FAO FORESTRY PAPER

150

The new generation of watershed management programmes and projects

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A resource book for practitioners and local decision-makers based on the findings and recommendations of an FAO review

Prepared in collaboration with:
European Observatory of Mountain Forests (EOMF)
International Centre for Integrated Mountain Development (ICIMOD)
Red Latinoamericana de Cooperación Técnica en Manejo de Cuencas Hidrográficas (REDLACH)
World Agroforestry Centre (ICRAF)

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Preface

The conservation, use and sustainable management of watershed resources in order to meet the demands of growing populations has been a high priority for many countries over the past several decades. Particularly during the 1990s, integrated watershed management through people's participation has become widely accepted as a promising approach for conserving water, land and biodiversity, enhancing local livelihoods, improving the economy of upland inhabitants and people living in downstream areas, and ensuring sound sustainable natural resources management overall.

On the occasion of the International Year of Mountains, 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 of integrated and participatory watershed management. The overall objectives were to promote the exchange and dissemination of experiences in implementing watershed management projects in the decade from 1990 to 2000 and to identify the paradigm, approach and methods for a new generation of watershed management programmes and projects.

Experts from four continents contributed to the assessment, which yielded four regional workshops held in Nairobi (Kenya), Kathmandu (Nepal), Arequipa (Peru) and Megève (France) and an international conference in Porto Cervo (Sardinia, Italy). Workshop and conference findings are presented in detail in five volumes of proceedings, published in the FAO-FORC Watershed Management and Sustainable Mountain Development Working Papers series. Also implemented in the context of this review, and published in the same Working Paper Series, are two national case studies, for Nepal and Burundi, and two regional case studies, for the Mediterranean and Latin America.

This resource book represents a summary and critical analysis of the rich discussions and vast material that emerged during the review, as well as the review's findings and recommendations. It presents the state of the art in watershed management approaches and practical experiences, and proposes new ideas and approaches for future projects and programmes. The ideas and recommendations presented in this resource book are certainly not the final truth, but reflect the provisional outcome of work in progress. The resource book should promote further reflection and creative thinking about watershed management, and should give food for thought for the development of future watershed management projects and programmes.

The review of watershed management experiences and the resulting documents and recommendations are an important contribution to the implementation of Chapter 13 of Agenda 21, the follow-up to the International Years of Mountains (2002) and Freshwater (2003), the promotion of the Johannesburg Plan of Implementation, and the achievement of the Millennium Development Goals. For FAO, over the next few years, the results of the review and the approaches presented in this resource book will be the basis for developing, in a collaborative manner, new projects and programmes on different continents in order to test, validate and implement the new approaches to watershed management.

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Acknowledgements

This publication is the final outcome of a collective process involving more than 150 professionals in watershed management with different technical backgrounds and from different regions of the world.

The watershed management review process was initiated in 2001, under the overall supervision of Moujahed Achouri, former officer in the Forest Conservation Service (FORC) of FAO, and Larry Tennyson, FORC consultant. Based on a stock-taking exercise of watershed management experiences for the period 1990 to 2000, Achouri and Tennyson designed and coordinated an inter-regional review, which was implemented during 2002 and 2003. This book was developed in 2005 and 2006, based on papers presented and discussions held in four regional workshops and an international conference, national and subregional case studies and final reports by Achouri and Tennyson.

Under the supervision of Jean Prospère Koyo (Chief FORC), the preparation of this resource book was coordinated by Patrizio Warren (social scientist, consultant), with contributions from a working group including Thomas Hofer (FORC officer in charge of watershed management), Douglas McGuire (Mountain Partnership Secretariat), William Fleming (watershed management specialist, University of New Mexico, Albuquerque, United States), Benjamin Kiersch (consultant in environmental economics) and Silvia Berini (editorial assistant). Initial drafts of the publication were peer reviewed by Carlos Marx Carneiro (FAO-RELAC and Red Latino Americana de Manejo de Cuencas), Brent Swallow (ICRAF, Nairobi), Kumar Upadhyay (senior watershed management expert, Nepal), Roger White (ICIMOD, Kathmandu), Pier Carlo Zingari (EOMF, Chambery, France) and Larry Tennyson (University of Arizona, Tucson, United States).

Jane Shaw was responsible for the final editing and Pietro Bartoleschi for the layout and graphics. Andrea Perlis (officer in charge of publications in the Forestry Department) oversaw the finalization of the book. All photos (including the cover photo) are by T. Hofer, FAO.

Acronyms

ACID	Amansuri Conservation Integrated Development (Ghana)
ANA	Asociación Nueva América (Ecuador)
ANAP	National Association of Small Farmers (Cuba)
asl	above sea level
CAMP	Catchment Management and Poverty Alleviation (Programme)
CAP	Common Agriculture Policy (EU)
CAPRi	Collective Action and Property Rights (System-Wide Programme)
CBD	Convention on Biological Diversity
CDG	community development group
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CPR	common pool resource
DANIDA	Danish International Development Agency
DFID	Department for International Development (United Kingdom)
EOMF	European Observatory on Mountain Forests
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FONAFIFO	National Forestry Financing Fund (Costa Rica)
FONAG	Watershed Protection Fund (Ecuador)
FORC	Forest Conservation Service (FAO)
FSSP	Forest Sector Support Programme (Viet Nam)
GDP	gross domestic product
GEF	Global Environment Facility
GIS	geographic information system
GTZ	German Agency for Technical Cooperation
GWS	Ghana Wildlife Society
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	World Agroforestry Centre
IIED	International Institute for Environment and Development
INBO	International Network of Basin Organizations
IUCN	World Conservation Union
IWRM	integrated water resource management
IYM	International Year of Mountains
JDS	Jomoro District Assembly (Ghana)
LEHP	La Esperanza Hydropower Project (Costa Rica)
LSP	Livelihoods Support Programme (FAO/DFID)
MDG	Millennium Development Goal
MEA	Millennium Ecosystem Assessment
MOU	Memorandum of Understanding
NAMRSAP	Natural Resource Management Sector Assistance Programme (Nepal)
NGO	non-governmental organization
NTFP	non-timber forest product
PDR	(Lao) People's Democratic Republic
PES	payment(s) for environmental services
PMC	Project Management Committee
PRA	participatory rural appraisal
PUCD	FAO Inter-Regional Project for Participatory Upland Conservation and Development
RDO	regional development organization

REDLACH	Latin American Watershed Management Network
SCWMC	Soil Conservation and Watershed Management Component (Nepal)
SEED	services, economy, environment and democracy (approach)
SLA	sustainable livelihood approach
SWOT	strengths, weaknesses, opportunities and threats (analysis)
UMAT	Unit on Environment and Tourism (Ecuador)
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
VLC	virtual learning community
WFD	Water Framework Directive
WOCAT	World Overview of Conservation Approaches and Technologies
WRC	Water Resources Commission (Ghana)
WSD	watershed development

About this resource book

For several decades, improved watershed management has been a high priority for many countries. Since the 1990s, integrated and participatory watershed management has been seen as a promising approach for conserving water, land and biodiversity, enhancing local livelihoods and supporting broader sustainable development processes at the national and river basin levels.

During the International Year of Mountains, FAO and its partners undertook a large-scale assessment and global review of the current status and future trends of integrated and participatory watershed management. The general objectives were to promote the exchange and dissemination of experiences in implementing watershed management projects in the decade from 1990 to 2000, and to help identify the paradigm, approach and methods for a new generation of watershed management programmes and projects.

Experts from four continents contributed to the assessment through four regional workshops in Nairobi (Kenya), Kathmandu (Nepal), Arequipa (Peru) and Megève (France), and an international conference in Porto Cervo (Italy). Workshop and conference findings have been published in five volumes of proceedings in the FAO-FORC Watershed Management and Sustainable Mountain Development Working Papers series. This resource book provides a critical summary of the FAO review's findings and recommendations.

The resource book has been written primarily for field-level watershed management practitioners and local decision-makers involved in watershed management at the district or municipality level. It is also expected to be a useful source of information on the new generation of watershed management for other readers, such as senior officers, consultants, evaluators, policy-makers and watershed management students.

To facilitate the retrieval and use of information, the resource book allows for different levels of reading and learning. Page-side callouts and subheadings facilitate a rapid scan of the contents of each chapter. Core information is summarized in the main text. Boxes illustrate key topics, burning issues and expert opinions, or present real-life examples. Short fiction narratives (one prelude and two interludes) illustrate the link between the everyday professional life of watershed managers and the subject dealt with in the following chapter.

The resource book addresses the new paradigm of watershed management as outlined by the FAO review from four complementary angles.

The first chapter looks at the history of watershed management, emphasizing how a discipline initially based on water engineering and forestry has become a multidisciplinary approach rooted in general and human ecology and linked to agriculture, rural development, environmental economics and social sciences.

The second chapter summarizes the conceptual background inspiring many of the discussions made during the FAO review. It deals with new perspectives on watershed biophysical processes, human ecology and environmental economics.

The third chapter describes some ongoing changes in programme design and implementation strategy, and outlines the profile of the new generation of watershed management programmes and projects.

The fourth chapter links the new watershed management approaches to the policy environment of the new millennium. It also deals with critical factors for the successful implementation of the new approach, such as capacity building and financing.

The annexes provide additional information on specific methods and resources for watershed management.

Prelude
Stories of people and water

SOR PAOLO AND SORA MARIA

Sor Paolo and Sora Maria are a retired couple in their late sixties who 20 years ago invested their savings in a piece of land at Lunghezza, near Rome on a curve of the river Aniene. It was an excellent place for fishing – Paolo's favourite pastime. Ten years after buying this land, they started to build a house. When Sor Paolo retired from his job in Rome, the couple moved to Lunghezza.

In November 1999, heavy rains in the Apennines caused minor floods in the Aniene valley, and in early December the upper Aniene dam had to be opened to release water from the San Cosimato hydropower basin. A sudden increase of runoff proved perilous for downstream banks. Thousands of hectares of arable land were flooded, including Paolo's property. The emergency services were efficient, so there were no causalities or losses of livestock. Property damage was covered by insurance, and the regional government made a small subsidy available.

However, since the 1999 flood, Paolo and Maria do not feel safe at home. Sor Paolo still takes his fishing kit to the river in the early morning, but there are no more fish in the Aniene, so he just spends hours watching the river flow by. Sometimes the stream carries by big masses of foam, and sometimes there is a greasy layer covering the water. Sor Paolo knows that pollution comes from the industrial area of Tivoli, about 6 km upstream from his land; public health authorities have warned Lunghezza farmers to stop using river water to irrigate vegetables and water animals. Sor Paolo will probably have to pay somebody to dig a well so that he can have clean water for his vegetables and flowers. This is an expensive job, and he does not like having to pay for it when the waters of the Aniene are right there.

DON BELISARIO

The small forest-covered canyon where Don Belisario and his family live contrasts sharply with the bare landscape of the hills surrounding the town of Jocotán in Eastern Guatemala. Every morning Don Belisario thanks the Virgin of Ocopa that he did not clear the trees from his plot, as his neighbours did. During an agroforestry course that he attended, he learned that trees prevent the canyon's creek from drying up. This water is an essential asset in Don Belisario's livelihood: it allows him to water the grafted fruit tree plantlets that he sells to other farmers, and the forest nursery that he looks after for the municipality. Creek water is also essential for the ceramics cottage industry that the women of the family run.

However, these activities are not enough to make the household budget; during the rainy season, Don Belisario has to rent 1.5 ha of hillside land to grow maize and beans for family consumption. Over the last 20 years, hillside agriculture has become difficult in Jocotán. Lost harvests and poor yields have many causes: the population has grown beyond the hills' agricultural carrying capacity; household lands have shrunk because of inheritance splits; and deforestation has increased, accelerating runoff. On top of all this, climate change is making rainfall increasingly unpredictable. The effects of environmental degradation on people's livelihoods are clear in Jocotán: lost or meagre yields are pushing hundreds of *campesino* families towards poverty and food-insecurity every year. To counteract drought, people are growing sorghum instead of maize. Some innovators have adopted new agricultural technologies recommended by extensionists. High-yielding and drought-resistant hybrid maize and bean seeds, which need expensive chemical fertilizers and pesticides, have also been introduced. There are demonstration plots for land husbandry, water harvesting and agroforestry plantations, but these are too labour-intensive for most families. As nobody can live from farming alone, most men migrate seasonally to banana plantations and big ranches on the coast. Others work in the towns, often looking for ways to reach Mexico and the United States.

So far, the tree nursery has helped Don Belisario avoid migration, but for how much longer will water to irrigate the nursery be available from the creek? In 2000, Don Belisario remembers, it took only five minutes to fill his watering can from the creek's main source; now it takes ten. He also remembers that the source went dry for several days last year, and he lost more than 200 mango plantlets. Since then, every Sunday, Don Belisario prays the saints not to let his source die.

CHAPAJI

Chapaji is the richest man in Bhusunde Bazar, a rural village in the middle hills of Nepal. He is the owner of the biggest and best-stocked shop in town, and the most important intermediary in Bhusunde Khola valley. Yet Chapaji cannot forget that his wealth and power originated from the 8 ha of terraced paddy field that he inherited from his father. This is a vast area of land to people in the middle hills of Nepal, where most families own less than 1 ha of rainfed land. Chapaji's terraces are in a very special position. They are high enough to be protected from the Bhusunde river floods during the rainy season, and low enough to be permanently irrigated by several local sources during even the driest season; they produce two high-yielding harvests a year.

In his early years, Chapaji used to loan his rice surplus to upland families who lacked land or rainwater and could not satisfy their own needs from on-farm production. Nowadays, the rice business has become a secondary activity for Chapaji, and tenants take care of it. However, Chapaji is still sentimentally attached to his land, and very concerned about the maintenance problems reported by tenants. For the last ten years, increasing work has been needed to keep the sophisticated hydraulic system in operation. This system allows water to flow gently through the terraces, preventing both stagnation and emptying. During heavy monsoon showers, huge amounts of rainwater mixed with sediment and stones pour on to the delicate earth mounds, sweeping away the bamboo and wood check-dams. These light structures are very efficient at managing the gentle stream of the paddy terrace, but totally inadequate for withstanding runoff from the hill. The tenants complain that the rainy season harvest is spoiled and too much maintenance is needed to make their business tenable. They have asked Chapaji to revise the terms of their contracts, leading him to understand that they will give up their jobs if he does not consider their claims.

While trying to find ways of keeping the tenants happy without losing too much of his own profit, Chapaji curses the people in hillside villages, who have progressively extended their farming and grazing land into the forest buffer zone, which had protected his terraces against runoff and landslides for centuries. He is furious with the people in upland settlements, who he sees as being able only to make children they cannot feed and to fell sacred trees for fuelwood and fodder. They do not understand that the gods created the forest to protect the property and life of those with a wealthy and successful karma. These miserable people have no right to interfere with this divine design and should be stopped. Chapaji decides to visit his friends at district headquarters to see what can be done.

Chapter 1
Lessons from the past

Watershed ecology is of special importance for many people

Sor Paolo, Don Belisario and Chapaji live in different regions of the globe, belong to different social groups and hold different values and views about the world and the human condition. Nonetheless, they all struggle with the same basic problem that billions of people face: controlling the flow of water and runoff material that are dragged down slopes. This is the core focus of watershed management, which is an applied and multidisciplinary subject based on geology, ecology, environmental economics and the social sciences.

Watershed management is primarily a matter of gravity. Gravity makes rainwater flow at a speed – and with a power – that is directly proportional to the slope gradient. Rocks, soil, vegetation cover and human-made artefacts can slow the flow and divert part of it to the subsoil. Gravity makes it possible to distribute highland rainfall over downstream areas, create and renew surface and underground water resources, irrigate plants, water animals, enrich land with mineral and organic sediments, and transport biological materials such as seeds. Gravity makes watershed ecosystems highly dynamic and entropic.

Watershed ecology is very important to humankind. The world's supply of freshwater depends largely on people's capacity to manage upstream–downstream flows. Food security also largely depends on upland water and sediments. Inappropriate watershed management creates many problems. Deforestation, inadequate hillside agricultural practices and overgrazing may increase runoff, prevent the recharge of upland sources (as in Don Belisario's case) and generate seasonal torrents that spoil lowland fields (as in Chapaji's case). Badly engineered watersheds (as in the Aniene Valley) may not be able to stand heavy rains. Watercourses are also very good vectors for biological and industrial chemical pollution (as in Sor Paolo's case).

THE LONG HISTORY OF PEOPLE AND WATER

Watershed management is 5 000 years old

Ever since agriculture began, humans have been manipulating water and slopes in order to benefit cultivation and control floods and drought. By 3000 BC, early attempts to control water flow had evolved into sophisticated extended irrigation systems. Irrigation was discovered in China, on the banks of the Yellow River, and in the Fertile Crescent, which roughly corresponds to the watersheds of three major Near East rivers: the Nile, the Euphrates and the Tigris. From these cradles, irrigation diffused rapidly throughout Asia. By 2500 BC, irrigated agriculture was being practised in the Indus valley, and between 500 and 1 000 years later it had spread to peninsular India and southeast Asia. By 1500 BC, it had been reinvented in the American continent.

The Greeks, Romans and other Mediterranean people were familiar with water engineering, but they applied the technology more to urban water supply than to irrigation. Nevertheless, Mediterranean hillside terracing and tree planting on slopes – which still characterize the regional landscape – were the forerunners of modern watershed management techniques. Ancient hydraulic technology and land husbandry expertise were further refined during the Middle Ages. Well-fed irrigation systems that still function in oases on the edge of the Sahara testify to the precision and effectiveness of Arab water engineering. Major hydraulic civil–military works carried out by Italian Renaissance towns, such as Florence, demonstrate what technology was achieving in Europe by the end of the sixteenth century. The capacity to control water flow also increased in Asian, American and African societies: by 1000 AD, the Incas had refined a sophisticated watershed management model, based on the vertical integration of different ecotypes existing in Andean watersheds. Similar approaches were developed by other upland people in Europe and Asia.

In Europe, the potential of watershed technology started to be fully exploited at the beginning of the modern era. Between the sixteenth and seventeenth centuries, the introduction of New World crops such as maize, potato and tomato, the diffusion of non-fallow cultivation techniques based on slow drainage and abundant fertilization, the suppression of the commons and privatization of agricultural lands, and the rapid improvement of machinery led to ever-increasing agricultural yields. Surpluses were essential for sustaining the growing population employed in industry, trade and services, but they also required major public investment in irrigation, land reclamation and watershed management works.

The rise of modern watershed management

By the end of the nineteenth century, engine-powered machinery was helping hydraulic engineers in the West to work on a larger scale and at a faster pace. In the first half of the twentieth century, major lowland drainage and land reclamation schemes were implemented in the United States, Europe and overseas colonies, while the discovery of hydroelectric power technology was giving additional impetus to hydraulic public works.

After the Second World War, watershed management became an important element of development policies, as advocated by the Bretton Wood institutions and the United Nations (UN) system. Between 1950 and 1970, big irrigation schemes and hydropower dams were constructed in Asia, Africa and Latin America to promote agricultural development and economic growth while ensuring water and electricity supply. The environmental and social costs of these large-scale watershed works were often underestimated.

By the 1960s, problems with protecting artificial basins and channels from runoff and sedimentation helped to increase practitioners' and policy-makers' awareness of the importance of upstream–downstream linkages in watersheds. Watershed planning started to consider more thoroughly such processes as seasonal torrents, erosion, rapid basin saturation and downstream floods. The integrated development approach encouraged decision-makers to pay more attention also to the economic and social implications of watershed management, which became "integrated watershed management".

WATERSHED MANAGEMENT AND SUSTAINABLE DEVELOPMENT

In the 1970s, people all over the world started to notice the environmental threats affecting the planet. Following a warning from the scientific community, the UN called the Conference on Human Environment in 1972, urging Member States to pay more attention to the management and conservation of natural resources in their development efforts.

In the following years, environmental concerns became an essential ingredient of political rhetoric, mass communications and the thinking of the general public. Green movements mushroomed in the North and South, and new "ecologically sound" rules and behaviours were promoted. However, economic development and nature conservation continued to be perceived as two different and diverging goals. Environmental protection was seen as a luxury that only rich countries could afford; unindustrialized countries were expected to concentrate more on fighting poverty, disease and illiteracy.

The UN Brundtland Commission changed this view of human ecology. Its *Our common future* report (issued in 1987) emphasized the economic significance of natural capital endowments and demonstrated the important role that sound development practice can play in environmental protection. The report promoted a new type of development, which satisfies the current needs of human populations without compromising the chances of future generations. The document refers to this as "sustainable development".

Several chapters of Agenda 21 refer to watershed management

The UN Conference on Environment and Development (UNCED), in Rio de Janeiro, Brazil in 1992, publicized the concept of sustainable development. Among other important policy documents, the conference approved Agenda 21, which has provided the essential guidelines for sustainable development policy and practice ever since. Among Agenda 21's statements on watershed management issues (Box 1), the most extensive are in Chapter 13 on "Sustainable mountain development", which includes a programme area on promoting integrated watershed development and alternative livelihood opportunities. This establishes a framework for linking:

- the development of appropriate land-use planning and management for both arable and non-arable land in order to prevent soil erosion, increase biomass production and maintain the ecological balance;
- the promotion of alternative income-generating activities, such as sustainable tourism and fisheries and environmentally sound mining;
- the improvement of infrastructure and social services in mountain areas, in order to protect the livelihoods of local communities and indigenous people;
- mitigation of the effects of natural disasters related to poor watershed management through hazard prevention measures, risk zoning, early warning systems, evacuation plans and emergency supplies.

Agenda 21 also stresses that successful watershed management must be based on local stakeholders' informed participation in natural resource management, economic growth and social change.

Agenda 21 played an important role in adoption of an integrated and participatory approach to conservation and development. It incorporated the views of economists and social scientists in watershed management; helped ecologists and foresters to understand local livelihood systems and recognize the validity of some indigenous solutions to site-specific problems; improved communications and collaboration among planners and local people; and encouraged participatory watershed management. A large number of watershed management projects and programmes were implemented all over the world by different organizations and stakeholders, many of them using integrated and participatory approaches. Watershed management institutions were increasingly involved in the global events that followed the Rio Conference – the World Summit on Sustainable Development (2002), the International Years of Mountains (2002) and Freshwater (2003), etc.

BOX 1

Watershed management issues in Agenda 21

Agenda 21, Chapter 13 "Sustainable mountain development" includes the following statements on mountain watersheds:

> Nearly half of the world's population is affected in various ways by mountain ecology and the degradation of watershed areas. About 10 percent of the earth's population lives in mountain areas with higher slopes, while about 40 percent occupies the adjacent medium- and lower-watershed areas. There are serious problems of ecological deterioration in these watershed areas... Soil erosion can have a devastating impact on the vast numbers of rural people who depend on rainfed agriculture in the mountain and hillside areas. Poverty, unemployment, poor health and bad sanitation are widespread. Promoting integrated watershed development

Continues

Box 1 continued

> 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. In addition, promoting alternative livelihood opportunities, particularly through development of employment schemes that increase the productive base, will have a significant role in improving the standard of living among the large rural population living in mountain ecosystems.

Reference to watershed management-related topics is also made in other chapters of Agenda 21. For instance, Chapter 10 "Integrated approach to the management of land and land resources" states:

> Expanding human requirements and economic activities are placing ever increasing pressures on land resources, creating competition and conflicts and resulting in suboptimal use of both land and land resources. If, in the future, human requirements are to be met in a sustainable manner, it is now essential to resolve these conflicts and move towards more effective and efficient use of land and its natural resources. Integrated physical and land-use planning and management is an eminently practical way to achieve this… Land resources are used for a variety of purposes which interact and may compete with one another; therefore, it is desirable to plan and manage all uses in an integrated manner. Integration should take place at two levels, considering, on the one hand, all environmental, social and economic factors (including, for example, impacts of the various economic and social sectors on the environment and natural resources) and, on the other, all environmental and resource components together (i.e., air, water, biota, land, geological and natural resources). Integrated consideration facilitates appropriate choices and trade-offs, thus maximizing sustainable productivity and use

Chapter 11 "Combating deforestation" includes the following statements on watershed degradation and rehabilitation:

> Forests worldwide have been and are being threatened by uncontrolled degradation and conversion to other types of land uses, influenced by increasing human needs, agricultural expansion, and environmentally harmful mismanagement... The impacts of loss and degradation of forests are in the form of soil erosion, loss of biological diversity, damage to wildlife habitats and degradation of watershed areas, deterioration of the quality of life and reduction of the options for development. The present situation calls for urgent and consistent action for conserving and sustaining forest resources. The greening of suitable areas, in all its component activities, is an effective way of increasing public awareness and participation in protecting and managing forest resources. It should include the consideration of land use and tenure patterns and local needs and should spell out and clarify the specific objectives of the different types of greening activities.

