There is a strong need to build the capacity of key institutions in Africa, with emphasis on developing tools and approaches in Africa that are appropriate for African conditions.
- There is very little effective monitoring and evaluation of water quantity and quality.
- Improved information and information management systems can assist in the resolution of conflicts over water and watershed management (examples from Ghana).
- Good economic and social planning must be based on good understanding of hydrological relations and good data on demand and supply of water.
- There are a number of important misunderstandings about the relations among trees, forests and key hydrologic properties (especially the effects of trees and forests on landslides and floods).
- There are unexploited opportunities for sharing concepts and lessons learned across the African continent – among scientists of different disciplines, between scientists and policy-makers and resource users, and among countries at different stages of institutional development.
- Some advances have been made in the state of science of watershed management, and these need to be more widely shared across the region.
- There has been little sustained experimentation and monitoring.
- There is need for greater awareness raising among the public and among policy-makers.
- There is need for more open sharing and more consistent collection of data.
- There is need for more training and capacity building.
- Success stories from Africa are needed, no matter how site-specific, in order to make the case for watershed management with policy-makers and donors. Especially valuable will be success stories in which science and knowledge make a difference in watershed management and watershed management makes a difference in people's lives.

PROPERTY RIGHTS – LAND, FOREST AND WATER RIGHTS

- Africa has a legacy of close interaction between land and water rights, with water rights largely following land rights.
- Water has recently been declared a national resource in South Africa and Ghana, implying the need to transfer it from locations of relative plenty to areas of relative scarcity. In South Africa, this is part of a complicated system of interbasin transfer of water resources from high-availability areas in the east of the country to high-population and low-supply areas in the central areas.
- Property rights to watershed resources are held under multiple property systems, and are sanctioned by multiple sources of authority. It is important that new agencies have real power, are articulated with property rights arrangements, and are harmonized with existing, trusted and legitimate sources of power.
- Privatization of watershed resources is a default pathway of development.

NEW FINANCING AND BENEFIT SHARING MECHANISMS

- There is a need to mobilize more consistent and long-term donor financing for conservation and investment in watershed management. Donors should be urged to address long-term investments that can reduce the need for short-term relief.
- In some instances, there may be good possibility to link investments in watersheds to people's willingness to pay for reliable and good-quality water – environmental services.
- There are many unanswered questions about who should receive compensation for watershed protection and how that compensation should be paid.
- Large questions remain about the potential for involving the private sector in watershed management, and how that potential can be enhanced.

NETWORKING

- There is a need for networks around watershed management issues; although networks that are already in place, such as WaterNet, should not be reproduced.
- There is a need for networking around catchments – linking community groups and civil society organizations with agencies and authorities with management responsibilities.
- There has been little South–South linkage within Africa and between Africa and other developing regions.
- There is a need for more cross-country sharing of lessons and experiences within Africa.
- There is a need for networks that link social and biophysical scientists.
- There is a strong need to link policy and science, based on good accepted science, receptive policy-makers, and networks between them.

ANNEXES

ANNEX A
ABSTRACTS OF PRESENTATIONS

PART 1 FAO WATERSHED MANAGEMENT REVIEW

Preparing the next generation of watershed management programmes

Moujahed Achouri, Forestry Department, FAO, Rome, Italy

Much progress has been achieved in watershed management, especially during the 1990 to 2002 period, when new approaches and methodologies were developed to promote participatory integrated watershed management. However, no clear picture has been drawn on what has proved to be successful and what can be done to improve future watershed management programmes. In fact, the latest systematic effort to review and assess watershed management strategies and approaches at a global scale was conducted 18 years ago by FAO at the expert meeting held in Kathmandu, Nepal, from 25 February to 1 March 1985. Hence, in-depth analysis of watershed management achievements and existing gaps, with particular emphasis on the 1990 to 2002 experiences, is a prerequisite to the further development of watershed management programmes.

This paper reviews and assesses watershed management activities in order to provide reliable information on lessons learned and existing gaps. Such information is greatly needed to justify investment in watershed management activities and to implement such activities in areas where they are most needed. The assessment process was designed to respond to the needs and to take into account the characteristics of different audiences involved in watershed management. It comprises consultation, investigation, stocktaking, case studies, workshops, international conferences and dissemination of the results.

Review and assessment of watershed management strategies and approaches

L.C. Tennyson, Watershed Management Consultant, FAO, Rome, Italy

Watershed management is considered by many to be the most appropriate approach to ensure the preservation, conservation and sustainability of water- and land-based resources and for improving the livelihood of people inhabiting upland and lowland areas. Integrated watershed management with participation of all the relevant key stakeholders has become widely accepted as the approach best suited for sustainable management of renewable and non-renewable natural resources in upland areas. Concerned governments and development assistance organizations have been employing watershed management principles since the 1960s in an attempt to reverse the degradation of water- and land-based resources. Through these years of development, strategies and approaches for implementing watershed management interventions have changed as the discipline moves forward along the learning curve. By responding to research results, lessons learned, failures and successes, the periodic review and evaluation of the discipline continues to be dynamic, with adjustment and

modification as required to meet changing needs. In view of the changes in development during the past decade, FAO decided to conduct a review and assessment of watershed management development strategies and approaches to determine the present status of watershed management development. The review and assessment were to identify any major gaps and formulate guidelines for future development projects and programmes. The previous review was conducted from 1985 to 1986. The overall study includes a survey of key actors; stocktaking of FAO experiences; case studies; regional workshops and international conferences; and preparation of guidelines and strategies for future watershed management development programmes. A summary is given of the experiences of the key actors and FAO in watershed management development projects and programmes during the 1990 to 2000 period. Topics covered include technology, training and education, gender and participatory methods, as well as recommendations for future watershed management programmes.

PART 2 LINKS AMONG LAND USE, TREE COVER AND WATER IN WATERSHEDS

Land–water relationships in rural watersheds

Jean-Marc Faurès, Land and Water Development Division, FAO, Rome, Italy

It is often assumed that land-use practices generate significant impacts on water resources and affect the downstream population in river basins. A great deal of controversy exists regarding the direction and magnitude of these possible impacts, their influence in the relations among the different population groups within a watershed, and the mechanisms that would allow a distribution of the costs and benefits among different stakeholders.

The effects of land use on water resources vary with local conditions. Good monitoring of the impacts of land use on water is made difficult by the extensive delays between cause and effects and the interferences between human-induced and natural impacts. These limitations affect our capacity to draw clear and straightforward conclusions on the relations between land use and water in watersheds. Although not fully understood, the issue of scale also greatly affects the relation between water and land use: some experiences indicate that the impacts of land management on the hydrology and sedimentation in river basins are more easily observed in small watersheds than in large basins. On the other hand, scale is less relevant when dealing with issues of water quality, and the negative impacts of agriculture on water quality can be observed at all scales in the watersheds.

Care must be taken to avoid misinterpretation and generalization of results, in particular when scaling up results obtained on relatively small watersheds. Case studies of land–water relations are presented and analysed with a view to recommend possible changes in land-use practices in small watersheds.

Watershed management – can we incorporate more evidence-based policies?

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In the early 1990s the concepts underlying integrated water resource management (IWRM) were developed. These are now agreed and supported by all development organizations (Calder, 1999), and are seen as the necessary, if not always sufficient, prerequisites for achieving the Millennium Development Goals (MDGs). These concepts are also seen as the guiding principles for the "blue revolution" in new land and water management policies, and form the basis for designing watershed development projects.

From consideration of the outcomes of current watershed development projects and land and water policies in different parts of the world, it is concluded that very serious deficiencies exist and in many situations perverse policy outcomes are apparent.

It is argued that the challenge in developing the next generation of watershed development projects is *how to implement* these IWRM concepts in a wider resource management context where there are:

- increasingly severe and conflicting demands on the land and water resource to supply food, water and other goods and services (e.g. timber, fisheries, conservation, amenity);
- sectoral conflicts among the water, land, power generation, irrigation and piped water and sanitation provision sectors;
- concerns that upstream management of land and water in watershed development projects generally ignores downstream impacts, particularly as they affect the lowland rural and urban poor, transnational and coastal interests;
- concerns that the opportunities that better resource management (IWRM) provide in a rapidly globalizing world economy will be captured by the non-poor.

Implementation of the well-meaning IWRM concepts will require confronting the complex and messy real-world situation where it is important to recognize that land and water policies and practices at the international, national and local levels are generally driven, dominated and exploited by the vested interests of sectoral, powerful and wealthier groups (using, knowingly or unknowingly, whatever land and water myth supports their cause), usually at the expense of the poorer in society.

Outcomes are often the opposite of what is expected, and billions of dollars of development funds are being expended on unachievable targets in relation to watershed development projects.

PART 3 FARMING AND WATERSHED MANAGENT IN SUB-SAHARAN AFRICA

Runoff and erosion control under improved fallows in western Kenya

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Alain Albrecht, World Agroforestry Centre, Nairobi, Kenya

Runoff and erosion have been receiving much attention for decades, yet they still constitute a major problem in the humid tropics. Most research on soil erosion has focused on controlling runoff through barrier strips and terracing on the landscape level, and less attention has been given to the processes taking place at the plot level for undisturbed soils. Thus, the aim of this study was to examine runoff, soil and carbon loss for *in situ* soils under two improved fallow species (*Tephrosia candida* [IF-Tc] and *Sesbania sesban* [IF-Ss]) and two tillage practices (conventional tillage [CT] and no-tillage [NT]) for a sandy loam and a clay soil in western Kenya. Runoff and soil loss were measured using a field rainfall simulator for pre-wetted conditions. The hypothesis of this study was that improved fallows (IF) in association with no-tillage would enhance soil properties, thereby increasing infiltration of rainwater and controlling soil and carbon losses. The effect of fallowing on improving soil properties was expected to be larger for the clay soil than for the sandy loam because of the larger capacities of clay particles to bind organic matter and form aggregates.

The results from this study show that improved fallows increased infiltration and reduced soil losses at both sites, with greater effect for the clay soil ($p \leq 0.001$). For the clay soil, IF (IF-Tc and IF-Ss) significantly increased infiltration, by 35 to 38 percent (63 vs. 85 to 87 percent, $p \leq 0.030$), and reduced soil loss, by 88 to 93 percent (50 vs. 4 to 6 g m^{-2}, $p \leq 0.002$). For the sandy loam, the differences in infiltration and soil loss between continuous crop (CC) and IF were only significant for IF-Ss, which increased infiltration by 54 percent (48 vs. 74 percent, 0.089) and reduced soil loss by 70 percent (37 vs. 11 g m^{-2}, $p \leq 0.101$). For the clay soil, C losses were reduced by 79 to 83 percent (0.19 to 0.24 vs. 1.15 g C m^{-2}, $p \leq 0.004$), while IF-Ss reduced C losses by 75 percent for the sandy loam (0.42 vs. 1.69 g C m^{-2}, $p \leq 0.039$). For the clay soil, the impact of IF on infiltration, soil and carbon losses was caused by significant improvements in soil properties (soil organic carbon, bulk density and soil aggregation), while for the sandy loam, the improvement in soil properties was only significant for soil organic carbon (SOC) under IF-Tc. Here runoff and soil loss were reduced through control of crusting processes by IF. No-tillage significantly reduced sediment concentration, soil and carbon losses under IF for the clay soil, while for the sandy loam, NT reduced carbon losses only under IF-Ss.

Results from ten years of watershed and water resources research in semi-arid southern Zimbabwe

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The semi-arid areas of Zimbabwe, located in natural regions IV and V, receive low and erratic rainfall. Dryland crop production is not reliable, forcing communities living in these areas to rely on stored water. Both surface and groundwater resources depend on the hydrology of catchments; hence, catchment hydrological studies are prerequisite to sustainable management of water resources. Watershed and water resources studies commenced in the early 1990s in southern Zimbabwe. This work concentrated on two headwater subcatchments of the Runde catchment, which were fully instrumented, enabling measurements of all components of hydrology, including rainfall, runoff, groundwater levels and soil moisture.

Results from these studies show that on the catchment scale, runoff from semi-arid areas is generally only a small part of the water balance. Long-term trends in groundwater levels reflect the effect of cycles in rainfall, and surface water redistribution is of particular importance for groundwater recharge in years with low or unevenly distributed rainfall, when it would not otherwise have occurred. Water use from small dams can safely be increased by up to ten times without drying up the dam to beyond allowable levels in 78 percent of the years that were studied.

Conservation farming – a strategy for improved agricultural and water productivity among smallholder farmers in drought-prone environments

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Water is a primary limiting factor for crop growth in semi-arid and dry subhumid savannah agro-ecosystems. However, this is not necessarily owing to low seasonal rainfall but rather to poor distribution of rainfall and large losses of water in the on-farm crop water balance. Conservation farming (CF), which aims at maximizing rainfall infiltration, water holding capacity and crop water uptake capacity, is an effective *in-situ* water harvesting strategy for smallholder farmers in drought- and dry-spell-prone savannahs. In this paper, on-farm farmer-driven trials on tractor-based, animal-drawn and manually based conservation farming systems are presented. As shown from trials in semi-arid regions of the United Republic of Tanzania, Madagascar and the Sudan, yield differences between conservation farming and conventional ploughing were significant, and largest during the driest years – an indication of the water harvesting effect. The largest yield increase was realized when water harvesting through conservation farming was combined with soil fertility management, resulting in an average yield increase exceeding 200 percent compared with current local practices. Rainwater productivity increased substantially from the 3 800 m^3/tonne required in the conventionally ploughed system compared with on average 1 500 m^3/tonne for maize under conservation farming. The paper further discusses the challenges of achieving wider adoption of CF practices, and the wider advantages in terms of labour saving, which is particularly important in the region at present owing to the HIV-AIDS pandemic.

Above-ground transformations in agroforestry systems in watersheds: case of cocoa agroforests of central Cameroon

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Transformations in agroforestry systems in watersheds of the African humid tropics have been continuing for many decades. These transformations have often involved modifications in species as well as spatial arrangements of indigenous trees within tree-based systems. In the forest margins of central Cameroon, these transformations started with the settlement of pioneer populations, their development of cocoa plantations, onwards to the more recent intensification of diverse high-value trees and smallholder plantations systems. These transformations, although largely unmonitored, have been influencing the biophysical dynamics in these tree-based economic landscapes in important ways.

Tree-based systems (mixed and monocultures) are certain to spread in the coming years. This paper presents the results of a characterization study of a complex cocoa system as an example of the issues that resource managers are likely to encounter increasingly in the coming years when dealing with the management of tree-based systems for rural livelihoods.

The study indicates that economic considerations are likely to continue to influence the transformations of tree-based systems in the future. These transformations are expected to be characterized by greater regularity in inter-tree distances (equidistant spacing), lower levels of diversity per farm in favour of greater productivity, and fewer strata as diversity continues to drop. Economic considerations are expected to increase at the expense of environmental ones. This paper raises an important question: How can we ensure that environmental concerns are balanced with economic ones?

PART 4 SOCIAL ASPECTS OF WATERSHED MANAGEMENT

The sociological approach in watershed management: from participation to decentralization

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Watershed management is based on an integrated approach that also includes human and social dimensions, from the plot or community level to their insertion in broader territories. To ensure sustainability, the participation of the populations directly involved is required. However, the application of participatory approaches implies certain methodological conditions, as well as the use of certain tools adapted to each situation encountered. Decentralization and devolution of authority are necessary for real increases in local participation, and require suitable institutional and organizational prerequisites to associate local needs and expectations with broader political dimensions. In the search for equilibrium

among local and global actors, partnership among all actors becomes paramount. For participatory and decentralized watershed management to be effective, three things are required: sharing of information, strengthening the capacity of local organizations through the formation of local networks and focal points, and promoting dialogue among these. FAO has developed an analytical model (RED-IFO) and field applications that associate participation and decentralization.

Catchment property rights and the case of Kenya's Nyando basin

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It is generally acknowledged that insecure and incomplete property rights have large effects on the use and management of watershed resources. The standard policy response to this problem is to privatize farmland, declare riverine areas to be public property, and establish a set of restrictions on the use of both private and public land. This paper presents a more nuanced concept of catchment property rights, drawing on key concepts from watershed hydrology and the multidisciplinary social science of property rights. We present preliminary results from a study of the Nyando river basin in western Kenya. The implications are that policy reforms aimed at catchment property rights need to recognize the complexity and interconnections that make up hydrologic catchments, give greater priority to key catchment resources such as domestic water and sediment filters, recognize the key links between water and land rights, and devise ways to harmonize the multiple sources of authority that govern the use of management of watershed resources.

Managing micro-catchment resources: institutional arrangements for water use in Chiwi district, Zimbabwe

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The last two decades have seen the emergence of new strategies for natural resource management and supporting institutions throughout the Southern African region. There is a clear shift from the centralized and State-driven natural resource management regimes of the colonial period and the immediate post-independence years towards decentralized and community-based management regimes. This paper discusses both individual and collective institutional arrangements for managing water resources, focusing on a micro-catchment area in Chiwi district in Zimbabwe. Many rules governing water use are implicit, rather than formal, explicit, rules. In most cases, these institutional arrangements, even if they are implicit, allow conditional access based on appropriate use. Water is used for many purposes and the rules differ according to the type of use. Priority is given to cleanliness around the water sources, in particular where drinking-water is collected. This is key to determining who has access to water sources, especially those that are privately owned. The study shows that there is general compliance and minimal conflict over water use, regardless of the shift in boundaries of use during times of stress, for instance during the dry season or in drought years.

Participatory approach in watershed management: sustainable agriculture and participatory rural development in the watershed area of Tassaout (High Atlas Mountains of central Morocco)

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In Morocco, of 15 million ha of upland areas, 11 million ha are considered to be at high risk, and 3 million ha need urgent management, as reported by various studies. Several experiences have shown the need to replace the narrow concept of watershed management with a broader and integrated one that is based on a participatory and partnership approach, and that includes sustainable agriculture and long-term rural development, besides the fight against water erosion.

The 1990s were characterized by the development of several plans and strategies, among which are the National Environment Action Plan (NEAP), the National Action Programme to Combat Desertification (NAPCD), the National Forestry Programme (NFP) and the 2020 Rural Development Strategy (RDS). These strategic frameworks for planning contain all the necessary elements for the conservation of natural resources, taking into account environmental concerns and the sustainable economic and social development of mountain areas. The Project MOR/93/010, Pilot Project for the Development of River Basins: Participatory Approach to Planning and Management, initiated by the Ministry of Water and Forestry and UNDP, contains essential links to the government's strategy for soil conservation and watershed management using field testing and an approach in which development is central to address the ecological, economic and social impacts of erosion.

The Tassaout Valley is part of the two pilot areas where the project was executed. The pilot watershed management project put in place in Tassaout between 1996 and 2002 achieved a high level of success owing to the novel way in which it was implemented with the following features:

- consideration of both hydrologic and ethnic considerations in defining the areas of implementation;
- recruitment of a local team of organizers who were not overly constrained by existing administrative structures;
- emphasis on novel approaches to agricultural practices that would conserve soil and water;
- a new spirit of cooperation between forestry administration and the local population.

The lessons learned from this experiment have contributed to defining a new approach for the conservation of water and soil, and for watershed management with the participation of populations, who are involved in both the identification of actions to be undertaken and their implementation and monitoring. This will help create a climate of confidence between populations and the forest administration, whose previous relationship was essentially characterized by forest police interventions.

Watershed hydrology, livelihoods and poverty: an integrated hydro-social analysis from the Limpopo basin

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The role of the hydrological cycle in contributing to the livelihoods of rural communities is often said to be important, but clear evidence of this is rarely offered. Furthermore, where such aspects are considered, they are largely focused on the use of water from rivers, boreholes or some form of storage (blue water).

In this study, the hydrological cycle is considered in its entirety. Links among rural livelihoods, land use and the goods and services provided by the evaporation and transpiration components of the hydrological cycle (green water) are assessed through analyses of rural livelihoods in the Luvuvhu catchment, Limpopo Province, South Africa. Results highlight the importance of green water, and thus the importance of access to land and use of the natural resource base in disaggregated rural community livelihood strategies

Finally, we describe a methodology for linking common outputs from hydrological models to rural livelihood impacts. In this way, the potential role of land-use change in disaggregated rural livelihoods can be assessed for various development scenarios, such as increases in commercial afforestation and dryland agriculture.

PART 5 AFRICAN EXPERIENCES IN WATERSHED MANAGEMENT

Processes that will influence resource allocation in the Republic of South Africa

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Under the 1956 Water Act of South Africa, the management of water and the provision of water were designed to benefit a very limited section of the population. Water use was primarily for irrigation, which resulted in depriving a large sector of the community of a basic water supply. Thus, the availability of water for development and for the sustainability of the environment was not present. Since the advent of a democratic South Africa in 1994, government policy has focused on equitable and sustainable social and economic development for the benefit of all people. In 1997, the Cabinet adopted a National Water Policy (NWP) for South Africa in response to the new direction of government policy and as part of the process of a thorough review of the existing water law. The NWP was preceded in 1996 by the development of 28 Fundamental Principles and Objectives for New South African Water Law. The National Water Act (NWA) of 1998 (Act No. 36) was published and derives directly from the Fundamental Principles and Objectives for New South African Water Law and the NWP proposals for managing water resources. Although the NWA is the principal legal instrument, water resource management in South Africa is supported by other legislation as well. Successful water resource management will therefore depend on cooperation among all spheres of government, and the active involvement of water users and other organizations and stakeholders.

Public trust is fundamental to South Africa's new water resource management regime, and the national government's responsibilities and obligations in this regard have found legal expression in the NWA. Effective implementation of these responsibilities and obligations implicitly requires that they be exercised within the framework of some kind of national water management plan. The National Water Resource Strategy (NWRS) is intended to provide this framework. A strategy was called for in the NWA, a draft was then published for comments, and the strategy was recently finalized. As part of the fundamental reform process of the law relating to water resources, the NWA recognizes the need for integrated management of all aspects of water resources and, where appropriate, the delegation of management functions to the regional or catchment level so as to enable everyone to participate. To this end, Catchment Management Agencies (CMAs) will progressively be established. These CMAs will develop Catchment Management Strategies (CMS) within the framework as set out by the NWRS. Until such time as the CMAs are established and are fully operational, the national Department of Water Affairs and Forestry (DWAF) will have to continue managing the water resources in the various water management areas through its regional offices. In light of this responsibility, DWAF's corporate perspective on how the water resources should be managed has been put on paper through the establishment of Internal Strategic Perspectives (ISPs).

The intention of this paper is to inform the reader about these processes, which will have a significant influence on future procedures, structures, programmes and the allocation of resources in the Republic of South Africa.

Putting integrated water resource management into practice – Ghana's experience

Kwame Odame-Ababio, Water Resources Commission, Accra, Ghana

For nearly a decade, Ghana has been implementing reforms in the water sector to promote the objectives of integrated water resources management (IWRM) in line with the approach proposed at the 1992 Dublin International Conference on Water and Environment (ICWE), which was also emphasized at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro that same year.

In 1996, a significant step was taken by the Government of Ghana to address the diffused state of functions and authority in water resources management and to put them into an integrated form. An Act of Parliament (Act 522 of 1996) was promulgated to establish the Water Resources Commission (WRC) with the mandate to regulate and manage the country's water resources and to coordinate government policies in relation to them.

Since its establishment, the Water Resources Commission has developed strategies and policies that will ensure sustainable water resources management.

This paper gives an overview of some aspects of water sector reforms in Ghana. It concludes by highlighting some of the tasks that WRC is focusing on to promote IWRM in Ghana.

Water sector reforms in Zimbabwe: the importance of policy and institutional coordination on implementation

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Increasing water scarcity because of increasing demand on a finite water supply, unpredictable climatic variations and deteriorating water quality has led many governments to join a worldwide call for an integrated and more sustainable approach to water management. In sub-Saharan Africa, environmental degradation is accelerated by poverty and poor access to water, which has led to even less water availability for basic human sustenance. The integrated approach to water management attempts to promote greater efficiency of water use, while protecting water catchment areas. However, it has been observed that the success of such reforms depends largely on a sound base of institutional linkages with policies that do not conflict. The timing of implementation, financial sustainability and a general sound capacity base are all ingredients to a successful water reform process.

Water erosion and silting in the Niger River basin in the context of watershed management

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The Niger River basin is of great importance to the population and the economy of the region. Decades of continuing soil erosion are causing silting of the river and endangering the stream flow. Small-scale projects successfully developed relevant approaches and methodologies to address the problem. However, these projects were mainly sectoral and have not been implemented on a larger scale.

The process of silting in the Sahelian-Saharan part of the basin is a serious threat to the regular flow of the river. Fully aware of the gravity of this situation, the ABN member states have obtained support from the African Development Bank to start up a multinational programme to resolve water erosion and silting in the Niger River basin.

The programme intends to reinforce cooperation and regional integration through the sustainable management of natural resources by providing all ABN member states with suitable tools for coordinated and sound watershed management. This paper describes the several components and impacts of the programme, as well as the methodological approach used for implementation.

The broken link in the agricultural production system in Ethiopia and its impacts on natural resource management

Gete Zeleke, Amhara Regional Agricultural Research Institute, Ethiopia

Why famine in Ethiopia again? What are the external and internal policy issues related to natural resources management? What are the impacts on Africa's development of the Western world's wrong intervention? What should be the right balance between food aid and development assistance?

Regional programme for the integrated management of the Fouta Djallon highlands

Amadou Maiga, FAO, Conakry, Guinea

The main objectives of the FEM project (PDF-B phase) are the sustainable use and protection of the international watershed area, natural resources and biologicial diversity of the Fouta-Djallon highlands. In order to meet these objectives, an integrated and sustainable natural resources management programme for the Fouta Djallon highlands will be developed as the overall development objective of the project. This objective will be accomplished through the enhancement of knowledge; complementing methodologies; identification of suitable conservation strategies; and sharing of useful experiences and lessons learned concerning natural resources management.

Outcomes of the project include:

- a *diagnostic transnational analysis* of the environment and management problems of the Fouta-Djallon highlands;
- *strengthened coordination mechanisms*, including the establishment of a Pilot Committee and a Scientific and Technical Committee for the project;
- a *legal framework* emphasizing the international character of the area of the Fouta-Djallon highlands and a framework of agreement on the cooperation among the benefiting nations of the watershed area of the Fouta-Djallon highlands;
- a detailed project document based on the results of the activities to be submitted to FEM.

ANNEX B
OPENING REMARKS

DR DENNIS GARRITY, DIRECTOR-GENERAL, WORLD AGROFORESTRY CENTRE

Good morning everyone, and welcome to the beautiful city of Nairobi and to the science park campus of the World Agroforestry Centre. Our centre is delighted to have the honour of hosting you here during the coming days of this important meeting.

Mr John Munyes, Assistant Minister for Water Resources Management and Development, Republic of Kenya; Professor R.W. Michieka, Director-General of the National Environmental Management Authority; Mr Bruce Isaacson, Representative of FAO to Kenya; Mr EI-Hadji Sène, Director of the Forest Resources Division, FAO, we are indeed grateful that each of you is with us today to grace the opening of this workshop. As we are all aware, in a world of growing interrelatedness and interdependency the global community is awakening to the utter tragedy of the fact that hunger and poverty continue to afflict such a huge proportion of our fellow human beings. It is a tragedy because we know the means exist to rectify this, but sadly, the will to do so is still inadequate to the task.

Nearly 1 billion people continue to live their lives in desperate poverty when we all know that this simply does not need to be the case. And a very large proportion of these disadvantaged, often excluded, people are the rural poor who occupy watersheds, and particularly upper watersheds throughout the globe.

There is indeed a high correlation between the incidence of poverty and residence in the key watershed areas of so many countries in the developing world (and in the developed world as well).

People are at the centre of the drive to achieve the Millennium Development Goals, the framework that the global community has targeted for united approaches comprehensively to attack hunger and poverty in the coming years.

If watersheds are the basis of the livelihoods of so many of these disadvantaged people, and if their activities in the watershed are so crucial to the quality and quantity of water that impinges on the downstream communities and cities of the world – as they most definitely are – then finding ways of better managing the world's watersheds can only grow enormously in importance in the coming years.

Thus, understanding the past experience in managing watersheds nationally, regionally and globally will be assuming an ever-greater importance. Synthesizing that experience into ever-improving guidelines for future action is assuming more urgent attention, and developing better means of networking among all those involved in this endeavour will be crucial.

These profound issues are what this meeting is all about, and what the series of meetings around the world of which this is a part, are all about.

Thus, I anxiously look forward to the outcome of this process and the leadership it will provide for accelerating progress in watershed management for the benefit of the entire global community, particularly the poorest of our brethren.

Agroforestry focuses on the role of trees, at the farm level and the landscape level, in addressing hunger, poverty and environmental regeneration. Agroforestry fosters the deployment of trees that work for people, particularly the rural poor, in ways that enable them to make a better living, while at the same protecting and enhancing the quality of the environmental services that matter to them, and that matter to the wider society as well. Thus, the science and practice of agroforestry is well acknowledged to be a central pillar in achieving success in watershed management under a very wide range of conditions throughout the world's watershed area. Recognizing the significance of this role, we at the World Agroforestry Centre see the application of agroforestry science to watershed management as one of our most important areas of work and endeavour. Thus, we, along with many partner organizations, have been continually deepening and broadening our efforts to apply agroforestry to discovering and applying better methods of pro-poor watershed management.

Likewise, we see the connectedness of improved watershed management with efforts better to conserve and use the precious biodiversity resources that reside in both the protected areas in watersheds and outside those protected areas throughout the agricultural landscape. And we are working on exploiting the growing opportunities that the deployment of trees by smallholder farm families will contribute to carbon sequestration in ways that can generate additional financial resources for improving their livelihoods.

All of these interrelated aspects of the potential for agroforestry (pro-poor watershed management, biodiversity conservation, and carbon sequestration for climate change amelioration and adaptation) make up our major organizational theme on Agroforestry for Environmental Services, which Dr Brent Swallow, our session chair, is leading.

In this context, we are working and networking with scores of partner institutions to seek ways of rewarding upland dwellers for the environmental services that they provide to society, thus generating financial resources for their own development while fostering better husbandry of watershed resources, biodiversity resources and carbon. This is the basis for a new network in Asia that is coordinated by our centre. It is known as RUPES, or Rewarding Upland People for Environmental Services.

Here in Eastern Africa, and particularly in Kenya, we have been engaged in ambitious work, along with many partners, in developing and deploying the principles of pro-poor integrated watershed management in key watersheds that are of crucial significance, particularly in the Lake Victoria basin.

Mr Minister and Mr Director-General, we are fortunate to have the opportunity to work with you and your colleagues on these and other watershed management challenges here in Kenya, not only in the Lake Victoria basin, but increasingly also on Mount Kenya and Mount Elgon (which are the key water towers for this nation's people).

All of this work, and more, has instilled in us a passion for pushing forward towards much better ways of working. In this work, we are involved in developing an integrated natural

resource management framework. It is an approach in which the research process is not separate from, but rather deeply embedded in, the development activities that the research seeks to enhance. This places research within an action environment, and fosters ever-accelerating cycles of adaptive management.

This is an innovative concept for research – "research within development" – but one that we see as a crucial foundation to greater relevance and effectiveness. We see it as fundamental to achieving what we are really aiming for, which is demonstrated success in showing how watershed management can be done on the ground in a wide range of circumstances, pragmatically, realistically and cost-effectively, to the clear benefit of the poor who de facto manage watershed resources in so many situations around the world.

Thus, we look forward earnestly to being a part of this process of learning and sharing experience and methodologies, looking to the greater goal of finding and fostering watershed management solutions that work ever-better for our partners and clients.

I would like to end by expressing our deepest thanks to you Mr El Hadji Sène, Mr Moujahed Achouri, Larry Tennyson and all our friends at FAO for their foresight and drive in spearheading the process in which we are engaged today, bringing us together as a community of concerned practitioners in better watershed management, and moving us forward vigorously to the identification of best practices in applied watershed management that can serve as guidelines for so many in future years. And to all of you who are with us here today, l bid you to exercise yourselves to engage, vigorously, in making these discussions really stimulating, thought-provoking and productive.

Thank you.

DR EL-HADJI SÈNE, DIRECTOR, FOREST RESOURCES DIVISION, FAO

I am pleased and honoured to welcome you, on behalf of the Director-General of the Food and Agriculture Organization (FAO), to this important regional workshop on Preparing the Next Generation of Watershed Management Programmes. I sincerely thank you all for your presence and participation in this major event dealing with watershed management past, present and future perspectives. I would like also to extend my thanks to ICRAF for co-organizing this regional workshop, to Dr Dennis Garrity for his openness and strong drive to develop partnership and cooperation among our institutions. I extend special thanks to Dr Brent Swallow and his team for the assistance they have provided, and the kind and efficient support throughout the preparation process, which has made this workshop a reality open to promising developments. At FAO, and l believe mostly so at ICRAF, we treasure and apply cooperation and multidisciplinary approaches, and that is why this workshop and the process in which it is included are supported by many departments in FAO, three of which are participating in and supporting your workshop.

Why should we focus on watershed management?

The conservation, use and sustainable management of watershed resources to meet the demands of growing populations have been a high priority of many countries in the world for the past several decades. In this respect, integrated watershed management through people's participation has become widely accepted as the approach that ensures the sustainable management of natural resources and a better agriculture economy for upland people, as well as for those living in downstream areas.

Integrated watershed management was also recognized as a suitable approach to address poverty and food insecurity for people living in the same basins. Ecology, soils, physical climatology and other sciences should also integrate all social and human dimensions. Thus, it can offer balanced options and help provide guidelines for choosing acceptable and viable management alternatives.

Chapter 13 of UNCED Agenda 21, for which FAO is the UN Task Manager, stresses, "Promoting integrated watershed development programmes through effective participation of local people is a key to preventing further ecological imbalance. An integrated approach is needed for conserving, upgrading and using the natural resource base of land, water, plant, animal and human resources".

Why we are here

Although much progress has been achieved in watershed management, no clear picture was drawn on what has been really working and what can be done to improve future watershed programmes. Therefore, an in-depth analysis of watershed management practices, achievements and existing gaps was identified at FAO as a prerequisite to further satisfactory development of watershed management programmes.

In addition, a number of key issues of major concern to watershed management development come at the forefront. They relate to participatory processes, matching technologies and desired results, sustainability and replicability, institutional, organizational and legislative arrangements, the adequate policy and strategic framework. All these need in-depth analysis, adaptation and fine-tuning.

Therefore, it was proposed to review and assess watershed management activities with the aim to provide reliable information on lessons learned and existing gaps. The following major steps were identified as necessary for the proposed review and assessment of watershed management activities: 1) stocktaking exercise; 2) case studies analysis; 3) regional workshops; 4) international conference – synthesis of findings; and 5) formulation of guidelines and dissemination of results.

A series of regional workshops have already been conducted in Mégève, France (European Regional Workshop), Aleppo, Syrian Arab Republic (Near East and North Africa), Arequipa, Peru (Latin American Regional Workshop) and Kathmandu, Nepal (Asian Regional Workshop). These workshops were important steps in the process, providing an opportunity to watershed management groups all over the world to exchange and discuss achievements and

to exchange gaps of diverse nature in watershed management. They have helped generate insights on possible new directions and innovative approaches and strategies for future watershed management programmes.

The present FAO/ICRAF African Regional Workshop provides to you, dear colleagues, professionals working in the region to share lessons learned on watershed management, to identify from your diversified experience the elements that constitute effective watershed management and contribute to opening new perspectives and building a vision on more efficient and sustainable ways of doing the job.

What are the workshop objectives?

The broad objective of this regional workshop is to promote the sharing, dissemination and exchange of information on watershed management achievements and present gaps, and thus to provide required support for the development of enhanced practices, more effective watershed management through better designed and adequately implemented projects and programmes.

The workshop aims to achieve the following specific objectives:

- assess and identify the nature and extent of achievements and existing gaps in the state-of-the-art of watershed management programmes and approaches in Africa;
- identify lessons learned and principal issues emerging from past experiences in the region, with particular focus on the 1990 to 2002 period;
- identify guidelines for the formulation and implementation of the next generation of watershed management projects/programmes, with special focus on the role of effective watershed management in the conservation and sustainable use of water resources.

What are the expected results?

By involving many experts and institutions dealing with watershed management, it is expected that in addition to outlining the state-of-the-art watershed management in the region, the workshop will contribute to raising awareness and support for implementation of effective watershed management at the local, national and regional levels. From this workshop, you should depart with stronger drive, interest and advocacy for appropriate initiatives on watershed management in the many places where it is needed in Africa.

This workshop is built in the process I have just introduced, and of course its outcome will be an important input for the international conference Integrated Watershed Management: Water Resources for the Future, Porto Cervo, Sardinia, Italy 22 to 24 October 2003 that tops it. It will bring your contribution to the formulation of guidelines for the design and implementation of the next generation of watershed management programmes.

The workshop findings will also contribute to the follow-up of the International Year of Mountains and to achieving the expected results of the International Year of Fresh Water, which 2003 is.

Once again, I thank you all and I look forward to a great contribution of the Nairobi workshop, with an African flavour, to this endeavour to develop appropriate policies and strategies for future watershed management programmes. Thank you for your patience.

PROF. R.W. MICHIEKA, PH.D., EBS, DIRECTOR-GENERAL, KENYA NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

Hon. John Munyes, Assistant Minister for Water Resources Management and Development (for the Minister, Hon. Martha Karua), Dr Dennis Garrity, Director-General, World Agroforestry Centre; Dr EI Hadji Sène, Director, Forest Resources Division, FAO; distinguished participants, ladies and gentlemen, I am delighted to have been invited to participate in this very important African Regional Workshop. I am indeed honoured to join this distinguished gathering of researchers, teachers, extension workers, policy-makers and experts in watershed management from around Africa, which will spend the next few days in preparing the next generation of watershed management programmes for our African region. I wish to thank the World Agroforestry Centre and the Food and Agriculture Organization of the United Nations for spearheading this effort, and the World Agroforestry Centre for providing pleasant and conducive facilities for the workshop.

The presence of our Minister for Water Resources Management and Development is indeed a firm indication of the commitment of the Government of Kenya to proper water management, and particularly the need continually to look for and adopt innovative approaches and strategies for watershed management programmes.

Ladies and gentlemen, water is vital for the sustenance of all life. Access to water is restricted, and its availability for socio-economic and ecological demands is primarily influenced by its quantitative distribution in space and time, and also by its quality. The distribution countrywide varies from one drainage basin to another. The surface runoff and groundwater recharge rates are influenced by variation in rainfall intensity, soil types, vegetation cover and presence or absence of wetlands.

The Environmental Management and Coordination Act of 1999 has provisions for protection and management of rivers, lakes, wetlands, hill tops, hillsides, mountain areas and forests, all of which are relevant to management of water catchments. Indeed, the Director-General of the National Environment management Authority (NEMA) of Kenya must be given written approval for any activity in relation to a river, lake or wetland, which must be supported by an environmental impact assessment study report.

Additionally, the Minister for Environment, Natural Resources and Wildlife may issue general and specific orders, regulations or standards for the management and protection of riverbanks, lakes shores, wetlands or coastal zones.

Wetlands in the country include swamps, deltas, bogs, floodplains, areas bordering water bodies such as mangrove forests, riverine ecosystems, lake shores, estuaries, and marine mudflats that have moisture most of the year. Their multiple contributions to water bodies include provision of nutrients that sustain primary productivity, forming the basis of food chains, act as filters of polluted water, silt, eutrophication, etc. Wetlands are exploited on both

seasonal and long-term bases through grazing, direct harvesting of plant material and fishing. They form important habitats for fish breeding, as well as other forms of life. They are major water sources for industrial, domestic, livestock and agricultural uses, and also function as natural water reservoirs and regulators, as well as providing opportunities for recreation and tourism. Kenya is a signatory to the Ramsar Conservation on wetlands conservation and management, and has set aside lakes Nakuru and Naivasha as Ramsar sites.

Soil erosion is a major problem in many river catchment areas. This has direct impact on the water quality and the life of reservoirs and irrigation channels, and the life of aquatic ecosystems.

Flooding is a recurring problem affecting areas like the Lake Victoria basin and the Tana River basin. Flood control, therefore, is a priority concern because of the frequency and the magnitude of the damage that floods cause.

Mountain ecosystems are an important source of water. However, human activities adversely affect these ecosystems, which are rapidly changing, as they are susceptible to accelerated soil erosion, landslides and rapid loss of habitat and biological diversity. Hence, proper management of mountain resources deserves immediate attention.

Mountains/highland ecosytems influence climate and are main water catchment zones. Interference with these ecosystems can have major impacts on land productivity and biodiversity, as well as the quality of the environment.

Forests cover a very small proportion of Kenya's total land area, but they conserve biological diversity, water and soil. The destruction of forests is threatening ecological functions, including protection of water catchments and conservation of valuable gene pools of fauna and flora. It also endangers the nation's water supplies for a large proportion of the population and causes severe siltation problems for the major hydroelectric and irrigation schemes. Excessive deforestation also upsets carbon dioxide balance in the atmosphere, which results in adverse climatic changes such as global warming.

Ladies and gentlemen, development of innovative approaches to the conservation of water catchment in Kenya calls for:

- establishment of national instruments for attaching appropriate economic and financial values and benefits to water resources;
- promoting cooperation between water catchment preservation and water-use stakeholders;
- providing incentives to accelerate integrated management, through community institutions and private sector partnerships;
- establishing new administrative structures for managing water resources, which make the user responsible to other users and not to the government alone;
- developing the capacity of local communities to participate in watershed and water resource conservation efforts, supply decisions and maintenance skills;
- integrating all production systems in all sectors, i.e. agriculture, forestry, industrial, urbanization, settlement, etc., to the preservation and wiser use of water resources;
- devolve planning, implementation and monitoring and evaluation to communities and other stakeholders.

Mr Chairman, I wish to conclude by once again thanking the organizers of the workshop for bringing these experts together to:

- assess and identify the nature and extent of achievements, as well as challenges, in watershed management;
- identify lessons learned from past experiences;
- identify appropriate approaches for future watershed management.

Thank you.

HONOURABLE MARTHA KARUA, MINISTER FOR WATER RESOURCES MANAGEMENT AND DEVELOPMENT

Presented by Hon. John Munyes, Assistant Minister

Director-General, World Agroforestry Centre, Dr Dennis Garrity; Director, Food and Agriculture Organization, Nairobi Office; distinguished workshop participants, ladies and gentlemen, I am delighted to be with you this morning during the start of this esteemed workshop as you embark on mapping out the next generation of watershed management programmes. Indeed, this is an important forum, and the task ahead is no doubt challenging.