Chapter 12 "Combating desertification and drought" states:

> Desertification affects about 3.6 billion hectares, which is about 70 percent of the total area of the world's drylands or nearly one-quarter of the global land area.
> In combating desertification on rangeland, rainfed cropland and irrigated land, preventative measures should be launched in areas which are not yet affected or are only slightly affected by desertification; corrective measures should be implemented to sustain the productivity of moderately desertified land; and rehabilitative measures should be taken to recover severely or very severely desertified drylands.
> An increasing vegetation cover would promote and stabilize the hydrological balance in the dryland areas and maintain land quality and land productivity.

WATERSHED MANAGEMENT IN FAO

Since the late 1980s, FAO has promoted watershed management by implementing several field projects (Boxes 2 and 3) and documenting best practices and lessons learned in several publications. In 1992, FAO was appointed task manager for Chapter 13, Agenda 21, and has been active in broadening integrated and participatory watershed management and mainstreaming watershed management and sustainable mountain development issues into policy fora since then.

From 1998 to 2002, FAO played a leading role in preparations and observance of the International Year of Mountains (IYM), whose mission statement was to "promote the conservation and sustainable development of mountain regions, thereby ensuring the well-being of mountain and lowland communities". The IYM helped to establish several international initiatives to improve the lives of mountain people and protect mountain environments.

In 2002, the need to take stock of existing experiences and rethink the watershed management paradigm led FAO to launch a comprehensive inter-regional review of integrated and participatory watershed management. This initiative was part of the implementation of Chapter 13, Agenda 21 and of the follow-up to the International Years of Mountains and Freshwater. It involved more than 80 institutions and more than 300 professionals.

BOX 2

FAO-promoted watershed management field projects in the 1990s

FAO implemented the following eight major watershed management projects between 1990 and 2000:

- Participatory Watershed Management Training Project, 1996 to 1999, Asia region (FAO/Netherlands);
- Participatory Upland Conservation and Development, 1992 to 2000, inter-regional: Bolivia, Burundi, Nepal, Pakistan, Rwanda and Tunisia (FAO/Italy);
- Shivapuri Watershed Management and Fuelwood Project, 1985 to 1999, Nepal (FAO/Norway);
- Participatory Watershed Management, 1995 to 1999, Viet Nam (FAO/Belgium);
- Mithawan Watershed Management, 1995 to 2000, Pakistan (FAO/Japan);
- Watershed Management: Three Critical Areas, 1993 to 1999, Myanmar (FAO/United Nations Development Programme [UNDP]);
- Watershed Planning and Management, 1993 to 1997, Pakistan (FAO/UNDP);
- Suketar Watershed Management, 1989 to 1997, Pakistan (FAO/UNDP).

All eight projects included community or group participation and invested considerable resources in training local technicians and villagers. All projects had social and biophysical-technical components, but there were insufficient indicators to evaluate the performance of these. Most projects lacked sustainability indicators.

Future projects need to pay more attention to:

- project design, to avoid overcomplicated expected outputs, unclear objectives and complex designs;
- comprehensive and clearly defined performance indicators;
- monitoring and evaluation procedures that clearly link project performance with objectives;
- sustainability indicators that are linked to project objectives.

The broad objectives of the FAO watershed management review, which was mainly implemented during 2002 and 2003, were: (1) to collect and disseminate the information needed to assess watershed management as implemented during the 1990s; and (2) to support and guide development of a new generation of more effective watershed management projects and programmes.

Four regional consultations (Europe, Latin America and the Caribbean, Asia and Africa) were held and their proceedings published. The review process culminated in an inter-regional conference at Sassari, Sardinia, Italy where recommendations for policy-makers were summarized in the Sassari Declaration (Box 4).

The following chapters are based largely on findings of the FAO review. The ideas and recommendations presented are the results of work in progress; they are meant to promote further reflection and creative thinking about future watershed management projects and programmes.

BOX 3

The Inter-Regional Project for Participatory Upland Conservation and Development

The FAO Inter-Regional Project for Participatory Upland Conservation and Development (PUCD) was funded by the Italian Cooperation. It ran from 1992 to 2000 in selected pilot watersheds of Bolivia, Burundi, Nepal, Pakistan, Rwanda and Tunisia.

PUCD's main aim was to identify and field test methods and techniques for promoting and consolidating people's participation in the sustainable management of upland watersheds. Its immediate objectives were to:

- establish participatory and integrated watershed management at the selected sites;
- incorporate the participatory and integrated watershed management approach into national policies for rural development and natural resource conservation, and into decentralized planning systems;
- replicate successful methods, techniques and tools through communication and training.

Project management was based on action learning. National field teams prepared yearly work plans through participatory assessment, planning, implementation, evaluation and replanning exercises with local stakeholders such as communities, grassroots organizations, the private sector, government line agencies, local authorities, non-governmental organizations (NGOs) and other development institutions.

The teams ensured that lessons learned could be applied both within and outside the project areas. A coordination unit at FAO headquarters systematized the lessons learned and mainstreamed the project experience within FAO and other international organizations. Case studies, field guides and communication materials were published.

According to the final evaluation, PUCD "has largely achieved its objectives. Its pilot, open-ended and flexible design has been instrumental in proving that … the participatory and collaborative management process is a very adequate strategy to trigger local development, empower people and contribute to natural resources conservation and sustainable management. The 'learning-oriented' approach has enabled the progressive redefinition of project strategy, field procedures, technologies and tools according to the specific and changing circumstances at the different levels."

PUCD provided a learning environment in which people from different countries and different backgrounds put the policy statements of Agenda 21, Chapter 13 into practice. It also created a group of professionals from FAO and other institutions who are aware of the pros and cons of the new approach and capable of carrying out the necessary work.

BOX 4

Sassari Declaration

Within the context of the Millennium Development Goals and with the intent of preparing for the next generation of watershed management, the objectives of the international conference "Integrated Watershed Management: Water Resources for the Future" were to: (1) provide an adequate opportunity/platform to all concerned parties to share information and contribute to a better understanding of the current status of watershed management; and (2) provide advocacy and support for the implementation of effective watershed management at different levels. Conference recommendations are as follows:

1. There is a need to focus increased global and regional attention on watershed management because watersheds integrate resources, environmental services, uses and users; watersheds connect people who may never meet and may vary greatly in terms of wealth, livelihoods and culture; good planning requires good understanding of linkages between upstream and downstream hydrologic and land-use systems; investments are long-term and generate benefits and costs across large distances; and interventions that are good for individuals or communities may be detrimental to wider societal interests.

2. Outputs from the Sassari conference and the associated regional workshops should be used to develop a set of guidelines for the next generation of watershed management programmes that can be applied to the design and screening of new projects.

3. Some of the key elements of the guidelines for the next generation of watershed management programmes include: a multisectoral approach; a combination of bottom-up and top-down planning, monitoring and evaluation; clear procedures for environmental impact assessment of interventions, including dams and reservoirs; networking among key stakeholders; consideration of socio-economic and cultural aspects and natural processes; gender balance in decision-making; embracing new approaches for sharing knowledge and learning; sustainable finance; compensation mechanisms; capacity building at all levels; reforming governance, linking surface, groundwater and coastal water sources; a shift from looking at supply to demand of water; efficiency of water use; coping with hydrologic extremes and natural hazards; and the integrated management of water, vegetation, soils and sediments.

4. Guidelines for the next generation of watershed management programmes should be tested and demonstrated in pilot cases, with planning and implementation from local, national and transnational scales. These pilot cases should include institutionalization of watershed approaches into national systems.

5. Considering the need for integrated approaches to watershed management, it is recommended that donor agencies, financial institutions, government departments, civil society organizations and the private sector commit to long-term intersectoral and innovative planning, finance and execution of watershed management.

6. Because watersheds often span political boundaries, watershed management should be seen as an integrative approach that has value in understanding and resolving conflicts between upstream and downstream communities and countries.

Continues

Box 4 continued

7. Because rural and urban poverty is a significant contributing factor to watershed development and degradation, it is recommended that the multiple linkages between poverty and watershed management be better understood and considered in the planning of both watershed management and poverty alleviation programmes.

8. It is recognized that there is an urgent need to build capacity of all stakeholders (including watershed inhabitants and professionals at the local and national levels) to understand and manage the multisectoral processes and approaches necessary for effective watershed management.

9. At present, land and water governance institutions and policies are often inadequate to support the integrative and multisectoral approach needed to implement watershed management. It is therefore recommended that: (1) institutions for integrated basin management be established and strengthened with appropriate legal status, resources and financing; (2) there be more effective and equitable communication among local communities, managers and policy-makers; and (3) policies be based on clear evidence and tested principles.

10. Access to a minimum amount of safe water should be recognized as a fundamental human right of all people.

11. Considering that the management over land and water resources is highly fragmented at all levels, it is recommended that consideration be given to establishing an international forum that focuses on integrated watershed management, including land-use and human activities that have an impact on water.

Chapter 2
Rethinking watersheds

> Are watersheds appropriate management units? There is a need to rethink scale of intervention, upstream–downstream linkages, temporal and spatial processes, biophysical and socio-economic linkages, and political issues.
>
> Inter-Regional Conference, Group 3

The new concept for watersheds is based on current research and project experiences in hydrology and ecology, human ecology and environmental economics. This chapter summarizes a number of relevant issues for the next generation of watershed management programmes and projects.

NEW PERSPECTIVES ON WATERSHED HYDROLOGY AND BIOECOLOGY

Land use has an impact on the hydrological regime and quality of water downstream. The importance of this impact varies with the type of land use, the size of the watershed, climate, soil characteristics, topography, geology, etc. (Bosch and Hewlett, 1982; Bruijnzeel, 1990; Calder, 1999). In the past, neither the public nor decision-makers fully understood the relative importance of these factors and the need to consider the specific characteristics of each situation. This created misconceptions, particularly about the main causes of floods and droughts. The media, NGOs, government officials and some scientists have often convinced the public that deforestation is a main cause of changes in water regimes, because it leads to increased floods and reduced dry season flows in rivers. Many agencies have funded conservation and reforestation programmes in response to these concerns and perceptions about the causes and effects (Kaimowitz, 2004).

Forest, precipitation and water

Research on how forest cover affects rainfall remains inconclusive (Kaimowitz, 2004). The higher evaporation rate and greater aerodynamic roughness of forests compared with agricultural and pastureland increase atmospheric humidity and moisture convergence, but enhanced rainfall in forested areas cannot be attributed to forests themselves. Cloud forests may be exceptions, where cloud-water deposition may exceed interception losses (Calder, 2003). The effects of mountains and trees on the interception of rainfall may explain the observed differences. The discussion is complicated by the high variability of rainfall in space and time. The impact of forest cover on precipitation would probably be only marginal compared with other factors. Although the possibility that land-use change modifies rainfall patterns cannot be totally discarded, natural factors (and possibly climate change) have a far greater impact on rainfall than any change in land use would have (Box 5).

Worldwide, many watershed studies indicate that water yield increases when forests are harvested (Brooks, 2002). Research from the United Kingdom and elsewhere shows that water yields from forested catchments are generally lower than those from grassland or moorland landscapes because of higher interception losses (McKay and Nisbet, 2002). This research suggests that there “may be a 1.5 to 2.0 percent reduction of potential water yield for every 10 percent of a catchment under mature evergreen forest”. Evaporation from deciduous woodland is generally less because of lower interception during the leafless period.

Forests use more water than other land uses

Forests use more water, through interception and complex evapotranspiration processes, than other land uses such as grassland or agriculture. Forests therefore reduce

BOX 5

Do forests really decrease runoff and regulate dry season flows?

Studies indicate that in wet conditions, interception losses are higher from forests than from shorter crops, primarily because the atmospheric transport of water vapour is increased by forests' aerodynamically rough surfaces. In dry conditions, transpiration from forests is likely to be higher because of the generally greater rooting depth of trees compared with shorter crops, which gives trees greater access to soil water. Consequently, contrary to widely accepted myths, runoff from forested areas will be less.

The few exceptions to this are cloud forests – where cloud water deposition may exceed interception losses – and very old forests. Reduced runoff following a bushfire in 200-year-old mountain ash (*Eucalyptus regnans)* forest in a water catchment for Melbourne, Australia is attributable to increased evaporation from forest regrowth, which has a much higher leaf area index than the old forest had.

General conclusions can be drawn about the impacts of forests on annual flow, but not about those on seasonal flow regimes. Site-specific, often competing processes operate, and the direction and magnitude of an impact may be difficult to predict for a particular site. It can be expected, however, that: (1) increased transpiration will reduce soil moisture and dry season flows; and (2) increased infiltration under natural forest will increase soil water recharge and dry season flows.

Drainage activities associated with plantation forestry in United Kingdom uplands increased dry season flows through initial dewatering and longer-term hydraulic changes to the drainage system. Pine afforestation of former grassland in South Africa reduced both annual and dry season stream flows. Similar results were found with eucalypt plantations in the Nilgiris region of south India. Bruijnzeel (1990) concludes that the infiltration properties of tropical forests are critical to how the available water is partitioned between runoff and recharge, leading to increased dry season flows.

Source: Calder, 2005.

total runoff: "most forests will evaporate significantly more water than shorter vegetation and reduce water for recharging aquifers or supplying rivers" (Calder, 2003). In the United Kingdom, coniferous afforestation in upland areas typically reduces annual stream flows in those areas by 20 percent. Compared with grassland, pine forests reduce recharge by about 75 percent and oak forests reduce it by 50 percent (Calder, 2003). The widely held view that "more trees equals more water from the catchment" is a misconception in many countries. The clarification of this issue is very important, especially where markets for environmental services are involved.

Hydrological regimes

In some cases, changes in land use have an impact on the hydrological regime of a river basin; for instance, forest clearing has a direct 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. For example, the impact of wetland protection on flow regimes is still subject to debate; some research suggests that wetland protection increases peak flows and reduces base flows, while other research indicates increased water storage capacity, leading to reduced 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 soil or diminishes its porosity will increase runoff and peak flow during rainfall events, and will possibly also increase flooding

(Kaimowitz, 2004). These findings hold for only small areas, however; at large scales the extent, intensity and distribution of storm events are likely to have much larger impacts on runoff than land-use changes have.

Extending or maintaining the duration of dry season base flows is important for irrigation, wildlife, riparian health and other ecological functions (Fleming, 2003). Research from the United Kingdom indicates that large areas of evergreen forest can result in significant declines in summer base flows in lowland areas (McKay and Nisbet, 2002). Forest design can help mitigate the impact of water use by trees, and the same research shows that water yields from young forests, felled areas and deciduous woodland are likely to be similar to those from grassland. This suggests that more diverse ecosystems should help to even out the effects of forestry at the larger watershed scale.

Hofer and Messerli (2006) found no statistical correlation between human activities in the Himalayas, e.g., deforestation, and large-scale floods in the lowlands, e.g., in Bangladesh. The authors concluded that deforestation in mountain areas should not be blamed for flood catastrophes in distant downstream areas. The many benefits of upstream watershed conservation should be considered at the scale of mountain communities and their smaller watershed environments (Box 6).

BOX 6

Forests and floods in Himalayan watersheds

Every year, during the monsoon season, the Himalayan region attracts worldwide attention because of disastrous flooding in the plains of the Ganges and the Brahmaputra. It is generally assumed that rapid forest removal in the mountains is responsible for these floods, based on the following chain of mechanisms: population growth in the mountains → increased demand for fuelwood, fodder and timber → increasing forest removal in ever-more marginal areas → intensified erosion and higher peak flows in rivers → severe flooding and siltation in densely populated and cultivated plains.

However, although in recent decades the Himalayas and their forelands have certainly undergone dynamic changes in land use owing to rapid population growth, the scientific community increasingly views the assumptions in the previous paragraph as too simplistic and misleading. Evidence from more than 20 years of research in the Himalayan region suggests that the impacts of mountain deforestation on hydrological systems depend more on scale.

Human-induced ecological changes in the Himalayas occur at the small-scale level, where forest clearance in a local highland watershed can lead to increased runoff and accelerated soil erosion in that watershed. At the large scale of the Ganges-Brahmaputra-Meghna system, however, there is no significant correlation between human activities in the mountains (forest removal) and catastrophes in the plains (floods). Human influences are dwarfed by the massive dimensions of natural processes. There is also no statistical evidence that flooding in Bangladesh has increased over the last 120 years, even though deforestation has increased constantly. Precipitation and runoff in the Himalayas do not seem to contribute significantly to the floods in distant Bangladesh because the flood flows and peaks of Himalayan tributaries are levelled into the base flow of the bigger rivers as they move downstream.

Mountain dwellers and their land-use practices should therefore not be blamed for floods in the plains far downstream, although mountain people do have a responsibility to use their environments sustainably. Mountain forests are crucial for the ecology of the entire Himalayas and for the people who depend on it; afforestation programmes should be regarded in this context, and not as a means of preventing flooding in the lowlands.

Source: Hofer, 2005.

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

Observable impact of land use on:	Watershed size		
	Small (0.1–10 km²)	Medium (10–100 km²)	Large (at least 100 km²)
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

Source: Kiersch, 2000.

Sedimentation and erosion

Sedimentation can adversely affect reservoirs, waterways, irrigation systems and coastal zones, with negative implications for aquatic biology, fish production and biodiversity. The relationship between erosion rate and quantity of sediment transported by rivers is complex and depends on the geographical scale under consideration. Erosion and sedimentation vary widely according to geologic, climatic and other conditions. There is clear evidence that farm-level land-use practices can have a significant impact on the rate of erosion. Changes in land cover from forest to agriculture, for example, usually increase soil erosion, while good agricultural practices reduce it.

The impact of land-use practices on the overall sediment yield of river basins is very difficult to assess. Most of a river's sediment load originates from specific locations within the watershed and arrives in the river during extreme climatic events. The delivery of sediment to a river basin is relatively slow. Over the life span of a reservoir, very little sediment from the upper watershed travels more than 100 to 200 km. Thus, any impact that land-use practices have on the sedimentation rate of a large river will be felt only several decades later, when it is very difficult to distinguish between natural and human-induced sediment load.

Importance of scale

The impact of land use on river regime is a question of scale

Scale is one of the most important parameters in assessing the impact of land use on water. Table 1, which is based on numerous case studies, classifies the potential impact of land use on different aspects of water regime and quality, as a function of basin scale. Land use is likely to have a significant impact on water regime and water availability in only very small watersheds. As watersheds increase in size, the impact of land use on the hydrological regime becomes insignificant compared with that of natural factors, such as the intensity of extreme rainfall events. At larger scales, however, land use does have an impact on water quality, and the cumulative effects of pollution, for example, can be observed in large river basins.

Non-point-source pollution and deterioration of water quality

In regions of intensive agriculture, inappropriate application of fertilizers and pesticides may result in chemicals being washed out of the fields into rivers or aquifers, where they become concentrated and pollute the water sources of downstream users. Cattle feedlots, which are now recognized as a major cause of pollution, are also usually considered as non-point-source pollution, usually at a more localized scale.

As well as the quantity, the quality of water is also an important concern

Non-point-source pollution is relatively easy to assess because it makes radical changes to the chemical composition of the water. However, it is very difficult to quantify, mainly because of the complex degradation processes of some chemicals – particularly pesticides and toxic trace elements. Most non-point-source chemical and organic pollution of water resources occurs in industrialized countries, but it is increasing in several developing regions where intensive agriculture is practised.

Assessing and quantifying the impacts of land use on a river's water quality require a thorough analysis of the situation and a clear understanding of the physical processes concerned. When responding to watershed problems, the elements to be studied include the scale of the watershed, the distinction between natural and human-induced hazards, chemical processes, and the distinction between point-source and non-point-source pollution.

Eutrophication

Eutrophication is the process by which damaging quantities of nutrients accumulate in water bodies (Fleming, Hufschmidt and Hyman, 1982). Nutrients, mainly nitrogen and phosphorus, come from a variety of sources, including agricultural fertilizers, municipal sewage, grazing in riparian areas, and sediment from eroded watersheds. Although nutrients from natural sources are needed to keep the ecosystem productive, excess amounts from human activities can overload rivers and lakes, causing algal blooms and reduced water quality. High concentrations of algae consume the oxygen dissolved in water while they decompose, causing anoxic conditions that are toxic to aquatic life. Fish cannot survive in water with little or no dissolved oxygen, and many lakes, reservoirs, rivers and estuaries have lost valuable aquatic resources through eutrophication. Several species of algae are unfit for human and livestock consumption. Excessive algal growth has caused serious problems in the Lake of Zurich in Switzerland, Lake Erie in the United States, Phewa Lake in Nepal, the Nile Delta in Egypt, Negril Delta in Jamaica, Skaha Lake in Canada, Poza Honda Reservoir in Ecuador (Box 7), the Sea of Galilee in Israel, and Lake Garda in Italy.

BOX 7

Eutrophication in Ecuador

Poza Honda, Ecuador's first major reservoir, was constructed in 1970 in a small coastal watershed in Manabí province to supply water for domestic use and irrigation. Five years later, it was 25 percent full of sediment. Deforestation on steep slopes, unrestricted grazing and erosive agricultural practices had led to excessive nutrient loading, causing severe eutrophication and anoxic conditions throughout the reservoir, which had a mat of blue-green algae 20 cm deep. Water treatment filters required daily maintenance and irrigation canals were blocked by large-rooted plants.

A US$2 million watershed restoration plan was launched to protect the reservoir shoreline and conserve sub-watersheds. The plan included range management to control livestock grazing on steep slopes. After 13 years, the sedimentation rate had slowed from an annual 4 percent of reservoir volume to 2.5 percent, and 80 percent of the reservoir shoreline was protected from livestock grazing by a vegetative buffer zone. Nutrient influx was substantially reduced and algal growth controlled, making fishing a productive activity for watershed residents. Water quality was improved, with sufficient dissolved oxygen to support a healthy aquatic ecosystem while supplying water for domestic and agricultural uses.

Source: Fleming, 1995.

The nutrients causing eutrophication come from several locations scattered across a watershed; accordingly, projects aimed at reducing the movement of nutrients from the land should be carried out at the watershed level (Fleming, Hufschmidt and Hyman, 1982). Soil is the main carrier of nutrients, and erosion control is one of the most effective mitigation measures. While in small watersheds, upstream conservation (e.g., leading to reduced erosion) can have an immediate and substantive downstream impact (e.g., leading to reduced sedimentation and eutrophication in reservoirs and lakes), in large drainage basins, the relationship between upstream conservation and downstream impacts is more difficult to quantify.

Impacts of climate change and human activities

There is increasing evidence that the climate system is experiencing pronounced change, with an increase of 0.6 °C in the mean surface temperature of the planet since the end of the nineteenth century (IPCC, 2001). A substantial proportion of the warming over the last 50 years is attributed to human-induced greenhouse gasses. Changes to the hydrological cycle have also been detected, particularly in mountain areas; in temperate regions, mountain areas are experiencing increased intense precipitation events, while mountain rainfall in tropical regions has decreased and become more erratic, especially in areas affected by el Niño.

As most of the freshwater used by humans originates from precipitation in upper watersheds, the impacts of global climate change have become a major issue in mountain research. According to Uhlenbrook, Wenninger and Lorentz (2005), such impacts depend on rainfall changes and on land-use practices. For instance, a slight increase in event-precipitation is likely to have a much larger impact on runoff and flood discharge when inappropriate watershed management practices are applied.

Land-use changes are changing watershed landscape patterns, ecosystem function and climate dynamics; they affect biodiversity and hydrology and the transport of latent heat, carbon dioxide, nutrients and pollutants. Although global change is largely driven by nature, humans have become a significant environmental force with vast implications for watershed systems. Humans are not only subject to environmental change, but also constitute one of the main driving forces behind that change (Huber Bugmann and reasoner, 2005).

WATERSHED HUMAN ECOLOGY

Most watersheds are human-made environments

Most people live in watershed or river basin ecosystems that they have moulded to their needs throughout history; with the exception of a few residual and strictly protected areas, the ecology of most watersheds is in many ways human-made (Box 8). The relationship between human populations and watersheds has usually been adaptive, homeostatic and resilient. There are very few documented instances of human-made watershed collapses throughout the 5 000-year history of watershed management.