However, before I continue with my message this morning, I wish to take this early opportunity to welcome you to Kenya, and Nairobi in particular, those of you that have come from other parts of the world. Feel at home and take time out of your busy schedule to sample some of Kenya's hospitality and beautiful sceneries. We love visitors and take pride in hosting our guests.

Ladies and gentlemen, this important forum has come at the right time for us in Kenya, when we are operationalizing the Water Act 2002. The act, which became effective from March this year, heralds a new chapter for the water sector reforms in the country. The act recognizes the role of other actors and stakeholders in the management of water resources, and also defines the role of the government, through the ministry in charge of water affairs, as that of policy formulation direction, sector coordination and financial aspects of development.

The ongoing water reforms, which are geared to improve efficiency and effectiveness of water resources management and provision, are derived from the fact that water resources and services have in the past been managed unsustainably. In this regard, establishing institutions that will manage water services, including protection and conservation and proper management of watersheds in the entire country, is of paramount importance in our plans.

In the overall strategy, efforts are focused on major key areas, including but not limited to institutional framework, capacity building, private sector participation, finance, monitoring and information dissemination.

Ladies and gentlemen, allow me to share with you some data of my ministry's water programme. There are currently more than 1 500 water supplies under various management agencies. The ministry itself runs more than 600 rural water supplies, out of which 200 schemes

are gazetted for revenue collection. The National Water Conservation and Pipeline Corporation, which is a parastatal body under my ministry, runs more than 48 water supplies. Local communities within the watersheds, combined with self-help groups and NGOs, run more than 865 schemes. It is important to mention here that 9 000 boreholes have been registered with the Registrar of Water Rights.

Further, approximately 57 million m^3 of water are extracted annually for various purposes across the country. Out of these, 50 percent is used for domestic and livestock purposes, while the rest is used for irrigated agriculture. Hand-dug wells sustain 12 percent of the total household water needs in Kenya. This information underscores the partnership and collaboration among stakeholders in water services and the importance of proper management of watersheds. The ministry's vision is complete access to water services for all, including the ecosystem requirements.

I wish further to inform this forum that specific areas of water services not adequately accounted for have been identified. These include the following:

- large quantities of unaccounted water;
- occurrences of leakages within water supplies;
- poor reticulation of water in old pipes;
- poor network designs and low water tariffs that encourage water wastage.

Because of increased human population in this country, many activities have been taking place in recent years particularly in water conservation areas. Extensified cultivation to increase food production, as well as poor farming practices have led to serious soil erosion and overall reduction in water recharge capability into soils. As a result, rivers and streams have run dry, because of depletion of water sources across areas that had plenty of water before. This scenario has been replicated almost in the whole region. This trend cannot be allowed to continue. Mitigation measures must be sought, deliberated upon and urgently implemented.

The ministry has formulated a water resources management strategy, at present in draft form, to capture some of the challenges of watershed management. A Water Resources Management Authority will soon be launched with the goal of ensuring that the water resources of this country are protected, conserved and allocated in an equitable manner. Our present challenge is how to integrate river basin approach and administrative boundaries for the Water Boards established to be economically viable.

Ladies and gentlemen, it is therefore important for this workshop to throw light on the way forward, strengthening the regional strategies on watershed management. This workshop should also address all the problem features of watershed management within the region, and chart out a well thought programme for the implementers to use, now and in the future. I would also urge you to strive and consider affordability and situational considerations of your recommendations.

With those few remarks, may I wish you fruitful deliberations, a safe journey back home and also declare this workshop officially opened.

Thank you.

ANNEX C
WORKSHOP PROGRAMME

WEDNESDAY 8 OCTOBER 2003

08.00-09.00 Registration of participants
Moderator/presenter: Elizabeth Were and Antonia Okono

Workshop Opening
Chair: Brent Swallow

09.00-09.15 Introduction/Moderation
Moderator/presenter: Brent Swallow

09.15-09.45 Welcoming statements
Dennis Garrity, Director-General, ICRAF
El-Hadji Sène, Director, Forest Resources Division, FAO
Prof. R. W. Michieka, Director-General, NEMA

09.45-10.15 Official opening
Hon. John Munyes,Assistant Minister for Water Resources Management and Development, Republic of Kenya

10.15-10.30 Participant self-introduction

Session 1: Presentation and discussion of technical papers: An overview
Chair: Gete Zeleke
Rapporteur: David Mungai

10.40-11.00 Moujahed Achouri: *Preparing the next generation of watershed management programmes*

11.00-11.20 Larry Tennyson: *Review and assessment of watershed management strategies and approaches – Phase I*

11.20-11.40 Ian Calder: *Watershed management – can we incorporate more evidence-based policies?*

11.40-12.00 Jean-Marc Faurès: *Land-water relationships in rural watersheds*

12.00-12.40 Discussions

Session 2: Presentation and discussion of technical papers: Upland-lowland linkages and interactions

Chair: Sène El Hadji
Rapporteur: Moujahed Achouri

14.20-14.40 Gete Zeleke: *The broken link in the agricultural production system in Ethiopia and its impacts on natural resource management*

14.40-15.00 J.I. (Seef) Rademeyer: *Evolution of water use and water law, and the effect of this on water management in the Republic of South A*frica

15.00-15.20 Alain Albrecht: *Runoff and erosion effects of agroforestry*

15.20-15.40 Francis Mugabe: *Results from ten years of watershed and water resources research in semi-arid southern Zimbabwe*

15.40-16.00 Discussions

Session 3: Presentation and discussion of technical papers (continued)

Chair: Hodson Makurira
Rapporteur: Jean-Marc Faurès

16.30-16.50 Brent Swallow: *Watershed property rights*

16.50-17.10 Jean Bonnal: *Sociological approaches to basin management: from participation to decentralization*

17.10-17.30 Amadou Maiga: *Regional programme for the integrated management of Fouta Djallon highlands*

17.30-18.00 Discussions

THURSDAY, 9 OCTOBER 2003

Session 4: Presentation and discussion of technical papers: Case studies on watershed management-related issues

Chair: Mohamed Bakarr
Rapporteur: David Nyantika

08.30-08.45 Robert Hope: *Integrating watershed hydrology and rural livelihoods: a case study from the Limpopo Basin, South Africa*

08.45-09.00 David Mungai: *Land-water relations in high water stress areas of Kenya*

09.00-09.15 Ousmane Diallo: *Water erosion and silting in the Niger River basin in the context of watershed management*

09.15-09.30 Discussions

09.45-10.00 Abdellah Zitan: *Participatory approaches to basin management: sustainable agriculture and participatory rural development in the Tassout watershed (Upper Atlas in Central Morocco)*

10.00-10.15 Kwame Odame Ababio: *Putting integrated water resource management (IWRM) into practice – Ghana's experience*

10.15-11.00 Discussions

11.30-17.30 Alex Awiti and David Mungai: *Field trip (packed lunch)*

FRIDAY, 10 OCTOBER 2003

Session 5: Working group discussions (three parallel working groups)
Moderator/presenter: Larry Tennyson and Moujahed Achouri

08.30-11.00 *Group 1:*
Watershed management: upland-lowland linkages and interactions
Facilitators: Jean Marc Faurès and Gete Zeleke;
Rapporteur: Alex Awiti

Group 2:
Policy and institutions: context of integrated watershed management
Facilitators: Jean Bonnal and Brent Swallow;
Rapporteur: David Mungai

Group 3:
Watershed management experiences: to include technical, socio-economic, scale of implementation and other relevant topics
Facilitators: Larry Tennyson and Antonia Okono;
Rapporteur: Abdellah Zitan

11.30-13.00 **Session 6: Working group discussions (three parallel working groups)**
Chair: Joy Turkahirwa
Rapporteur: Ian Calder

14.00-15.00 **Session 6 (continued – plenary): Presentation/discussion of working group findings**
Chair: Joy Turkahirwa
Rapporteur: Ian Calder

15.00-16.00 **Session 7: Closing session**
Chair: Dennis Garrity
Moderators: Brent Swallow and Moujahed Achouri

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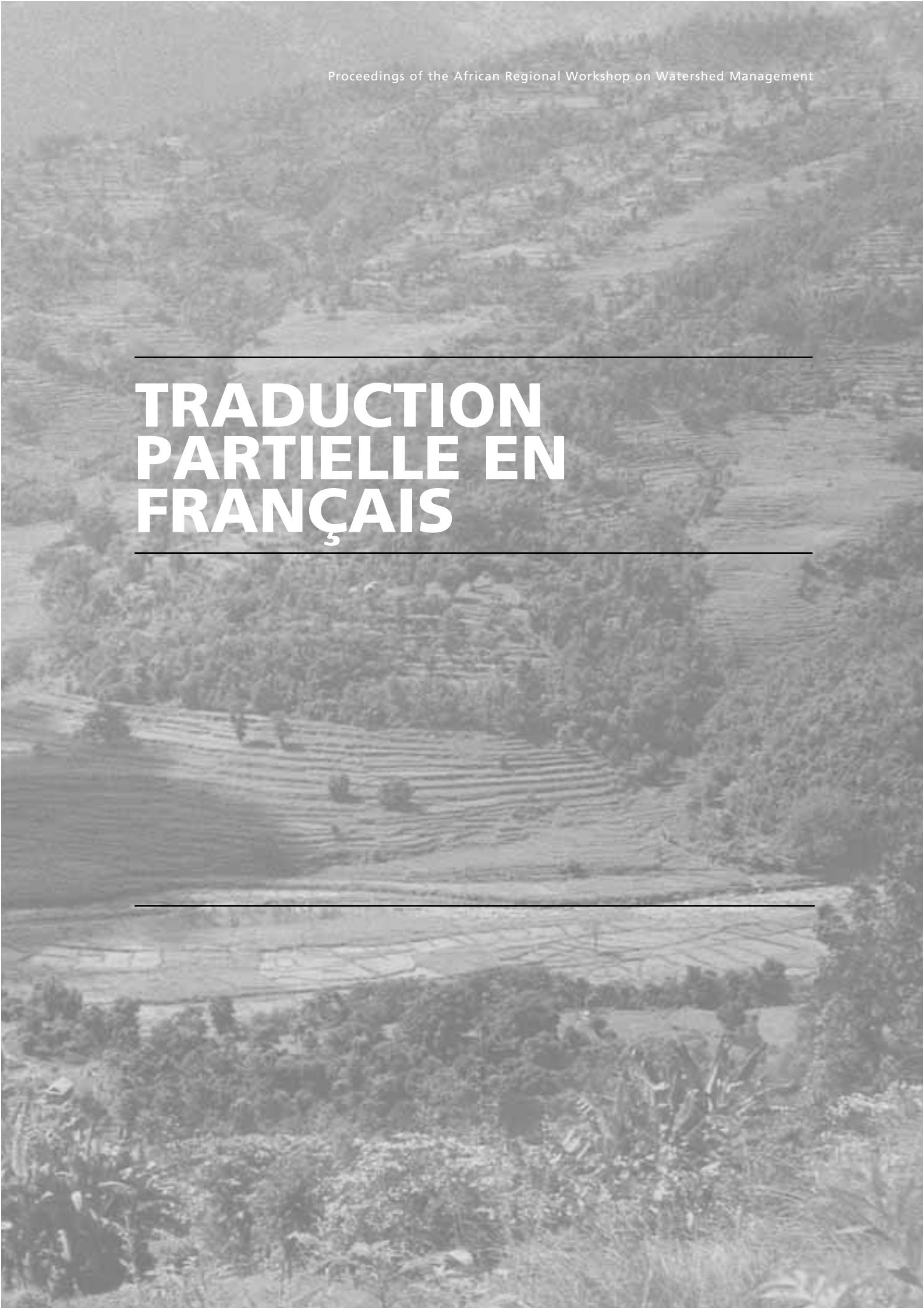


TRADUCTION PARTIELLE EN FRANÇAIS

PRÉFACE

À l'occasion de l'Année internationale de la montagne, la communauté internationale ayant reconnu à l'unanimité l'importance d'assurer une mise en valeur harmonieuse et durable des zones montagneuses et des bassins versants, l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) et ses partenaires ont décidé de procéder à une évaluation mondiale de l'état actuel et de l'orientation future des connaissances et des techniques relatives à l'aménagement intégré des bassins versants.

Les objectifs de cette évaluation étaient de promouvoir le partage et la transmission des expériences ayant trait à l'aménagement des bassins hydrographiques, d'identifier les difficultés de mise en œuvre et de développement des techniques utilisées durant la décennie 1990-2000, et de faire le point sur les paradigmes et méthodes nouvellement proposés. Une nouvelle génération de projets d'aménagement intégré des bassins hydrographiques sera bientôt définie sur la base des enseignements tirés de diverses expériences.

Des experts des quatre continents ont participé à l'évaluation qui s'est appuyée sur: 1) l'analyse des expériences d'aménagement des bassins versants à partir de questionnaires envoyés aux partenaires actifs sur le terrain; 2) les rapports complets des quatre séminaires régionaux tenus à Nairobi (Kenya), à Katmandou (Népal), à Arequipa (Pérou) et à Megève (France); 3) quatre études de cas sur le bassin méditerranéen, le Népal, la Bolivie et le Burundi; 4) la conférence internationale de Porto Cervo, dans la province de Sassari, en Sardaigne (Italie).

Les concepts et les méthodes relatives à l'aménagement des bassins versants ont été passés en revue et diverses expériences ont été évaluées. Les conclusions de l'étude figurent dans plusieurs documents, dont les comptes-rendus des séminaires et les rapports des quatre études de cas.

Depuis plusieurs décennies, de nombreux gouvernements accordent une priorité à la conservation, à l'utilisation et à l'aménagement durable des bassins versants pour répondre aux besoins d'une population croissante. On reconnaît aujourd'hui que la participation des populations à l'aménagement intégré des bassins versants est une approche qui garantit une gestion rationnelle et durable des ressources naturelles ainsi qu'une amélioration des conditions économiques des populations vivant dans les zones amont et aval.

Le séminaire africain régional sur l'élaboration de la prochaine génération de programmes d'aménagement des bassins versants, qui a été co-présenté par la FAO et le Conseil international pour la recherche en agroforesterie (CIRAF), s'est déroulé du 8 au 10 octobre 2003 au siège international du CIRAF à Nairobi (Kenya). Le séminaire a réuni 42 chercheurs, éducateurs, experts en développement, responsables d'aménagement de bassins fluviaux et

représentants gouvernementaux chargés de l'agriculture, de l'environnement, des terres et des eaux, venus de 13 pays africains, du Royaume-Uni, du Secrétariat de la Communauté de l'Afrique orientale, de la FAO et du CIRAF. Le séminaire s'est organisé autour de communications techniques, d'une visite sur le terrain, de groupes de travail et de débats en séance plénière dont la traduction simultanée a été assurée en français et en anglais.

Plusieurs thèmes ont été reconnus à l'unanimité comme étant prioritaires. Ces thèmes ont été mis en exergue dans le résumé du séminaire et lors de la conférence internationale de Sassari. Les plus importants sont la pauvreté, la gouvernance, les connaissances et l'information, et la nécessité de renforcer les capacités en matière d'aménagement intégré des bassins versants.

Le taux de pauvreté est plus élevé en Afrique que dans toute autre région du monde et il ne cesse d'augmenter dans de nombreux pays africains. Un taux élevé de pauvreté absolue a de multiples incidences sur l'aménagement des bassins versants: les gouvernements, comme les utilisateurs des ressources, n'ont que des perspectives à court terme et ont peu de moyens d'investir; l'investissement public est fortement tributaire des priorités définies par les bailleurs de fonds qui tendent à privilégier la lutte contre la pauvreté plutôt que la gestion des ressources naturelles.

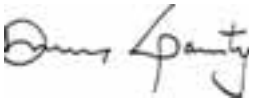
Les structures de gestion des bassins versants en Afrique doivent tenir compte de la nature transactionnelle des ressources en eau de la région: la plupart des pays africains partagent d'importants bassins fluviaux avec d'autres pays et les principales sources d'eau sont partagées entre deux ou plusieurs pays. De nombreux pays africains ont récemment adopté de nouvelles politiques de gestion de l'eau et de l'environnement et de nouveaux engagements ont été pris pour parvenir à une harmonisation régionale des politiques de mise en valeur des bassins versants. De nombreux problèmes subsistent toutefois. Les politiques régionales et nationales dans l'ensemble des secteurs concernés par la gestion de l'eau et de l'environnement doivent être harmonisées. Il est également indispensable de développer de toute urgence les capacités institutionnelles et de concevoir des mécanismes de financement et d'exécution pour que ces politiques puissent être pleinement mises en œuvre aux niveaux régional, national et local.

Les programmes d'aménagement des bassins versant manquent de données sur les relations de cause à effet. Le manque de connaissance est particulièrement important au niveau des relations entre les arbres, les forêts et les phénomènes hydrologiques à grande échelle, telles que les inondations et les glissements de terrain. Les données et les informations, lorsqu'elles existent, sont rarement communiquées aux autorités gestionnaires pour les aider à remplir leurs fonctions.

Il sera indispensable de consentir des investissements substantiels dans le développement des capacités et la constitution de réseaux afin d'améliorer l'aménagement des bassins versants en Afrique. Les capacités des principales institutions africaines devront être renforcées, en mettant plus particulièrement l'accent sur l'importance de développer en Afrique des outils et des méthodes adaptés à l'Afrique. Les systèmes de collecte et de suivi des données de base sont plus ou moins défaillants dans tous les pays africains. La constitution de nouveaux réseaux permettrait aux diverses parties concernées par l'aménagement des bassins versants en

Afrique de partager les concepts et les enseignements tirés de l'expérience sur ce continent. Il sera donc utile d'élargir la mise en place de réseaux entre les scientifiques de disciplines diverses, les responsables politiques, les utilisateurs des ressources, et entre les pays qui en sont à différents stades de développement institutionnel.

El-Hadji Sène
Directeur,
Division des ressources forestières
FAO



Dennis Garrity
Directeur général
Conseil international pour la recherche
en agroforesterie (CIRAF)

NOTE DES ÉDITEURS

Le matériel préparé pour (et durant) l'Atelier est présenté dans ce document. Cela comprend les 15 études complètes proposées par les auteurs (Chapitres 1 à 15) ainsi que des résumés de toutes les communications qui ont été présentées à l'atelier (Annexe A). Etant donné la variété des sujets débattus, les études et résumés ont été regroupés en cinq grandes parties dont: Brève revue par la FAO de l'aménagement des bassins versants (Partie 1), Relations entre utilisation des terres, couverture forestière et eau dans les bassins versants (Partie 2), Agriculture et aménagement des bassins versants en Afrique subsaharienne (Partie 3), Facteurs sociaux dans l'aménagement des bassins versants (Partie 4), et Expériences acquises dans le domaine de l'aménagement des bassins versants en Afrique (Partie 5). Les résultats des groupes de travail et les conclusions de l'atelier sont présentées dans la Partie 6. D'autres informations sont présentées en Annexes B et D.

Les travaux de l'Atelier régional organisé en Afrique sur la préparation de la nouvelle génération de programmes et projets sur l'aménagement des bassins versants en Afrique ont été réalisés en anglais et français. Cette publication comprend donc une partie en français, avec une introduction, des résumés et les conclusions de l'Atelier.

BREF APERÇU DE LA NOUVELLE GÉNÉRATION DE PROJETS D'AMÉNAGEMENT DES BASSINS VERSANTS ET DE L'ATELIER DE NAIROBI

En 2002-2003, la FAO a été chargée de diriger une évaluation mondiale sur l'aménagement des bassins versants à partir des programmes précédents. L'évaluation a commencé durant l'Année internationale de la montagne en 2002 et a pris fin au cours de l'Année internationale de l'eau douce en 2003. Pour la réaliser, plusieurs activités connexes ont été menées et divers organismes et experts ont été invités à y collaborer. Le Département des forêts de la FAO a été responsable de l'évaluation et d'autres divisions de la FAO y ont contribué.

Les objectifs de l'étude étaient les suivants:

- évaluer les programmes, politiques et connaissances en matière d'aménagement des bassins versants;
- identifier les principaux résultats et enseignements tirés des expériences des 15 dernières années;
- déterminer les principales faiblesses;
- élaborer des recommandations pour la "prochaine génération" de programmes d'aménagement.

L'évaluation a donné lieu à plusieurs activités, parmi lesquelles:

- une enquête auprès d'acteurs clés;
- des études de cas dans quatre régions;
- un séminaire avec les centres du Groupe consultatif pour la recherche agricole internationale (GCRAI) organisé lors de la Réunion sur la gestion intégrée des ressources naturelles à Alep (République arabe syrienne);
- quatre ateliers régionaux en Europe, Asie, Amérique latine et Afrique;
- une conférence internationale de clôture en Sardaigne (Italie).

Financé par le gouvernement néerlandais, le séminaire régional africain sur les bassins versants a été co-présenté par la FAO et par le Conseil international pour la recherche en agroforesterie (CIRAF). Les objectifs de l'atelier qui ont porté sur les enjeux spécifiquement africains de l'aménagement des bassins versants, étaient les suivants:

1. évaluation des programmes et des méthodes d'aménagement des bassins versants en Afrique par l'identification et la quantification des résultats positifs ainsi que des faiblesses;
2. analyse des enseignements et des principales difficultés qui ressortent des expériences réalisées dans le domaine de l'aménagement des bassins versants en Afrique, notamment durant la décennie 1990-2000;
3. formulation de recommandations utiles à la conception et à la mise en œuvre de la prochaine génération de projets et de programmes d'aménagement en Afrique.