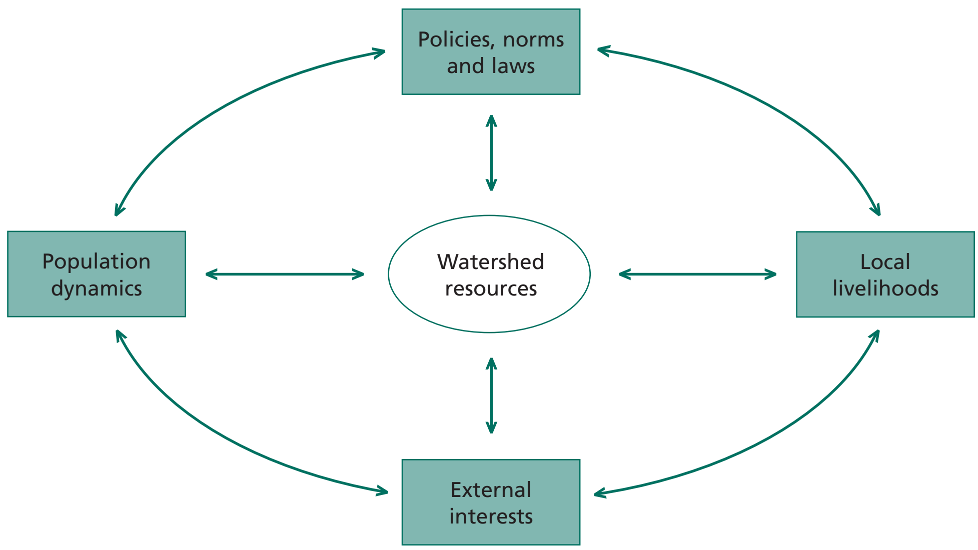
Factors in watershed human ecology fall under four main headings: local population dynamics, local livelihood systems, external interests, and policies, norms and laws (Figure 1). Interactions among these factors largely determine a watershed's environmental conditions at a given time.

Watersheds and human population dynamics

Population dynamics are changes in the number and socio-economic composition of the people living in a given area. They include changes to the balance between births and deaths ("natural growth"), and in- and out-migration.

Natural growth depends on the average number of successful pregnancies in a woman's reproductive life, mortality (particularly infant, child and maternal mortality) and life expectancy. It is influenced by genetic factors, the natural environment and a host of economic, social and cultural factors such as dietary patterns and contraception practices. Although unhealthy environments and non-adaptive behaviour can slow or stop natural growth, human populations tend to increase exponentially. During the

FIGURE 1
The human ecology of watersheds



BOX 8
Natural and humanly modified environments

Since the 1970s, human ecologists have focused on the ways in which human populations modify, shape and sometimes nurture the environment. In 1982, Roy Bennett summarized the findings of this research as follows:

> It is self-evident that human activities may alter natural environments, and geographical and ecological studies have shown in detail the mechanisms by which this has taken place, and the extent to which it has occurred. Here the term "natural" is being used to mean unmodified by *Homo sapiens*, but, of course, this does not mean that environments are not being constantly modified by other organisms. In fact, "pure nature" does not exist, and from an anthropological point of view, the environment must include humans and the result of their activities. The "natural regions" distinguished by biogeographers commonly correspond to regions transformed through human manipulation, and are only "natural" in a rather general sense… Thus environmental determinism cannot be simply represented as environment → society, but must be represented as environment ⇆ society. All environmental factors may be so modified. Populations of plant and animal species may be selectively husbanded, soils may be artificially enriched, climates altered through the removal of tracts of vegetation, and entire topographies transformed through the creation of irrigated rice terraces.

Source: Bennett, 1982.

last 100 years, this trend has been strengthened by the worldwide diffusion of modern sanitation, health care and formal education, which have decreased infant, child and maternal mortality and increased life expectancy. This is "demographic transition", which is intertwined with socio-economic development and cultural change (Box 9).

As a result of development and modernization, human populations are tending to grow beyond the carrying capacity of local environments and their resources. Local societies often seek to address this situation through migration. For instance, during the second half of the twentieth century, many upland populations migrated to find better opportunities in the lowlands or towns. More efficient agricultural technologies were also adopted to feed more people. Population pressure on downstream ecosystems and the demand for upstream ecosystem resources and services, such as water, power, timber and minerals, have increased. Upstream–downstream migration often worsens watershed environments (Box 10). Depopulation of mountain areas and urbanization have also caused major socio-political strains.

BOX 9

Agricultural frontier and demographic transition among the Shuar

The upper Morona and Santiago watershed in eastern Ecuador is the homeland of the Shuar, an indigenous group that adhered to traditional tropical forest hunting-horticulturist livelihood systems until the early twentieth century, when population density was about 1.2 inhabitants per square kilometre. In the 1960s, the Government of Ecuador started to colonize the Shuar territory and created a special institution to build the necessary infrastructure. Many Shuar abandoned the valley to escape abuse from the colonists. They migrated to the hills, where they started to combine indigenous slash-and-burn agriculture with cattle ranching.

In the mid-1960s, missionaries assisted the Shuar Federation to defend indigenous land rights, ensure that the Shuar shared in the benefits of development and preserve indigenous culture. The federation promoted the registration of Shuar settlements as legally acknowledged cooperatives; the procurement of agricultural land titles; credit and technical assistance for cattle ranching; and bilingual education, modern health care and transport services.

Over the next 20 years, the federation achieved its development objectives, but at a high price in terms of deforestation, the extinction of most hunting and gathering species and the degradation of fragile hillsides. This was mainly because it had adhered to the existing legal structure, which claimed all the Amazon as State property to be distributed to individuals or legally recognized groups according to their "exploitation capability". This policy made forest clearing for pastureland an inexpensive way of qualifying for huge land extensions, including those that the federation secured for many Shuar settlements. Cattle rearing provided Shuar people with income to pay for schools fees, health services and manufactured goods.

Modern health care reduced under-five mortality from 267 per thousand in 1976 to 99 per thousand in 1992. The population grew by about 4 percent a year; in the early 1990s, there were 5.2 people per square kilometre of entitled land, and this was expected to reach 10.6 people by 2006. The Shuar Federation was not sure that the land would be able to sustain all these people, so it made environmental sustainability a major objective, introducing agroforestry, new income-generating activities based on indigenous expertise, and the diversification of production. These initiatives may improve the human ecology of Morona Santiago watershed and prevent environmental catastrophe, but they cannot restore the ecological conditions and livelihood strategy that existed before the demographic transition.

Source: Borrini-Feyerabend and Pimbert, 2005.

BOX 10
The colonization of the Peruvian *montaña*

The eastern slopes of the Peruvian Andes are covered with tropical rain forest in a *montaña* landscape of steep mountains and deep valleys, dug out over the millennia by large rivers and their tributaries running towards the Amazon basin. These watersheds cover a total area of 270 000 km^2, and until the early twentieth century they were inhabited almost solely by a few thousand indigenous people.

Road construction across the mountains encouraged Quechua small farmers from the highlands and unemployed urban dwellers to migrate into the *montaña.* Large international companies established vast coffee, cocoa and ranching estates, offering jobs. The population increased from 240 000 in 1940 to 1.2 million by 1981. As natural growth accounts for only a twofold increase, most of this fivefold increase in 41 years was due to immigration.

One of the attraction factors of the large migration flow was a national policy to extend the agricultural frontier into the Amazonian uplands by constructing roads and infrastructure, facilitating land entitlements, assisting farmers and providing credit to small and medium-sized businesses. A side-effect was the development of a seasonal labour market, attracting thousands of landless highland farmers to the *montaña* watersheds. Among the expulsion factors were unequal land distribution in the Andes and the low productivity of mountain agriculture; a natural increase of the Andean population that was greater than the growth of on-site employment opportunities; and a national macroeconomic crisis, which led to increased unemployment in urban areas of Peru.

Governments and international agencies supported colonization of the *montaña* watersheds because it acted as a safety valve for Andean agricultural land tenure and productive structure. However, it also had severe environmental and social consequences. Deforestation, soil erosion, river pollution, conflicts with indigenous people, drug trafficking, civil war and poverty can all be attributed to this attempt to provide for the landless by expanding the agricultural frontier, without first resolving the inequities in access to natural resources and the unsustainable livelihoods systems that are prevalent in the Andean highlands.

Source: Barton *et al.,* 1997.

Local livelihood systems

Livelihoods link local people to watershed natural resources

Local livelihood systems are the most direct link between human population and the watershed natural environment. They comprise the assets, strategies, norms and institutions that allow households to make a living and reproduce within a particular natural and political environment. They include:

- access to and use of natural assets such as soil, water, forest, minerals and energy;
- norms and laws that regulate and protect such access and use;
- expertise, technology and infrastructure that utilize natural resources without overexploiting them;
- social institutions that mediate conflicting interests and promote cooperation regarding upstream ecosystem resources such as water, power, timber and minerals;
- values and beliefs that make sense of these features and support natural resource use.

Although types of livelihood system can be identified on a geo-ecological or historical basis, actual livelihood systems tend to be highly localized. Their geographic scope is generally limited to relatively small social groups living in self-contained territories, such as a sub-watershed, or a particular ecological floor or biotope (mountains, hills, lowlands, riverbanks, a valley, a swamp or a small town). Box 11 gives examples of local livelihoods in watershed ecosystems.

Local livelihood systems are cultural products. They develop slowly through trial and error, with experiences being transmitted from one generation to the next through behaviour, language, art, science and religion. Local livelihood systems should not be seen as solely traditional, however, as they are dynamic, evolutionary and open to innovation; they continuously *adapt* to environmental, demographic, economic, social and cultural changes. This process is not free from inefficiencies, waste and error, which may cause negative trends or shocks leading to watershed collapse. Box 12 gives an example of environmental degradation that is clearly related to the pressure of market economy, population growth and climate change on local livelihoods.

Most local livelihood systems manage natural resources relatively efficiently and sustainably: communal grazing has supported human livelihoods in inhospitable Alpine high-mountain environments for centuries, and water-sharing systems have sustained agricultural production in dry Near Eastern lowlands. In the Amazon, small-scale itinerant agriculture contributes to forest biodiversity through the diffusion of secondary forest species, which provide food for different species of mammals and birds, and by increasing sunlight infiltration in the surrounding dense rain forest areas. Box 13 gives another example from the West African savannah.

BOX 11

Local livelihoods in watershed ecosystems: examples from Nepal, the African lake region and central Italy

In Nepal's middle hills, the primary livelihood activity is agriculture on small terraces. Soil structure and fertility are maintained by compost, crop residues and leaf litter gathered from communally or State-owned forests. Manured livestock bedding is the main compost. Livestock are either kept in paddocks, or grazed on fallow land, common property forests and upland pastures. Richer households supplement farming with income from local businesses or employment. Poorer and landless households depend on non-land-based activities such as labouring, artisan work and non-timber forest production (Ellis and Allison, 2004).

On the shores of the African Great Lakes, the Sudd and Niger delta wetlands and shallow inland lakes, households practise agriculture, fisheries and livestock grazing on private land and common property resources. Crops, including paddy rice in wetland areas, are grown on land held under customary tenure, including that claimed during the seasonal retreat of lake water levels. Inundated areas that individual households have not claimed for crop agriculture are used for livestock grazing. Fisheries are State-controlled, but managed *de facto* as commons. Wealthier households own fishing-related assets and more land and livestock than other groups. Middle-income families own land, but cannot afford fishing-related assets. Lower-income households have access to land for subsistence cropping, but own fewer livestock and can fish only as crew labourers on other people's boats (Ellis and Allison, 2004).

In the Umbria region of Italy, traditional smallholder livelihoods are based on a mix of cereal and legume cropping, tree cropping, animal breeding and forestry. Cereal, leguminous and fodder crops are planted on rotation in small valley plots with abundant water throughout the year. Olive trees, nuts and vineyards are cultivated on slopes up to 700 m above sea level. Upland durmast and chestnut forests and rangeland prairies cover more than 70 percent of this rugged watershed area, and provide fodder, fuelwood, timber, chestnuts and other forest fruits. Although all farmers in this area have access to European Union Common Agriculture Policy subsidies, farming does not usually provide a living for all the family. Most watershed inhabitants complement their agricultural and forestry earnings with wage labour, trade and small agritourism enterprises (Warren, 2004).

BOX 12

Livelihoods and environmental degradation in the hills of eastern Guatemala

Jocotán municipality corresponds to the southern catchment of the Copán-Ch'orti' watershed in southeast Guatemala near the border with Honduras. Its very rugged, sloped territory of 148 km^2 ranges from 1 800 to 300 m above see level (asl). The total population is 37 000 people: 5 000 in the town and 32 000 in hamlets scattered throughout the countryside – about 215 people per square kilometre. In Jocotán there are too many people with too little land, in a very dynamic, fragile ecosystem.

When Spanish colonizers founded the town of Santiago de Jocotán in 1539, most of the Copán-Ch'orti' watershed was covered with subtropical rain forest in the valley, acacia forest on sloped hillsides and pinewoods in the highlands. Spanish settlers exploited the fertile alluvial valley intensively for cocoa, tobacco, sugar cane, salzaparilla, indigo and cattle. Ch'orti' *campesinos* who were not involved in colonial production were forced to grow subsistence maize on the sloping, stony, fragile and dry hillsides. This poor land had to be rotated every few years, leading to deforestation in the watershed.

Liberal reform in the nineteenth century transferred indigenous communal land titles to the municipality, enabling Jocotán's powerful Spanish entrepreneurs to increase their control over arable land and labour. By the end of the century, immigrants were moving to iron mines and coffee plantations in the uplands. The Ch'orti' retired towards less accessible and less productive areas, where they diversified their subsistence household economies with sales of small surpluses and handicrafts, sharecropping or wage labour.

By the 1920s, after two centuries of continued deforestation, there was insufficient land for crop rotation and the pressure on soil intensified. Rainfall was declining and in the 1950s, hillside *campesinos* started to sow drought-resistant sorghum as a security crop, along with traditional maize and beans. Men began to migrate seasonally to fruit plantations and big estates.

These strategies allowed *campesinos* to satisfy their immediate needs and maintain their families on farms. However, unfavourable terms of trade, population growth and subsequent increases in land fragmentation have caused continuous decline in households' natural, physical and financial assets over the last three or four decades. Shrinking land areas have led to overexploitation of soil and progressively decreasing yields, which chemical fertilizers have only partially amended. Lack of cash, labour and expertise prevent most *campesinos* from investing in soil conservation and water harvesting. In the meantime, surviving patches of pinewood on the mountain tops are being degraded by small-scale timber activities and daily fuelwood collection.

Vegetation cover is now inadequate to retain rainfall, humidity and soil. The rainy season often starts a month late and has longer and more frequent interruptions. Rainfall washes away huge amounts of fertile sediment, and landslides threaten infrastructure, crops, property and life. *Campesino* livelihoods in Jocotán are at increasing risk, and local people and institutions recognize the need to identify sustainable development alternatives.

Source: Warren, 2005.

BOX 13

Misreading an African landscape

Kissidoudou prefecture in the upper catchment of the Niger river has a striking landscape with patches of dense, verdant, semi-deciduous rainforest towering over expanses of grassy savannah. These forest islands, scattered over the gently rolling hills, are generally circular, of 1 or 2 km in diameter and usually contain one of the prefecture's 800 villages.

Since the French occupation in 1893, Guinea's administrators saw these forest patches as the last relics of a dense humid forest that once covered the landscape. They believed that local inhabitants had progressively converted the forests into savannah through shifting cultivation and fire setting, preserving only the narrow belts around villages. The European Union (EU)-funded Programme d'Aménagement des Bassin Versantes de l'Haute Niger assumed the same, 100 years later.

However, historical sources, interviews and satellite images show that these forest islands are not the relics of forest destruction. Instead, farmers grew them on what was originally savannah for subsistence, social and ritual purposes. The geographical distribution of the forest islands reflects the demographic dynamics of the last century, with Kuranko and Kissi villages splitting and new settlements being created, each with its own human-made forest. Aerial photographs and satellite images of five major villages show that between 1952 and 1992 forest islands increased in all locations.

The false assumptions about the Kissidoudou landscape reflected the power relations that colonial and post-colonial land policies supported. Because vegetation was considered degraded rather than natural, many traditional methods used by farmers to enrich their landscapes were obscured and marginalized. Policy-makers and environmental scientists assumed that people would improve forest and savannah habitats only through external programmes and projects and State-assisted village planning. Discussions presented inhabitants as incapable of managing resources sustainably, promoting the idea that external interventions were needed to improve the situation on their behalf.

Source: Fairhead and Leach, 1996.

Local livelihoods and external interests in watershed ecology

The case studies described in Boxes 9 to 13 highlight that local livelihood systems are best understood as part of broader economic, social and political systems. The nation State and decentralized governance units (departments, districts, municipalities, etc.) are the most prominent external actors in watershed human ecology, but global markets and international institutions have become increasingly important in determining access to and use of watershed natural resources over the last 50 years.

The socio-economic importance of watershed ecosystems goes far beyond local residents' interests. Food, timber and fuelwood produced in an upland valley may be needed in a downstream town. The inhabitants of a town and its rural hinterlands may wish to build a dam in a valley to prevent floods, irrigate fields and produce hydropower. A national or international corporation may wish to obtain a concession for extracting minerals or building a tourist resort. An environmental protection agency may decide to create a national park to protect mountain biodiversity. Sometimes these external interests are compatible with those of watershed inhabitants, but in other cases they pose a threat to local livelihoods. In all cases, watershed inhabitants have to share control over watershed resources with outsiders.

Policies, norms and laws

At the local level, watershed natural resources are held under a variety of tenure and access arrangements. These can be customary and rooted in local livelihoods and culture, or statutory and enforced by the State to harmonize on- and off-site interests and ensure that strategic environmental goods and services continue to be provided downstream. This situation has often led to complex and pluralistic tenure regimes in which private, social and State property coexist. As Box 14 illustrates, overlapping linkages and conflicting rules in pluralistic tenure regimes often have important implications for the environmental and socio-economic processes in watersheds.

BOX 14

Customary and statutory land rights in Kenya

The Nyando River basin covers 3 500 km^2 of western Kenya and has some of the country's most severe agricultural stagnation, environmental degradation and deepening poverty. The river is also a major contributor of sediment, nitrogen and phosphorus to Lake Victoria. About 750 000 people from two major language groups live here: the Luo in the lower and middle watershed, and the Kalenjin upstream. Resettlement of large farms in the "white highlands" led to the coexistence of Kalenjin with people of other ethnic groups, contributing to politically motivated "tribal clashes" in the 1990s.

The Kalenjin upper basin is comprised of gazetted forests, commercial tea plantations and small, steep-hillside agriculture plots on degazetted forest land. Mid-altitude areas contain smallholder farms (maize, beans and some coffee, bananas, sweet potatoes and dairy) and large-scale commercial farms, mostly sugar cane. The flood-prone Luo lakeshore area is mainly for subsistence production of maize, beans and sorghum, and commercial production of sugar cane and irrigated rice. Smallholder farmers and the National Irrigation Board own downstream, irrigated areas.

Land and water in the Nyando basin are held under a wide variety of both customary law and statutory property right arrangements, with 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. Land degradation is most severe in subdivided agricultural leaseholds and freehold land in adjudication areas. In the former, problems are associated with poor land-use planning during the transition from large- to small-scale farming in the 1960s and early 1970s. The companies that purchased land on behalf of groups of shareholders failed to consider the land's productive capacity, the terrain or the need for public utilities. Land buying along ethnic lines led to clusters of different cultures living together on the same landscape, resulting in weakened traditional systems as people relied more on statutory law.

In Luo-designated areas, natural population growth led to the overuse of all land resources. In addition, some government and trust land areas have not been assigned to specific users, leaving them very vulnerable and subject to abuse because of their *de facto* open access. Many other areas, that are important for catchment management, spring heads, riparian areas, wetlands and water harvesting structures have been designated as private property.

This complex land tenure system creates many problems for watershed management. High erosion rates in the lower basin are associated with the overuse of uncultivated private areas for grazing and wood collection; in the upper basin, they are associated with the private allocation and farming of steep hillsides. Gully formation and low-quality water in mid-altitude areas are associated with the common use of springs on private land. Deforestation of riparian areas is associated with privatization and the ineffective enforcement of rules. Lack of public water management infrastructure is associated with lacking public or collective land for water storage structures.

Source: Swallow, Onyango and Meinzen-Dick, 2005.

States regulate access, tenure and use of watershed resources through policies, norms and laws. Regulation may have major implications on in- and out-migration dynamics and livelihood systems and often plays a crucial role in shaping the human ecology of the watershed (Boxes 9 and 10).

Once again, watershed scale is a crucial factor: the bigger the watershed area, the more complex the interplay between on- and off-site socio-economic interests, and the greater the need for regulation. Managing major river basins that are strategic assets for national economies is a public affair, while river system basins that are of concern for several countries, such as the Congo, the Rhine, the Amazon, the Tigris and Euphrates, and the Ganges, are subject to transboundary management agreements and interventions (Box 15). The same applies to some landlocked basins, such as the Mediterranean (Box 16), the Caspian Sea and Lake Victoria.

BOX 15

Transboundary watershed management and regional integration in West Africa

At 4 200 km, the Niger is the third longest river in Africa; its basin is the ninth largest in the world, with 2.2 million km^2 of surface. It is an important asset for nine West African countries – Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, the Niger, Nigeria and Chad – some of which are among the world's poorest countries.

The river crosses four climatic zones: humid tropical, dry tropical, semi-arid and arid. Its very variable rainfall ranges from 4 000 mm in the Guinea Gulf to 200 mm in the Sahel. Widespread environmental degradation and deteriorating natural resources in the basin are a result of unsustainable agricultural and ranching practices, bush fires and deforestation, pollution, water and wind erosion, silting of water courses, and proliferation of aquatic plants. Land degradation is a major threat for productivity and food production, particularly in the Sahelian area in the mid-watershed. An increasingly dry climate and decreasing sedimentation, associated with increasing demand for agricultural land, have contributed significantly to the destruction of vegetation cover. Stream flow, ecosystems and socio-economic activities are seriously threatened.

The Niger Transboundary Watershed Programme was set up to combat hydrological erosion. Its long-term objectives are protecting the basin's natural resources and conserving its hydrological potential in order to foster development, decrease food insecurity and poverty and preserve local ecosystems. It adopts a participatory, gender-sensitive approach, aimed at strengthening local stakeholders' responsibility and involving them in rehabilitation activities.

The programme includes a regional component aimed at strengthening the basin authority's capacity to intervene at the transboundary level. Three national components, designed as investment projects, focus on priority actions for environmental protection and the combating of siltation in Burkina Faso, Mali and the Niger. All three share common development objectives, but each has significant autonomy. National activities follow the participatory approach and aim to raise the awareness and commitment of local stakeholders at all stages of implementation.

Programme aims include stabilizing 3 000 to 5 000 ha of dunes, managing/protecting rangeland and catchments, rehabilitating 13 500 ha of degraded land through agroforestry, enhancing the watershed management capacity of local institutions and people, and strengthening the Niger Basin Authority. Other expected outputs include: a tool kit for identification, planning, coordination, monitoring and evaluation; a management plan for combating hydraulic erosion and siltation; enhanced food security and livelihoods for local people; income generation and diversification; rural employment; and women's empowerment through income-generating activities and literacy.

Source: Diallo, 2005.

Relationships between the human population and the watershed environment take place in a comprehensive framework that includes on- and off-site, upstream and downstream, micro and macro processes. This framework depends largely on the policies and laws through which the national society and international treaties regulate the use of watershed resources and services. The human ecology of watersheds is based on the micro- and macroeconomics of natural capital.

BOX 16

Freshwater in the Mediterranean basin

The Mediterranean region is bioclimatically characterized by strong summer droughts; over the last 20 years, most countries have experienced droughts lasting several years. Irregular precipitation and high water in the Mediterranean often cause flooding, and rain is a major cause of soil erosion. Major drainage and irrigation works in the nineteenth and twentieth centuries transformed numerous marshy plains into high-yielding land.

Today, the region's water demand is 300 billion m^3 – 100 percent more than a century ago and 60 percent more than 25 years ago. This demand is unevenly distributed among countries, ranging from 100 to more than 1 000 m^3/capita/year. Irrigation accounts for 82 percent of demand in the southern Mediterranean, but with the total urban population (in towns of more than 10 000 inhabitants) forecast to increase from 43 million in 1995 to 80 million in 2025, aqueducts and water treatment will need considerable investments in order to supply the necessary water and sanitation. As the world's most visited tourist destination, the summer demand for potable water increases greatly in coastal areas of the Mediterranean.

Water withdrawal already exceeds 50 percent of the renewable natural water in the Syrian Arab Republic, Tunisia and the Mediterranean watershed of Spain, and 90 percent in Egypt and Israel. Groundwater exploitation exceeds 400 percent in the Libyan Arab Jamahiriya. The Mediterranean's very unsustainable water consumption is caused by the overexploitation of groundwater and the increased use of fossil resources. Erosion and reservoir siltation also contribute, with annual losses of useful capacity reaching 2 to 3 percent in northern Africa; half of Morocco's useful capacity will be lost by 2050. The overexploitation of coastal aquifers has caused much seawater invasion, and up to 90 percent of wetlands in Mediterranean areas have disappeared, with a huge impact on ecosystems. Conflicts of use and interest between upstream and downstream areas, cities and farming, the short and the long terms are likely to worsen as the management costs for water protection, urban sanitation and pollution control grow.

In order to improve the balance between water supply and demand, stabilize pressure on the environment and address social and economic issues, there is a need to link resource management and water demand, particularly through reducing losses, increasing efficiency and arbitrating in resource allocation. This means defining environmental and social objectives, allocating roles between the public and private sectors, decentralizing management and increasing stakeholder participation, and applying technical and economic tools. Above all, agricultural and rural development policies in the Mediterranean region should consider environmental and social issues while they seek higher irrigation efficiency.

Source: Dassonville and Fé d'Ostiani, 2005.

WATERSHED ECONOMICS

Watersheds provide human societies with many goods and services, such as clean water, erosion control, carbon sequestration and conservation of biodiversity. Unlike timber, livestock products or minerals, however, the value of these goods and services is rarely expressed in monetary terms and there are no markets where they can be bought or sold. These goods and services are known as “public goods” or “positive externalities” (Cornes and Sandler, 1996).

The concept of public goods implies that one person’s consumption of a good does not diminish another person’s (*non-rivalry*) and does not bar anyone else from benefiting from the good (*non-exclusion*) (Table 2). Watershed-generated environmental public goods include regulation of water flow and quality, sediment delivery and the maintenance of landscape beauty.

An externality is a commodity’s value that is not reflected in that commodity’s market price. For example, the value of a forest in controlling stream-bank erosion and sediment load in a river is not reflected in the market price of the forest land, neither is the value of a highland swamp in recharging an aquifer reflected in water price. Farmers do not usually take externalities into account when they are deciding whether to conserve forest or clear trees, sell the timber and convert to other land uses.

Markets for non-rival and non-excludable goods and services generally fail because there are no incentives for beneficiaries to pay providers. As any payment to improve a good or service will benefit all beneficiaries, it is rational for each beneficiary to wait and see whether others will make an investment that improves access to the service. This is a “free-rider strategy”; if all beneficiaries adopt it, the good or service will not be supplied.

Society generally attaches a high value to the positive externalities of watershed landscapes and will take action to guarantee that they are provided for and conserved. This is the primary justification for the public funding of watershed management programmes. Many countries have laws regulating access to and use of watersheds, but these are often inefficient and difficult to implement; it is difficult to enforce laws aimed at protecting the landscapes that provide positive externalities.

Internalizing watershed externalities in market exchanges

Command and control approaches to protecting the flow of benefits from watershed landscapes have often failed, so efforts have recently been made to create markets for these externalities. Under such payment for environmental services (PES) mechanisms, the beneficiaries of externalities or services pay the providers. This transforms an externality into a tangible income for service providers. When providers and beneficiaries are located in the same watershed, most environmental services of interest are water-related, and depend on the type of water use, the hydrological regime and geological features of the watershed, and climatic factors. Table 3 summarizes the watershed-related environmental services identified in some Latin American studies. Watershed services also include carbon sequestration and the conservation of biodiversity.

TABLE 2
Characteristics of watershed goods and services

	High rivalry	Low rivalry
Low excludability	Public goods Most watershed environmental services, such as erosion control	Common pool resources, such as community woodland, fish in reservoirs and rivers
High excludability	Toll goods, such as access to national parks	Private goods, such as timber, minerals, agricultural produce

Source: Landell-Mills and Porras, 2002.

TABLE 3
Watershed environmental services and their users

Service	Users
Improvement or stabilization of annual water flow	Drinking-water suppliers Hydroelectric facilities with multi-annual storage Irrigation
Improvement or stabilization of dry season flows	Drinking-water suppliers Runoff river hydroelectric facilities Irrigation
Low concentrations of suspended sediments	Drinking-water suppliers Hydroelectric facilities with multi-annual storage Runoff river hydroelectric facilities
Low concentrations of sediment bed load	Hydroelectric facilities with multi-annual storage Irrigation
Low concentrations of fertilizer and pesticide residues	Drinking-water suppliers
Improvement of microbial quality	Drinking-water suppliers

Source: Kiersch, Hermans and Van Halsema, 2005.

The values of watershed environmental goods and services can be categorized according to the total economic value framework (Barbier, 1991; Pearce and Turner, 1990; Munasinghe, 1993). This framework divides the total value into use values and non-use values. Use values are those assigned to a resource that is needed for a current or future economic activity. They can be divided into: direct use values, reflecting a good's value as a direct input into an activity; indirect use values, reflecting a good's value in providing the environment for an activity; and option values, reflecting the value of guaranteed future access to a good. Non-use values are not associated with economic activities. Existence values apply to resources whose existence is very valuable to some people for religious or cultural reasons. Legacy values are those ascribed to the availability of a resource to future generations. Figure 2 illustrates the application of the total value framework to watershed water resources.

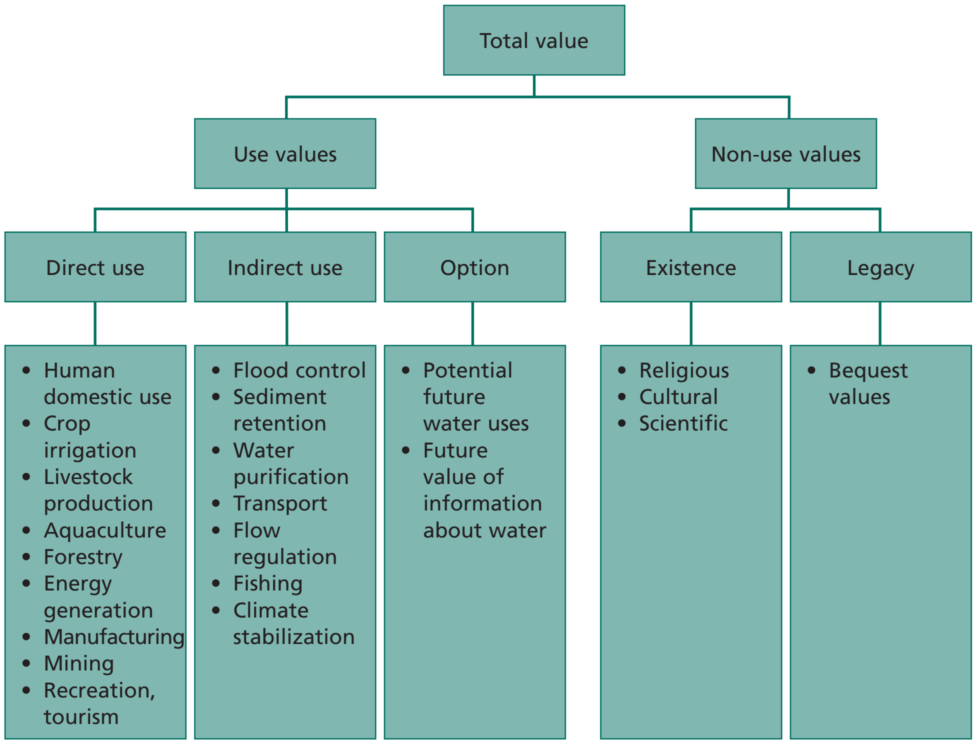
As Figure 2 shows, watershed environmental services typically have direct use or indirect use values, and may also have option, legacy and existence values, for example, from biodiversity conservation.

Assessing the economic value of watershed-generated services is not straightforward. First, the biophysical linkages between land use and water resources in the watershed must be well understood: there should be evidence that a specific land or water use upstream will benefit downstream water users. Second, the externality needs to be valued in economic terms. A PES mechanism can then be set up in which beneficiaries pay land users for providing the services.

Valuable and non-valuable watershed services

Although valuation methods for environmental services have been improved, there are limits to what they can achieve. Economic valuation makes costs and benefits transparent to decision-makers and the public, but it cannot assess moral or aesthetic considerations, such as the value of a resource that is needed for an ecosystem to function. Intergenerational equity is also difficult to assess. Discount rates and weighting approaches are used to account for resource stocks and flows over time (Pearce, 1983), but decisions about the proper weights for environmental, social and economic factors and for short-term versus long-term benefits are moral decisions that become political (Echavarría, 2000).

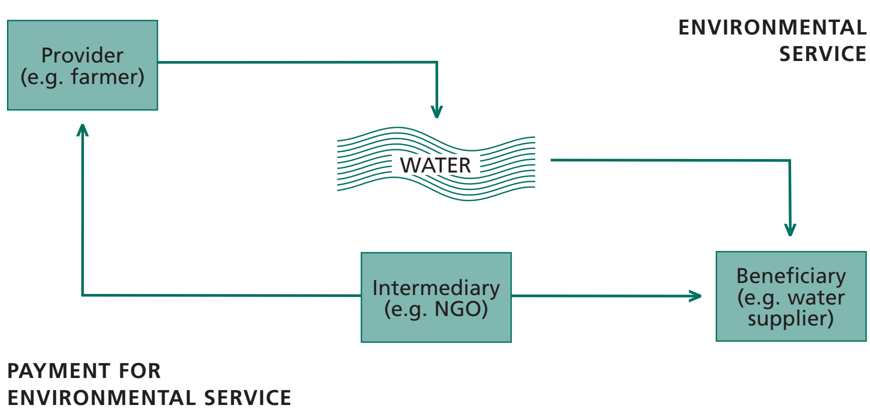
FIGURE 2
Total economic value framework as applied to watershed water resource



Source: Echavarría, 2000.

In spite of these concerns, the PES approach is a useful innovative concept for watershed management. Most PES schemes recognize that the environmental services provided by watershed systems will become increasingly scarce, depending on the willingness of beneficiaries to invest in their continued provision. Figure 3 illustrates a typical PES scheme for watersheds. Upstream *providers* supply a well-defined water-related environmental service to downstream *beneficiaries*, who *compensate* the providers through the payment scheme, either directly or through an *intermediary*.

FIGURE 3
Outline of PES scheme for watershed management



Watershed-based PES schemes can be divided into two main categories (Kiersch, Hermans and Van Halsema, 2005):

- *Local schemes* involve the service providers and beneficiaries of one watershed. Downstream beneficiaries may include municipal or private water supply, hydroelectric and other companies, such as beverage manufacturers. Providers may include individual landholders or groups of landholders, such as agricultural cooperatives (Boxes 17 and 18).
- *National-level programmes* finance incentives for land users through cross-sectoral subsidies such as taxes on fuel or energy production. The funds are channelled through government programmes, and there is not always a direct link between service providers and beneficiaries (Boxes 19 and 20).

BOX 17

A private agreement on compensatory payment for watershed management services in Costa Rica

In Costa Rica, several laws and regulations protect the ecosystems that regulate water resources by restricting land use in forested areas so as to preserve vegetation cover and avoid pollution. Since 1996, the government has also sponsored PES schemes to create economic incentives for conserving forest and to compensate those whose land or land uses generate environmental services. The Ministry of Environment is responsible for enforcing these laws and schemes, imposing fines and granting water concessions to La Esperanza Hydropower Project (LEHP).

Hydropower production requires regular water flows. About 98 percent of the LEHP watershed's 34 km² area is forested, and seasonal variations in river stream flow are a particular concern. In 1998, LEHP and the conservation NGO that owns the upstream watershed signed a private contract to reduce the risks associated with changes in land use. The main goal is to conserve forest cover in the upstream watershed in order to reduce fluctuations in stream flow and ensure regular downstream flow.

This was necessary because of a landownership dispute between LEHP and the NGO regarding the 1.5 ha site for the hydropower plant, which was on land that the NGO owned. The contract grants land-use rights to LEHP for 99 years; the NGO retains ownership and carries out activities to protect the forest cover of the watershed. LEHP compensates the NGO through payments that increase during the first five years and are then calculated on the basis of power production and inflation. The original value of the hydrological service was based on that used in similar government schemes. The payments contribute 10 to 25 percent of the NGO's annual budget, and increase the operation and maintenance costs of the power plant by 21 percent. In case of delayed payment, the NGO can revoke the right to use the land and all the infrastructure it contains.

Source: Rojas and Aylward, 2003.

BOX 18

A public–private PES scheme in rural Ecuador

Pimampiro municipality has about 20 000 inhabitants, 6 300 of whom are urban residents. It depends on water that originates in upstream forests and grassland. Between 1987 and 1997, an agricultural cooperative – the Asociación Nueva América (ANA) – acquired 638 ha of forest, upland prairie and agricultural land in the upstream watershed. Further encroachment on forests and upland prairie would put the town's water supply at risk.

In 2001, Pimampiro municipality and ANA signed a cooperation agreement with the twofold aim of preserving forest cover and upland prairie and protecting the water sources that supply urban Pimampiro with drinking-water. The municipality's Unit on Environment and Tourism (UMAT) makes contracts with cooperatives, based on their land management plans, and pays compensation for land uses that support water provision. The scheme was established with an international grant of US$15 000. Conserving primary forest and upland prairie attracts the highest payments, of US$1/ha/month, while secondary forest earns US$0.75/ha/month, and intervened primary forest or upland prairie US$0.50/ha/month. Agricultural land receives no payment. Payments are made after inspection by an UMAT technician every four months. In cases of repeated non-compliance, providers are excluded from the scheme.

The municipality has committed itself to directing 20 percent of residents' water fees into the fund. This amounts to less than US$4 000 a year, which is barely sufficient to pay the compensation on 638 ha and the administration, oversight and technical costs. To cover all the upstream area that provides water, a total of 4 285 ha would have to be included in the scheme, implying a sixfold increase in compensation payments, which is currently out of the municipality's reach.

Source: Ambrose, 2002.

BOX 19

Transfer of hydropower revenue to watershed management institutions in Colombia

With 47 468 m^3/capita/year, Colombia has abundant water resources. However, densely populated areas generally have less available water, triggering concerns about an impending water crisis in the medium term. Extreme climatic events such as el Niño have already caused considerable losses in the hydroelectric sector.

In response, the government is transferring 6 percent of the gross energy sales of hydroelectric projects to the municipalities and regional development organizations (RDOs). By law, 50 percent of these funds must be invested in improving watershed areas upstream of hydroelectric facilities, and RDOs must formulate and implement watershed management plans. Of 23 RDOs, 16 have hydroelectric projects in their areas, and between 1994 and 2000 they received a total of US$135 million from hydroelectric revenues.

This scheme is a powerful tool for investing in environmental services from upper watersheds, but payments are increasingly used to cover RDO administrative costs and other purposes. To rectify this, watershed management plans need to prioritize the areas of a watershed that provide the greatest hydrological impacts downstream. RDOs should define clear and verifiable indicators and a monitoring and evaluation system to assess the impacts generated.

In other PES schemes, such as in the Cauca valley, downstream water users transfer a share of their self-imposed water user fees to projects that conserve the upstream watershed (Echavarría, 2002b).

Source: Estrada and Quintero, 2004.

BOX 20
Costa Rica's National Forestry Financing Fund

Faced with diminishing forest resources caused by the advancement of the agricultural frontier, Costa Rica is at the forefront of PES development. The Forestry Law of 1996 established a national-level payment system that recognizes forested areas' provision of watershed protection, carbon sequestration, biodiversity conservation and preservation of scenic beauty. The National Forestry Financing Fund (FONAFIFO) administers payments under this programme, nearly two-thirds of which are funded from a fuel tax, with lesser shares provided from sales of carbon credits to international companies (18 percent), international donors, such as the Global Environment Facility (GEF), the World Bank and the German Bank for Reconstruction and Development (16 percent), and hydroelectric producers (5 percent). Since 2005, FONAFIFO has issued environmental service certificates to anyone interested in forest preservation.

The programme compensates forest preservation, reforestation and, since 2005, agroforestry and integrated plantation systems on the basis of the opportunity costs of converting forest to other productive uses. Between 1997 and 2004, more than 400 000 ha of land and more than 7 000 families benefited from the scheme; more than 80 percent of the contracts issued were for protecting existing forest and agroforestry. In some areas, however, the programme's payments have proved to be too small. In the peri-urban area around La Heredia, for example, the water supply company increased water tariffs in order to pay additional incentives to landholders in the watersheds that provide drinking-water. Contracts are signed for ten years for reforestation, five years for forest protection, and three years for agroforestry. Payments for forest protection are spread evenly over the contract period, while for reforestation and agroforestry about 50 percent is paid during the first year to aid landholders' initial investments.

The programme is very popular, with supply far outstripping demand. In 2005, FONAFIFO awarded contracts to only 12 percent (608 ha) of the projected reforestation area, 30 percent (132 000 ha) of the agroforestry area, and 57 percent (31 000 ha) of the forest protection area. Nevertheless, forest cover grew from 32 percent in 1990 to 45 percent in 2004. The FONAFIFO scheme has also encouraged similar private PES schemes, such as La Heredia and La Esperanza (Box 17), which take advantage of the national institutional set-up.

Source: Rojas and Aylward, 2003; FONAFIFO, 2005.

Interlude 1
Sunday talks on watershed management in San Miguel

Sunday is the market day in San Miguel del Valle. Early in the morning, small farmers come to town from the hillside villages to sell their vegetables, fruits and handicrafts and to shop. Most trade takes place before 11 o'clock, when church services begin. Later, knots of people gather in Park Square to comment on the week's news. The discussions, gossip and arguments of this informal forum are the life blood of municipal governance.

Ignacio de la Rueda, San Miguel's young and energetic mayor, is aware that his new watershed management project will be on trial in Park Square today. He has been pushing for this project since he graduated in hydraulic engineering, and over the last ten years has spent a lot of time and energy convincing his fellow citizens that seasonal floods in the lower San Miguel valley can be controlled by canalizing the streams and torrents flowing from the Apo peak, through the orchid forest on the northern slope of the valley. The work will reclaim more than 800 ha of fertile, irrigable land, and a small hydropower dam located at the mouth of the canyon could supply very low-cost electricity to the municipality.

So far, lack of funds and political will have prevented this project from being implemented. However, after winning the municipal elections, Ignacio has convinced his party colleagues in the government to include the project in its national sustainable development agenda and recommend it for donor funding. The project was approved by the government and the donor, which requested formal ratification from the municipal council. Ignacio has reassured the council that the project would benefit the whole constituency, gaining bipartisan consensus for the first time in San Miguel political history. However, he is aware that it will have very little chance of succeeding unless Park Square groups endorse the council decision.

After church, Ignacio is approached by Don Eleuterio, the old botanist who is in charge of the orchid biotope, a protected area supported by an international NGO. Don Eleuterio comes straight to the point: "I am really disappointed by the way in which the council dealt with conservation issues. I supported you in the election, because I thought that you were sensitive to biodiversity and willing to protect the orchid biotope. But last week you mentioned drying the forest piedmont swamp. That swamp provides the humidity that many forest orchids need to grow and blossom. It also hosts many rare bird and endemic plant species. The swamp should be treated as part of the biotope, and not as a buffer zone where anybody can dig channels."

Ignacio answers gently: "You should not take the draft plan as final. Many important aspects are still to be considered in depth, including the exact location of the channel catchments. Most of the piedmont swamp is marked on the map as a buffer area for the biotope, which means that only very limited interventions will be made, according to the findings of an environmental impact assessment. I am as interested as you are in conserving the mountain forest: that's where our water comes from." "All right", says the botanist, "we will discuss this when the Ministry of Environment team comes for the environmental impact assessment."

Ignacio is crossing Park Square when a child calls him to tell him that Don Emiliano wants to buy him a drink at the coffee shop. Ignacio is not eager to talk to Don Emiliano and his landowning and business friends, but he realizes that it would not be polite (or politically advisable) to ignore the invitation.

Don Emiliano is sitting at a table with Don Victor and Don Arturo: "The San Miguel business community owes a lot to you for this brilliant project, which will bring prosperity and progress to the whole community", he says. "We were not among your voters at the last election, but we congratulate you for the way you are handling this issue. Please take a seat and tell me what you would like to drink."

"Don Emiliano is happy", says Don Arturo, who owns half the arable land in the valley, "because he is already counting the money he will make from supplying contractors with food, beer and materials and accommodating foreigners in his brand new hotel. I and the other big farmers in San Miguel also expect to have a role in this development. We are sure that our entrepreneurial spirit and investment capacity will be taken into account when the land and water that your project reclaims are distributed." Then, looking slyly at Ignacio, he adds, "I am sure you will agree that government and donor efforts to improve agriculture in our municipality should not be spoiled because land and water are made available to people who do not know how to make a profit from them."

Don Victor explains: "It is no secret that the Small Farmers' Union is putting you under pressure to assign the reclaimed land to a small farmer cooperative. They say it is for social justice, but these cooperatives have no business experience or working capital. I really hope that all the work you have done so far does not end up with such a populist conclusion." "By the way," Don Arturo adds, "we can pay the municipality a higher rent and offer a share of our profits, if needed…"

Ignacio cuts off the conversation, finishing his drink, "This is a complex and sensitive issue, which the council will consider carefully. I am confident that we will reach consensus in the end, but any statement I make at this point would be premature. So thank you for the pleasant conversation and the drink and have a nice Sunday."

Back on Park Square, Ignacio hears a loud voice: "See what happens to those who are blessed by education and politics: they sit at the rich men's table and forget about their friends and comrades." It is Jorge, his childhood friend, who is sitting with his Small Farmers' Union colleagues.

As Ignacio nears the group, Jorge says: "I bet my harvest that the three coyotes you have been talking to were trying to convince you to sell them the land you already promised to us." "Come on Jorge!" exclaims Ignacio, "You know very well that I am not entitled to promise the land to anybody, including union members. But I will do all I can to make sure that this land is used wisely and sustainably."

"What does that mean?" asks Don Pepe, one of the small farmers. "Let's take your case as an example, Don Pepe," answers Ignacio, "tell us about your land". Don Pepe starts: "My father left me 1 ha of hillside plot. To make a living out of it, I had to cut down all the trees and shrubs. Then, year by year, rainy season showers dragged all the good soil downhill, and I am left with a plot of stones and clay." "Well," says Ignacio, "sustainable use means preventing that sort of thing from happening."

"How do you think you will manage that?" asks Lucho, the vice-president of the union. "By leasing valley land at special conditions to hillside farmers who are prepared to plant trees on their sloped plots. That will prevent soil and debris from sliding downhill and filling the channels and reservoir." Jorge interrupts: "Do you really want to force people to plant trees on their ancestors' farmland?"

"I do not want to force anybody to do anything," Ignacio replies, "but I believe that our ancestors would agree that maize, beans and vegetables grow better on the flat, fertile and irrigated land of the valley, while hillsides provide excellent ground for fruit, coffee, cocoa and timber trees." "Right," says Don Pepe, "that is how my grandfather managed the farm. But when the landlords took away our downstream plots, we were forced to sow maize and beans on the slope. Can we be sure that this will not happen again when the flooded land is reclaimed?"

“To be honest, I do not know”, says Ignacio. “but this time the council is politically committed to giving small farmers a chance. Can we talk about this later? I am terribly hungry and my wife has lunch waiting for me.” “All right,” says Jorge, “we know that you are doing your best to make the project work for poor people too. I tease you because I do not want you to become a selfish, boring politician.”

Nearing home, Ignacio sees a brand new car parked in front of his front gate. Doña Elisa, the vice-mayor, is standing by the car. When she sees Ignacio, she calls him: “I have just arrived from the capital with some friends who would like to meet you. Do you have five minutes for us?” “I am in a bit of a hurry,” says Ignacio “but we can shake hands.”

Doña Elisa, does the introductions: “Mr Gutierrez from Water and Electricity Ltd and Mr and Mrs Alameda, the owners of Alameda Country Resorts. You have a meeting with them on Monday.”

“We had planned to come tomorrow,” says Mrs Alameda “but then we decided to take advantage of this sunny day to enjoy the valley. I am sure that when the swamp is drained and the White Canyon lake has been established, San Miguel will be a great place for tourists: a nice small colonial town in a rural environment, with a fresh climate, good air, an orchid forest and a little lake for swimming and sailing.” “That is what our urban customers want,” adds Mr Alameda, “San Miguel has a great future in the tourism industry.” “Not only that,” says Mr Gutierrez, “I have seen where the dam will be built and calculate that with a minor engineering change, the hydropower plant could produce much more electricity than planned. You can sell us some of the power we need to supply the district capital. Water is also interesting … but we will talk about all this tomorrow.” “Yes, of course,” answers Ignacio, “In the meantime please relax and enjoy the place.” “Great, goodbye,” say the visitors.

Ignacio crosses the street and opens his front door. Suddenly, the unmistakable spicy smell of his wife’s roast meat makes him feel safe; until tomorrow, at least.

Chapter 3
A new approach to watershed management

> Watershed management has evolved and passed through several developmental stages. In the initial stages, it was a subject of forestry and forestry-related hydrology. The involvement of people was not an issue. It was solely an affair of government forest departments. During the second stage, it became land resources management-related, including activities with an eye on economic benefits. At this stage, the focus was on beneficiaries. It is now "participatory and integrated" watershed management, with involvement and contribution from local people.
>
> Kathmandu workshop

This chapter clarifies what is innovative in the new generation of watershed management. It also discusses how these innovations link to parallel changes in other areas of development and conservation.