Le séminaire s'est déroulé du 8 au 10 octobre 2003 au siège international du Conseil international pour la recherche en agroforesterie (CIRAF). Les discours d'ouverture ont été prononcés par Dennis Garrity, Directeur général du CIRAF, M. El-Hadji Sène, Directeur de la Division des ressources forestières de la FAO, et R.W. Michieka, Directeur général de la Commission nationale de gestion de l'environnement du Kenya. Le séminaire a été officiellement inauguré par John Munyes, Ministre adjoint de la gestion et du développement des ressources hydriques du Kenya, représentant du Ministre Martha Karua. Les débats ont eu lieu en français et en anglais, avec traduction simultanée.

Moujahed Achouri a ouvert la première session technique en présentant globalement le contexte et les objectifs de l'étude mondiale. Larry Tennyson lui a succédé en récapitulant les résultats obtenus avant le séminaire régional africain. Deux communications d'ordre général ont ensuite été présentées: l'une, par Ian Calder, sur l'importance de fonder les programmes d'aménagement des bassins versants sur les preuves scientifiques des interactions entre l'eau et les arbres; l'autre, par Jean-Marc Faurès de la FAO, sur les relations existantes entre la terre et l'eau.

La seconde session technique, terminant la première journée du séminaire, a été consacrée à sept documents avec des portées d'analyse diverses. Alain Albrecht a analysé les incidences de l'agroforesterie sur les parcelles de terrain exploitées; Brent Swallow a étudié les droits de propriété dans les bassins versants; Seef Rademeyer s'est intéressé à la gestion nationale des ressources hydriques en Afrique du Sud et Amadou Maiga a décrit une approche régionale pour l'aménagement du massif de Fouta Djallon en Afrique occidentale. Ces documents se sont appuyés sur diverses approches disciplinaires. Jean Bonnal a fait ainsi appel à la sociologie pour analyser la participation et la décentralisation tandis que Gete Zeleke a souligné l'importance de bénéficier d'un soutien plus large et plus durable pour assurer la gestion des ressources naturelles en Éthiopie afin de réduire les interventions d'aide alimentaire et de secours inscrites sur le court terme.

La deuxième journée du séminaire (le 9 octobre) a été consacrée à une autre session technique et à une visite sur le terrain. Les cinq communications techniques présentées ont analysé en détail des exemples concrets en Afrique: le bassin Limpopo en Afrique du Sud (Robert Hope), les plateaux intérieurs du Kenya (David Mungai), le bassin du fleuve Niger (Ousmane Diallo), le Haut Atlas au Maroc (Abdellah Zitan) et les bassins fluviaux du Ghana (Kwame Odame Ababio). Une nouvelle fois, les analyses ont concerné des échelles différentes: les communications de Robert Hope, de David Mungai et d'Abdellah Zitan ont porté sur la petite échelle du bassin; celle d'Ousmane Diallo, sur le système transfrontalier du fleuve Niger et celle de Kwame Odame Ababio, sur l'ensemble des ressources hydriques au Ghana.

Au cours de la visite sur le terrain, les participants ont pu ainsi se rendre compte des difficultés et des conflits que pose l'aménagement des bassins versants sur le terrain et hors du terrain. Les participants se sont rendus en car jusqu'au district montagneux de Thika au Kenya et ont été aimablement accueillis par les fonctionnaires du Ministère de l'agriculture du district. Ils ont pu constater le degré d'érosion des versants abrupts, se rendre sur une zone récemment touchée par des glissements de terrain et visiter le barrage de Ndakaini qui est géré par le Conseil municipal pour alimenter la ville de Nairobi en eau. L'eau du barrage semblait très claire et la zone de capture assez bien entretenue. Il est toutefois ressorti des échanges que la situation risquait d'être modifiée par un aménagement non coordonné des terres alentours. Bien que les associations communautaires locales et les entreprises en aval aient fait connaître leurs

inquiétudes relatives à l'utilisation du barrage et de l'eau qu'il retient, aucune réponse précise ne leur a été donnée.

Les communications techniques et la visite sur le terrain ont servi de préalable aux groupes de travail qui se sont déroulés le troisième et dernier jour de l'atelier. Le premier groupe s'est intéressé aux relations amont-aval dans l'aménagement des bassins versants; le deuxième groupe, au cadre politique et institutionnel; le troisième groupe, aux questions de mise en œuvre des programmes d'aménagement, y compris les interventions techniques, la participation des parties concernées, l'échelle d'exécution et les facteurs socio-économiques influant sur la mise en œuvre. Il a été demandé à tous les groupes d'étudier les résultats et les lacunes des réalisations antérieures, et de formuler des propositions d'orientations pour l'avenir. Les groupes ont délibéré en français et en anglais, avec une traduction informelle au sein des deux groupes. Les rapports ont été élaborés durant la pause du déjeuner et ont été présentés en séance plénière en début d'après-midi (voir les conclusions des groupes de travail). Brent Swallow a terminé le séminaire avec la présentation et la discussion du résumé provisoire (voir Chapitre 3). Les conclusions ont ensuite été faites par Dennis Garrity, Directeur général du CIRAF.

Le résumé définitif de l'atelier qu'ils avaient approuvé a été présenté ultérieurement au colloque international organisé par la FAO à Sassari (Italie), moins de deux semaines après le séminaire de Nairobi. Les versions définitives de toutes les communications techniques ont été élaborées, révisées et finalisées au cours de l'année 2004.

Les participants ont été conviés au séminaire sur invitation. Les organisateurs ont choisi des personnes et des institutions susceptibles de représenter: (1) toutes les régions du continent africain – l'Afrique du Nord, l'Afrique occidentale aride et semi-aride, l'Afrique centrale et l'Afrique occidentale humide, la Corne de l'Afrique, l'Afrique orientale et l'Afrique australe; (2) les pays africains francophones et anglophones; (3) les questions liées à l'aménagement des bassins versants à plusieurs niveaux, depuis l'utilisation des terres au niveau de la parcelle jusqu'aux bassins transfrontaliers; (4) les différents intervenants, depuis les organisations internationales, les gouvernements régionaux, les organismes publics nationaux et locaux, les politiciens élus, les responsables de la gestion des ressources hydriques jusqu'aux organisations non gouvernementales (ONG) et aux chercheurs; (5) les points de vue de diverses disciplines – hydrologie, sociologie, économie, agriculture et ingénierie. Il a été demandé à tous les participants de soumettre une communication technique; les résumés ont été examinés et les participants sélectionnés ont été invités à faire une communication. Au total, 48 participants, représentant 13 pays et trois organisations internationales, ainsi que trois experts du Royaume-Uni et d'Amérique du Nord, ont participé au séminaire

DISCOURS DE BIENVENUE ET COMMUNICATIONS D'ORDRE GÉNÉRAL

Les discours d'ouverture ont été prononcés par Dennis Garrity, Directeur général du Centre mondial d'agroforesterie (CIRAF), El-Hadji Sène, Directeur de la Division des ressources forestières de la FAO et par R. W. Michieka, Directeur général de l'Autorité nationale de l'environnement du Kenya. Le séminaire a été officiellement inauguré par John Munyes, Ministre adjoint de la gestion et du développement des ressources hydriques du Kenya, représentant du Ministre Martha Karua.

Dennis Garrity a accueilli les participants au siège international du CIRAF à Nairobi (Kenya). Le CIRAF mène une recherche et des projets pilotes pour montrer que l'agroforestrie - la plantation d'arbres sur de petites exploitations - peut aider à réduire la pauvreté, à améliorer la sécurité alimentaire et à protéger l'environnement naturel, et qu'elle peut être un moyen de répondre aux besoins et aux aspirations d'un milliard de pauvres dans les pays en développement. Les populations pauvres sont fortement tributaires des ressources naturelles et subissent souvent les plus lourdes conséquences des catastrophes naturelles, comme par exemple, les inondations et les sécheresses. Dans de nombreuses régions, leur densité dans les zones amont des bassins est tellement forte que leurs modes d'exploitation des terres et leurs pratiques agricoles affectent la fonction des bassins hydrographiques et la biodiversité. Compte tenu de la poussée démographique et de la raréfaction de l'eau, il sera important d'accorder une place de plus en plus importante aux relations entre terres, eaux et gestion des arbres dans les zones amont des bassins et à la protection des utilisateurs d'eau en aval. Dans le cadre de sa récente restructuration, le CIRAF a décidé de renforcer la priorité qu'il accorde aux aménagements de bassins orientés en faveur des populations pauvres, notamment en Afrique orientale et en Asie du Sud-Est. En Afrique orientale, le CIRAF s'intéresse plus particulièrement au bassin du lac Victoria, et, de plus en plus, aux châteaux d'eau que constituent les monts Kenya et Elgon.

El-Hadji Sène a accueilli les participants au nom de l'Organisation des Nations Unies pour l'agriculture et l'alimentation. La FAO a accordé la plus haute importance à ce séminaire et y a délégué des représentants de trois divisions, et ceci pour plusieurs raisons. La FAO est le Chef de projet de l'Action 21 du Chapitre 13 de la Conférence des Nations Unies sur l'environnement et le développement (CNUED) qui préconise d'attacher une plus grande importance aux programmes intégrés d'aménagement des bassins versants. Les grandes lignes de ces programmes ont été définies mais on ne sait pas encore vraiment ce qui fonctionne bien et mal dans des contextes spécifiques. Par ailleurs, la question de l'aménagement des bassins versants a été l'un des thèmes principaux des Années internationales des Nations Unies consacrées à la montagne en 2002 et à l'eau douce en 2003. En 2002 et en 2003, la FAO a ainsi été le chef de file des efforts internationaux déployés pour analyser les expériences d'aménagement des bassins versants.

El-Hadji Sène a ensuite présenté les axes de l'étude mondiale, les principales activités entreprises et les objectifs du séminaire. Il a invité les participants à exposer les grandes lignes de l'état actuel des connaissances en matière d'aménagement de bassins versants dans la région, à susciter une meilleure prise de conscience et un plus grand soutien aux actions d'aménagement efficace des bassins à l'échelle locale, nationale et régionale. Il a également souhaité qu'ils quittent le séminaire avec une détermination nouvelle, un intérêt renouvelé et le désir de mettre tout en œuvre pour que des initiatives appropriées soient développées partout où cela est nécessaire en Afrique.

R.W. Michieka a souligné l'importance du séminaire pour les populations et le gouvernement du Kenya car l'aménagement des bassins versants est l'une des priorités de l'Autorité nationale de la gestion de l'environnement au Kenya. L'érosion des sols sur les exploitations agricoles limite la productivité, diminue la qualité de l'eau, provoque l'ensablement des rivières et des réservoirs, et contribue aux problèmes d'inondations et d'eutrophication des lacs. Les zones humides constituent d'importants réservoirs d'eau; elles aident à filtrer les polluants pour les sources d'eau et à préserver la biodiversité. Les rares ressources forestières subsistant au Kenya

influent sur la qualité et la quantité d'eau ainsi que sur la préservation de la biodiversité. Plusieurs défis se posent aujourd'hui à la Commission nationale de gestion de l'environnement du Kenya: attribuer une juste valeur aux ressources hydriques; promouvoir la coopération dans le domaine de la gestion des ressources en eau; proposer des mesures d'encouragement aux communautés et aux sociétés privées pour les inciter à participer plus efficacement à la gestion de ces ressources; prendre de nouvelles dispositions administratives plus équitables pour les utilisateurs de l'eau; mieux intégrer les divers secteurs concernés par l'eau; enfin, déléguer les fonctions de planification et de gestion des ressources hydriques aux niveaux concernés. On attend de ce séminaire qu'il contribue à relever ces défis.

Le discours du Ministre Martha Karua a présenté une vue d'ensemble des ressources hydriques du Kenya et des nombreuses difficultés que doit affronter le gouvernement dans ce secteur: eau non comptabilisée, gaspillage, inondations et pénuries d'eau saisonnières dans les rivières et les réservoirs. Ces problèmes ont été à l'origine de l'élaboration et de l'approbation de la nouvelle loi sur le régime des eaux de 2002. Cette loi redéfinit le rôle du gouvernement dans la gestion des ressources hydriques. Elle change radicalement la fonction du Ministère de l'eau, crée de nouvelles institutions de gestion à l'échelle nationale, régionale et locale, et donne un nouveau rôle au secteur privé et aux associations d'utilisateurs de l'eau. L'une des principales missions du gouvernement aujourd'hui est de faire appliquer cette loi. Le séminaire s'est donc déroulé au bon moment pour le gouvernement et les habitants du Kenya.

VUE D'ENSEMBLE DES COMMUNICATIONS

Les communications de Moujahed Achouri (et de Larry Tennyson [première partie]), qui ont étayé le discours d'ouverture de M. El-Hadji Sène, ont fourni de plus amples détails sur le processus d'études et de débats lancé par la FAO en 2002. Le séminaire régional africain est la dernière d'une série d'actions incluant des études théoriques, des ateliers régionaux et des évaluations réalisés avant la conférence internationale de Porto Cervo, dans la province de Sassari, en Sardaigne (Italie) du 22 au 24 octobre 2003 sur le thème 'Des ressources en eau pour l'avenir'. Les résultats seront largement diffusés pour aider à mieux concevoir la prochaine génération des programmes d'aménagement des bassins versants.

Larry Tennyson (y a résumé les résultats d'une enquête réalisée auprès d'acteurs clés ainsi que les conclusions de l'étude de la FAO sur les expériences en matière de bassins versants et des ateliers régionaux précédents. Sa communication s'est terminée par un tableau récapitulant les scénarios antérieurs et indiquant des orientations pour les programmes d'aménagement à venir. Les principaux enseignements se résument en six points:

1. Dans le passé, l'aménagement des bassins versants était fondé sur les symptômes biophysiques; à l'avenir, il faudra s'attacher à identifier les causes sous-jacentes et les remèdes aux problèmes;

2. dans le passé, priorité a été donnée aux conséquences en aval résultant de l'utilisation des terres en amont; à l'avenir, il faudra accorder au moins autant d'importance aux coûts et avantages sur le terrain de l'aménagement des bassins versants;

3. dans le passé, les programmes d'aménagement des bassins versants ont supposé que le gouvernement avait une bonne capacité d'action et que l'environnement politique était propice; à l'avenir, il faudra que les programmes renforcent les capacités et suscitent les changements de politiques nécessaires;
4. dans le passé, les programmes d'aménagement des bassins versants ont adopté une approche verticale descendante pour le développement et le transfert de technologie; à l'avenir, il faudra plutôt insister sur l'apprentissage participatif des multiples parties concernées;
5. dans le passé, les programmes ont été avant tout axés sur la production de denrées alimentaires spécifiques; à l'avenir, on cherchera plutôt à associer diverses utilisations des terres afin de consolider les moyens d'existence des populations rurales;
6. dans le passé, les approches en matière d'aménagement intégré des bassins versants se sont greffées sur des projets de développement rural existants et se sont appuyées sur les ministères responsables en la matière; à l'avenir, les programmes seront fondés sur l'utilisation multiple des ressources naturelles et les questions spécifiques seront prises en charge par les institutions responsables concernées.

Les communications de Ian Calder et de Jean-Marc Faurès (deuxième partie) ont étudié les liens existants entre l'exploitation des terres, le couvert végétal et l'eau, fournissant ainsi des informations utiles pour mieux aménager les bassins versants. Les deux communications se fondent sur des données recueillies en plusieurs lieux dans les zones tropicales. J.M. Faurès a résumé les conclusions d'une étude effectuée par la Division de la gestion des sols et des eaux de la FAO qui s'est terminée par une importante cyberconférence. En termes de liens biophysiques entre l'utilisation des terres et des eaux, l'étude montre que l'utilisation des sols a une incidence significative sur la qualité de l'eau, par le biais notamment des pesticides, de la salinité et des nutriments solubles. L'utilisation des terres peut avoir des conséquences mesurables sur la disponibilité totale et les schémas saisonniers de l'eau dans les petits bassins hydrographiques; dans les bassins plus vastes, ces conséquences sont en général masquées par la variation spatiale et temporelle de l'intensité des précipitations, le régime des pluies et des eaux de ruissellement, le type de sol et la répartition géographique des matières d'origine. I. Calder a repris quelques-unes de ces observations. Il a remis en question certaines conventions et a regretté le peu de liens entre les politiques et les sciences de gestion intégrée de l'eau. Les généralisations sur les relations arbres-eau utilisées pour justifier des programmes de plantation d'arbres et de récupération de l'eau sont souvent erronées et des millions de dollars sont ainsi gaspillés. D'après lui, il est indispensable de mieux comprendre ces relations dans des contextes spécifiques et cette compréhension doit être étayée par des modèles empiriques pouvant être facilement calibrés pour d'autres conditions. J.M. Faurès) affirme en outre que l'on peut mettre en place des mécanismes de services environnementaux pour améliorer les liens entre éléments amonts et avals de bassins, mais à condition d'avoir au préalable évalué précisément les coûts des connections et des interventions éventuelles.

Les 15 autres communications techniques ont tiré des conclusions générales à partir de contextes particuliers sur le continent africain. Elles varient par l'échelle et la portée d'analyse: de l'analyse des institutions régissant les bassins versants et fluviaux transfrontaliers jusqu'aux interactions entre l'utilisation des sols et de l'eau au niveau des parcelles. Les communications d'Amadou Maiga et d'Ousmane Diallo (cinquième partie) sur l'aménagement des bassins versants du massif du Fouta Djallon et du bassin du Niger ont apporté une vision plus large. L'importance et les difficultés de gérer les bassins fluviaux partagés ont été soulignées plusieurs fois au cours du séminaire. S'il existe des exemples remarquables d'accords efficaces sur les

bassins fluviaux transnationaux, la plus grande part des ressources hydriques partagées restent les ressources les plus litigieuses et le moins bien exploitées du continent. Les ressources hydriques, telles que les lacs Tchad et Victoria, sont déjà gravement détériorées. A. Maiga a décrit une nouvelle approche prometteuse pour gérer les ressources partagées du massif de Fouta Djallon et O. Diallo a expliqué les difficultés que pose la gestion partagée du bassin du fleuve Niger dont la source se trouve dans le Fouta Djallon. Les gouvernements doivent s'engager à agir davantage, en particulier au niveau d'institutions et de lois communes.

Quatre communications ont été consacrées à la gestion des ressources en eau à l'échelle nationale (cinquième partie): Gete Zeleke pour l'Éthiopie, S. Rademeyer pour l'Afrique du Sud, Kwame Odame-Ababio pour le Ghana et Hodson Makurira et Menard Mugumo pour le Zimbabwe. Ces communications reflètent les principales différences que l'on peut rencontrer dans les pays africains. À l'un des extrêmes, S. Rademeyer montre que l'Afrique du Sud gère des ressources en eau très limitées d'une manière rigoureuse et moderne. La capacité de stockage de l'eau par habitant est relativement élevée par rapport à d'autres pays africains; les institutions chargées de la gestion de l'eau sont assez évoluées et tous les bassins fluviaux, à l'exception d'un seul, sont reliés entre eux. L'eau est considérée comme une ressource nationale et il est garanti à chaque personne une quantité minimale d'eau à usage domestique et personnel. La gestion de l'eau et la réglementation de son utilisation bénéficient d'investissements substantiels en infrastructures et en ressources humaines et financières. Le Ghana, quant à lui, a adopté une approche similaire: l'État a en effet investi dans le stockage de l'eau à grande échelle et dans un système national de gestion et de suivi. Le Zimbabwe, pour sa part, a promulgué une nouvelle loi sur l'eau en 1998 qui a mis fin à des décennies de discrimination entérinées par les textes précédents relatifs à l'attribution de l'eau. La nouvelle loi a été conçue de manière à faire participer tous les acteurs concernés par la gestion de l'eau et à utiliser plus efficacement les droits d'usage de l'eau, les permis remplaçant les droits d'usage, les programmes d'utilisation des eaux de retenue et les allocations minimales d'eau réservées à l'environnement. Malheureusement, les nouvelles institutions ont besoin de ressources supplémentaires alors que le financement, consenti tant par les bailleurs de fonds qu'au niveau national, a considérablement diminué. Les capacités de l'Éthiopie en matière de gestion des ressources hydriques semblent, quant à elles, sous-développées. Bien que le pays bénéficie de pluies relativement abondantes, il n'a pour ainsi dire aucune capacité de stockage et les investissements dans la gestion de l'eau ou dans l'aménagement des bassins versants sont très faibles. L'Éthiopie est fortement tributaire du financement des bailleurs de fonds qui est en général plutôt consacré aux opérations de secours qu'au développement à long terme et à la conservation des resources.