This is a period of experimentation in watershed management

Worldwide environmental, socio-economic and political changes are challenging some of the foundations on which watershed management has been based for the last 20 years. Watershed management is going through a period of experimentation in which old and new practices often coexist and mix. The new generation of watershed management programmes being developed has a different approach, design and implementation strategy. Table 4 summarizes some of the paradigm shifts that are emerging from this experimentation.

TABLE 4
Old and new generation paradigm shifts

Past generation	Next generation
Integration of socio-economic issues within watershed management programmes	Emphasis on watershed natural resource management as part of local socio-economic development processes
Focus on "people's" or "community" participation, with an emphasis on bottom-up participatory planning	Focus on multi-stakeholder participation, linking social, technical and policy concerns in a pluralist collaborative process
Rigid programme design that overestimates central government's capacity to enforce policies, and lacks adequate institutional/organizational arrangements at the local level. Short-term planning and financing	Flexible programme design that adjusts to local governance processes. Long-term planning and financing
Implementation responsibility entrusted to "heavy" institutions, such as donor-assisted programmes or government watershed authorities	Implementation responsibility entrusted to "light" institutions such as watershed management fora, consortiums and associations, with programmes and authorities playing a facilitating and subsidiary role
Focus on on-site, short-term effects. Small-scale projects with little watershed or basin-level coordination	Focus on upstream–downstream linkages and long-term impacts. Local-level processes coordinated at the watershed or basin level
Quick-and-dirty participatory assessment and evaluation (e.g., participatory rural appraisal [PRA]), with little or no linkage to natural and sociological evidence	Dialogue between local and scientific knowledge in "fairly-quick-fairly-clean" action research processes, involving a variety of stakeholders
Belief that access, tenure and social conflicts in watersheds can be solved by technically sound interventions	Awareness that most access, tenure and social conflicts in watersheds are rooted in society and politics and should be managed through continuing negotiation

WHAT DOES "INTEGRATED" WATERSHED MANAGEMENT REALLY MEAN?

> In the formulation of (watershed management) plans, both the attributes of the land and water resources and the socio-economic factors which affect the development of the human beings in the area in general, and land-use practices in particular, should be taken into account. Moreover, there should be provision for perpetual operational support. Without adequate social control of the use of the world's land and water resources, their technological overdevelopment can lead in the long run to regional or national underdevelopment. Furthermore, there must be an awareness of the total soil and water resources system, both upstream and downstream, and of the interrelated benefits that can be obtained by the wise application of modern technology.
>
> K. King, Director of FAO Forestry Department, 1977

The integration of environmental and socio-economic issues is not new to good watershed management

The integrated watershed management of the late 1980s was a forerunner of sustainable rural development, as advocated at the 1992 Rio summit. Both approaches share a systemic view of biophysical and social interactions, a concern for the on- and off-site and the short- and long-term effects of change, and a fundamental belief that appropriate social management can optimize the functioning of human ecosystems. Both aim to generate benefits for people and environments.

This shared paradigm suggests that it is difficult to distinguish integrated watershed management from sustainable development in watershed areas. Poverty and unsustainable livelihoods often contribute to watershed degradation, and planning needs to take more effective account of the multiple linkages between poverty and watershed management. Box 21 provides an example of how natural resource management, socio-economic development, sustainable livelihoods and poverty alleviation goals are being integrated in watershed management programmes. However, this approach has not always brought the intended positive impacts on livelihoods and the environment (Box 22).

Socio-economic and natural resource objectives are not always compatible

There is a risk that too great a commitment to sustainable livelihoods and poverty alleviation goals will push watershed management programmes' environmental role into the background. Although environmentalism has also gathered momentum, trade-off issues between livelihood and environmental concerns have arisen, especially in poverty alleviation and food security interventions. Water-centred and people-centred objectives are not always compatible, and may need to be addressed in different ways.

There is a fundamental dilemma about the relationship between integrated watershed management programmes and sustainable development processes:

- Should watershed management programmes incorporate sustainable development objectives, by committing to providing benefits and services that are not directly related to natural resource management? or
- Should they be embedded in broader sustainable development processes, by ensuring that sustainable development considers land and water issues?

The first option can be referred to as "programme-led" integrated watershed management. It prevails in many developing countries where, because of insufficient coverage by line agencies and development programmes, integrated watershed management programmes often include socio-economic development activities as complementary components of natural resource management interventions.

Watershed management links local livelihoods and natural capital assets

Embedded watershed management, on the other hand, focuses on those aspects of sustainable livelihoods that are directly linked to natural capital assets, for example, by strengthening local actors' capacity to manage agricultural land and allied resources in ways that promote environmental stability and food and water security. Other elements that are relevant to sustainable development – off-farm livelihood diversification, education, health, etc. – are less relevant to watershed management programmes.

BOX 21

Integrated watershed management and sustainable rural development in the Lao People's Democratic Republic

The Lao People's Democratic Republic (PDR) is a mountainous land-locked country with relatively low population density. Some 87 percent of its territory is upland, where there are high incidences of poverty and little infrastructure. Lao PDR has rich biodiversity and the least damaged ecosystems in Southeast Asia, but unsustainable resource management is beginning to reverse this situation.

Since 2000, the Ministry of Agriculture and Forestry has implemented an integrated watershed management strategy aimed at: (1) improving the conservation and management of watershed natural resources to enhance their use in sustainable economic production; and (2) alleviating poverty and improving sustainable livelihood opportunities, particularly where local needs are met by watershed natural resources. Meeting these two objectives simultaneously is a major challenge; each watershed has different needs, as illustrated by four model watersheds established to test the integrated watershed management approach.

Nam Tong watershed in Vientiane province, northern Lao PDR, covers 556 km^2. It contains 27 villages and a wide valley with relatively good soil conditions. It has medium levels of immigration, relatively good market access – mainly to Vientiane city – and good potential for diversified agriculture and aquaculture. The area is self-sufficient in rice, but some households lack rice at certain times of year and live below the poverty line. The watershed planning process identified land-use options for diversifying agriculture, livestock and aquaculture while maintaining the present 70 percent forest cover.

Nam Tim watershed in Bokeo province, northern Lao PDR, covers 220 km^2. It has 23 villages and a population of about 10 000 people from several ethnic groups. Another 21 villages (6 500 people) outside the watershed practise shifting cultivation in its upper parts. The government has built a reservoir to irrigate 1 200 ha in the area. The Nam Tim Integrated Watershed Management Project identified pressure from shifting cultivation as a serious problem and plans to protect the watershed's headwaters and introduce improved agricultural practices and alternative income-generating activities.

Nam Neun watershed in Xieng Khouang and Huaphan provinces, northeastern Lao PDR, is a mountainous area of 6 881 km^2. About 400 villages practise shifting cultivation and upland rice farming, raise livestock, gather non-timber forest products (NTFPs) and grow opium. This area's watershed plan addresses conservation, development and upstream–downstream linkages, as well as poverty alleviation and the eradication of opium cultivation.

Nam Et Phou Loei National Biodiversity Conservation Area in Huaphan and Luang Prabang provinces, northern Lao PDR, is a mountain range of 4 200 km^2 with high levels of biodiversity. It contains the headwaters of four major watersheds and about 110 villages in its buffer zone, with another 35 inside the conservation area. These practise mainly shifting cultivation and some opium production. Its watershed plan focuses on sustainable use of the area's natural resources.

Source: Pravongviengkham *et al.*, 2005.

BOX 22

Fallacies of integrated watershed development in India

In India, watersheds have become the pivotal unit for rural development programmes. India's first guidelines for integrated watershed development (1986) were based on the assumption that investments in watershed management have long-lasting impacts on the livelihoods of small farmers whose land is not suitable for large-scale irrigation and hi-tech agriculture. Some 60 percent of India's arable land falls into this category. The core objective was to enhance rural food security and incomes through improved natural resource management.

Between 1994 and 1999, there were about 10 000 watershed projects in India, and during 2001/2002, about 6.2 million ha of rainfed land in 5 200 micro-watersheds was under treatment, at an estimated cost of US$175 million. There are, however, no sound, comprehensive data on the performance and impact of these projects.

Local assessments and national indicators suggest that most watershed projects have not been successful. Some have not provided even the minimum drinking-water and fodder needs of watershed inhabitants, others have overlooked pastureland development and soil-moisture conservation practices, and many have failed to arrest land degradation. One study indicates that the rate of land degradation in rainfed areas during the 1990s was more than twice that of the 1980s, largely because of increased soil erosion. Continued lack of drinking- and irrigation water in several states shows that drought-proofing interventions have not generated significant downstream impacts.

These disappointing results are largely due to flaws in the financing and implementation mechanism established in the 1986 guidelines. Fixed budgeting does not adapt to the wide biophysical and socio-economic variability among watersheds, and rigid adherence to guidelines prevents projects from sharing experiences and lessons. Watershed projects' multiple objectives led them to channel limited investments into a range of on- and off-farm activities, often involving trade-offs among the interests of different stakeholders. Packages of measures, from building check-dams to promoting income-generating activities, became too large and difficult to manage, and the spreading of funds over many actions made impacts slow to materialize and intangible. Projects also often applied unscientific soil and water conservation methods, which decreased the cost-effectiveness of their interventions.

The Indian watershed management programme also lacked sustainability and equity. Many projects had no strategy for maintaining assets after project support ended; the only benefit that many farmers derived from watershed projects was the possibility of short-term paid work. Communities saw few long-term benefits from projects, so had little interest in operating and maintaining project assets. In addition, many property regimes in rural India are incompatible with the 1986 watershed management guidelines. Land is inequitably distributed and groundwater rights are bundled with landownership. Most watershed programmes have a clear hierarchy of benefits and beneficiaries: those farm households that obtain improved irrigation benefit the most; other farmers obtain on-farm treatments such as field bunds; while those with no land or livestock benefit the least. There is a need to place these issues at the centre of a participatory process and to initiate negotiations among different beneficiaries and stakeholders.

Source: Sharma, 2005.

Natural capital assets such as land and water are an obvious linkage between watershed management and livelihoods. However, watershed programmes that focus only on natural resources have limited impacts on livelihoods and poverty (Box 23). It is difficult for people affected by landlessness, illiteracy and disease to use natural resources sustainably.

BOX 23

Enhanced water availability and the livelihoods of poor households in South Africa

The hydrological cycle is often believed to make an important contribution to the livelihoods of rural communities, but there is little evidence to support this claim. Discussions tend to focus on water from rivers, boreholes or storage (“blue water”), and neglect the role of evaporation (“green water”), which is often critical for agriculture and rural livelihoods. The goods and services provided by evaporation and transpiration are being assessed by the Catchment Management and Poverty Alleviation (CAMP) Programme, supported by the United Kingdom’s Department for International Development (DFID) in South Africa, the United Republic of Tanzania and Grenada, and directed by a stakeholder group of forest, water and poverty interests (Box 31).

CAMP’s South African project focuses on Luvuvhu catchment in Limpopo province, which drains into the Limpopo River at the border with Zimbabwe and Mozambique. This catchment illustrates the acute problems that human-induced changes in vegetation coverage cause for water and land-use management. In Luvuvhu, expanding commercial forestry is replacing indigenous species with exotic ones, which are invading an area that is short of water and has a high prevalence of poverty.

The CAMP project is investigating how different scenarios of forest cover affect the hydrological regime and water availability, and how these in turn affect economic production and livelihoods. Linkages between water availability and livelihoods are being surveyed in several communities. Changes in river flow and evaporation caused by changing land cover are assessed using land-use-sensitive hydrological models that were specially configured for the Luvuvhu, and a framework of the linkages between water flows and the economic and livelihood values of water has been devised.

So far, the analysis has not demonstrated any significant association between income increase and greater access to water – through either improved water supply or higher rainfall. Once the statutory requirement of 25 litres of water/capita/day is met, further provision of water does not produce significant livelihood benefits. In addition, although there may be food security gains from increased water provision (e.g., for irrigating kitchen gardens), the poorest in society are less likely to benefit; wealthy households with greater access to home-based reticulated supplies will benefit more.

Sources: Calder, 2005.

TABLE 5
Comparison between (programme-led) integrated and embedded watershed management

Integrated watershed management	Embedded watershed management
Environmental and socio-economic issues are strictly related and cannot be addressed separately	Most environmental problems are related to socio-economic issues, but there is always scope for measures and actions that specifically address environmental issues
Watershed management programmes should have a sustainable development mandate and aim at both natural resource and sustainable livelihoods goals	The mandate and goals of watershed management programmes should focus on natural resource management for sustainable livelihoods and development
Integrated programmes to address environmental and livelihoods issues comprehensively should be developed	Sectoral programmes focusing on watershed natural capital assets should be developed. Issues that are not related to natural capital should be addressed in collaboration with other programmes or institutions

Integrated watershed management moves towards embedded watershed management

Partnerships between watershed management programmes and other institutions working on livelihoods, poverty alleviation, land reform, education and health issues make it easier to address environmental and socio-economic issues effectively. The differences between such embedded watershed management and the integrated approach are presented in Table 5.

So far, embedded watershed management has taken place in affluent countries, where infrastructure, social welfare services and public subsidies are available, and environmental conservation is a public concern. For instance, watershed management interventions in de-populated mountain areas of Western Europe are integrated with socio-economic development through activities that strengthen local capacities to manage forest, land and water. These interventions also promote conservation-based livelihood alternatives – such as tourism, organic farming, local food specialities and handicrafts – by linking watershed management interventions to existing public sector incentives for natural resource conservation and other subsidy systems (Boxes 24 and 25).

BOX 24
Embedded integration of environmental and socio-economic issues in France

The Plateau de la Leysse is the upstream part of the watershed near the urban settlement of Chambéry in France. The valley below is classified as being at flood risk. The upstream watershed covers 10 150 ha, half of which is private and public forest. The other half is agricultural land and prairies, parts of which have been abandoned over the last 30 years. Conservation of the area is entrusted to the Regional Natural Park of the Bauges.

In 2002, private landowners, the park and the area's six municipalities signed a collaborative management agreement aimed at managing the land sustainably – keeping it alive, attractive and visited while developing the local economy, which is based on agriculture and heritage. Following on from this, an intermunicipal consortium was established to manage a five-year plan and annual implementation programmes. The juridical framework of this initiative is a national law that reinforces environmental protection and management through public participation and natural resources management (National Law of France No. 95, 2 February 1995).

During discussions with all actors, local communities and inhabitants identified the elements that provide quality of life in the area. A legal association was established to manage the preparatory phase of the initiative, whose operational plan identifies specific sectors, areas, measures, means and funding in an integrated way. As well as technical aspects, the plan includes involving local populations and sensitizing young people.

The actions that concern water bodies identify resources, evaluate the condition and rehabilitation needs of these, use technical enterprises for management and monitoring, and communicate to users and the public.

After an initial investment of €100 per hectare, the estimated annual costs (in 2002) are €50 for planning and €75 for field management, making a total of €125 per hectare. These costs are low compared with those of managing smaller areas or sectors because planning and management are at an appropriate scale.

Source: Zingari, 2005.

BOX 25

Embedded integration of environmental and socio-economic issues in Italy

Two-thirds of Italy is mountain area. In the late 1990s, Italy developed territorial pacts (National Laws Nos 104 of 1995 and 662 of 1996), which are legally binding social partnership contracts for planning. The pacts are public and private agreements to implement local development measures that integrate natural resource management, industry, agriculture, fisheries, public services, tourism and infrastructure. Any area can have a pact, but marginal areas are priorities. Territorial pacts now involve 47 percent of Italy's total population and cover 53 percent of its land area. The pacts' use of an integrated cross-sectoral approach and their involvement of key actors make them relevant to watershed management.

The main feature of the pacts is that they harmonize different local actors without imposing external conditions: participation is voluntary and includes all sectors – administration, enterprises, banking, research, trade, etc. The objective of a territorial pact is to achieve cohesion among current and new initiatives involving natural resources, people and economic activities. Each pact concerns specific activities, such as the management of natural resources, including water resources; more than half of the pacts approved up to 2003 include natural resource and hydrology aspects. The territory covered by a pact can range from one small watershed to, for example, the 1 600 km stretch of the Apennines.

The territorial pact for the province of Rieti involves 12 municipalities, three mountain communities and 35 signatory parties. It has created 227 new full-time jobs, and used €18 million for two main activities: reinforced capacity building in small and medium enterprises; and investment in infrastructure, tourism and environmental services, including agriculture and forestry.

The territorial pact provides a framework for action and advantages from economies of scale, but human and cultural dimensions have a great influence on its implementation. The territorial pact is not intended to be a policy instrument but a real governance goal.

Source: Zingari, 2005.

With some exceptions (Box 26), there is little embedding of watershed management in developing or transitional countries, which tend not to have an effective public sector in rural areas or subsidies and incentives. Over the last ten years, however, poverty reduction and sustainable livelihood initiatives, administrative decentralization, public–private partnerships and expansion of the market for environmental services have started to offer watershed management programmes new opportunities for partnership with local development processes in many areas of Africa, Asia and Latin America. Scope to explore the potential for embedding watershed management is increasing in developing countries as well.

BOX 26

Embedding watershed management in sustainable development in Cuba

Mountain areas cover 18 percent of Cuba's territory and are of great environmental and cultural importance. These complex and fragile ecosystems contain the country's main water, forest and mining resources and produce nearly all its coffee and cocoa outputs. Mountain areas were also the sites for most of Cuba's liberation war, and are now of immense symbolic significance to the population.

Cuba was one of the first countries to include environmental issues in its constitution (Article 27 of 1976), and has issued environmental laws since before the Bruntdland Report presented its principles for sustainable development. The relationship between social and environmental issues is fully included in national development policies, which are based on the belief that improved social conditions are a precondition for effective natural resource management.

In spite of this commitment, however, mountain areas fell behind the rest of the country. National programmes to improve social and environmental conditions either came too late or failed to address the specific needs of mountain areas. As a result, mountain people began to migrate to cities on the plains, leaving mountains with no workforce.

In response to this, the government implemented two projects in the late 1980s: the Plan Turquino and the Plan Manatì. The Plan Turquino was a socio-economic programme aimed at stabilizing mountain populations and making mountain areas as independent from urban centres as possible. The construction of 300 schools and 42 hospitals brought the levels of health service and education provision in mountain areas close to national levels. Four new mountain universities train professionals who have direct experience of local environmental problems and agricultural production issues (Box 43). The plan also trained small farmers in environmental protection and organic farming techniques, which are disseminated by university staff and local people through training courses, pilot projects and demonstration plots. Combined with the opening up of local markets and family agricultural production, these initiatives have significantly reduced the area's dependence on markets in the plains. The Plan Manatì was an environmental programme aimed at preserving the balance among agricultural areas, forests and watersheds.

In 1995, the Government of Cuba united the two plans into the Plan Turquino-Manatì, which covers the entire mountain population of 48 municipalities in the Guanihuanico, Guamuhaya, Sierra Maestra and Nipe-Sagua-Baracoa massifs. This plan is managed by the central government, with decentralization to the provincial or municipal levels for local projects. Its managers claim that the Plan Turquino-Manatì is Cuba's most important sustainable mountain development project. As well as including watershed management in social development, the plan focuses on training and information, involving universities, experts, extensionists and local populations in the sustainable use of local natural resources.

Source: Berini, 2004

PARTICIPATORY VS. COLLABORATIVE WATERSHED MANAGEMENT

Participation has been viewed as an attribute of good watershed management practice for more than 20 years

Along with integration, participation has been another essential attribute of good watershed management practice for more than 20 years. In 1983, FAO issued a conservation guide on community participation in upland management. Some of the aspects mentioned in that guide are still relevant today: (1) natural resource management cannot be successful and sustainable without the support and participation of natural resource users; (2) participants should have decision-making capacity and responsibility (empowerment); and (3) the promotion of participation in watershed management is a long and time-consuming process that requires appropriate means.

It is now clear, however, that beneficiaries, people or communities are not the only important actors in participatory watershed management. Collaboration between watershed management programmes and civil society is now increasingly mediated by a variety of institutional actors, including legally recognized user groups, unions, associations, cooperatives, local administrations, line agencies, NGOs and private companies. As these actors have diverse and sometimes conflicting interests and concerns, the main goal of participatory watershed management has shifted from awareness raising and social mobilization to negotiation and partnership.

This shift is linked to the administrative decentralization processes that followed the political reforms of the 1990s in many countries (Boxes 27 and 28). By transferring planning and governance responsibilities to local authorities, decentralization assigns a pivotal role in territorial management to regional, district and municipal administrations. Local governance processes have therefore become increasingly important for watershed management.

Administrative decentralization offers interesting opportunities for the new generation of watershed management programmes, but there are constraints to working with local governments and civil society institutions. It is often easier for central governments to devolve powers to lower units of government than to ensure that those units have the resources, capability and accountability necessary to fulfil their new functions. There is therefore a need to enhance the capacity of local governments and civil society actors to deal with technical issues, including those raised by the embedding of watershed management in territorial governance.

Participatory watershed management moves towards collaborative watershed management

External actors, such as downstream interest groups and national governments, are affected by local watershed management decisions. Hence, off-site problems and downstream impacts need to be incorporated more effectively in watershed management planning. Negotiations among local stakeholders should be linked to expert screening of the technical consistency and off-site effects of stakeholders' plans. An approach that is extremely bottom-up is not a recipe for success in watershed management, especially when downstream needs and interests are to be considered. Local stakeholder participation, horizontal linkages among authorities and local organizations, and mutual agreements among local administration, government and the private sector are all needed.

Watershed management programmes are shifting from a participatory to a collaborative approach (Boxes 28 and 29). The term "collaborative" refers to participation in natural resource management that is pluralist and based on mutual learning, exchange and negotiation among actors with diverse interests and concerns, including technical experts and policy-makers. The differences between participatory and collaborative watershed management are summarized in Table 6.

BOX 27

Participation, collaboration and decentralization in watershed management

Although most watershed management programmes, projects and plans include people's participation, it is not always clear that they implement it. One of the problems is that many watershed experts find it difficult to change their management-based, top-down method of working and do not fully understand the situation of watershed inhabitants. At the same time, local people continue to see themselves as the passive recipients of material assistance and find it difficult to enter into a new type of participatory relationship. What slows things down the most, however, is a failure to recognize local people and their associations as true partners.

It is difficult to deal with the wide variety of situations that are brought about by the participatory approach, even when it is properly implemented. There has been a shift from the top-down approach, based on providing services, to one that gives priority to individual demands. Governments are disengaging, and this can leave vacuums that may have adverse effects on communities. Giving priority to local people is a good step, but many people are now being called on to make decisions without seeing the broader picture. To avoid some of the dangers of the participatory approach, decentralization has to be strengthened; the intermediate levels – regions and provinces – need the means to provide an interface between national requirements and local expectations.

A watershed policy based on watershed players must recognize the demands of local communities and territories, while national policies have to take into account the agro-ecological, social and cultural characteristics of different territories. These two dimensions can work together only when there are strong measures to improve information sharing, strengthen the capabilities of people at all levels and organize rural areas. The major challenge is incorporating local community initiatives into a comprehensive approach.

Under decentralization, the State becomes the mobilizer and facilitator of the local development initiatives that are proposed by local communities. Economic reforms and decentralization aim to allow local initiatives that cater to local special interests, while preventing local elite groups from claiming the role of "people's representatives" to organize, run and take over projects and programmes. A contractual and partnership approach seeks to establish new relations among rural development players rather than imposing vertical relations based on strategies that ignore local and regional processes.

Central government watershed management institutions must be replaced by new ones that can create conditions for dialogue among farmer organizations and other watershed players. These new institutions must create, convert and strengthen intermediate institutions, which in turn should guide the formation of government policies to accompany decentralization. Intermediate watershed institutions should collate and regionalize the demands of rural people, and build partnerships with other rural development players to become the fora for mediation and arbitration.

Source: Bonnal, 2005.

TABLE 6
Comparison between participatory and collaborative watershed management

Participatory watershed management	Collaborative watershed management
Focuses on communities and people and targets grassroots social actors: households, small communities	Focuses on civil society and targets a variety of social and institutional actors, including local governments, line agencies, unions, enterprises and other civil society organizations, as well as technical experts and policy-makers
Based on the assumption that sound natural resource management is a public concern that is shared by all social actors	Based on the recognition that stakeholders have particular – sometimes contrasting – interests in natural resources, which need to be accommodated
Seeks (or claims) to make decisions through a bottom-up process, by which grassroots aspirations are progressively refined and turned into operational statements and action	In decision-making, seeks to merge stakeholders' aspirations and interests with technical experts' recommendations and policy guidelines through a continued two-way (bottom-up and top-down) negotiation process
Centred on the watershed management programme, with local government assisting as a side supporter	Centred on the local governance process, with the watershed management programme acting as facilitator and supporter
Aimed at creating a general consensus, presuming that conflict can be solved through dialogue and participation	Aimed at managing social conflicts over natural resources, based on awareness that dialogue and participation can mitigate (partially and temporarily) conflicts, but not solve them structurally

BOX 28
Collaborative management of natural resources: a definition

Collaborative management – also called joint, mixed, multi-party or round-table management – was developed in the 1990s by the World Conservation Union (IUCN) to embed the management of protected areas in local livelihoods, culture and governance. In collaborative management, social actors negotiate, define and guarantee among themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources.

Collaborative management is:

- a pluralist approach to managing natural resources, incorporating a variety of partners in a variety of roles, generally with the goals of environmental conservation and the sustainable use and equitable sharing of resource-related benefits and responsibilities;
- a process that requires full access to information on relevant issues and options, freedom and capacity to organize, freedom to express needs and concerns, a non-discriminatory social environment, will to negotiate, and confidence that agreements will be respected;
- a complex, often lengthy and sometimes confused process involving frequent changes, surprises, sometimes contradictory information, and the need to retrace steps;
- a political and cultural process that seeks social justice and democracy in the management of natural resources;
- the expression of a mature society that understands that there is no "unique and objective" solution to environmental problems, but rather a multiplicity of different options that are compatible with both local knowledge and scientific evidence and capable of meeting the needs of both conservation and development.

Source: Borrini-Feyerabend, 2000.

BOX 29

Towards collaborative watershed management in India

Watershed management in India has evolved from a purely technical, top-down approach in the 1970s to the current decentralized participatory approach. In 2003, the Ministry of Rural Development's guidelines on watershed development transferred a pivotal role in managing local watershed projects to village-level local government – the *panchayati raj*. This policy built on experiences of the German Agency for Technical Cooperation (GTZ), which has been involved in integrated watershed management programmes in India since the late 1990s.

GTZ defines watershed management as guiding and organizing the use of a watershed's land and other resources to provide people with desired goods and services sustainably and without adversely affecting soil and water resources. This recognizes the interrelationships among land use, soil and water, the linkages between upland and downstream areas, and the numerous types of stakeholders. GTZ's approach to watershed management encourages stakeholder participation, because a watershed development project can become sustainable only when local actors own and maintain project assets. Across India, locally elected *panchayati raj* can play a major role in this.

GTZ-supported projects focus on developing the capacity of human resources, local communities and local institutions to manage natural resources effectively. Improved farming systems – crop management, pasture and fodder development, livestock management and organic farming – provide sustainable rural livelihoods and opportunities for adding value to farm and non-farm products and services. Key features of the GTZ approach are managing the often competing demands on a watershed, such as the water needs of agriculture, households, industry, livestock, forests, wildlife and tourism, and managing conflict among social groups and between the upstream and downstream users of watershed resources. Decentralization is promoted through village-level water resources projects, self-help groups, local knowledge centres and capacity building for local actors. Technical backstopping is supplied through strengthened linkages among *panchayati raj*, line departments and private sector institutions and companies. A participatory impact monitoring system enables local governments and other stakeholders to make sound and timely decisions.

GTZ's experiences in India suggest that the best approach to watershed management is participatory, uses sound local technologies and promotes the sharing of costs and benefits. In line with government policy, GTZ's watershed projects use revenue villages or panchayats as the units of implementation, and work with local stakeholders to plan, design, implement and monitor interventions, prioritizing activities that strengthen local livelihoods. This all helps to build a sense of local ownership.

The experiences also show the importance of forging good institutional linkages. There is a crucial need for supporting actors to provide long-term technical backstopping after project support has ended. GTZ phases out the temporary organizational structures and services that run projects, and institutes post-project networking among permanent stakeholders who will continue the processes started by the project and ensure sustainability.

Source: Kotru, 2005.

KNOWLEDGE: MERGING SCIENCES AND LOCAL CULTURES

Collaborative watershed management processes must be based on shared knowledge. In conventional watershed management, planning was largely based on "hard" natural sciences and social surveys. During the 1990s, PRA methods were adopted, with the twofold aim of understanding local people's views and involving local people in establishing priorities. This did not always lead to effective exchanges of information on natural resource issues among technical experts and local stakeholders. Insufficient expertise in social and cultural research turned many participatory appraisals into "quick-and-dirty" exercises, whose main output was a shopping-list of felt needs to be accommodated in watershed management plans (Box 30).

BOX 30

Flaws in participatory appraisal and planning methods in Nepal

The Soil Conservation and Watershed Management Component (SCWMC) of the Denmark–Nepal Natural Resource Management Sector Assistance Programme was implemented from 1998 to 2004 to help soil conservation offices launch participatory watershed management in the Nepalese Middle Hills. The programme covered 20 districts, 24 sub-watersheds and 700 communities, representing about 30 000 households.

SCWMC was based on building grassroots organizational and financial capacity in integrated watershed management. Groups of participants were established at the ward and micro-catchment levels, until it became clear that these were not sufficiently socially homogeneous to function as local development units. SCWMC therefore shifted to hamlet-level community development groups (CDGs).

PRA and "vision planning" were used for participatory planning at the CDG level. The programme expected each CDG to set a development vision that was compatible with watershed management principles, such as "becoming a well-protected and healthy village". This vision would then be put into operation through a plan with specific objectives, such as "reclaiming all local degraded lands and applying soil conservation treatments to local gullies and landslides" and "obtaining access to safe drinking-water and the use of a latrine".

SCWMC introduced the service, economy, environment and democracy (SEED) approach to prioritize the activities financed by the programme. Ideally, communities were to prioritize activities that provide services, promote production, protect the environment and promote democratic norms.

Budgets were set according to communities' planned activities, with CDGs free to prepare relatively large projects. This helped the CDGs to develop the necessary skills to approach other donors for funding. Compulsory group saving schemes strengthened the groups' ownership of programmes.

Through this bottom-up planning process, CDGs drove the implementation of SCWMC. However, owing to insufficient technical backstopping from field staff and lack of expertise among community members, many CDGS implemented additional work with their budgets, which forced them to compromise on quality. CDGs were also more concerned about the service component of SEED than the environment, economic and democracy aspects, so they pressurized field staff to direct resources away from soil conservation and watershed management towards the building of schools, household water supply schemes, irrigation canals and other things that were beyond the natural resource management scope of the programme. In the long term, this threatened the relevance and sustainability of SCWMC efforts to promote sound soil conservation and watershed management practice at the grassroots of rural society.

Source: Sthapit, 2005.

Action research

In watershed management, there are still large gaps between science and practical expertise, between theory and practice, and between desire for collaboration with stakeholders and capacity to manage such collaboration. An approach is needed that links local and scientific knowledge by incorporating sound action research practice into collaborative watershed management.

Action research can be described as adaptive, collaborative, interactive, pluralist or participatory research. In watershed management, it focuses on subjects that reflect local priorities and aims to identify site-specific solutions to the problems faced by watershed stakeholders. End-users participate in identifying research topics, designing research and validating results. Procedures and outputs should be easy to understand and use for watershed inhabitants, NGOs, local governments, trainers, watershed managers and others (Boxes 31 and 32).

Action research is a joint learning process based on cross-cultural dialogue

Action research for watershed management should address natural resource management in the context of the existing productive systems and social institutions that regulate access and tenure. Local views on these issues should be gathered, and when appropriate compared with relevant scientific knowledge and policy orientations. In this way, action research can promote a two-way cross-cultural learning process through which expert knowledge is adapted to local environmental and socio-cultural conditions, while local knowledge is enhanced and strengthened by scientific understanding of the issues at stake.

BOX 31

Interactive research and action learning for watershed management: the CAMP project

What impact will improved watershed management have on local livelihoods? How can watershed management technology be used to strengthen natural capital assets and decrease environmental vulnerability? These questions are being addressed by interactive research within the CAMP programme. In interactive watershed management research, watershed stakeholders collaborate with scientific researchers at both the design stage, by helping to define programme objectives and ensuring that resources are mobilized, and the implementation phase, by monitoring and steering the programme. Experiences from South Africa, the United Republic of Tanzania and Grenada suggest that this approach has the following benefits:

- Through close involvement in the research, stakeholders assume ownership of the programme and are more likely to understand and adopt research findings.
- Best use is made of existing knowledge and data resources by building on the collective resources of all stakeholders.
- The action learning process contributes to awareness building and facilitates negotiation among different interests.
- Two-way information flows are established between stakeholders and researchers, as well as among different stakeholders.
- All aspects of watershed ecology, including livelihoods, governance and upstream–downstream linkages, are considered and represented.
- Collaboration among stakeholders with different interests and perspectives is more likely to achieve watershed management objectives.

Source: Calder, 2005.

BOX 32

Collaborative watershed management and action research in the United States

More than 150 years of agricultural development in the United States upper Midwest has created one of the most productive agricultural areas in the world. Today, however, the sustainability of this profitability and the impact on human and environmental resources are being questioned. To expand production in the Minnesota River basin, wetlands have been drained and converted to croplands, and extensive tile drainage networks and ditch systems are moving water off the land and into stream channels. Annual crops have largely replaced tall grass prairie species in the uplands and native riparian forests along stream banks and in floodplains. Stream channels have been modified to reduce flood damage to crops and farming communities.

An interdisciplinary, participatory watershed management programme was launched in the Minnesota River basin to address these ecological and hydrological imbalances. This uses a collaborative research and education approach to identify, evaluate and develop alternative cropping and management strategies that incorporate trees, woody vegetation and herbaceous perennials. It also considers alternatives to annual cropping that can compete financially with current production systems, on their own or through payment for the environmental services they provide. Programme objectives were defined with the participation of landowners, local citizen groups and local, state and federal government agencies, and partnerships have been formed with citizen groups, agency personnel, agroforestry cooperatives, university faculty and individual farmers.

Farmers adopt the programme’s land-use changes and management practices with the help of learning groups that include people who have already implemented agroforestry and perennial cropping systems. Through these groups, stakeholders identify sustainable and profitable land management options that landowners can adopt easily. Field research and monitoring of demonstration areas quantify the production outcomes and hydrologic and water quality changes associated with different cropping systems. Changes in vegetative cover in upland watersheds and riparian areas will be simulated, and different scenarios of change investigated to determine the effects of scale and landscape position on project objectives.

Hydrologic modelling provides information for the economic evaluation of downstream impacts. On- and off-site costs and benefits are evaluated from the perspectives of both farmers and stakeholders in the river basin (externalities). An assessment of markets for products from alternative perennial cropping systems is essential. Workshops where land managers and farmers can discuss the economic and policy issues that constrain implementation are planned, and educational materials for different audiences will be prepared.

This programme is expected to promote land-use changes that diversify the agricultural landscape, sustain the rural economy, enhance hydrologic storage and function, and improve water quality in the Minnesota River basin. Landowners, technical service providers, policy-makers and other stakeholders have been involved from the outset. The initial learning groups are expected to expand into a network for improving and adapting management practices. The programme should lead to continuing diversification of land use and management, better understanding of the watershed benefits derived from improved land use, more involved and informed citizens, and – ultimately – the policy changes needed to support sustainable land-use practices.

Source: Brooks, Current and Wyse, 2005.

As suggested in Box 32, action research should feed a multi-stakeholder process. Research should be planned as a long-term learning exercise that includes the dissemination and replication of successful results, local best practices and lessons learned through demonstration sites and training. User-friendly tools for assessing the impacts of watershed management interventions – including local geographic information systems (GIS) – should be developed and used in participatory monitoring and evaluation. Skills in facilitating action research at the local level also need to be enhanced.

POWER: RIGHTS AND CONFLICT

Collaborative watershed management is not socially and politically neutral

The big challenge for collaborative watershed management is improving natural resource use from within local societies. This facilitates greater social ownership of watershed management interventions, and hence more sustainable environmental impacts. However, by involving social actors and local institutions in joint decision-making, watershed management can no longer be seen as a neutral or purely technical exercise; any collaborative watershed programme takes place within the local political arena.

A watershed programme or institution should intervene in local politics as an external regulatory stakeholder, and must not ignore existing power imbalances. This is because the key actors in watershed degradation are often the powerless, disadvantaged and marginal groups – such as upstream small farmers or the rural poor – whose needs and problems are not taken fully into account by local politics. Empowerment through interest groups and incentives, for example, ensures that weaker groups are not excluded from the collaborative process, but these measures may sometimes be insufficient to overcome the power gaps among stakeholders.

Natural resource use, access and tenure are the most critical links between local communities and watershed management. Collaborative management measures, such as awareness raising, capacity building, mediation and incentives, may help to resolve small, self-contained conflicts over natural resources. Conflicts that are rooted in tenure systems and access rules, however, will also need legal and legislative action to define and accommodate contrasting resource claims and rights.

Collaborative watershed management at the local level is not a "magic wand" that is sure of success because its practitioners are committed, patient and dedicated. Chapter 4 describes how collaborative watershed management is part of a more comprehensive policy reform of the land and water sectors, which is supported by strong rural development initiatives and measures to promote rural livelihoods.

INSTITUTIONAL AND FINANCIAL ARRANGEMENTS FOR COLLABORATIVE WATERSHED MANAGEMENT

Collaborative watershed management requires long-term strategic planning processes

Most government or donor-funded watershed management programmes follow a clearly defined project logical framework (logframe) specifying what is to be achieved and how. Objectives, outputs and activities are defined during the identification and formulation phase, and are normally based on limited information and superficial consultation with local stakeholders. Although project documents can be revised and amended, the general structure of the logical framework is maintained throughout the life of the project. Timing is also predetermined, which puts managers under constant pressure to deliver.

This planning format is not compatible with the new approach to watershed management, which requires greater flexibility in programme design. Strategic planning for watershed management needs to take into account different temporal and spatial scales and accept a degree of uncertainty. Watershed interventions should be planned progressively, with the involvement of local stakeholders and technical experts, and with a medium- to long-term vision.

Permanent watershed institutions should be created (or strengthened) to ensure long-term collaborative watershed management. The relationship between watershed management institutions and local institutions and civil society should be one of subsidiarity, i.e., watershed institutions should act only on those issues that local government, civil society or private actors cannot deal with themselves. The institutions should provide: (1) a forum for pluralist consultation and negotiation; and (2) the administrative and operational capacity to solve technical problems. The differences between watershed management delivered under a project format and that provided as a subsidiary service are presented in Table 7.

Permanent, subsidiary watershed management institutions are needed

Collaborative watershed management should preferably be the responsibility of "light" institutions such as watershed fora, observatories, municipal consortia, negotiation tables, water boards and land management committees (Box 33). The role of informal indigenous institutions should also be recognized and supported (Box 34).

Existing "heavy" watershed and water-supply authorities might also be the focal points of collaborative watershed processes, but their mandates and institutional cultures need to be reformed so that they can apply the pluralist and subsidiary approach to collaborative watershed management.

The financing of permanent watershed institutions is a controversial issue. Government or donor financing may be justified by the public-good nature of watersheds and the economic externalities that watershed management generates. In order to ensure regular funding, however, market-based mechanisms should also be developed. The water and energy sectors and the carbon sequestration market provide promising channels for recovering the operation costs of watershed management though PES schemes (Chapter 4).

MATTERS OF SCALE

Watershed management can be implemented at scales that range from small upland watersheds to entire transboundary river basins. Collaborative watershed management has flourished in relatively small territorial units, generally corresponding to sub-watersheds. The advantage of these small-scale programmes is that activities can be intensive and face-to-face interaction with local stakeholders is easier. Small-scale pilot projects have a limited impact at the watershed or river basin level, however, and the scaling-up of successful local experiences is a critical challenge for the new generation of watershed management programmes.

TABLE 7
Watershed management delivered under a project format and as a subsidiary service

Project	Subsidiary service
Logframe-based, planning defined in detail at the beginning of the project, with only minor adjustments allowed during implementation	Strategic planning with major impact objectives defined in advance, and secondary outcomes, outputs and activities identified during the run of the service
Short-term, intensive presence in the watershed (normally five to ten years)	Long-term presence with variable degrees of intensity according to needs
Primarily responsive to donor and government	Primarily responsive to local government and civil society
Priorities often driven by outsiders' criteria, including delivery pressure	Priorities primarily driven by insiders' problems: conflicts, negotiation, fundraising, etc.
Limited responsibility for fundraising	Actively involved in fundraising
Services provided on an all-inclusive, "full-board" basis	Services subsidiary to stakeholders' initiative and resources, and delivered on a cost-recovery basis
Requires an appropriate exit strategy to ensure that achievements are sustainable	Sustainability is built day by day

The scaling-up of pilot experiences also helps to embed watershed management in local governance. A watershed programme should overlap as much as possible with the administrative unit that delivers economic and social services. The territory should also be sufficiently large and populated to sustain the costs of a permanent watershed management institution.

The optimal scale of a collaborative watershed programme depends on several factors, including the watershed's strategic value, the existing demand for watershed services, ecosystem fragility, disaster risk, local stakeholders' priorities and the financial and technological resources that are available. The nature and size of the final expected impact should be consistent with the scale of the programme.

The design and operation of local programmes must also consider upstream–downstream linkages. Any local-level intervention should be viewed on the "big picture" screen, and a methodology for multi-level watershed, sub-watershed and micro-watershed planning should be developed.

BOX 33

"Heavy" and "light" watershed management institutions in Indonesia

Most watershed management in the Asia–Pacific region takes a project approach, in which organizations are established for the delivery of goods and services, extension, training of farmers and other activities. A major problem is that project extension teams encroach on the jurisdiction of government institutions, often leading to conflict and hindering project delivery.

Indonesia has about 470 watersheds. These vary in size and condition, and many are degraded. In 1999, the Ministry of Forestry issued guidelines for watershed management planning, which aim to prioritize those watersheds that most need management interventions, based on a systematic and scientific assessment.

Priorities were set through consultations at the central level. A group of expert stakeholders, including government officials, watershed professionals and academics, decided the relative importance of the biophysical, socio-economic and other factors that act on a watershed and govern the benefits of interventions. This reduced the disciplinary bias in which, for example, a hydrologist tends to assign most importance to hydrological factors.

In the field, however, watershed management officers and local administrators often failed to cooperate, mainly because watershed boundaries tend not to correspond to the administrative boundaries of other management and development initiatives. This generates conflicts and complex problems that no single institution has been able to solve.

The government is now promoting the participation of local administrations and other stakeholders in watershed management decision-making. Regional watershed management fora involve traditional leaders and representatives from local administrations, NGOs, community-based organizations, universities and other civil society organizations, as well as government experts, and are expected to accommodate national and local interests in watershed management through negotiation among stakeholders. Initial experiences in central and east Java, north Sumatra and south Sulawesi have had promising results.

Source: Anwar, 2005.

BOX 34

Indigenous water management institutions in Zimbabwe

Over the last two decades, there has been a paradigm shift in conservation and natural resource management in most African countries, from costly State-centred control towards community-based approaches. Debate on the institutional arrangements for common pool resource (CPR) use has concentrated on visible and formal institutions, but other hidden and informal institutions, such as social networks, are also important for natural resources.

Romwe micro-catchment is in Chivi district, southern Zimbabwe, which has low rainfall (450 to 600 mm per annum), poor soils and severe droughts. The dryness of the area makes water a key resource in local livelihoods. As well as the three villages within the catchment, another seven villages nearby use Romwe's resources.

Water sources are either community- or privately owned. Community-owned sources include boreholes, Barura dam, streams and deep wells, which different villages use for different purposes and at different times of year. The boundaries of who can use water resources depend on the type of source and its particular use. Community-owned water sources are subject to a variety of rules and regulations, some of which are generic, while others are specific to the type of water source.

Most privately owned water sources are deep wells close to homes or in fields and dug by households with their own labour, hired labour or assistance from neighbours. Some wells have been inherited from parents and grandparents. It is rare for a single household to have exclusive use of a well, but well owners attach conditions to the use of their wells. An individual may have access to water for domestic purposes, such as drinking, cooking and laundry, but when larger amounts are needed – e.g., for beer brewing – permission has to be sought.

During droughts, when water is limited, well owners may limit the number of households that can fetch water from their wells, the frequency of fetching water, and the purposes and volumes of water to be collected. Individual owners set rules regarding access, and village health workers set rules regarding hygiene; these are communicated verbally to well users. Denial of access to water is generally resented in the community.

Water access is based on reciprocity. The benefits that well owners derive from the people who use their wells include access to arable land through land leases, draught power for agricultural work, labour, and social capital when the people who share a water point engage in other projects together.

The institutional arrangements governing communal and privately owned water sources are not usually written down, but community members know them well. Most arrangements are defined very generally, and give access conditional on appropriate use. This non-specificity allows flexibility in resolving particular cases, which recent calls to codify the rules and regulations for resource use overlook. In Africa, formalizing landholdings through registration increases conflicts over land rights, particularly when groups customarily had informal access to water. Local communities' customary rights over common pool resources and the value of flexibility in these arrangements must be recognized.

Source: Nemarundwe, 2005.

Interlude 2
Letter to a friend

Dear Juan

Thank for your message and sorry for the delay in answering. Life has become hectic in San Miguel!

I am pleased that you now have a Ph.D. in Development Studies and are coming back to contribute to our country's future. I share your enthusiasm for sustainable development, but after ten years in San Miguel I have seen that things are terribly complex in real life and change comes very slowly.

Three years ago, the government approved and financed the San Miguel Watershed Management Programme. Work to drain the valley and build a hydropower dam on the White Canyon progressed smoothly, creating temporary jobs and business opportunities for our citizens and contributing to my re-election as mayor of San Miguel.

Unfortunately, we had a lot trouble with Prof. Eleuterio, the Scientific Director of the orchid forest biotope. For more than a year, he used the press, social mobilization and the courts to resist the (partial) drainage of the piedmont swamp, insisting that it would affect the micro-climate and stop some rare orchid species from flowering. Finally, the scientists carrying out the environmental impact assessment found that his worries were exaggerated, and that the planned drainage of 30 percent of the swamp would not cause any significant change to the upland forest microclimate.

Following his defeat, Prof. Eleuterio retired. The new manager of the biotope believes that natural resources are primarily for the benefit of the people and has launched a biotope collaborative management process, which calls stakeholders to contribute to "embedding conservation in development". The biotope now has infrastructure for ecotourism: a canopy trail, log cabins, health food kiosks and a horseback tour centre, which are managed by members of the community. There is also a cooperative orchid nursery that supplies the international orchid market with plantlets of sought-after local varieties.

These initiatives and some good advertising have tripled the number of tourists visiting the orchid biotope over the last two years, and this has had an impact on businesses in town. More and more people are involved in tourism, providing bed and breakfast and other services. New restaurants and shops sell orchids, local handicrafts, local food, T-shirts and other gadgets. Tourism has become the main topic of conversation in Park Square, with people particularly anxious to know when construction of the Alameda White Canyon Inn resort is going to start. They expect this to make up for the unemployment that we are expecting in a few months, when the channel and dam yards close. Some dream that a tourist boom will make San Miguel rich.

Unfortunately, the Alameda Inn's lawyers are delaying signature of the final agreement with the municipality, which owns the land where the resort will be built. They say that their clients want to see the finished White Canyon lake before they sign, but I think that this is just an excuse. The real problem is that investors are waiting for the courts to clarify the legal status of the reclaimed land.

This is the crux of the problem. You may remember how the River Shore Protection Act transferred the alluvial, flood-prone area at the bottom of the valley to the municipality about 20 years ago. As the land had been swamp for 150 years, nobody objected to the decision at the time, but now the hydraulic works have turned it into the most productive land in the valley, Don Victor, Don Arturo and other local landowners are insisting that the area is no longer under the River Shore Protection

Act's jurisdiction and should be returned to its legitimate owners. Their lawyers have found an old title certifying that the land has been owned by their families since 1856. The district court has rejected this claim, but the landowners have appealed to the Supreme Court and our lawyer says that top-level jurists tend to pay more attention to the legal form of a claim than its substance. If this happens, we have little chance of winning the case.

This is a critical issue for me. As the town mayor, I promised that the reclaimed land would be distributed equitably among the hundreds of small farmers who are struggling to survive on their unproductive and erosion-prone hillside parcels. My political future depends on fulfilling that commitment. My constituency does not like the permanent picket that the Small Farmers' Union has set outside the town hall to put pressure on council members, or the graffiti calling me "liar" and "swindler".

As a watershed management professional, I know that unless tree crops replace maize and bean farming on the valley's steep slopes, the channels and lake will soon be filled with runoff debris. In addition, the contract with Water and Electricity Ltd for using the dam and reservoir sets very high penalties if the water's sediment levels increase beyond the threshold that their machinery can tolerate. This whole endeavour will become financially unsustainable if the municipality has to pay those penalties. That is why I planned to lease the reclaimed land to hillside farmers on condition that they move their annual crop plots downstream and convert their hillside land to agroforestry and conservation farming. If the landlords win their case, all this work will be lost.

I do not want to discourage you from returning home, but I thought you ought to see how top-level politicians and donors can pay lip service to "sustainable development" and "enabling environment", while a bunch of privileged landowners use the law to prevent change from taking place.