Les communications de Brent Swallow, Leah Onyango et Ruth Meinzen-Dick, et de Nontokozo Nemarundwe et Robert Hope (quatrième partie), ont concerné les ressources hydriques et l'aménagement des bassins versants à l'échelle des zones de captage et des villages, là où les interactions entre facteurs sociaux et hydrologiques sont sans doute les plus claires. B. Swallow, L. Onyango et R. Meinzen-Dick ont développé un modèle conceptuel des droits de propriété des bassins versants qu'ils ont ensuite appliqué à une analyse des incidences des droits de propriété sur la gestion et l'utilisation des ressources dans le bassin, très dégradé, de Nyando dans l'ouest du Kenya. Quatre implications générales se sont dégagées du cadre conceptuel et de l'analyse proposés: (1) le régime foncier, le mode de peuplement, la densité de population et les systèmes d'utilisation des terres sont étroitement liés par des processus historiques communs; (2) les droits relatifs à la terre, à l'eau et aux arbres sont souvent interdépendants dans les cultures africaines; (3) les captages de taille moyenne sont régis par une multitude de

droits de propriété imbriqués, et parfois contradictoires; (4) les parties du paysage qui ont le plus grand impact sur la gestion globale du captage de l'eau – notamment les zones riveraines, les clôtures et les routes – sont souvent les plus contestées et sont régies par les droits de propriété les plus ambigus. R. Hope a présenté un modèle d'attribution et d'estimation en eaux bleues-vertes et l'a appliqué au bassin de Luvuvhu dans le massif de Limpopo en Afrique australe. L'analyse a relié les moyens d'existence des populations à l'évaporation et à la transpiration de l'eau (eau verte) et a montré que les personnes relativement démunies sont fortement tributaires de l'eau verte pour obtenir un revenu et assurer une agriculture de subsistance. N. Nemarundwea décrit la flexibilité et le chevauchement des institutions chargées de la gestion publique de l'eau dans un village du Zimbabwe. Cette étude de cas détaillée a montré la diversité à la fois des ressources hydriques et des dispositions institutionnelles qui existent souvent au sein de certains villages: les règles y sont connues de tous mais sont implicites, flexibles et nuancées. L'étude de cas a également mis en évidence que de nombreux villages africains ont la capacité de développer des systèmes complexes et perfectionnés de gestion de l'eau bien que les particularités de ces systèmes échappent souvent aux observateurs étrangers qui s'attendent à des classifications bien définies, des règles codifiées et des mécanismes formels d'exécution.

Les communications de Jean Bonnal et de Zitan Abdellah (quatrième partie) ont souligné l'importance de la participation dans l'aménagement des bassins versants. Z. Adbellah a décrit l'approche participative utilisée lors de la mise en œuvre de l'aménagement du bassin de la Tassaout dans le Haut Atlas Central du Maroc. Le projet expérimental exécuté entre 1996 et 2002 dans la Tassaout a été réussi grâce à l'adoption d'une approche novatrice dont les caractéristiques sont les suivantes: (1) prise en compte des données tant hydrologiques qu'ethniques lors de la définition des domaines d'application; (2) recrutement d'une équipe locale d'organisateurs relativement autonomes par rapport aux structures administratives en place; (3) mise en valeur de méthodes novatrices en matière de pratiques agricoles visant à conserver les sols et les eaux; (4) nouvel esprit de coopération entre l'administration forestière et la population locale. J. Bonnal a analysé le contexte socio-politique de la participation dans l'aménagement des bassins versants et montré que la décentralisation et la délégation des pouvoirs sont indispensables pour que les populations locales puissent réellement accroître leur participation aux projets: la décentralisation, pour sa part, requiert une prise en compte des questions institutionnelles et organisationnelles dans le cadre de l'environnement politique local. Une gestion participative et décentralisée des bassins versants ne peut fonctionner que si trois conditions sont réunies: (1) la mise en commun de l'information; (2) une consolidation des organisations locales; (3) la promotion du dialogue entre organisations locales et nationales.

Trois communications ont analysé les interactions entre l'agriculture et la gestion des ressources en eau. F. T. Mugabe (troisième partie) a étudié les conséquences de l'utilisation et de l'aménagement des terres sur la réalimentation des nappes d'eau souterraines et du réservoir de la zone de captage de Romwe dans le sud-est semi-aride du Zimbabwe. D'après une analyse de données détaillées recueillies sur cette zone pendant les 10 dernières années, l'aménagement des terres a des incidences considérables à la fois sur la réalimentation des nappes souterraines et sur les écoulements directs de surface. La réalimentation des eaux souterraines varie fortement dans l'espace et dans le temps, la réalimentation se produisant surtout au moment de certaines pluies, là où l'eau de surface s'accumule et plus particulièrement autour des bourrelets de niveau et le long des drains de surface. La quantité d'eau de ruissellement produite par les orages dépend de l'activité agricole, cette dernière favorisant l'infiltration et diminuant les eaux

de ruissellement. Anja Boye et Alain Albrecht ont décrit les conséquences de l'agroforesterie et des pratiques agricoles de conservation sur l'infiltration et les eaux de ruissellement dans les systèmes agricoles de l'ouest du Kenya. Des résultats expérimentaux montrent qu'une amélioration de la jachère peut accroître l'infiltration et réduire l'érosion des sols dans des proportions variables en fonction du type de sol. Il a été surprenant de constater que la culture sans labour a une faible incidence sur l'infiltration et l'érosion des sols. Johan Rockström et Kurt Steiner se sont intéressés à l'innovation technique en agriculture écologique et à sa capacité d'augmenter la quantité disponible et de rationaliser l'utilisation de l'eau en agriculture. Des essais dans les zones semi-arides de la République Unie de Tanzanie, de Madagascar et du Soudan montrent que ce type d'agriculture peut entraîner une forte hausse de la production et de l'efficience d'utilisation de l'eau. Les résultats sont toutefois meilleurs lorsque cette agriculture est associée à des actions visant à accroître la fertilité des sols. Cette observation confirme la conclusion que la fertilité des sols et la conservation de l'eau sont des techniques complémentaires susceptibles d'augmenter de manière considérable tant la production agricole que l'utilisation rationnelle de l'eau dans les zones semi-arides de l'Afrique.

La communication technique de P. Mbile *et al.* (troisième partie) a exploré les relations entre les fonctions des bassins versants et la structure des agroforêts de cacaotiers dans la zone humide du Cameroun. Selon les résultats des enquêtes réalisées dans 30 de ces forêts, les cacaotiers, bien que d'une faible valeur économique directe pour les exploitants qui les cultivent, revêtent une importance capitale pour la conservation de la biodiversité, l'interception et l'infiltration des précipitations. D'après les auteurs, les exploitants risquent d'abattre les cacaotiers en grand nombre pour s'orienter vers une production différente, ce qui pourrait profondément bouleverser les bilans hydriques et les fonctions des bassins versants.

RÉSUMÉ DES PRÉSENTATIONS

PARTIE 1 – REVUE DE LA FAO SUR L'AMÉNAGEMENT DES BASSINS VERSANTS

Élaboration de la nouvelle génération de programmes d'aménagement des bassins versants

Moujahed Achouri, Département des forêts, FAO, Rome (Italie)

De grands progrès ont été réalisés dans le domaine de l'aménagement des bassins versants, en particulier de 1990 à 2002 lorsque de nouvelles méthodes et méthodologies ont été développées en vue de promouvoir une gestion intégrée et participative. Toutefois, les résultats n'ont pas été clairement et globalement évalués et l'on ne sait pas quelles améliorations apporter aux prochains programmes d'aménagement. En fait, depuis la réunion d'experts organisée par la FAO à Katmandou du 25 février au 1er mars 1985 (il y a donc 18 ans), aucun effort systématique n'a été déployé pour examiner et évaluer les stratégies et les méthodes d'aménagement à l'échelle internationale. Avant d'élaborer de nouveaux programmes, il est donc indispensable de procéder à une analyse approfondie des points forts et des faiblesses des expériences précédentes, en s'attachant plus particulièrement à la période 1990-2002.

Cette communication propose un examen et une évaluation des programmes d'aménagement des bassins versants afin d'obtenir des informations fiables sur les résultats issus de l'expérience et les lacunes existantes. Ces informations sont indispensables pour justifier les investissements dans les actions d'aménagement des bassins versants et pour exécuter ces actions là où le besoin est le plus grand. Le processus d'évaluation a été conçu de manière à considérer les besoins et à tenir compte des caractéristiques des divers acteurs associés à l'aménagement des bassins versants. Il se compose de consultations, d'enquêtes, d'inventaires, d'études de cas, de colloques, de conférences internationales et d'une diffusion des résultats.

Examen et évaluation des stratégies et des méthodes d'aménagement des bassins versants – Phase I

L. C. Tennyson, Consultant en aménagement des bassins versants, FAO, Rome (Italie)

L'aménagement des bassins versants est souvent considéré comme l'une des méthodes les mieux adaptées pour garantir la préservation, la conservation et la durabilité des ressources en eaux et en terres et pour améliorer les moyens d'existence des populations vivant dans les hautes terres et les basses terres. On reconnaît aujourd'hui largement qu'un aménagement intégré faisant appel à la participation de tous les acteurs concernés constitue l'une des meilleures méthodes pour assurer une gestion durable des ressources naturelles renouvelables et non renouvelables dans les zones de hautes terres. Les gouvernements et les organismes d'aide au développement se sont appuyés sur les principes d'aménagement des bassins versants depuis les années 60 pour tenter de mettre un frein à la dégradation des ressources issues de la terre et de l'eau. Au cours de ces années, la discipline a acquis de l'expérience, ce qui a modifié

les stratégies et les méthodes de mise en œuvre. L'examen et l'évaluation périodiques se poursuivent de manière dynamique en tenant compte des résultats de la recherche, des enseignements tirés de l'expérience, des échecs et des réussites des stratégies et des programmes, et en procédant à des ajustements et à des modifications en fonction de l'évolution des besoins.

Compte tenu des changements observés dans le domaine du développement au cours de la dernière décennie, l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) a décidé de réaliser un examen et une évaluation des stratégies et des méthodes relatives à l'aménagement des bassins versants afin de faire le point sur la situation actuelle. Cet exercice devait permettre d'identifier les faiblesses majeures et de définir les orientations des futurs projets et programmes. Le précédent examen s'est déroulé de 1985 à 1986. L'étude globale s'appuie sur une enquête réalisée auprès d'acteurs clés, des études de cas, des séminaires régionaux et des conférences internationales; elle inclut l'élaboration de recommandations et de stratégies pour les futurs programmes d'aménagement. Elle comporte également un résumé de l'expérience des principaux acteurs et de la FAO dans les projets et les programmes exécutés durant la période 1990-2000. Les thèmes couverts portent sur la technologie, la formation et l'éducation, les questions de parité hommes-femmes, les méthodes participatives ainsi que les recommandations intéressant la prochaine génération de programmes d'aménagement des bassins versants.

PARTIE 2 – RELATIONS ENTRE UTILISATION DES TERRES, COUVERTURE FORESTIÈRE ET EAU DES BASSINS VERSANTS

Relations terre-eau dans les bassins versants de zones rurales

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On suppose souvent que l'utilisation des terres a des conséquences importantes sur les ressources en eau et qu'elle a un effet sur les populations vivant dans la partie aval des bassins fluviaux. La nature et la portée de ces conséquences éventuelles, leur influence sur les relations existantes entre divers groupes de populations dans un même bassin versant et les mécanismes qui permettraient de répartir les coûts et les avantages entre les différentes parties prenantes sont très controversés.

Les incidences de l'utilisation des terres sur les ressources hydriques varient selon le contexte local. Il est difficile de les contrôler en raison du temps considérable qui s'écoule entre cause et effet et des interférences entre les incidences naturelles et celles induites par l'homme. De ce fait, il est difficile de tirer des conclusions claires et directes sur les conséquences de l'utilisation des terres sur l'eau dans les bassins versants. Bien qu'elle ne soit pas pleinement comprise, la question de la taille des bassins affecte aussi ces relations de manière significative: certaines expériences montrent que les incidences de la gestion des terres sur l'hydrologie et sur la sédimentation dans les bassins fluviaux s'observent plus facilement dans les petits bassins versants que dans les grands. En revanche, la taille d'un bassin importe moins lorsque l'on considère la qualité d'eau. En effet, on peut observer les impacts négatifs de l'agriculture sur la qualité de l'eau, à tous les niveaux, dans les bassins versants.

Il faut veiller à ne pas mal interpréter et à ne pas généraliser les conclusions, notamment lorsque l'on extrapole des résultats obtenus dans des bassins relativement petits. Des études de cas sur les rapports terre-eau sont présentées et analysées dans l'objectif de recommander des changements possibles dans l'utilisation des terres dans les petits bassins versants.

Peut-on inclure davantage de politiques axées sur les résultats pour aménager les bassins versants? – Vers la prochaine génération de projets d'aménagement

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Les concepts sous-jacents à la gestion intégrée des ressources en eau ont été développés à la fin des années 90. Ces concepts sont maintenant approuvés et soutenus par tous les organismes de développement (Calder, 1999) et sont considérés comme des préalables nécessaires, quoique souvent insuffisants, à la réalisation des Objectifs du Millénaire pour le développement. Ils sont également considérés comme les principes directeurs de la 'Révolution bleue' dans les politiques de gestion des eaux et des terres et constituent la base de la conception des projets de développement des bassins versants.

L'analyse des projets de développement des bassins ainsi que des politiques relatives à l'eau et à la terre dans divers pays montre qu'il existe de très sérieuses insuffisances et que dans de nombreux cas, l'impact des politiques est pervers. Le défi à relever, lors de l'élaboration de la nouvelle génération de projets de mise en valeur des bassins versants, consistera à savoir *comment appliquer* ces concepts dans le cadre plus large d'une gestion des ressources qui se caractérise par:

- des pressions de plus en plus intenses et conflictuelles sur les ressources en terres et en eaux pour l'approvisionnement en nourriture, en eau et en autres biens et services (bois d'œuvre, pêche, conservation, commodités d'usage, par exemple);
- des conflits intersectoriels pour la fourniture d'eau, de terre, d'électricité, d'irrigation, de canalisation et d'assainissement;
- des préoccupations sur la gestion amont des terres et des eaux qui, dans les projets de mise en valeur des bassins versants, ignore en général les incidences sur les zones en aval, notamment lorsqu'elles se répercutent sur les pauvres en zones rurales et urbaines et sur les intérêts transnationaux et côtiers;
- la crainte que les opportunités créées par une meilleure gestion des ressources dans une économie mondiale en voie de globalisation rapide soient accaparées par ceux qui ne sont pas les plus pauvres.

La mise en œuvre des concepts de la gestion intégrée des ressources en eau devra affronter une réalité difficile et complexe: les politiques et les actions relatives à la terre et à l'eau à l'échelle internationale, nationale et locale sont en effet généralement dictées, dominées et exploitées par les intérêts directs de puissants et riches groupes sectoriels (utilisant à leur avantage, de bonne ou de mauvaise foi, n'importe quel mythe relatif à la terre et à l'eau), et ceci, en général, au détriment des plus pauvres. En conséquence, les résultats sont souvent contraires aux prévisions et des milliards de dollars affectés au développement sont gaspillés pour des objectifs irréalisables dans le cadre de projets d'aménagement des bassins versants.

PARTIE 3 – AGRICULTURE ET AMÉNAGEMENT DES BASSINS VERSANTS EN AFRIQUE SUBSAHARIENNE

Contrôle des eaux de ruissellement et de l'érosion lors de jachères améliorées dans l'ouest du Kenya

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On s'intéresse aux eaux de ruissellement et à l'érosion depuis des décennies mais le problème reste entier dans les régions tropicales humides. La majeure partie de la recherche sur l'érosion des sols s'est axée sur le contrôle des eaux de ruissellement au niveau du paysage par le biais des bandes tampons et de terrasses et s'est moins intéressée aux processus se déroulant au niveau de la parcelle sur des sols intacts. L'objectif de cette étude est d'étudier les eaux de ruissellement, les pertes de sol et de carbone sur des sols *in situ* pendant deux types de jachères améliorées (*Tephrosia candida* [IF-Tc] et *Sesbania sesban* [IF-Ss]), et deux techniques de labour (travail du sol classique [CT] et culture sans labour [NT]) pour un limon sableux et un sol argileux dans l'ouest du Kenya. Les ruissellements des eaux et l'érosion des sols ont été mesurées en utilisant un simulateur de précipitations sur le terrain en condition pré-arrosée. L'hypothèse de cette étude était qu'une jachère améliorée (IF) associée à l'absence de labour améliorerait les propriétés du sol grâce à l'augmentation de l'infiltration de l'eau et à la réduction des pertes de sol et de carbone. On prévoyait que l'effet de la mise en jachère sur l'amélioration des sols serait plus important pour un sol argileux que pour un sol de limon sableux car les particules d'argile ont une plus grande capacité de rétention de matière organique et de formation d'agrégats.

Les résultats de l'étude montrent que les jachères améliorées ont augmenté l'infiltration et réduit les pertes de sols sur les deux sites, et plus efficacement dans le cas du sol argileux ($p \leq 0.001$). Dans le cas du sol argileux, la jachère améliorée (IF-Tc et IF-Ss) a augmenté sensiblement l'infiltration, de 35 à 38% (85 à 87% au lieu de 63%, $p \leq 0.030$), et réduit les pertes de sol de 88 à 93%, (4 à 6 g m^{-2}, au lieu de 50 g m^{-2}, $p \leq 0.002$). Dans le cas du limon sableux, les différences d'infiltration et de pertes de sol entre la culture continue (CC) et la jachère améliorée (IF) ne se sont révélées significatives que pour la jachère IF-Ss (*Sesbania sesba*) qui a amélioré l'infiltration de 54% (74% au lieu de 48%, 0.089) et réduit les pertes de sol de 70% (11 g m^{-2} au lieu de 37 g m^{-2}, $p \leq 0.101$). Dans le cas du sol argileux, les pertes de carbone ont été réduites de 79 à 83% (0.19 à 0.24 g C m^{-2} au lieu de 1.15 g C m^{-2}, $p \leq 0.004$), alors que la jachère IF-Ss a apporté une réduction des pertes de carbone de 75% pour le sol de limon sableux (0.42 g C m^{-2} au lieu de 1.69 g C m^{-2}, $p \leq 0.039$). Pour l'argile, l'incidence de la jachère sur l'infiltration, les pertes de sol et de carbone proviennent d'une forte amélioration des propriétés physico-chimiques du sol (carbone organique, densité volumique apparente et agrégation du sol) alors que dans le cas du limon sableux, on n'a observé une amélioration des propriétés du sol que pour les cultures en jachère améliorée de type IF-Tc. C'est la maîtrise, par la jachère améliorée, des processus de formation de couches durcies qui a permis de réduire les ruissellements et les pertes de sol. Pour les sols argileux en jachère améliorée, le non-labour a fortement réduit la concentration en sédiments, l'érosion des sols et les pertes de carbone, alors que dans le cas des limons sableux, le non-labour n'a réduit les pertes de carbone que dans les jachères améliorées de type IF-Ss.

Conclusions des recherches menées pendant 10 ans sur les bassins versants et les ressources hydriques des zones semi-arides du Zimbabwe méridional

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Les précipitations dans les zones semi-arides du Zimbabwe, situées dans les régions naturelles IV et V, sont faibles et irrégulières. L'aridoculture n'est pas fiable et les communautés qui vivent dans ces zones sont donc tributaires des réservoirs d'eau. Les eaux de surface et souterraines dépendent toutes de l'hydrologie des bassins; les études hydrologiques de bassin sont donc un préalable nécessaire à la gestion durable des ressources hydriques. Les premières études consacrées aux bassins versants et aux ressources hydriques datent du début des années 90 dans le Zimbabwe méridional. Elles se sont concentrées sur deux sous-captages d'eaux d'amont du bassin du Runde qui ont été complètement instrumentés afin de mesurer tous les paramètres hydrologiques, dont le volume pluviométrique, le volume des eaux de ruissellement et des eaux souterraines ainsi que l'humidité du sol.

Ces études montrent qu'à l'échelle du bassin, le ruissellement provenant des zones semi-arides ne constitue en général qu'une faible part du bilan hydrique. Les tendances à long terme des niveaux d'eaux souterraines traduisent l'effet des cycles de précipitations. La redistribution des eaux de surface est particulièrement importante pour reconstituer les eaux souterraines durant les années de faibles pluies ou de précipitations mal réparties qui ne peuvent, à elles seules, suffire. Dans 78 pour cent des années étudiées, la quantité d'eau fournie par de petites retenues peut être multipliée jusqu'à 10 fois sans que la retenue ne soit asséchée au-delà des niveaux admissibles.

L'agriculture écologique: une stratégie pour accroître la production agricole et la productivité hydrique des petits agriculteurs dans les régions sujettes à la sécheresse

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L'eau est l'un des principaux facteurs limitant la croissance de la production agricole dans les écosystèmes des zones semi-arides et subhumides de savane. Cela n'est pas nécessairement dû à la faiblesse des pluies saisonnières mais plutôt à une répartition inégale et à des pertes d'eau considérables dans les bilans hydriques des cultures sur les exploitations agricoles. L'agriculture écologique, dont l'objectif est d'optimiser l'infiltration des eaux de pluie, la capacité de retenue des eaux et les flux d'eau transmis aux plantes par le sol, est une stratégie efficace de récupération de l'eau *in situ* pour les petits agriculteurs dans les savanes exposées à la sécheresse.

Le présent document présente des essais *in situ*, conduits par des agriculteurs, de mise en œuvre de méthodes agricoles écologiques dans lesquelles le travail de la terre se fait à l'aide de tracteurs, d'animaux, ou à la main. Comme le montrent les expériences réalisées dans les régions semi-arides de la République Unie de Tanzanie, de Madagascar et du Soudan, les écarts de rendement entre l'agriculture écologique et l'agriculture classique sont importants et particulièrement élevés durant les années les plus sèches, ce qui démontre l'incidence de la récupération de l'eau. La plus forte augmentation de rendement s'est produite lorsque l'on a

associé l'agriculture écologique et la gestion de la fertilité des sols: la hausse des rendements a dépassé 200% en moyenne par rapport aux méthodes locales habituelles. La productivité des précipitations a considérablement augmenté, passant des 3 800 m^3 la tonne requis par le système classique de labour à environ 1 500 m^3 la tonne pour le maïs cultivé à l'aide de l'agriculture écologique. Le document analyse également les problèmes liés à un élargissement de l'adoption de l'agriculture écologique et les avantages supplémentaires résultant d'une économie de main d'œuvre, ce qui est très important dans une région actuellement frappée par la pandémie du VIH et du SIDA.