Best regards

Francisco

Chapter 4
Enabling conditions

In many ways, the new generation of watershed management is still in its infancy, or at best its adolescence. Partial, local and self-contained experiences in different regions of the world are demonstrating the potential of embedded, collaborative approaches, but also the constraints to change in specific locations and the challenges in scaling-up local experiences. Many of these constraints do not depend on programme design and implementation; they are instead related to the policy and institutional environment in which innovative thrusts develop.

A number of major political and institutional changes are therefore necessary for the new generation of watershed management to mature. These include:

- policy reforms that fully recognize the multiple roles of watershed management in sustainable development and create an intersectoral framework for implementation;
- updating, improvement and enforcement of laws affecting watershed management;
- enhancement of the institutional mechanisms that link watershed-level interventions to relevant national, regional and global policies;
- stronger incorporation of sound science and local knowledge in watershed policy-making;
- strengthened capacity building and awareness raising at all levels;
- the creation of mechanisms for long-term financing of collaborative watershed management processes.

ENABLING POLICIES

At the turn of the millennium, the international community was committing itself to achieving the human and sustainable development goals that were identified in the 1990s. The Millennium Declaration (2000) and the Johannesburg Plan of Implementation (2002) emphasized the need to accelerate progress towards poverty eradication, universal access to basic services (education, health, water, sanitation, etc.) and sustainable use of natural resources. Governments are urged to develop policies to transform these principles into effective action.

Watershed management concepts and methods have an important role in this. Sound watershed management is essential for achieving Millennium Development Goal (MDG) 7, ensuring environmental sustainability, particularly its two targets of:

- integrating sustainable development principles into country policies and reversing the loss of environmental resources;
- halving by 2015 the proportion of people without sustainable access to safe water.

In addition, by enhancing the availability and use of land and water resources for food security and economic development, watershed management can significantly contribute to eradicating extreme poverty and hunger (MDG 1).

Natural resource management and poverty should be addressed as two sides of the same coin

Watershed management addresses global environmental issues that include protection of mountain natural and human ecosystems, freshwater supply, flood control, and prevention of ocean pollution. Sustainable development policies now use watershed management as a multi-purpose approach to be incorporated in different sectoral and sub-sectoral policies.

In sustainable development, natural resource management and poverty should be addressed as two sides of the same coin. Rural and urban poverty often contribute to watershed degradation, so watershed management policies must be designed within the framework of national poverty reduction and rural development strategies, with a clear understanding of the multiple linkages between poverty and environmental degradation. Policies should address watersheds as planning and management units where natural resources can be used to achieve social equity goals.

In many countries, however, watershed management is still not addressed as an integrating element. Different policies – for agriculture, environment, water, planning, land, poverty, etc. – often work at cross-purposes or in competition, rather than complementing one another, and government departments and donors often lack convergence. Insufficient coordination and dialogue mean that sectoral efforts are not driven by real unity of intentions (Box 35). There is a need to move from compartmentalized multi-sectoral efforts to full intersectoral integration.

BOX 35

Compartmentalization of watershed management in India

India has about 16 percent of the world's people and only 4 percent of its freshwater resources. In the 1990s, the rate of groundwater extraction in India exceeded the replenishment rate by an estimated 104 billion m^3 per year, compared with 30 billion m^3 in China and 10 billion m^3 in northern Africa. The World Bank calculates that blocks where exploitation is beyond the critical level are increasing by 5.5 percent a year. In 1995, the Government of India developed guidelines for watershed development, but legislative measures to protect and manage India's water resources are hindered by a lack of integrated framework for watershed management, ineffective departmental coordination and a focus on supply- rather than demand-side mechanisms.

Water is a state responsibility, so the administrative control and responsibility for water development rests with state-level line departments. Watershed protection and development is the responsibility of three ministries and their state line agencies. The Ministry of Agriculture has worked in watershed development since the 1960s, focusing on erosion-prone agricultural land, optimizing production in rainfed areas and reclaiming degraded lands. Ministry of Rural Development watershed projects since the late 1980s address poverty alleviation through improved soil and water husbandry. The Ministry of Environment and Forests covers forest and wasteland.

Under the 1980 National Perspective Plan for Water Resources Development, a National Water Development Agency was set up to carry out surveys and prepare feasibility reports of the links between water and other sectors. The agency is in charge of water policy, but not watershed development.

The Working Group on Watershed Development recognizes the importance of macro-management for watersheds and calls for watershed development programmes to focus on regenerating the productivity of degraded lands through a single national initiative. However, there is no mechanism for linking watershed and water management, and no effective communication at either the national or state level among the various ministries concerned with watershed management, which continue to be driven by separate and differing policy priorities.

Source: Wilson, Amezanga and Saigal, 2005.

Flaws in water policies

The water sector should provide the core focus for environmental policies that harmonize the priorities of different sectors (agriculture, irrigation, forestry, etc.). However, even where there are guidelines for the integrated management of surface, ground and coastal waters, important elements of watershed systems are still often addressed as separate units, such as mountain forests (Box 36). Upstream–downstream linkages are therefore not taken fully into account. National governments should apply a watershed management perspective to review and harmonize all their sectoral policies affecting water use: household water supply, environment, agriculture, forestry industry, land planning, etc.

BOX 36

Mountain forests and watershed management in Europe

Some 38.8 percent of the EU-15's total land area is covered by mountains. These areas have a population of 54 million, and the GDP of two-thirds of them is lower than the EU-15 average. Mountain forests cover 28.1 million ha and affect the water balance of more than half of Europe.

According to the European Observatory on Mountain Forests (EOMF), several negative trends are affecting the status of mountain forests in Europe:

- growing instability and ageing stands, including overstocking of living and dead wood;
- damage from pollutants, game, logging, fires, tourism and recreation activities;
- loss of biomass density and biodiversity;
- lack of natural regeneration and reduction of management practices;
- decreased forest revenues and declining local knowledge and practices.

Forests used to be an asset, providing security and solutions to many different problems. Now, however, many mountain people view them as a liability or danger. The flood events of 2002 in Central Europe confirmed that, along with extreme climatic events and downstream infrastructures, the abandonment of productive practices in mountain forests is threatening the functioning of watersheds all over the continent.

To address this situation, in 2002 the International Consultation on Mountain Forests recommended that the EU adopt the following fourfold approach:

- *Widening perspectives:* mountain forest resources and communities are part of larger ecosystems and processes. They influence mountain massifs, the conservation of natural and cultural assets, rural development patterns, water and watershed management processes, and economic, social and territorial cohesion – people should be kept on the land.
- *Reinforcing locally adaptive management:* if mountain forest resources and communities are to be sustainable, their management must be adapted to local conditions and situations. It should take account of both local knowledge and interdisciplinary research.
- *Sharing responsibilities:* the natural conditions in mountain regions and the interrelationships between upland and lowland areas require the sharing of responsibilities, involvement of local communities, promotion of governance and collaborative management, and strengthening of solidarity at different levels.
- *Sharing benefits:* under appropriate management, mountain ecosystems provide many benefits to lowland regions. Alliances, coalitions, partnerships, agreements and contracts for forest conservation and management between local and non-local actors help to share these benefits at all levels.

Source: Zingari, 2005.

Compartmentalized water management is particularly common in sub-Saharan Africa. In the late 1990s, most African countries developed new water policies that define stakeholders' roles in integrated water management and provide for new multi-layer water management institutions. Water rights and ecological reserves are more fully recognized, and negotiation platforms for shared resource use and management have emerged in some places (Box 37). In most countries, however, these new policies have not been fully implemented, because funds, human resources and local involvement are lacking (Box 38). Linkages between watershed management and water policies tend to be self-contained at the local level, but effective water policies require multi-sectoral interventions at the national or transnational level.

BOX 37

Water sector reforms in sub-Saharan Africa

Over the last two decades, new strategies and supporting institutions for natural resource management have emerged throughout sub-Saharan Africa. There is a shift from centralized and State-driven natural resource management to decentralized and community-based regimes. As part of this, water sector reforms in several countries address the environment as a legitimate water user, and emphasize pollution control. Water management functions are decentralized to the catchment or watershed level, so stakeholders have more say in the management of water in their own areas. The following are some examples of these reforms.

In 1998, after long stakeholder consultations, **Zimbabwe** passed a new water act based on economic efficiency, environmental sustainability and equitable use. The act treats groundwater and surface water as parts of one hydrological system. Water cannot be privately owned, and water rights have been replaced with short-term water use permits; renewal is subject to water availability and evidence of efficient use. Watershed and sub-watershed catchment councils of stakeholders have been formed. Pollution is better controlled through the polluter-pays principle. Fees for commercial water services are retained by the National Water Fund to finance the statutory services provided by the Zimbabwe National Water Authority.

In 1996, the Parliament of **Ghana** established the Water Resources Commission (WRC) to regulate and manage the country's water resources and coordinate related government policies. WRC comprises the major regulators and users in the water sector, providing a forum for integrating and balancing the different interests of water institutions (hydrological services, water supply, irrigation development, water research, environmental protection, forestry and minerals) and civil society stakeholders (indigenous leaders, women's associations, NGOs, etc.). Since 2001, a Water Management Fund has financed conservation activities, information systems, local watershed management institutions and research. The income of this fund comes from a raw water charge (a 0.7 percent tariff increase), licence fees and fines for offences.

Since 1994, government policy in **South Africa** 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 with three main objectives: equitable access to water, sustainable use of water, and efficient and effective water use. The National Water Act is based on these objectives and provides for the protection, use, development, conservation, management and control of South Africa's water resources. The National Water Resource Strategy describes how water resources are protected, used, developed, conserved, managed and controlled in accordance with the policy and law. A vital element of this strategy is the progressive decentralization of water resource management to catchment management agencies and local-level water user associations, which allocate the available water among competing user groups.

Sources: Makukira and Mugumo, 2005; Odame Abaio, 2005; Rademeyer, 2005.

Inadequate watershed legislation

Inadequate or outdated watershed management legislation and regulatory measures constrain all regions. Legislation and measures in most Asian and African countries are particularly inadequate for intersectoral collaboration and the allocation of funds and authority. Many legal issues concerning watershed management cannot be settled, because laws are obsolete, contradictory or lack clear guidelines for application. Countries need to reform their laws, based on sound watershed management principles.

Lack of enforcement of existing laws constrains the embedding of watershed management principles in conservation and development policies (Box 38). Watershed authorities should have the power to harmonize rights and enforce decisions. For example, at the territorial level, laws and regulations could be enforced by strengthened watershed authorities with legislative and judiciary, as well as executive, branches.

BOX 38

Why water sector reform has not performed as expected in Zimbabwe

Although Zimbabwe has a legal framework for integrated water management (Box 37), this is not reflected on the ground. The following paragraphs explain some of the reasons for this failure.

Land reform: Water sector reform was launched at the same time as land reform in Zimbabwe. While water sector reform promoted equitable and sustainable utilization, more stakeholder participation and introduction of the user-pays principle, land reform aimed to redistribute land and encourage greater utilization of national land resources. The two policies seemed to complement each other, but their objectives proved conflictive. Many established farmers did not pay for water permits, because they were uncertain about occupying the land after the land reforms; new farmers were reluctant to pay for water use because it had not been paid for previously. New settlers were also more interested in consolidating their land claims than in attending water management meetings.

Political interference: In a bid to retain popularity, politicians made water as cheap as possible, undermining the pricing policy, which has to raise sufficient funds to maintain high standards of water service delivery. Politicians also protected defaulters of water permit payments from disconnection.

Donor withdrawal: Initially, the water sector reform was donor-driven. By the time the catchment councils were being launched, however, there was only one donor left to support two of the seven pilot catchments.

Financial stability: Fees for water permits – based on user- and polluter-pays principles – were expected to finance water service provision, topped up with government contributions of public funds. However, as already described, water fee revenues have been less than expected, and government budget allocations have been minimal.

Poor collaborative process: Catchment councils with representatives from local authorities, industry, commercial farmers, communal farmers and other interested parties were expected to find common solutions to water problems. However, each of these groups is interested in protecting its own interests only and there is little understanding or negotiation among them. In addition, council members have not been paid for their input into water affairs, meetings have become less frequent and user groups have been merged to reduce expenses. Water management stakeholders have therefore not been able to meet often enough.

Weaknesses of the coordinating agency: The Zimbabwe National Water Agency did not have enough staff to cope with the sudden demand for expert services, so it could not provide the services and functions financed by the Water Fund.

Source: Makukira and Mugumo, 2005.

In addition, special problems arise when rights to watershed resources are held under several different property systems that are sanctioned by different authorities. Such situations can lead to conflicts between local entitlements and national law (Box 39).

BOX 39

Assessing multiple property right systems in watersheds: the CAPRi framework

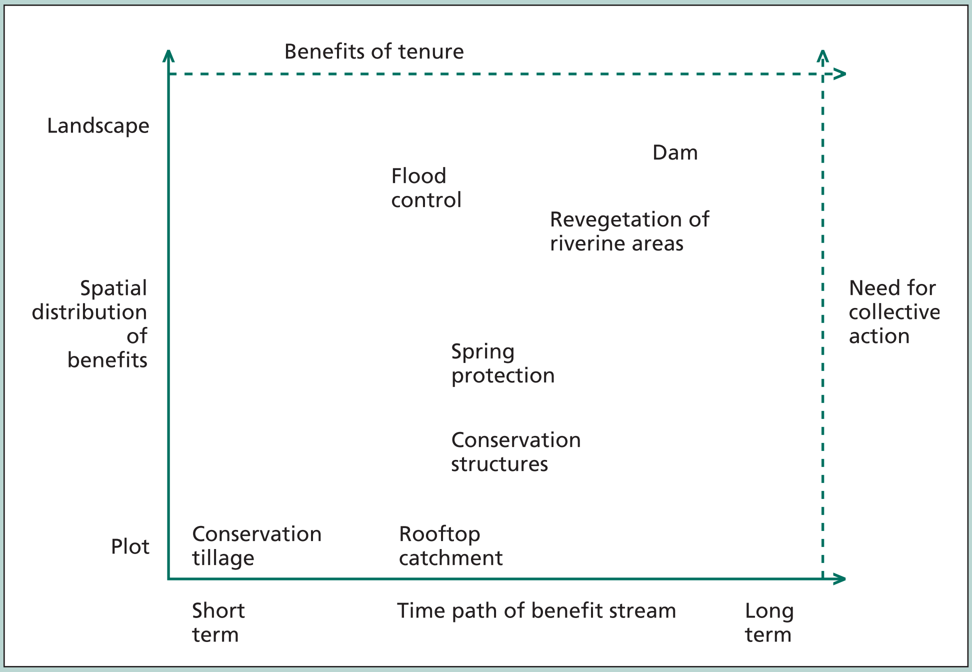
Conventional views of watershed rights presume that a single legal source of authority defines and enforces a single set of rules and laws governing people's access to, use and management of resources and their benefits. The legal pluralism approach recognizes that there are usually many institutions and sources of authority that affect people's use of watershed resources.

When applied to property rights, legal pluralism sets out to understand how individuals obtain access to and control over resources. This is governed not only by State-enacted rules and regulations, but also by norms and rules of behaviour that are generated by forms of social organization, such as villages, ethnic groups, associations and the State. Property rights can be influenced by statutory law, religious law, customary law, project law, organization law and local norms. Different types of law are supported and sanctioned by different social authorities, which tend to have different strengths and weaknesses; people with claims or complaints regarding watershed resources are likely to appeal to the laws and social authorities that support them the most.

The Collective Action and Property Rights (CAPRi) programme has developed a simple conceptual framework (Figure) 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. The key components of the framework are:

- duration of investment, which implies the value of long-term security of land tenure;
- spatial distribution of effects of investment, which implies the benefits to be obtained from collective action in resource management.

The figure indicates that watershed/catchment management is a resource investment that requires both secure property rights and strong collective action.



Source: Swallow et al., 2005.

MICRO–MACRO LINKAGES

Even in programmes that cover large land units such as river basins or administrative regions, collaborative watershed management focuses on intensive interventions in small geographical areas, often corresponding to sub-watersheds. Major watershed management programmes are "federations" of site-specific micro-interventions within a common institutional, methodological and operational framework.

The rationale for this micro-approach to large-scale programmes is twofold: (1) the complexity and specificity of watershed hydrogeological, ecological and socio-economic processes are best captured at the local level; and (2) implementing intensive watershed management interventions in critical locations, such as upland catchments or areas exposed to human-induced hydrogeological degradation, is more cost-effective than trying to control extended systems, such as river basins.

Collaborative watershed management and global change

The so-called "adapting mosaic" environmental policy scenario was described in a recent appraisal of the expected long-term global impact of having many integrated natural resource management and sustainable development micro-initiatives at the watershed level (MEA, 2005). In this scenario, global environmental crises are addressed through small, watershed-based initiatives, undertaken by decentralized institutions and embedded in broader sustainable development processes (Box 40).

The adapting mosaic scenario contrasts with the "technogarden" scenario, which addresses ecosystem problems through the intensive use of technology and ecological engineering, and with the "global orchestration" and "order from strength" scenarios, which expect environmental problems to be solved by global economic growth and redistribution or through *laissez faire*, respectively.

Although the global orchestration, technogarden and adapting mosaic scenarios may all have positive impacts on human well-being in both industrial and developing countries by 2050,[1] the latter two scenarios are expected to perform better in protecting environmental goods and enhancing environmental services.

FIGURE 4
The four Millennium Ecosystem Assessment scenarios

Global orchestration

Order from strength

Technogarden

Adapting mosaic

[1] The *laissez faire* order to strength scenario is expected to lead to economic growth based on increased environmental degradation and inequitable distribution of wealth.

BOX 40

Collaborative watershed management's contribution to a sustainable future

To explore the possible future of ecosystems and human well-being, the Millennium Ecosystem Assessment (MEA) global study developed four scenarios based on different assumptions about the driving forces of change and their possible interactions.

Global orchestration: This scenario depicts a globally connected society that focuses on global trade and economic liberalization. It adopts a reactive approach to ecosystem problems, but takes strong steps to reduce poverty and inequality and invest in public goods such as infrastructure and education. Global economic growth in this scenario is the highest of the four scenarios.

Order from strength: This scenario depicts a regionalized and fragmented world, concerned with security and protection, emphasizing regional markets, paying little attention to public goods and adopting a reactive approach to ecosystem problems. This scenario has the lowest economic growth rates (particularly in developing countries), which decrease with time, and the highest population growth of the scenarios.

Technogarden: This scenario depicts a globally connected world relying on environmentally sound technology, using highly managed, often engineered, ecosystems to deliver ecosystem services, and adopting a proactive approach to ecosystem problems. In this scenario, economic growth is relatively high and accelerates, while population in 2050 is in the mid-range of the scenarios.

Adapting mosaic: This scenario depicts regional watershed-scale ecosystems as the focus of political and economic activity, and foresees the rise of local ecosystem management strategies and the strengthening of local institutions. Investments in human and social capital focus on improving knowledge about ecosystem functioning and management, resulting in improved understanding of the resilience, fragility and local flexibility of ecosystems. The scenario is optimistic about people's capacity to learn, but prepared for sub-optimal management of ecosystems. Styles of governance vary greatly among nations and regions, with some investigating adaptive management alternatives, while others use bureaucratically rigid methods to optimize ecosystem performance. Outcomes are very diverse: some areas thrive, while others develop severe inequality or ecological degradation. Initially, trade barriers for goods and products are increased, but information barriers nearly disappear because of improved communication technologies and rapidly decreasing costs. Eventually, the focus on local governance leads to failures in managing global commons. Global environmental problems, such as climate change, marine fisheries and pollution, intensify. Communities cannot manage their local areas because global and regional problems are infringing on them, and communities, regions and nations develop networks for the better management of global commons. These networks adopt solutions that have been effective locally, and are particularly effective in areas with mutually beneficial opportunities for coordination, such as along river valleys. Sharing good solutions and discarding poor ones improves the approaches to social and environmental problems ranging from urban poverty to agricultural water pollution. As more knowledge is collected from successes and failures, much service provision improves.

Source: MEA, 2005.

The adapting mosaic scenario is expected to be the most cost-effective for key watershed variables such as water availability and quality, erosion control, genetic resources, pest control, storm protection and cultural adaptation. Given that the technology and public work investment required by the technogarden scenario are beyond the reach of many developing countries, the adapting mosaic, based on collaborative watershed management, would represent the most appropriate and viable alternative for sustainable development.

Scaling-up micro-experiences

Mosaics of self-contained, sub-watershed-level efforts embedded in local societies and cultures need more than local-level scaling-up policies if they are to restore and improve environmental goods and services. Governments need to link decentralization policies to national frameworks that mobilize the central-level inputs required to implement sound territorial watershed governance. Flexible and adaptive national guidelines should define the autonomy of local initiatives and the support they can expect from central government and higher-level institutions.

The watershed management policies of national governments should harmonize local institutions and establish institutional linkages at the regional and national levels. Policies should include criteria for funding local initiatives and clear procedures for prioritizing critical watersheds. Local project objectives and strategies should be based on national watershed guidelines and strategies.

Regional fora for transboundary watershed management

Strong international and regional fora promote negotiation among upstream and downstream administrative units or countries, particularly where local interventions affect transboundary watersheds and river basins.

The fora should be mechanisms for regional integration, based on synergy among national agencies and ruled by ad hoc international river basin management agreements. Fora should identify priority areas and set up networks of local collaborative watershed management initiatives.

Exchange of knowledge and experiences among the countries that share a river basin should be facilitated, in order to develop a common policy framework and ensure long-term commitment and steady funding to relevant institutions. This is an important priority for sub-Saharan Africa, which has many transboundary river basins. In the past, a lack of transboundary agreements constrained investment and the development of subregional watershed management initiatives. Recent developments in transboundary river basin management across Africa are promising, and include the Nile Basin Initiative, the Lake Victoria Development Programme, the Nkomati River Basin Agreement, the Niger Basin Authority and Lake Victoria Environment Management Programme. Much can be learned from these.

EVIDENCE-BASED POLICIES

Linkages between science and watershed management policies are a burning issue. Policy-makers find it difficult to accept the current level of uncertainty about watershed processes and tend to rely on outdated, oversimplified models, which create wrong assumptions and misconceptions. Watershed management policies are often based on myths or common wisdom, rather than scientific evidence (Boxes 41 and 42).

Enhanced communication between watershed scientists and policy-makers

Watershed management policies must be grounded on sound evidence, and the gap between science and policy can be filled by enhanced communication between politicians and practitioners. The research community should convey its findings to policy-makers in clear and ready-to-use formats, describing complex watershed

BOX 41

The impact of misconceptions on watershed management policies in Asia

The concepts underlying integrated water resource management (IWRM) were developed in the early 1990s and are supported by development organizations, which see them as prerequisites for achieving the MDGs. However, some watershed management policies have had perverse outcomes because they have been based on misconceptions. The following are some examples:

- In Southeast Asia, half a million livelihoods may have been lost because of logging bans based on misperceptions of forest and flood interactions.
- In India, watershed development projects with insufficient understanding of land and water interactions have resulted in reduced access to common property water for poorer people, unsustainable rates of groundwater depletion, closure of catchments, and serious downstream and environmental impacts.
- In China, afforestation programmes were based on very optimistic perceptions of the benefits of forests to the water environment, and may be damaging rural livelihoods, disadvantaging minority ethnic groups, reducing downstream and transnational water flows, and reducing food production.

The development community has to implement IWRM concepts in a wider resource management context and confront complex and messy real-world situations. It is important to:

- understand how the belief systems underlying scientific and public perceptions have evolved within different stakeholder groups, and how to enable more science-based policy development;
- develop management support tools, ranging from simple dissemination tools to detailed hydrological models, to help implement new land and water policies;
- understand the impacts of land and water policies on society's poorest; many existing policies do not benefit the poor significantly and may even result in perverse outcomes;
- recognize how different land and water-related policies affect the ownership of water resources; watershed development policies that promote increased water infiltration may transfer what was effectively a common property resource – the water running into a communally owned village tank or government-owned river – into an effectively privately owned resource of the landowner, who can afford to install electrically pumped groundwater supplies, or forest owner, whose forest consumes more water than most non-irrigated land uses;
- develop best practice guidelines for land and water management based on cross-regional experiences of research and policy development; this could include developing better management tools and sharing knowledge through bridging research and policy networks.

Source: Calder, 2005.

management processes in straightforward messages that prompt action and trigger investment. National research frameworks that feed relevant information into watershed management policy-making are also needed. National watershed management master plans, including mechanisms for identifying priority areas and hot spots, should be developed, and reviewed and adjusted frequently, based on sound monitoring and evaluation data. Relevant indicators and an appropriate information system should be identified and established. Existing databases need to be homogeneous and interfaced.

BOX 42

Watershed management and population dynamics in Nepal

It is difficult for watershed management programmes to achieve their goals without fully understanding the many interrelated physical, biophysical and human factors that act on watersheds. In Nepal there is a lack of evidence-based information for watershed planning. Benchmarks and changes resulting from watershed management interventions are seldom quantified, and the resource endowments and fragility of watersheds are rarely evaluated. Time series data for human-induced factors are lacking, and most studies fail to separate natural from human causes.