Transformations des systèmes agroforestiers dans les bassins versants: l'exemple des agroforêts de cacao dans le Cameroun central

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Les transformations des systèmes agroforestiers dans les bassins versants des zones tropicales humides en Afrique se poursuivent depuis plusieurs dizaines d'années. Ces transformations ont souvent concerné l'introduction de nouvelles essences, mais aussi l'aménagement spatial d'essences indigènes dans les systèmes d'exploitation. En lisière des forêts du Cameroun central, ces transformations ont commencé lors de l'installation des premières populations qui ont planté des cacaotiers; elles se poursuivent aujourd'hui avec l'intensification plus récente de plantations de différentes variétés d'arbres de valeur et de petites plantations. Bien qu'ils ne soient généralement pas suivis, ces changements influent considérablement sur la dynamique biophysique des paysages économiques qui intègrent des arbres dans les systèmes d'exploitation.

Il est certain que les systèmes agricoles qui incluent la plantation d'arbres (mixtes et monocultures) s'étendront dans les années à venir. Le présent document présente les résultats d'une étude de caractérisation portant sur un système complexe de cacaotiers pour illustrer les questions auxquelles seront confrontés les gestionnaires des ressources dans les prochaines années lorsqu'ils seront amenés à traiter de la gestion des systèmes d'exploitation qui intègrent des arbres et qui fournissent des moyens d'existence aux communautés rurales.

D'après l'étude, les questions d'ordre économique continueront probablement à influer sur l'évolution de l'agroforesterie. Ces évolutions devraient s'orienter vers une plus grande régularité de l'espacement des arbres (espacement équidistant), un moindre niveau de diversité par exploitation au profit d'une plus forte productivité, et une réduction du nombre des parcelles au fur et à mesure du recul de la diversité. On s'attend également à ce que les considérations économiques prennent le pas sur les préoccupations environnementales. Le présent document soulève une question importante: comment veiller à l'équilibre entre les préoccupations liées à l'environnement et les considérations d'ordre économique?

PARTIE 4 – FACTEURS SOCIAUX DANS L'AMÉNAGEMENT DES BASSINS VERSANTS

L'approche sociologique dans l'aménagement des bassins versants: de la participation à la décentralisation

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L'aménagement des bassins versants s'appuie sur une approche intégrée qui concerne aussi les dimensions humaines et sociales: de la parcelle, aux espaces communautaires et jusque dans leur insertion dans des territoires plus larges. Avec le souci de durabilité des actions d'aménagement, la participation des populations directement concernées est recherchée. Mais l'application d'approches participatives implique certaines conditions méthodologiques ainsi que le recours à des outils adaptés à chaque situation rencontrée. De même, la participation appelle aussi une décentralisation des pouvoirs de décision et présente donc des exigences institutionnelles et organisationnelles, susceptibles d'associer les attentes et demandes locales avec des dimensions politiques plus larges. Dans la recherche d'un tel équilibre du local au global, le partenariat entre tous les acteurs devient primordial et un dispositif de gestion participative et décentralisé des bassins versants ne peut fonctionner que si trois conditions sont remplies: le partage de l'information, la formation des relais locaux et l'organisation des associations et groupements ainsi que la concertation. La FAO a développé un modèle analytique (RED-IFO) et des applications de terrain (y compris dans le cas de l'aménagement des bassins versants) associant participation et décentralisation.

Droits de propriété de bassin et cas du bassin Nyando au Kenya

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On reconnaît en général que des droits de propriété non protégés et incomplets ont des incidences considérables sur l'utilisation et la gestion des ressources des bassins versants. Pour répondre à ce problème, la solution politique la plus souvent retenue consiste à privatiser les terres agricoles, à déclarer les zones riveraines biens publics et à restreindre de diverses manières l'utilisation des terres tant publiques que privées. Fondée sur les principes de base d'hydrologie de bassin et de sciences sociales multidisciplinaires en matière de droits de propriété, cette communication présente un concept plus nuancé des droits de propriété de bassin. Elle présente les premiers résultats d'une étude réalisée dans le bassin du Nyando dans l'ouest du Kenya, à savoir que les réformes politiques axées sur les droits de propriété de bassin doivent reconnaître la complexité et les interconnexions qui constituent un bassin hydrologique, accorder une plus grande priorité aux ressources de bassin essentielles telles que l'eau domestique et les filtres sédimentaires, reconnaître les liens critiques entre les droits fonciers et les droits relatifs à l'eau, et rechercher les moyens d'harmoniser les multiples textes juridiques qui régissent l'utilisation et la gestion des ressources de bassin.

Gérer les ressources des micro-bassins versants: dispositions institutionnelles relatives à l'utilisation des eaux du district de Chivi au Zimbabwe

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Depuis les vingt dernières années, de nouvelles stratégies de gestion des ressources naturelles et la création de nouvelles institutions à l'appui de ces stratégies ont vu le jour dans toute la région de l'Afrique méridionale. La gestion des ressources naturelles s'est nettement éloignée des systèmes centralisés et dirigés par l'État, comme cela était le cas à l'époque coloniale et dans les années qui ont immédiatement suivi l'indépendance, pour tendre vers des modes de gestion décentralisés fondés sur les communautés.

Le présent document analyse les dispositions institutionnelles, tant individuelles que collectives, régissant la gestion des ressources hydriques et décrit plus particulièrement un micro-bassin du district de Chivi au Zimbabwe. Un grand nombre des réglementations de l'utilisation des eaux sont implicites plutôt qu'explicites et formelles. Dans la plupart des cas, ces dispositions, même implicites, permettent un accès conditionnel fondé sur une utilisation appropriée. L'eau sert à de multiples fins et les règles dépendent du type d'utilisation. Priorité est accordée à la propreté aux alentours des sources d'eau, notamment là où l'on vient puiser l'eau potable. Ceci est essentiel pour déterminer qui a accès aux sources d'eau, en particulier aux sources privées. L'étude montre que l'utilisation de l'eau est en général respectée et qu'elle engendre peu de conflits, malgré quelques variations du périmètre d'utilisation durant les périodes sensibles, comme par exemple durant la saison sèche ou les années de sécheresse.

Approche participative dans l'aménagement des bassins versants: Agriculture durable et développement rural participatif dans le bassin versant de la Tassaout (Haut Atlas Central du Maroc)

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Résumé

Au Maroc, sur les 15 millions d'hectares de terres en amont des barrages, 11 millions d'hectares sont jugés à risques, alors que trois millions d'hectares sont à aménager d'urgence, tel fût le constat révélé par les différents travaux d'études et d'aménagement des bassins versants. Les multiples expériences menées ont montrés la nécessité de remplacer le concept étroit d'aménagement des bassins versants par un autre plus large et integré, basé sur des programmes conçus selon une approche participative et de partenariat, prenant en charge, en plus des aspects de lutte contre l'érosion hydrique, l'agriculture durable et le développement rural également sur une longue période.

Par ailleurs, la décennie 1990, a été marquée par l'élaboration de plusieurs plans et stratégies parmi lesquels on peut citer le plan d'action national pour l'environnement (PANE), le programme d'action national de lutte contre la désertification (PAN), le plan forestier national (PNF) et la stratégie 2020 de développement rural (SDR). Ces cadres stratégiques de planification contiennent tous les éléments nécessaires pour parvenir à une gestion conservatoire

des ressources naturelles et à la prise en compte des préoccupations environnementales dans le processus de développement économique et social durable des montagnes. Le projet MOR/93/010: *projet pilote d'aménagement des bassins versants: approche participative de la planification et de la gestion*, initié par le Ministère chargé des eaux et forêts et le PNUD, représente un maillon essentiel de la stratégie arrêtée par le gouvernement en matière de conservation des sols et d'aménagement des bassins versants en testant sur le terrain et en complétant une approche qui met l'accent sur le développement comme axe principal pour parer aux effets écologiques, économiques et sociaux de l'érosion.

La vallée de la Tassaout fait partie des deux zones pilotes choisies où le projet est intervenu durant la période de 1996 à 2002. Diverses missions de prospection et de mise au point ont permis d'ajuster les limites de la zone (sous bassin versant d'Aït Tamelil) afin de tenir compte des limites ethnique et celle des impluviums des B.V. Le recrutement d'animateurs contractuels fût l'option choisie dans la constitution d'une équipe de terrain de proximité, vu les difficultés et les contraintes du milieu montagnard et l'inertie des structures technico-administratives existantes.

La pertinence de cette expérience apparaît dans la mise au point d'une nouvelle approche de conservation des eaux et des sols et d'aménagement des bassins versants, avec la participation des populations aussi bien au niveau de l'identification des actions à entreprendre que dans leur mise en œuvre et leur suivi, favorisant ainsi l'émergence d'un climat de confiance entre les populations et l'administration forestière, dont les relations étaient marquées essentiellement par l'exercice de la police forestière.

Hydrologies, moyens d'existence et pauvreté dans les bassins versants: analyse hydro-sociale intégrée du bassin de Limpopo

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On dit souvent que le cycle hydrologique contribue de manière importante aux modes de subsistance des communautés rurales mais peu de preuves sont présentées. De plus, lorsque l'on s'intéresse à ces aspects, on se concentre surtout sur l'utilisation de l'eau provenant de rivières, de forages ou d'autres formes de stockage (eau bleue).

Cette étude porte sur la totalité du cycle hydrologique. Les rapports entre les modes de subsistance ruraux, l'utilisation des terres, et les biens et services fournis par l'évaporation et la transpiration, qui font partie du cycle hydrologique (eau verte), sont évalués à l'aide de l'analyse des modes de subsistance ruraux dans le bassin du Luvuvhu situé dans la province de Limpopo en Afrique du Sud. Les conclusions montrent l'importance de l'eau verte, et donc l'importance de l'accès à la terre et de l'utilisation des ressources naturelles, dans les stratégies des modes de subsistance des communautés rurales désagrégées.

L'étude décrit enfin une méthodologie permettant de lier les résultats communs des modèles hydrologiques avec les incidences sur les modes de subsistance ruraux. On peut ainsi évaluer le rôle potentiel du changement d'affectation des terres sur les moyens d'existence ruraux désagrégés dans le cadre de divers scénarios de développement, tels que l'augmentation de l'afforestation commerciale et l'aridoculture.

PARTIE 5 – EXPÉRIENCES DE L'AFRIQUE DANS L'AMÉNAGEMENT DES BASSINS VERSANTS

Processus qui influeront sur l'allocation des ressources en République d'Afrique du Sud

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La gestion des eaux et l'approvisionnement en eau, tels que définis dans la loi de 1956 sur le régime des eaux en République d'Afrique du Sud, ne bénéficiaient qu'à un segment très restreint de la population. L'eau était avant tout réservée à l'irrigation et faisait défaut à un vaste secteur de la population. Elle n'était donc pas utilisée à des fins de développement et de durabilité de l'environnement. Depuis la démocratisation de l'Afrique du Sud en 1994, les politiques gouvernementales se sont axées sur un développement social et économique équitable et durable pour tous les citoyens.

Suite aux nouvelles orientations de politique nationale et dans le cadre d'une étude approfondie de la législation relative à l'eau en vigueur, le gouvernement a adopté une politique nationale de l'eau (NWP, *National Water Policy*) pour l'Afrique du Sud en 1997. Cette politique s'inscrivait dans la lignée de 28 Principes et objectifs fondamentaux élaborés en 1996 pour la nouvelle loi nationale relative à l'eau. La loi nationale (NWA, *National Water Act*) de 1998 (*Act No. 36*) a été publiée et découle directement des Principes et objectifs fondamentaux et des propositions de la NWP pour la gestion des ressources hydriques. Bien que cette loi soit le principal instrument juridique pour gérer les ressources hydriques en Afrique du Sud, d'autres lois viennent aussi en appui. La réussite de la gestion des ressources en eau dépendra donc de la coopération qui sera établie entre tous les secteurs du gouvernement et de la participation active des utilisateurs de l'eau et d'autres organisations et acteurs concernés.

La confiance des citoyens est fondamentale pour le nouveau régime de gestion des ressources hydriques, et les responsabilités et les obligations du gouvernement national à cet égard se sont juridiquement exprimées dans la NWA. Pour que ces responsabilités et ces obligations puissent se concrétiser, il faut implicitement qu'elles s'exercent dans le cadre d'un plan national de gestion des eaux. L'objectif de la Stratégie nationale relative aux ressources hydriques (*National Water Resource Strategy*, NWRS), prévue par la NWA, est de définir un tel cadre. La version préliminaire de la NWRS a été diffusée pour observations, puis le texte a été récemment finalisé.

Dans le cadre du processus de réforme fondamentale de la loi relative aux ressources hydriques, la NWA reconnaît la nécessité d'une gestion intégrée de tous les aspects des ressources en eau et, lorsque cela est approprié, la délégation des fonctions de gestion au niveau régional ou au niveau du bassin afin que chacun puisse y participer. Pour cela, des organismes chargés de la gestion des bassins seront progressivement mis en place. Ces organismes formuleront des stratégies de gestion de bassin dans le cadre défini par la NWRS. Tant que ces organismes ne seront pas créés et opérationnels, le Département national des eaux et forêts continuera à gérer les ressources hydriques par le biais des bureaux régionaux. L'objectif général de ce département, qui occupe des responsabilités importantes en matière de la gestion des eaux, est détaillé dans des documents intitulés *Internal Strategic Perspectives* (ISPs).

La présente communication a pour objectif d'informer le lecteur sur les processus décrits ci-dessus qui auront des répercussions importantes sur les procédures, les structures, les programmes et l'affectation des ressources en République d'Afrique du Sud.

Mise en pratique de la gestion intégrée des ressources hydriques – l'expérience du Ghana

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Depuis presque dix ans, le Ghana a adopté plusieurs réformes pour promouvoir les objectifs de gestion intégrée des ressources hydriques conformes à la démarche proposée par la Conférence internationale sur l'eau et l'environnement qui s'est tenue à Dublin en 1992 et qui a été à nouveau soulignée lors de la Conférence des Nations Unies sur l'environnement et le développement (CNUED) à Rio de Janeiro la même année.

En 1996, le gouvernement du Ghana a franchi une étape capitale en décidant de mettre fin à la dispersion des fonctions et des responsabilités en matière de gestion des ressources hydriques et de les rassembler dans une entité intégrée. Le Parlement a promulgué une loi (Loi 522 de 1996) en vertu de laquelle la Commission des ressources hydriques a été créée avec pour mandat de réglementer et de gérer les ressources hydriques du pays et de coordonner les politiques nationales en la matière. Depuis sa création, la Commission a élaboré des stratégies et des politiques qui garantiront une gestion durable des ressources en eau.

Le présent document présente une vue générale de certains aspects des réformes entreprises dans le secteur de l'eau au Ghana. Il se conclut par une présentation des actions que mène la Commission pour promouvoir une gestion intégrée des ressources hydriques au Ghana.

Réformes du secteur de l'eau au Zimbabwe: l'importance de la coordination des politiques et des institutions lors de la mise en œuvre

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Compte tenu de la raréfaction croissante de l'eau due aux pressions de plus en plus importantes exercées sur une ressource limitée, des variations imprévisibles du climat et de la dégradation de la qualité de l'eau, de nombreux gouvernement ont décidé de se rallier à une action mondiale en faveur d'une approche intégrée et plus durable de la gestion de l'eau. En Afrique subsaharienne, la dégradation de l'environnement s'accélère en raison de la pauvreté et d'un accès limité à l'eau, ce qui a abouti à réduire encore la quantité d'eau disponible pour subvenir aux besoins fondamentaux des hommes. L'approche intégrée de la gestion de l'eau vise à promouvoir une plus grande efficacité de l'utilisation de l'eau tout en protégeant les zones de bassins versants. Il a toutefois été observé que la réussite de ces réformes est largement conditionnée par l'établissement d'une base solide de liens institutionnels avec des politiques qui ne soient pas en opposition. Le calendrier de mise en œuvre, la durabilité financière et une bonne base générale de capacités sont des facteurs de réussite des réformes relatives à l'eau.

Programme – cadre de protection contre l'érosion hydrique et de lutte contre l'ensablement dans le bassin du fleuve Niger

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Le bassin du fleuve Niger revêt une importance capitale pour les populations et les économies de la région. Les cours d'eau du bassin sont menacés par l'ensablement suite à l'érosion des terres depuis plusieurs décennies. Les projets réalisés dans le passé ont certes permis d'obtenir quelques acquis, notamment des référentiels techniques d'approches méthodologiques. Mais ces projets sont restés sectoriels et d'envergure limitée et les divers acquis ont été peu ou pas diffusés.

Le processus d'ensablement dans la partie sahélo-saharienne du bassin constitue une grave menace à l'existence du cours moyen du fleuve. Conscients de la gravité de la situation, la lutte contre l'ensablement est considérée comme un défi majeur par les autorités des Etats membres de l'Autorité du Bassin du Niger (ABN) qui ont obtenu l'appui de la Banque africaine de développement pour élaborer et mettre en œuvre un programme multinational de grande envergure de lutte contre l'ensablement dans le bassin.

Le programme vise à renforcer la coopération et l'intégration régionales à travers la gestion durable des ressources naturelles, et en dotant les Etats membres de l'ABN d'outils de planification concertée pour des actions cohérentes et coordonnées. Il constitue un bon cadre de concertation et d'harmonisation des méthodologies, qui contribuera au maintien du potentiel de production du bassin. Cette communication décrit les composantes et les impacts du programme ainsi que l'approche méthodologique retenue pour sa mise en œuvre.

Le lien brisé dans le système de production agricole en Éthiopie et son incidence sur la gestion des ressources naturelles

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Pourquoi la famine frappe-t-elle une nouvelle fois l'Éthiopie? Quelles sont les questions de politiques extérieures et intérieures liées à la gestion des ressources naturelles? Quelles sont les conséquences des interventions non adaptées du monde occidental sur le développement de l'Afrique? Quel devrait être le juste équilibre entre l'aide alimentaire et l'aide au développement?

Programme d'aménagement intégré du massif du Fouta Djallon – Phase PDF-B

Amadou Maiga, FAO, Conakry, (Guinée)

Les principaux objectifs du projet du FEM à réaliser au cours de la phase PDF – B, visent la conservation et l'utilisation durables des bassins versants internationaux, des ressources naturelles et de la diversité biologique disponibles dans le massif du Fouta Djallon. A cet égard, l'objectif de développement global du projet est la formulation d'un programme détaillé et durable d'aménagement des ressources naturelles du Fouta Djallon. Cet objectif sera accompli à travers l'amélioration des connaissances, l'harmonisation des méthodologies, l'identification

des stratégies de conservation et le partage des expériences et des leçons apprises sur la gestion des ressources naturelles.

Les résultats attendus de l'ensemble du projet sont les suivants:

- Une *analyse diagnostique transfrontière* de l'environnement et des problèmes d'aménagement qui se posent au massif du Fouta Djallon.
- Le *renforcement des mécanismes de coordination,* y compris la mise en place d'un Comité de pilotage du Projet et d'un Comité scientifique et technique.
- Un *cadre juridique* qui réaffirme le caractère international du massif du Fouta Djallon; et un accord-cadre de coopération entre les états arrosés par les eaux provenant du massif du Fouta Djallon.
- La préparation et l'approbation d'un document de projet FEM fondé sur la synthèse des résultats des activités de préparation du projet à soumettre à l'attention du FEM.

CONCLUSIONS DES GROUPES DE TRAVAIL

PREMIER GROUPE DE TRAVAIL: RELATIONS AMONT-AVAL

Le premier groupe de travail s'est intéressé aux interactions entre les zones situées dans les parties amont et aval des bassins hydrographiques et aux dispositions des programmes en la matière. Il a examiné l'état actuel des connaissances, des approches et des techniques ainsi que les conflits entre les divers groupes d'intérêt et les politiques, en analysant à chaque fois les faiblesses et les enseignements tirés. L'accent a été mis sur les questions liées à la quantité et à la qualité de l'eau. Le groupe a formulé des recommandations provisoires destinées à mieux comprendre les relations amont-aval lors de la conception des programmes d'aménagement des bassins versants.

État des connaissances

Les processus d'interactions entre zones amont-aval sont très mal connus, en raison principalement de leur complexité, de la très grande diversité des situations locales et de la difficulté de généraliser les résultats. Il n'existe pas d'outils appropriés pour élargir les connaissances et lorsque des données existent dans le milieu de la recherche scientifique, il est en général difficile de les communiquer aux responsables politiques, aux planificateurs et autres intervenants. Il y a également des insuffisances dans le transfert et l'échange de connaissances entre spécialistes des pays développés et des pays en développement ainsi qu'entre experts des pays en développement.

Certaines connaissances ont pu être tirées d'expériences antérieures. Il faut avant tout reconnaître le rôle essentiel que jouent la communication, la vulgarisation et l'éducation pour diffuser les bons messages à tous les acteurs concernés par l'aménagement des bassins versants. Une bonne connaissance des processus, fondée sur l'expérience locale, et une solide base scientifique sont nécessaires pour réussir l'aménagement des bassins versants. On peut souligner à cet égard que la possibilité d'échanger des expériences et des connaissances techniques renforce les capacités de compréhension et de planification à tous les niveaux. Il est essentiel que des liens soient établis entre les chercheurs et les spécialistes des pays développés et des pays en développement.

Approches et techniques

Les programmes d'aménagement des bassins versants sont trop souvent axés sur les interventions à court terme, ce qui constitue un handicap. Les objectifs et les bénéficiaires ciblés sont souvent mal définis, et les projets poursuivent donc en vain et de manière déséquilibrée des objectifs dans les zones tant amont qu'aval. Il ne peut être que bénéfique de clarifier les objectifs des programmes et de lier les interventions à ces objectifs.

Les programmes d'aménagement ont considérablement évolué depuis les dernières décennies mais il existe encore des cas où l'on ne tient pas assez compte des populations des zones des bassins, et l'on introduit alors des méthodes qui ne sont pas viables. On ne peut envisager un aménagement durable des bassins versants que si l'on associe les populations à la planification et à la mise en œuvre des programmes et que si les communautés comprennent les avantages à court et à long terme des actions proposées. La même observation s'applique à l'eau: la seule manière d'obtenir des résultats positifs est d'adopter une approche globale des problèmes hydriques dans les bassins versants. Il faut toutefois reconnaître que les approches centrées sur les personnes et celles centrées sur l'eau ne sont pas toujours compatibles dans les programmes d'aménagement et que les deux démarches requièrent peut-être des traitements différents. Si, dans le but de protéger l'eau, l'on demande aux agriculteurs des bassins versants de modifier la manière dont ils utilisent les terres, il faut leur proposer des mesures d'incitation claires. Pour réussir, les programmes d'aménagement axés sur les personnes doivent toujours se focaliser sur les revenus et la productivité.

Les enseignements tirés de l'expérience montrent que les programmes d'aménagement des bassins versants doivent être intégrés et impliquer tous les intervenants. L'échec des projets résulte en grande partie de l'application d'approches descendantes transposées et de principes rigides non adaptés aux conditions locales. Il provient également d'une focalisation excessive sur des perspectives à court terme. Le manque de droits fonciers et de droits liés à l'eau est reconnu comme constituant l'une des principales entraves à la réussite des programmes qui s'intéressent aux interactions amont-aval. Enfin, il apparaît nécessaire d'établir un lien entre les aspects biophysiques et socio-économiques lors de la planification des programmes d'aménagement des bassins hydrographiques.

Conflits entre groupes d'intérêt

Le groupe de travail a déterminé que l'une des principales difficultés survenant lors de la prise en compte des relations amont-aval dans les bassins versant provient des conflits entre groupes d'intérêt. Le manque de mécanismes institutionnels capables de promouvoir la négociation entre groupes d'intérêt au sein d'un bassin hydrographique est souvent la première cause de malentendu et d'incompréhension entre ces groupes. Une autre difficulté tient au fait que les groupes eux-mêmes ne comprennent pas les implications de leur comportement, notamment pour l'eau. Outre l'absence de mécanismes institutionnels, il faut remarquer que le cadre législatif dans lequel les négociations ou la collaboration amont-aval pourraient se dérouler n'existe généralement pas. Dans la majeure partie des cas, le régime foncier n'est pas bien défini, ce qui a de graves conséquences pour toute intervention à long terme. En fonction de la superficie des bassins, des problèmes logistiques se posent également lorsque l'on cherche à faire participer tous les acteurs aux programmes d'aménagement, ce qui se répercute sur le degré d'engagement et de participation des communautés locales.

Il existe divers outils pour surmonter certains des problèmes résultant des conflits entre groupes d'intérêt dans les bassins versants. Leur applicabilité varie selon le lieu. Dans certains cas, des lois et des réglementations peuvent améliorer considérablement la pérennité de la gestion des terres dans un bassin. Dans d'autres, il sera plus utile de conclure des accords locaux entre les agriculteurs des bassins et les utilisateurs de l'eau en aval. Dans d'autres cas encore, notamment en Amérique latine, les services liés à l'eau ont commencé à être payants.

Bien qu'il soit en général trop tôt pour évaluer leur viabilité, ces dispositions sont prometteuses et méritent d'être étroitement suivies.

Lorsque l'on cherche à améliorer les relations entre groupes d'intérêt, tous les efforts doivent être déployés pour s'appuyer sur les structures et les institutions locales en place. Les associations d'utilisateurs de l'eau, lorsqu'elles existent, peuvent jouer un rôle de premier plan dans la constitution d'une plate-forme de négociation entre les communautés situées dans les zones amont et aval des bassins.

Politiques

Alors que le milieu de la recherche et les intervenants s'efforcent de mieux comprendre les interactions amont-aval dans les bassins hydrographiques, les rares connaissances en ce domaine ne sont pas transmises de manière claire et intelligible aux responsables politiques. Les responsables politiques acceptent mal le haut niveau d'incertitude lié aux processus propres aux bassins versants et se limitent en général à des modèles simples qui véhiculent souvent des idées fausses sur ces processus. Les investissements consacrés aux bassins hydrographiques sont donc souvent fondés sur des hypothèses erronées, ce qui se solde par des résultats médiocres ou inexistants. La responsabilité est en partie imputable aux professionnels qui ne se rendent pas compte de l'importance de clarifier leurs conclusions et de les traduire de manière à ce que les responsables politiques puissent les utiliser pour prendre des décisions. Il faut donc renforcer les interactions entre les politiciens et les intervenants pour combler les lacunes de connaissances relatives aux relations amont-aval et pour améliorer l'élaboration et l'exécution des politiques.

Une autre difficulté provient de la nature sectorielle des politiques, en particulier de celles liées à l'utilisation des terres, à l'agriculture, à l'irrigation et à la forêt, qui aboutissent à des approches conflictuelles de gestion des terres. De plus, les pays développés dictent souvent les programmes de développement des pays pauvres en ne tenant pas, ou pas assez, compte de leurs besoins particuliers. Il faut enfin noter que les responsables politiques des pays en développement ont un champ d'action limité pour échanger leurs expériences et leurs approches en matière de politiques d'aménagement des bassins versants et de politiques connexes.

Questions d'échelle

Le groupe a déterminé que l'échelle est l'un des principaux facteurs influant sur les relations amont-aval. Le manque de clarté sur l'ampleur et l'impact possible d'une intervention donnée est souvent à l'origine de politiques et de programmes non adaptés, car la plupart des processus sont très influencés par l'échelle. Les pays sont souvent confrontés aux problèmes d'extrapolation d'approches réussies et à une compréhension insuffisante de l'impact des actions locales à de plus grandes échelles. De nombreux programmes n'aboutissent donc pas aux résultats prévus parce qu'ils ne disposent pas de mécanismes d'extrapolation à grande échelle, et que ni les technocrates ni les décideurs ne comprennent l'importance de la question.

Qualité de l'eau

Les questions de qualité de l'eau ont été abordées dans le cadre de l'Afrique subsaharienne. Les problèmes de pollution sont assez limités mais représentent toutefois un risque réel dans certains cas. Le groupe a souligné notamment que l'on connaît mal l'incidence de l'horticulture et d'autres types d'agriculture intensive sur la qualité de l'eau et qu'il n'existe pas de normes ou de réglementations relatives à la gestion de la qualité de l'eau en agriculture intensive. Il serait important de mieux comprendre le rôle des forêts et la manière dont elles affectent la qualité de l'eau. Le groupe a également reconnu que les bassins versants, lorsqu'ils sont correctement aménagés, contribuent de manière significative à améliorer la qualité de l'eau dans les bassins et les zones aval.

Recommandations

Pour remédier aux manques de connaissances, il est recommandé aux pays et aux institutions nationales de mettre en place des programmes de formation complets à tous les niveaux sur les interactions amont-aval, de promouvoir la recherche sur les questions controversées, en particulier sur le rôle des arbres dans la protection de l'eau, et de constituer des réseaux pour favoriser l'échange des données et de l'information. Il faut également que les programmes d'aménagement des bassins versants prévoient systématiquement des activités de communication et d'éducation pour les divers acteurs.

Sur le plan technique, il est recommandé que les programmes d'aménagement soient planifiés dans une perspective de moyen à long terme et qu'ils associent tous les acteurs concernés de manière appropriée. Les programmes doivent être détaillés et flexibles pour être adaptés aux conditions locales et doivent tenir compte des questions tant biophysiques que socio-économiques. Les projets et les programmes doivent être fondés sur le contexte propre à chaque bassin.

L'aménagement des bassins versants est un instrument idéal pour renforcer et améliorer les interactions entre les groupes d'intérêt à l'intérieur des bassins. Tous les mécanismes éventuels permettant de mettre ces groupes en rapport doivent être systématiquement étudiés et testés dans l'objectif de réduire les conflits et de consolider la collaboration. Ces mécanismes doivent réunir toutes les parties concernées de manière effective et s'appuyer sur des capacités institutionnelles, juridiques et légales qui auront été consolidées. Il est également recommandé de diffuser plus largement les outils existants qui peuvent aider à résoudre les conflits dans les bassins hydrographiques.

Sur le plan des politiques, les programmes d'aménagement doivent être conçus dans le cadre des stratégies nationales de lutte contre la pauvreté et de développement rural, et illustrer par là même l'intégration entre ces programmes et les stratégies de grande envergure. Il est important de promouvoir l'échange des connaissances et des expériences dans le domaine de l'aménagement des bassins versants entre les pays. Les pays et leurs partenaires financiers doivent, pour leur part, élaborer des politiques pour assurer un financement à long terme des programmes d'aménagement. Il est également recommandé de mieux faire comprendre, notamment aux responsables politiques, les relations existantes entre les terres et les eaux dans les bassins hydrographiques. Le milieu de la recherche a un rôle primordial à jouer dans la

diffusion aux responsables politiques de messages simples et clairs, sans négliger toutefois de rendre compte de la complexité des questions d'aménagement des bassins, tout en leur indiquant des opportunités d'investissements directs dans le secteur. Les liens entre la science et la politique doivent être renforcés. Enfin, il est nécessaire de renouveler les efforts pour mieux traiter la question des stratégies d'extrapolation des programmes d'aménagement des bassins versants.

Sur le plan de la qualité de l'eau, il est indispensable de mieux comprendre et documenter l'étendue du problème, de développer la prise de conscience des conséquences possibles de l'agriculture intensive (l'horticulture, en particulier) sur la qualité de l'eau et la santé, d'élaborer des stratégies globales pour gérer la qualité de l'eau dans les bassins, et d'élargir les connaissances sur le rôle des forêts dans les processus hydrologiques et la qualité de l'eau.

DEUXIÈME GROUPE DE TRAVAIL: POLITIQUES ET INSTITUTIONS AU SERVICE DE L'AMÉNAGEMENT INTÉGRÉ DES BASSINS VERSANTS

Au cours des 20 dernières années, des changements positifs se sont produits au niveau des politiques et des institutions nationales et transnationales qui influent sur l'aménagement des bassins versants. La plupart des pays africains ont adopté de nouvelles lois et politiques relatives à l'eau et à l'environnement qui servent de fondements juridiques et de cadres institutionnels pour améliorer l'aménagement des bassins hydrographiques. Des efforts de portée limitée ont été également déployés pour mettre sur pied des organismes transnationaux capables de gérer les nombreux bassins fluviaux transfrontaliers du continent. La mise en application des nouvelles lois et institutions nationales est toutefois entravée par le manque d'informations et de ressources. Dans une certaine mesure, l'aménagement des bassins versants se trouve confronté aux mêmes problèmes qui touchent à d'autres aspects de la gouvernance en Afrique, notamment la décentralisation et l'insuffisance des ressources. Les réussites et les échecs de l'aménagement des bassins transnationaux résultent du contexte politique global des relations inter-États. Le groupe de travail a répertorié les points forts et les faiblesses dans ces domaines clés et a formulé des recommandations susceptibles de remédier à la situation.

Politique relative à l'eau et institutions chargées de l'aménagement des bassins versants

Depuis le milieu des années 90, la plupart des pays africains ont promulgué des politiques et des lois relatives au régime des eaux qui définissent les rôles des diverses parties concernées par la gestion intégrée des eaux. La plupart des nouvelles lois prévoient des institutions multicouches de gestion des eaux et une plus grande reconnaissance des droits d'utilisation de l'eau ainsi que des réserves humaines et écologiques. Certaines organisations locales connaissent ces dispositions légales. La majeure partie des pays africains ont également adopté une nouvelle législation pour assurer la gestion de l'environnement et ont créé de nouvelles institutions pour la mettre en vigueur. Des plates-formes de négociation relatives à la gestion et à l'utilisation des ressources partagées ont été établies dans certains pays.

L'application des nouvelles dispositions institutionnelles reste cependant incomplète dans la plupart des pays en raison d'un manque de financement et de ressources humaines ainsi que d'une participation insuffisante des organisations et des communautés locales. Certaines des

nouvelles lois ne définissent pas clairement la base juridique, les droits d'utilisation des ressources et les responsabilités des divers acteurs. Les politiques et les lois nationales relatives aux eaux et aux bassins hydrographiques tendent à être sectorielles alors qu'une gestion efficace des bassins versants exige une coordination multisectorielle.

Décentralisation et participation des organisations locales

Certains pays ont réalisé une décentralisation politique effective, y compris au niveau de l'aménagement des bassins versants. Dans certaines zones de mise en œuvre pilote, les communautés ont davantage participé à la gestion des bassins et des ressources hydriques. Il est toutefois important de reconnaître que la gestion de la décentralisation est un processus à long terme, compliqué et à caractère politique. Dans la réalité, il s'est avéré plus simple de déléguer les pouvoirs à des niveaux administratifs inférieurs et à des groupes d'utilisateurs, plutôt que de leur transmettre les capacités, les valeurs, la motivation et la responsabilisation nécessaires pour remplir leurs nouvelles fonctions.

Grâce en partie aux stratégies de lutte contre la pauvreté adoptées par de nombreux pays africains, on reconnaît mieux aujourd'hui les besoins, y compris les besoins en eau, des groupes défavorisés en zones urbaines et rurales (en particulier des femmes, des personnes âgées et des jeunes). En réalité toutefois, les groupes d'élite locaux s'approprient souvent les pouvoirs délégués alors que de nombreux utilisateurs, plus démunis, ignorent encore leurs droits d'utilisation et d'accès aux ressources. Les efforts de sensibilisation auprès des communautés défavorisées tendent à être partiels et ponctuels.

Gestion des ressources hydriques transnationales

L'Afrique possède plus de bassins fluviaux transnationaux que toute autre région au monde. Dans le passé, cette caractéristique a été avant tout un obstacle aux investissements, à la gestion et au développement. À l'avenir toutefois, ce handicap pourrait se transformer en un avantage car une gestion commune peut entraîner de multiples gains sociaux, économiques et écologiques. Il existe des initiatives prometteuses pour améliorer la gestion des bassins transfrontaliers sur le continent africain. Ces initiatives doivent être vigoureusement renforcées et soutenues.

Le groupe de travail a répertorié les partenariats transnationaux suivants en Afrique: l'Initiative du bassin du Nil, le Programme de développement du lac Victoria par la Communauté de l'Afrique orientale (CAO), l'Accord sur le bassin fluvial de Nkomati (Swaziland, Mozambique, Afrique du Sud) et l'Autorité du bassin du Niger. Quelques nouveaux projets transnationaux, comme le Programme de gestion de l'environnement du lac Victoria, ont également insufflé un élan supplémentaire à ces initiatives. De plus, des efforts fructueux ont été déployés pour promouvoir la constitution de réseaux internationaux consacrés à l'eau et à l'aménagement des bassins versants, tels que WaterNet, SearNet et le Réseau des organisations paysannes et des producteurs de l'Afrique de l'Ouest. Il y a encore beaucoup à apprendre des exemples réussis de coopération internationale et de mise en réseau. Les fonds restent toutefois insuffisants pour assurer l'aménagement des bassins versants transfrontaliers sur le long terme. Il est indispensable de renforcer la coordination entre pays et bailleurs de fonds.

Informations et bases de connaissances en vue d'améliorer l'aménagement des bassins versants

Le manque d'informations et de connaissances relatifs aux principes et aux méthodes d'aménagement des bassins versants limite l'efficacité des interventions à tous les échelons. Les particuliers et les organisations de la société civile n'ont pas participé très activement aux programmes d'aménagement, ce qui s'explique en partie par l'insuffisance générale de la prise de conscience de l'importance des enjeux liés à l'eau et à l'environnement. Très peu de données ont été recueillies sur les programmes de gestion des bassins versants dans le continent africain.

Investissements

Les ressources manquent à tous les niveaux pour aménager les bassins versants de manière efficace. Il faut dégager des ressources publiques supplémentaires, notamment au niveau des bassins transnationaux et à l'échelle des bassins. De plus, tous les pays doivent mieux comprendre comment créer un environnement institutionnel et réglementaire susceptible d'encourager le secteur privé à investir et à s'impliquer davantage.

Recommandations

Politiques nationales: – Les gouvernements nationaux doivent revoir et harmoniser les politiques sectorielles relatives à l'eau et à l'aménagement des bassins versants dans leur pays (secteurs de l'eau, de l'environnement, de l'agriculture, de l'industrie, de l'administration et de la planification nationale). L'harmonisation des politiques doit reconnaître et prendre en compte la particularité de chaque bassin et les facteurs uniques qui façonneront leur aménagement (valeurs culturelles, hydrologie, climat, géologie, dimension/région, etc.). Il est recommandé d'élaborer de nouvelles politiques susceptibles de mobiliser de nouvelles sources de financement afin de pouvoir aménager les bassins versants dans les contextes variés de l'Afrique.

Institutions nationales: – Il est indispensable de renforcer la base de ressources et d'informations dans les institutions chargées d'aménager les bassins. Les organisations locales et les organismes de gestion des sous-bassins et des bassins hydrographiques doivent contribuer au développement de systèmes de gestion des ressources, et les autorités responsables de la gestion des bassins ne doivent pas uniquement se préoccuper de la simple distribution de l'eau, mais tenir compte également de l'amélioration et de la préservation des ressources. Il faut également prévoir une gestion et un financement intégrés du stockage et de la distribution de l'eau qui solidarise les intérêts locaux et tienne compte de la préservation et de la qualité de l'eau. Pour pouvoir aménager les bassins de manière efficace, les ressources et le financement doivent être mobilisés sur le long terme.

Institutions transnationales: – Les lois qui régissent l'eau à l'échelle nationale doivent être harmonisées entre les pays qui partagent des bassins et des ressources en eau.

Constitution de réseaux et partage de l'information: – Il est recommandé de favoriser l'échange d'informations et une meilleure prise de conscience chez les acteurs, à tous les niveaux, des conditions politiques et institutionnelles qui permettent d'aménager les bassins versants de manière efficace. Des réseaux doivent être constitués et renforcés à l'échelle nationale, régionale

et continentale. Il est indispensable de recueillir des données sur les ressources des bassins de manière plus systématique et de les diffuser avec plus de transparence aux divers intervenants. La collecte de données doit être l'une des principales responsabilités des autorités et des organismes chargés de la gestion de l'eau à tous les niveaux, depuis le sous-bassin jusqu'au bassin transnational.

TROISIÈME GROUPE DE TRAVAIL: EXPÉRIENCES D'AMÉNAGEMENT DES BASSINS VERSANTS: ENSEIGNEMENTS TIRÉS ET AVENIR

Services environnementaux des bassins: qui doit payer quoi?

Il est nécessaire de disposer d'un approvisionnement suffisant en eau propre pour aménager les bassins versants de manière durable. L'agriculture et l'industrie doivent tenir compte des besoins des utilisateurs en amont et en aval, et des interactions mutuelles entre utilisateurs (comme par exemple, des conséquences de l'utilisation de produits chimiques sur les utilisateurs se situant en aval).

Des méthodes efficaces de préservation de l'environnement doivent être appliquées au niveau du captage, et se propager à tous les niveaux. Il a été accordé une priorité croissante à l'aspect humain mais jusqu'où doit-on poursuivre sur cette voie aux dépends de la préservation de l'environnement? Les préoccupations environnementales ont, elles aussi, pris de l'importance et la question des compromis entre moyens d'existence et environnement se pose aujourd'hui, notamment dans le contexte de la lutte contre la pauvreté et des objectifs de sécurité alimentaire.

On pourrait commencer par envisager des mécanismes de facturation des services environnementaux dans le contexte d'un bassin hydrographique, ce qui contribuerait à leur entretien et à leur mise en valeur. Les habitants des villes étant les principaux consommateurs de l'eau des bassins devraient être les principaux payeurs. La facturation de l'eau en zones urbaines n'est pas systématique et seule une très faible part de ces revenus est réinvestie dans l'aménagement et la conservation des bassins qui aliment les villes. L'eau est une question importante pour les habitants des zones urbaines et ils pourraient se mobiliser pour exiger l'entretien et la mise en valeur des bassins versants. Le paiement des services environnementaux peut également agir plus directement en suscitant une autodiscipline et une utilisation plus rationnelle de l'eau.

Les questions hydriques sont des questions économiques

Il faut également mettre en place des mesures efficaces pour résoudre les conflits entre les utilisateurs des terres et des eaux, et entre les utilisateurs de l'eau se situant à divers endroits d'un bassin. Pour cela, il est nécessaire d'adopter une approche intégrée de gestion de la quantité et la qualité de l'eau, à tous les niveaux, avec un souci de transparence. Tous les acteurs ayant un intérêt économique dans le bassin doivent être impliqués et chacun devrait en retirer des avantages économiques. Malheureusement, les questions socio-économiques de cette nature sont trop souvent politisées et facilement détournées par les politiciens. Pour éviter ce biais, il est indispensable de disposer de données précises sur la qualité et les disponibilités de l'eau. Or ce type d'information fait actuellement défaut.

Transfert de technologie

Il faut se préoccuper davantage du transfert de technologie relatif aux avantages et aux incidences des activités d'aménagement des bassins versants. L'une des premières étapes consiste à sensibiliser les populations, en particulier les femmes et les jeunes, qui ont souvent la responsabilité d'approvisionner leur famille en eau. La planification doit être de nature participative. Les exemples réussis doivent être diffusés et reproduits, lorsque cela est possible.

Les manques de connaissances en matière d'évaluation des ressources sont très nettes. Il faut renforcer l'acquisition de connaissances dans le domaine des systèmes d'informations géographiques (SIG) et des Systèmes mondiaux de localisation (GPS) qui pourraient servir à la mise en place d'un système peu onéreux de planification pour l'utilisation des terres et des ressources naturelles, les études hydriques et le traitement des déchets. Lorsque cela est possible, il serait utile de constituer des réseaux informatiques et d'encourager l'usage des forums électroniques. Les réseaux et les forums en ligne, comme par exemple Cap-Net (*Capacity building for integrated water resource management*), ne sont pas connus de tous. Les réseaux consacrés aux questions hydriques devraient établir des liens avec les programmes nationaux et les actions déployées dans divers pays par *International Water Management Institut*s (IWMI). Constituer des réseaux est la tâche la plus simple: les relier entre eux pour qu'ils fonctionnent ensemble est plus difficile.

L'aménagement des bassins versants et la gestion des ressources naturelles sont les deux faces de la même médaille. Les planificateurs régionaux doivent y participer, et pas seulement au niveau des hauts responsables; des avis techniques sont aussi nécessaires. Des ateliers techniques régionaux, ainsi que la mise en commun et l'échange d'informations et de bases de données, existent déjà en Amérique latine et dans les Caraïbes. En Europe, des réseaux interactifs proposant des débats en ligne sur divers thèmes relatifs à la gestion de l'eau ont également été établis. L'Afrique du Sud, le Nigéria et le Maroc ont eux aussi constitué des réseaux. La plupart de ces initiatives entrent dans le cadre du Programme mondial de l'eau qui réunit des institutions, des chercheurs et des experts techniques.

Une stratégie de communication efficace, en particulier pour et entre technocrates, est un facteur déterminant pour le transfert de technologie. Il est tout aussi important de faire connaître les avantages aux parties directement concernées, d'évaluer les points positifs sur le plan de l'environnement, d'identifier les facteurs influant sur l'approvisionnement en eau, d'intégrer les valeurs culturelles, et d'encourager des modes de subsistance alternatifs afin de réduire la pression démographique dans les bassins versants et aux alentours. Il faut cependant noter que l'évaluation des avantages a plus souvent privilégié la conservation, la biodiversité et/ou l'industrie, l'agro-industrie, les besoins des agglomérations urbaines et l'exploitation minière que les besoins des pauvres et des plus petits utilisateurs.

Outre les méthodologies et les mesures, le transfert de technologie en faveur du développement doit également tenir compte du savoir-faire et des compétences des communautés locales. L'aménagement des bassins versants a été trop souvent fondé sur des connaissances « perfectionnées » fondées sur la recherche aux dépends des connaissances traditionnelles africaines. Les sociétés africaines se caractérisent avant tout par une forte tradition d''autosuffisance' et par le développement d'un savoir communautaire. Il est indispensable de recenser les technologies de conservation utilisées en milieu rural, d'évaluer leurs avantages et leur

pérennité, et de les intégrer dans les activités de vulgarisation. Les connaissances traditionnelles doivent être reconnues, ce qui renforcera par la même occasion la dignité des populations.

Une approche intégrée multisectorielle

Les stratégies de lutte contre la pauvreté et l'aménagement des bassins versants doivent être intégrées dans une approche multidisciplinaire afin de pouvoir gérer les conflits. Les politiques et l'environnement sont étroitement liés. Dans la plupart des cas toutefois, les politiques ne sont pas coordonnées au niveau national et les travaux de divers secteurs (agriculture, environnement, eau, planification, terres, ressources naturelles) se chevauchent souvent au lieu de se compléter. De plus, la plupart des gouvernements africains sont assujettis aux programmes d'aide extérieure et appliquent des stratégies 'isolées' de lutte contre la pauvreté. Or les conflits actuels et potentiels ne peuvent être résolus que par des projets et des solutions économiquement viables et durables pour l'environnement. Les gouvernements doivent assurer l'entretien de l'infrastructure des bassins, en particulier des bassins versants en zone rurale, en se rappelant que la majeure partie des communautés rurales n'ont pas la capacité de le faire de façon appropriée.

Par ailleurs, les points de vue concernant la pollution sont en général statiques alors que ce domaine et les problèmes associés sont très dynamiques. Les gouvernements locaux sont souvent accusés de polluer l'eau en utilisant de manière inconsidérée des décharges publiques situées dans des bassins ou des plaines fluviales. L'eau potable et l'assainissement font partie des Objectifs de développement du Millénaire des Nations Unies pour 2002. La migration est également une réalité socio-économique qui a des incidences sur l'environnement mais qui est souvent ignorée.

Échelle et priorité

On peut maintenant se demander quelle est la bonne échelle et la juste priorité: doit-on s'intéresser au ménage ou à la communauté? À petite ou à grande échelle? Doit-on tenir compte de l'entretien et de la conservation des bassins versants ou des moyens d'existence et des droits? Dans tous les cas, le principe directeur sous-jacent est qu'il ne faut jamais compromettre les ressources, ni privilégier les besoins d'un groupe donné quelle que soit l'échelle d'un projet. Toute intervention à l'échelle locale doit s'inscrire dans une perspective globale.

Les études d'impact sur l'environnement devraient être obligatoires et conditionner la réalisation des programmes et des projets, mais il arrive que les décideurs soient aussi les coupables, comme dans le cas précité où les gouvernements locaux sont responsables de la pollution. Pour réduire la pollution, une solution consisterait à imposer des pénalités dont le montant serait à la hauteur de l'infraction.

Contrairement à l'industrie, à l'agro-industrie et aux autorités locales, les agriculteurs défavorisés ont peu de choix et sont en général dans la catégorie des insolvables. La propriété de la terre et le régime foncier revêtent une importance particulière pour les habitants des zones rurales. La dégradation des terres est parfois due à la pauvreté et à l'absence de régime foncier.

Les paiements de pénalités de pollution devraient conduire à une intégration de la qualité et de la quantité d'eau utilisée. Mais pour cela, il faut bien entendu savoir qui a un droit d'usage de l'eau, et quelle est la qualité de l'eau reçue et la qualité de l'eau évacuée. Lorsque les droits se mêlent aux questions de qualité et de quantité, les utilisateurs peuvent s'autoréglementer et on peut leur laisser la responsabilité de la purification et du recyclage des eaux usées qu'ils produisent.

Les pénalités, pour être équitables, doivent inclure la totalité des coûts et des avantages. Dans la réalité toutefois, elles ne sont pas à la hauteur de la valeur réelle des avantages économiques issus de la pollution. Les plus grands responsables de la pollution (les agglomérations urbaines, les industries, les agro-industries, les exploitations minières) peuvent en général régler sans difficulté le montant des paiements qui leur sont imposés et qui ne constituent une mesure dissuasive que pour les petits utilisateurs. Il est également important de tenir compte de l'évolution de l'agriculture. L'agriculture n'est plus complètement biologique et peut contribuer, elle aussi, à la pollution.

L'avenir

Il faudra disposer à l'avenir d'une perspective intégrée pour tenir compte de tous les acteurs et chacun d'entre eux devra avoir un intérêt économique dans le bassin versant. Les programmes devront faire appel à la participation et impliquer les jeunes, les personnes âgées et surtout, les femmes. L'accès aux services des bassins versants ne devra pas être uniquement fondé sur ceux qui ont les moyens de payer mais tenir également compte de l'équité et de l'utilisation rationnelle.

Les démarches de développement en Afrique sont souvent dictées par les programmes de l'aide extérieure et de lutte contre la pauvreté. Les résultats doivent donc être liés aux stratégies nationales et régionales de réduction de la pauvreté. Des liens nationaux, régionaux et internationaux doivent être établis avec les stratégies de la Communauté de l'Afrique orientale (CAO), de la SADC (*Southern African Development Community*) et de la Communauté économique des États de l'Afrique de l'Ouest (CEDEAO), qui sont elles-mêmes reliées à celles du Nouveau partenariat pour le développement de l'Afrique (NEPAD) et aux Objectifs du Millénaire pour le développement fixés par les Nations Unies.

Compte tenu de l'approche fragmentée décrite ci-dessus, la plupart des programmes considèrent l'assainissement des bassins versants et/ou la lutte contre la pauvreté comme des problèmes 'autonomes'. Il faut pourtant relier le cadre général d'aménagement des bassins versants et les programmes sectoriels, en cours ou à venir. Idéalement, une démarche d'aménagement de bassin devrait bannir tout programme spécifique à un type de projet particulier. Les outils et les modèles d'évaluation doivent également être simplifiés et modifiés en permanence pour: i) les adapter aux réalités locales, ii) garantir que les 'boîtes à outils' suivent l'évolution de la dynamique, notamment dans le domaine de la pollution, iii) faciliter la projection et la modélisation d'hypothèses.

Il faut également disposer d'indicateurs simples pour refléter l'impact des interventions sur les activités économiques des populations. Les analyses coûts-avantages doivent toutefois couvrir la totalité du bassin afin d'identifier l'avantage le plus élevé pour le plus grand nombre de personnes: un coût au niveau local peut très bien se traduire par un avantage au niveau régional.

Mais il faut également se rappeler que la mise en valeur des ressources a été souvent réalisée en négligeant les avantages dont peuvent bénéficier les populations locales.

Les jeunes doivent être considérés comme un groupe distinct ayant des problèmes, des droits et des perceptions spécifiques. Ce ne sont pas tous des enfants, bien que l'on ait souvent tendance à les inclure dans le même groupe. Il est donc important de tenir compte des incidences sur les jeunes car ce sont eux qui géreront et préserveront les ressources naturelles futures, et c'est pour eux que la gestion durable de ces ressources présente le plus grand intérêt.

L'environnement doit être considéré en termes de biodiversité et de contexte culturel ainsi qu'en termes de flore et de faune locales. Les organismes doivent avoir un concept dynamique de la pollution. Le développement des capacités doit également faire l'objet d'une approche plus flexible, inclure un enseignement technique pour les jeunes qui peuvent travailler en dehors du bassin et promouvoir le transfert de technologie. La recherche de modes de subsistance alternatifs permettrait de réduire les pressions exercées sur les forêts et sur les autres ressources naturelles.

RÉSUMÉ APPROUVÉ DE L'ATELIER

QUELLE EST LA SPÉCIFICITÉ DE LA GESTION DES BASSINS VERSANTS PAR RAPPORT À CELLE D'AUTRES RESSOURCES?

- Les bassins versants sont des intégrateurs de populations, de ressources et de secteurs d'activité.
- Les bassins versants relient des personnes qui ne se voient jamais et qui peuvent avoir des revenus, des moyens d'existence et des statuts socio-économiques très différents.
- Les bassins versants comprennent des ressources multiples – ce sont en général des forêts, des terres humides, des zones de pêche, des terres agricoles, de l'eau et parfois des minerais et d'importantes réserves de biodiversité.
- Une bonne planification exige de bien comprendre l'utilisation des terres, les systèmes hydrologiques et les interactions.
- Les investissements se font sur le long terme et se traduisent par des avantages et des coûts s'étendant sur de grandes distances.
- Les interventions qui sont justifiées pour des particuliers ou pour des communautés ne sont pas toujours bénéfiques pour l'ensemble de la société tributaire du bassin versant.
- En Afrique, les conditions d'aménagement des bassins versants sont très variées en termes d'hydrologie, de politiques, de culture, de gouvernance, d'investissements et de répartition spatiale de la pauvreté à l'intérieur des bassins.

QUELLES SONT LES CARACTÉRISTIQUES DES BASSINS VERSANTS EN AFRIQUE?

- D'une manière générale, le taux de pauvreté en Afrique est plus élevé que dans toute autre région du monde et ne cesse d'augmenter dans de nombreux pays africains. La pauvreté a de multiples incidences sur l'aménagement des bassins versants: les utilisateurs et les gouvernements ont des perspectives à court terme et peu de ressources à investir; l'investissement public est fortement tributaire des priorités des bailleurs de fonds qui privilégient la lutte contre la pauvreté à court terme plutôt que les infrastructures, la conservation des ressources et les capacités techniques à long terme.
- La majeure partie des pays partagent d'importants bassins fluviaux et les principales ressources en eau sont partagées entre deux ou plusieurs pays.
- L'Afrique est fortement tributaire des priorités et des programmes des institutions financières multilatérales et des organismes donateurs.
- La plupart des pays sont confrontés à une baisse des réserves d'eau stockée dans les zones de captage, les terres humides, les lacs et les réservoirs.
- Certains pays ont un très faible niveau d'investissements dans les stockages artificiels (vasques, barrages, réservoirs), bien que cette observation varie considérablement d'un pays à l'autre.
- Il existe un large éventail de situations quant à l'hydraulicité, le couvert forestier et la qualité de l'eau.

- Les capacités des institutions nationales et régionales chargées de l'aménagement des bassins versants sont en général peu et inégalement développées, notamment en ce qui concerne l'intégration interdisciplinaire.

GOUVERNANCE DES BASSINS VERSANTS

- De nombreux pays ont récemment adopté de nouvelles politiques en matière de gestion des eaux et de l'environnement qu'il faut harmoniser d'un pays à l'autre et avec d'autres politiques sectorielles. Il est cependant encore plus important de développer les capacités institutionnelles, les mécanismes de financement et la gestion de l'environnement ainsi que les mécanismes de mise en œuvre qui permettront d'appliquer pleinement ces politiques.
- Certains pays se sont récemment engagés à réaliser une harmonisation régionale.
- Il est recommandé de mettre en place des systèmes de gestion imbriqués afin de mettre en corrélation les organisations locales et les autorités et organismes chargés des sous-bassins, des zones de captage et des bassins. Plusieurs pays ont récemment promulgué des lois pour mettre en place de tels systèmes mais il existe peu de cas où ces systèmes fonctionnent réellement de manière efficace et efficiente.
- L'Afrique est confrontée à des difficultés fondamentales et particulières qui découlent de l'existence de bassins versants et de bassins fluviaux transnationaux. Heureusement, des programmes ont été déjà mis en œuvre pour en aménager certains, comme le bassin du fleuve Niger, le Programme de développement du lac Victoria exécuté par la Communauté de l'Afrique orientale, l'Initiative du bassin du Nil, ou encore l'aménagement du massif du Fouta Djallon.

EXPÉRIENCES D'AMÉNAGEMENT DES BASSINS VERSANTS

- Il existe quelques cas de projets d'aménagement réussis à l'échelle locale (comme au Maroc) et des exemples de méthodes d'utilisation des terres ayant produit des effets bénéfiques sur les bassins hydrographiques (techniques agroforestières, agriculture écologique, par exemple).
- Il a été prouvé que les populations pauvres peuvent considérablement profiter d'une augmentation, même faible, d'un approvisionnement en eau durant la saison sèche.
- On a assez rarement extrapolé les expériences réussies d'aménagement de bassins versants pour les transposer au niveau régional ou national. Il serait utile de mettre en place des mécanismes financiers et institutionnels permettant d'extrapoler les projets réussis à des zones beaucoup plus vastes.
- Les organisations et les organismes impliqués dans l'aménagement des bassins versants manquent en général de coordination et d'harmonisation.

LIENS AMONT-AVAL

- La collecte de l'eau par les petits exploitants présente un bon potentiel pour augmenter la disponibilité de l'eau pour une utilisation domestique et pour une utilisation productive de faible envergure.
- Les retraits d'eau et la reconversion forestière sont mal maîtrisés dans les zones amont de nombreux bassins.

- Le déboisement et la dégradation des sols dans les zones amont augmentent le risque d'inondations dans certains petits bassins fluviaux.
- Les responsables politiques et les agriculteurs dans de nombreuses zones semi-arides sont particulièrement préoccupés par la présence d'arbres invasifs qui risquent d'avoir une incidence sur le débit fluvial et les réserves souterraines.
- Nombre d'interventions portant sur l'eau et l'aménagement des bassins versants sont mises en œuvre sans tenir compte des incidences en aval.
- L'importance de la qualité de l'eau et des ressources en eau souterraine a été sous-estimée.

CONNAISSANCES ET INFORMATIONS

- Les techniciens, le public et les responsables politiques manquent de connaissances importantes en ce qui concerne les relations de cause à effet dans les bassins versants.
- Il est indispensable de développer les capacités des institutions clés en Afrique, en attachant une importance particulière à la mise au point en Afrique d'outils et de méthodes adaptés aux conditions de l'Afrique.
- L'évaluation et le suivi de la quantité et de la qualité de l'eau sont pour ainsi dire inexistants.
- Une amélioration de l'information et des systèmes de gestion de l'information peut aider à résoudre les conflits liés à l'eau et à l'aménagement des bassins versants (exemple du Ghana).
- Une bonne planification économique et sociale doit s'appuyer sur la compréhension des relations hydrologiques et sur des données fiables relatives à l'offre et à la demande en eau.
- Il existe plusieurs malentendus importants sur les relations entre les arbres, les forêts et les principales caractéristiques hydrologiques (en ce qui concerne notamment l'impact des arbres et des forêts sur les glissements de terrain et les inondations).
- Des opportunités de partage de concepts et d'expériences sur le continent africain sont mal exploitées entre scientifiques de diverses disciplines, responsables politiques et utilisateurs de ressources ainsi qu'entre pays à divers stades de développement institutionnel.
- Certains progrès ont été réalisés dans le domaine des connaissances scientifiques concernant l'aménagement des bassins versants et doivent être plus largement partagés en Afrique.
- Il y a eu peu d'expérimentation et de suivi durables.
- Il faut sensibiliser davantage le public et les responsables politiques.
- Il est nécessaire de recueillir des données de manière plus cohérente et de les mettre en commun plus librement.
- Il faut renforcer la formation et le développement des capacités.
- Les exemples de projets réussis en Afrique, même s'ils sont spécifiques à un lieu précis, doivent être recensés afin d'établir le bien-fondé de l'aménagement des bassins auprès des responsables politiques et des bailleurs de fonds. Les exemples les plus précieux sont ceux où la science et les connaissances ont contribué à la mise en valeur des bassins versants et où l'aménagement des bassins a contribué à améliorer les conditions de vie des populations.

DROITS DE PROPRIÉTÉ ET DROITS D'USAGE DE LA TERRE, DE LA FORÊT ET DE L'EAU

- Les droits d'usage de la terre et de l'eau sont étroitement liés dans la tradition africaine et les droits relatifs à l'eau viennent bien après ceux relatifs à la terre.
- L'eau a récemment été déclarée ressource nationale en Afrique du Sud et au Ghana, ce qui implique la nécessité de transférer de l'eau des régions où elle abonde vers les régions qui en

sont moins bien pourvues. En Afrique du Sud, un système complexe de transfert interbassin a été mis en place pour transférer l'eau depuis l'est du pays où elle est abondante vers les zones du centre fortement peuplées où l'approvisionnement naturel est insuffisant.
- Les droits de propriété des ressources des bassins versants sont détenus dans le cadre de multiples régimes des biens et sont régis par de multiples juridictions. Il est important que les nouveaux organismes disposent d'un pouvoir réel, connaissent et appliquent les dispositions relatives aux droits de propriété et agissent en accord avec les sources de droit existantes qui sont légitimes et dignes de confiance.
- La privatisation des ressources des bassins versants est une voie de développement par défaut.

NOUVEAUX MÉCANISMES DE FINANCEMENT ET DE PARTAGE DES AVANTAGES

- Il est important de mobiliser à long terme et de manière plus cohérente le financement accordé par les donateurs pour la conservation et l'aménagement des bassins versants. Les donateurs doivent être encouragés à consentir des investissements à long terme afin de réduire le besoin d'une aide sur le court terme.
- Dans certains cas, il sera peut-être possible de conditionner les investissements à un consentement des utilisateurs à payer pour obtenir des services environnementaux fiables et de l'eau de bonne qualité.
- Il faut encore déterminer qui sera indemnisé pour protéger les bassins versants et sous quelle forme verser cette indemnité.
- Le potentiel de participation du secteur privé dans l'aménagement des bassins versants reste inconnu et l'on ne sait pas non plus comment le développer.

MISE EN RÉSEAU

- Il est indispensable de constituer des réseaux consacrés aux questions d'aménagement des bassins versants, mais il est important de ne pas essayer de reproduire des réseaux déjà existants tels que WaterNet.
- Il est nécessaire de constituer des réseaux sur les questions de captage de l'eau afin de relier les groupements communautaires et les organismes de la société civile avec les institutions et les autorités responsables.
- Il y a peu de communications Sud-Sud à l'intérieur du continent ainsi qu'entre l'Afrique et d'autres pays en développement.
- Les pays africains bénéficieraient d'une mise en commun des expériences et des enseignements issus de leur propre continent.
- Il serait utile de constituer des réseaux pour mettre en contact les spécialistes en sciences sociales et en sciences biophysiques.
- Il existe un besoin important de mettre en corrélation les politiques et les sciences en s'appuyant sur des sciences bien acceptées, sur des décideurs politiques réceptifs et sur la mise en réseau.

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