Among the misconceptions that this has caused, one of the most important for national development is the belief that migration from the Middle Hills to the Terai lowland would decrease upstream degradation and improve watershed management at the river basin level. The migration of landless Middle Hills farmers to rehabilitated lowland areas was first promoted in the late 1960s. Projects developed infrastructure and off-farm income-generating activities and introduced high-yielding crop varieties and hybrid domestic animals. Most of these projects were donor-funded and assisted by Western experts.

The impact of this policy on upstream–downstream linkages is not clear. Mass movements of people have reduced population densities in some Middle Hills areas and prevented the local population from growing beyond carrying capacity, but the population of the Terai lowlands increased from 3 million in 1961 to 11 millions in 2001. As a result of the migration, half the national population has settled in a fragile, flood-prone, unhealthy, tropical rainforest ecosystem. Decreased population pressure in the Middle Hills has not led to improved soil conservation and water management. Between 1991 and 2001, the cost of wage labour is estimated to have doubled in the Middle Hills, while rice prices increased by only 50 percent. Local farmers therefore have little incentive to maintain the paddy terraces that are vital for food security and watershed management

Devastating landslides and mass wasting in the Middle Hills are blamed on local people's overexploitation of natural resources, rather than on a combination of natural events and ill-conceived policies. Floods and heavy sedimentation in the Terai are attributed to mass wasting in the hills and mountains, with little consideration of other human factors such as the accumulation of sediment in downstream dam basins and irrigation channels and intense interference in riverbank areas. Watershed management policies need to be reappraised in the light of these multi-layer and multi-sectoral interactions.

Source: Poudel, 2005.

The role of watershed environmental economics

Economic facts from sound environmental economic assessments are essential in convincing decision-makers about the relevance and value of watershed management investments. Watershed management should incorporate more cost–benefit analyses and other economic valuation methods.

The role of local cultures in watershed management

The development of sound watershed management policies requires more than the mainstreaming of natural science and environmental economic evidence. Watershed ecology is primarily a human ecology, so a thorough understanding of watershed stakeholders' views, logic and knowledge is also necessary. For instance, it is important to consider the role that local technologies, practices, knowledge and customs play in local land and water management systems. Watershed management policies tend to overemphasize research-based knowledge at the expense of indigenous knowledge.

There is scope for gathering local watershed management cultures, evaluating their benefits and sustainability, and incorporating them into policies. This would facilitate the intercultural dialogue and social negotiation on which sound collaborative watershed management is based.

BOX 43

Mountain universities in Cuba

Informing and training local stakeholders improves integrated watershed and natural resources management and increases collaboration between technical experts and local populations.

In the late 1980s, Cuba established four mountain universities as part of its integrated mountain development policy. The universities aim to increase awareness and capacity among both specialists and local people through the creation of agroforestry technicians and extensionists.

Agroforestry technicians are professionals with the capacity to select and introduce innovative production and utilization techniques for local resources, and to manage and direct the adoption of these. Their main role is transferring technology and technical expertise.

Extensionists disseminate knowledge and sensitize the local population. They act as the messengers of community issues, mediating between universities and research centres and small farmers. At the mountain universities, extension students and teachers work on local issues with the community through educational, social and technical projects that are supported by research centres, the Ministry of Science, Technology and Environment and the National Association of Small Farmers (ANAP).

Knowledge sharing among small farmers is promoted by the farmer-to-farmer extension supported by ANAP and the universities.

The universities hold courses in agro-ecology and sustainable agriculture, forest science, sustainable coffee and cocoa production, rural extension, environmental awareness and water resources management. Courses focus on training professional agronomists who have agricultural and environmental expertise and organizational and management capacity. Of the 945 graduates between 1990 and 2002, an estimated 85 percent went on to work in the Plan Turquino (Box 26).

The universities' curricula focus on local environmental and agricultural issues. The mountain universities are important centres for experimenting and implementing research to benefit local people. Students' degree theses aim to solve the problems that face local production.

Any student can attend the courses, which are free and include accommodation close to the university. Each university has about 100 students who come from local mountain communities and towns in the valleys.

Courses for practitioners are also planned with the aim of improving the knowledge of non-specialists. Most of these will be for farmers who have higher education and land that can be used for experimental pilot projects for new agro-ecological techniques, and who are reference points for the community. This helps to involve local people more fully in the processes of change, experimentation and project implementation.

Source: Berini, 2004

CAPACITY BUILDING AND AWARENESS RAISING

Strengthened technical and communication skills among watershed management professionals and raised awareness among local stakeholders and the public are further important conditions for the take-off of the new generation of watershed management programmes.

Reform of educational curricula for watershed practitioners

To address the knowledge shortfall, technical schools and universities need appropriate watershed management curricula, which focus on practical implementation and give watershed professionals an interdisciplinary perspective. Comprehensive training programmes on collaborative management, action research and upstream–downstream interactions are also needed.

Training curricula should recognize cultural diversity as an important factor in professional practice. Methodologies and tools for conducting fieldwork under local conditions and in consultation with local stakeholders should be included; regional and international networks can help with this by providing supplementary learning through e-learning technology and other means.

Informing and educating local stakeholders

Capacity building at the municipal and regional levels needs more attention. Continuing education processes should be launched to increase the capacity of professionals, administrators and local stakeholders to understand and manage the intersectoral processes and approaches necessary for effective watershed management (Boxes 43 and 44).

Raising public awareness

Awareness strengthens local stakeholders' involvement in collaborative watershed management processes. Visual evidence generated by GIS is particularly effective in enhancing people's awareness of the interdependencies between watershed management and other sectors. People also need to be educated about water use, particularly for times of scarcity.

FINANCING COLLABORATIVE WATERSHED MANAGEMENT

Without steady financing, decentralized institutions are unlikely to succeed in collaborative watershed management. Although mechanisms are being tested for engaging the non-profit and private sectors in watershed management, the public-good nature of watershed environmental services justifies the use of public sector funding.

Public sector financing

National governments often have to create and maintain watershed infrastructure, because most rural communities lack the capacity to do so themselves. Core funding for collaborative watershed management should come from national governments, with local cost-recovery mechanisms providing complementary finances. Many governments do not invest enough in watershed management, and public sector participation needs to be strengthened.

Cost sharing mechanisms

The financing of collaborative management should be long-term, flexible and based on cost sharing. It should include incentives to support private initiatives in watershed conservation (Box 45). There are some interesting donor-funded watershed financing schemes in Latin America (Box 46), but in most countries public sector funding for watershed management is increasingly scarce. In addition, financial mechanisms and incentives to promote private sector investment and cost sharing by civil society stakeholders are often inappropriate. Owing to frequent changes in the political composition of governments and administrations, many watershed management plans are disrupted or discontinued after a four to five-year start-up programme.

BOX 44

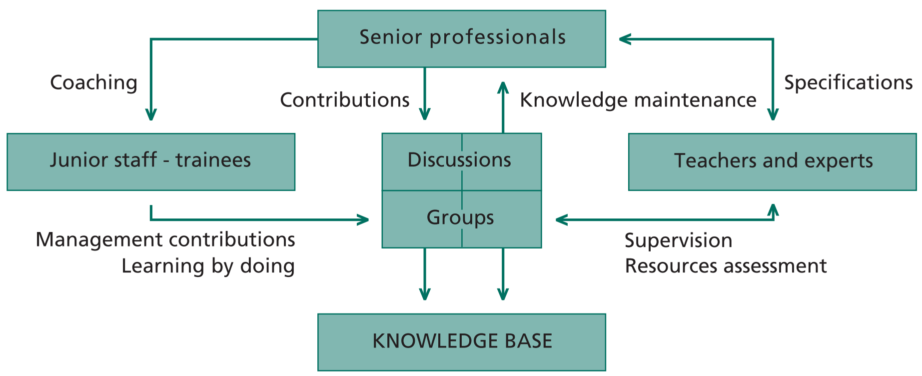
A virtual learning community to support the European Water Framework Directive

The International Network of Basin Organizations (INBO) was established in 1994 at Aix-les-Bains, France. Its aim is to promote integrated water resources management at the river basin level as an essential tool for sustainable development.

INBO has recently launched a continuing education programme for European water professionals, with financial support from the European Commission's Leonardo da Vinci Programme. The project consists of a continuous education and training scheme, based on collaboration among peers to implement the Water Framework Directive (WFD) through a virtual learning community (VLC). Results of the learning process will feed the knowledge base for future users. Interaction is multilingual and includes a translation program. The initiative involves river basin organizations, universities, water training centres and others.

The target group consists of junior and senior executives from European INBO member organizations who are implementing the WFD. The VLC will help participants to learn by doing. Junior integrated water managers will be trained by senior staff, who share their existing expertise (both formally and informally) with their younger colleagues, while updating their own knowledge. A total of 20 junior staff trainees will be divided into working groups, each responsible for one aspect of the WFD. Group leaders will distribute tasks among the individuals, organize exchanges, moderate fora, synthesize the various contributions, provide complementary materials (documents, testimonies, case studies, etc.) and organize Internet conferences with experts; all these activities help to improve the quality of work.

Functioning of INBO's virtual learning community



All trainees will contribute to all groups, prepare inputs on sub-topics and present monographs on various aspects of WFD implementation. Group discussions will be open to senior professionals, so that theory can be compared with hands-on practice. Teachers will define the course path and milestones, supervise the exchanges, guide the students and help them to analyse the external inputs, provide additional resources, and assess the results to validate the knowledge acquired. Senior group members will guide each group's analysis of its own work, and help it to mobilize complementary resources.

Source: Neveu, 2005.

BOX 45

Collaborative agreements between farmers and a water supply company in Germany

About 27 percent of the agricultural area in Germany's North Rhine-Westphalia state is under cooperative agreements, such as the Stevertal reserve agreement between water supply companies and agricultural water users.

Stevertal reserve supplies drinking-water to about 1 million people. One-third of its 880 km^2 watershed is used for intensive agricultural production, which caused increasing water contamination from fertilizer and pesticides and growing conflicts between agriculture and local water supply companies during the late 1980s. In 1989, a cooperative agreement among water supply companies, farmers and the local authorities aimed to reduce water and soil pollution. The agreement is a voluntary contract, which imposes land-use changes, such as the substitution or reduction of chemical fertilizer and pesticides, in exchange for compensatory payments and free advisory services for farmers. About 42 percent of the farmers and 61 percent of the agricultural land in the watershed are involved in the agreement, along with the water supply companies of four municipalities, local water authorities, the state's Ministry of Environment, Agriculture and Consumer Protection, the Chamber of Agriculture and several small agricultural associations.

Free educational and technical services and awareness building for farmers provide essential support to the cooperation agreement. Farmers' concern for and understanding of environmental issues is growing, and the image of agriculture and water supply companies has improved. The measures brought in under the agreement have led to increased biodiversity in the region.

An effective monitoring system enables participants to evaluate environmental and economic outcomes and change or improve measures. Owing to the large project area, there are very few controls of farmers' activities, but the environmental and economic improvements imply that these are performing well. Groundwater pollution has decreased significantly, leading to considerably lower costs for drinking-water extraction. Agricultural productivity has also increased, owing to better, more cost-effective management practices.

Sources: Freisem, 2002; INFU, 2001.

The role of donors

In Africa, Asia and Latin America, international donors have a huge role in financing watershed management. This has led to a proliferation of donor-instigated jargon and approaches, with national governments paying lip service to these in order to secure funding. This confusing situation calls for the harmonization of bilateral and multilateral cooperation policies, based on clear, long-term agreements.

Watershed trust funds

Watershed trust funds are capital asset funds that are established through central government allocations, donor grants and local tax revenue. These are invested in financial markets to ensure a steady source of funds for watershed management programmes. Capital disinvestment is restricted by the trust fund holder (the government), but collaborative watershed management institutions receive the interest generated by the fund. Some countries have already established environmental or forest trust funds, which they use to finance watershed management activities (Boxes 47 and 48).

Market-based financing mechanisms

In order to decrease their dependency on donors, developing countries should also consider market-based sources of finance for watershed management. Industrialized country experiences of mechanisms for transforming the environmental services produced by watersheds (e.g., water, power and carbon sequestration) into cash for collaborative management processes through PES schemes are of particular interest (see also Chapter 2 and the Annex). The potential for tapping and enhancing this type of private sector involvement in developing countries is still unclear, however.

BOX 46

A watershed protection fund in Ecuador

Most of the water supply for Ecuador's capital Quito originates in two watersheds in the ecological reserves of Cayama-Coca (4 000 km^2) and Antisana (1 200 km^2) in the Andes. Although these are both protected areas, their watersheds are threatened by agricultural production and extensive livestock grazing, with impacts on both the quality and quantity of water for drinking, irrigation, power generation and recreation. The destruction of forests and grassland contributes to degradation of the high plateau and is assumed to affect the stream flow, causing floods in winter and drought in summer.

In 1998, the Watershed Protection Fund (FONAG) was created to finance the environmental conservation of upstream reserves by municipalities and upstream land users. Conservation measures are implemented according to a collectively developed management plan, which is adapted to the environmental plans of the two ecological reserves.

FONAG became operational in 2000, and is managed by a private asset manager. Its Board of Directors comprises representatives of the municipality, conservation organizations, the hydroelectric company and water users. The fund is independent of the government, but cooperates with the environmental authority so that FONAG activities are in line with the conservation objectives of the ecological reserves.

FONAG received an initial donation from the United States Agency for International Development (USAID). User contributions vary; for example, the water supply company pays 1 percent of potable water sales, while other subscribers pay annual fixed amounts. Currently, the fund has nearly US$2 million, and investment bonds for 2005 are estimated at about US$500 000.

Source: Echavarría, 2000.

BOX 47

Environmental trust funds and watershed management in Bhutan and Viet Nam

Improving the funding of watershed management initiatives involves mobilizing more internal resources and getting longer commitments from donors. All countries need to establish fund-raising mechanisms by allocating a share of the revenue from hydropower, ecotourism, irrigation water fees and forests to watershed management. Environmental trust funds supported by international donors can be instrumental in this.

The Bhutan environmental trust fund was set up to finance nature conservation and biodiversity projects. Donors contribute to the government's core fund for implementing environment-related activities under its national programme. Interest from the fund is spent on projects, while the capital is locked to generate funding for future projects. The fund is administered by a steering committee of policy-level government officials and major donors.

Viet Nam's trust fund for forests was set up in 1999, under the Ministry of Agriculture and Rural Development. The fund is supported by international donors to implement the Forest Sector Support Programme (FSSP) and other government programmes for the forest sector, including the 5 million ha reforestation project. The trust fund's objectives include: (1) aligning donor support more closely to the priorities identified in the FSSP framework; (2) targeting poverty alleviation for donor support to the forest sector; (3) harmonizing aid to the forest sector and reducing transaction costs; and (4) supporting the transition towards a sector-wide approach.

In June 2004, the Vice-Minister of Agriculture and Rural Development and representatives of the Ministry of Foreign Affairs of Finland and the embassies of the Netherlands, Sweden and Switzerland signed a Memorandum of Understanding (MOU) establishing the trust fund. Since then, other international partners have signed the MOU and joined the fund.

Source: Upadhyay, 2005.

BOX 48

A conservation trust fund in the United States

The Zuni people have farmed the area of the present Zuni reservation in western New Mexico, the United States for more than 1 500 years. They use floodwater to irrigate this arid area, and have a tradition of managing resources sustainably. Over recent generations, however, the farmed area has decreased from 12 000 acres (4 860 ha) to about 1 000 acres (405 ha). Reasons for this decline include increased alternative sources of food and jobs and the degradation of soil and water resources.

In 1978, the Zuni sued the United States government for damage to federal land through mismanagement. The case was settled in 1988 and a trust fund of US$17 million was established through the Zuni Land Conservation Act of 1990 to restore the watershed using indigenous methods of land and water management. Interest from the Zuni Indian Resource Development Trust Fund goes to environmentally sustainable projects that include fish and wildlife, range conservation, hydrology monitoring, erosion control and a native seed bank. This has created nearly 50 jobs, making it one of the region's major employers.

In 1992, the Zuni conservation project drew up a watershed restoration plan to meet the needs of the community. User groups formed around issues raised at a series of consensus building workshops, with project activities discussed and approved by a tribal council of elders. Activities included Zuni women's use of indigenous methods to grow traditional subsistence crops such as squash, maize and beans. Garden design and the use of rock mulching and swales are based on revived traditional techniques for conserving water, soil and nutrients in an arid landscape.

Management plans were prepared to restore highly eroded areas, including those subject to sheet erosion, active gullies and arroyos. Grazing land was restored through animal control. Riparian protection measures included the restoration of channel meandering to allow water to reach floodplains during intense summer rains; channels were stabilized with vegetation through grazing management and small water spreading structures; and upstream swales slowed runoff on highly compacted soils, increasing infiltration and vegetative restoration. A methodology for local volunteers to monitor riparian health and water quality was taught in high schools. Annual monitoring of the sediment in stream channels is a reliable indicator of watershed restoration.

GIS mapping established existing land uses and targeted priority areas for restoration. Water distribution systems for livestock were extended to allow eroded areas to recover and to distribute horses, cattle and sheep more evenly across the watershed. Experimental gully control measures found that brush and rock structures, built by hand with on-site materials, filled with silt and trapped water for vegetation growth, thereby achieving much better erosion control than larger and more expensive earth or cement check-dams, most of which washed out with intense summer thunderstorms, causing gully deepening and bank erosion.

Sources: Enote, 1996 and Fleming, 2003.

Bibliography

Achouri, M. & Tennyson, L., eds. 2005. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the European Regional Workshop, Megève, France, 4 September 2002. Watershed Management and Sustainable Mountain Development Working Paper No. 6. Rome, FAO, FORC.

Achouri, M., Tennyson, L., Upadhyay, K. & White, R., eds. 2005. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Ambrose, K. 2002. *Pago por servicios ambientales. Una alternativa que contribuye al manejo y conservación de bosques y paramos. La experiencia de la Asociación Nueva América.* Imbabura, Ecuador, CEDERENA.

Anwar, S. 2005. Watershed management in Indonesia*.* *In* M. Achouri, L. Tennyson, K. Upadhyay and R. White, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Aylward, B., Bandyopadhyay, J., Belausteguigotia, J.C., Borkey, P., Cassar, A.Z., Meadors, L., Saade, L., Siebentritt, M., Stein, R., Tognetti, S. & Tortajada, C. 2006. Freshwater ecosystem services. *In* K. Chopra, R. Leemans, P. Kumar and H. Simons, eds. *Ecosystems and human well-being: Policy responses, Volume 3. Findings of the Responses Working Group of the Millennium Ecosystem Assessment.* Washington, DC, Island Press.

Barbier, E.B. 1991. *The economic value of ecosystems: 2 – Tropical forests.* LEEC Gatekeeper Series No. GK91-01. London, IIED.

Barton, T., Borrini-Feyerabend, G., de Sherbinin, A. & Warren, P. 1997. *Our people, our resources. Supporting rural communities in participatory action research on population dynamics and the local environment*. Issues in Social Policy Series. Gland, Switzerland, IUCN.

Bennett, R. 1982. *Environment, subsistence and system. The ecology of small-scale social formations*. Cambridge, UK, Cambridge University Press.

Berini, S. 2004. *Reconsiderar el desarrollo. Etnografía del Plan Turquino-Manatí en Cuba.* Milan, Italy, University Bicocca-Milano. Available at: www.fao.org/forestry/foris/data/extension/planturquino.pdf. (degree thesis)

Bonnal, J. 2005. The sociological approach to watershed management from participation to decentralization. *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Borrini-Feyerabend, G. 2000. *Co-management of natural resources: organising, negotiating and learning-by-doing.* Heidelberg, Germany, GTZ and IUCN, Kasparek Verlag.

Borrini-Feyerabend, G. & Pimbert, G.M. 2005. *Sharing power. Learning-by-doing in co-management of natural resources throughout the world.* Tehran, Islamic Republic of Iran, IIED and IUCN/CEESP/CMWG, Cenesta.

Bosch, J.M. & Hewlett, J.D. 1982. A review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration. *Journal of Hydrology*, 55: 3–23.

Brooks, D.B. 2002. *Water: local-level management.* Ottawa, Canada, International Development Research Centre.

Brooks, K., Current, D. & Wyse, D. 2005. Restoring hydrological function of altered landscape: an integrated watershed management approach. *In* L. Tennyson and P.C. Zingari, eds. *Preparing for the next generation of watershed management programmes and projects*. *Water resources for the future.* Proceedings of the International Conference, Porto Cervo, Sassari, Sardinia, Italy, 22 to 24 October 2003. Watershed Management and Sustainable Development Working Paper No. 9. Rome, FAO, FORC.

Bruijnzeel, L.A. 1990. *Hydrology of moist tropical forests and effects of conversion: a state of knowledge review.* Humid Tropics Programme, UNESCO International Hydrological Programme. Paris, UNESCO.

Bullock, A. 1992. Dambo hydrology in Southern Africa: review and reassessment. *Journal of Hydrology*, 134: 373–396.

Calder, I. 1998. *Review online of water-resource and land use issues.* SWIM Paper No. 3. Colombo, Sri Lanka, International Irrigation Management Institute (IIMI).

Calder, I. 1999. *The blue revolution, land use and integrated water resources management*. London, Earthscan.

Calder, I.C. 2003. Assessing the water use of vegetation and forests-development of the HYLUC, Hydrological Land Use Change model. *Water Resources Res.,* 39(11): 1318.

Calder, I. 2005. Watershed management: can we incorporate more evidence-based policies? *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Cornes, R. & Sandler, T. 1996. *The theory of externalities, public goods, and club goods*. Cambridge, UK, Cambridge University Press.

Dassonville, L. & Fé d'Ostiani, L. 2005. Mediterranean watershed management: overcoming water crisis in the Mediterranean. *In* L. Tennyson and P.C. Zingari, eds. *Preparing for the next generation of watershed management programmes and projects*. *Water resources for the future.* Proceedings of the International Conference. Porto Cervo, Sassari, Sardinia, Italy, 22 to 24 October 2003. Watershed Management and Sustainable Development Working Paper No. 9. Rome, FAO, FORC.

Diallo, O. 2005. Water erosion and silting in the Niger River basin in the context of watershed management. *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop. Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Echavarría, M. 2000. Valuation of water-related services to downstream users in rural watersheds: determining values for the use and protection of water resources. *In* FAO. *Land–water linkages in rural watersheds.* FAO Land and Water Bulletin No. 9. Rome, FAO.

Echavarría, M. 2002a. Financing watershed conservation: The FONAG water fund in Quito, Ecuador. *In* S. Pagiola, J. Bishop and N. Landell-Mills, eds. *Selling forest environmental services: market-based mechanisms for conservation and development.* London, Earthscan.

Echavarría, M. 2002b. *Water user associations in the Cauca Valley, Colombia: a voluntary mechanism to promote upstream–downstream cooperation in the protection of rural watersheds.* FAO Land Water Linkages Case Study Series. Rome, FAO. Available at: www.fao.org/landandwater/watershed.

Echavarría, M. & Lochman, L. 1999. *Policy mechanisms for watershed conservation: Case studies*. Arlington, Virginia, USA, Nature Conservancy.

Ellis, F. & Allison, E. 2004. *Livelihood diversification and natural resource access.* LSP Working Paper No. 9. Rome, FAO, Livelihood Support Programme.

Enote, J. 1996. *The Zuni resource development plan: a program of action for sustainable resource development.* Zuni Conservation Project Annual Report. 59 pp.

Estrada R.D. & Quintero, M. 2004. Propuesta metodologica para el análisis de cuencas: una alternativa para corregir las deficiencias detectadas en la implementación del pago por servicios ambientales. *In* FAO. 2004. *Payment schemes for environmental services in watersheds*. Land and Water Discussion Paper. Rome, FAO.

Fairhead, J. & Leach, M. 1996. *Misreading the African landscape. Society and ecology in a forest-savanna mosaic.* Cambridge, UK, Cambridge University Press.

FAO. 2004. *Review and assessment of the status of watershed management. Watershed management case study: Latin America.* Watershed Management and Sustainable Mountain Development Working Paper No. 3. Rome, FAO, FORC.

Fé d'Ostiani, L. 2004. *Watershed management: a key component of rural development in the Mediterranean region. Watershed management case study: Mediterranean.* Watershed Management and Sustainable Mountain Development Working Paper No. 4. Rome, FAO, FORC.

Fleming, W. 1995. *Water quality impacts from land use in an Ecuadorian watershed: Poza Honda Reservoir.* Escuela Politecnica Nacional Technical Report. Quito.

Fleming, W. 2003. Volunteer watershed health monitoring by local stakeholders: New Mexico watershed watch. *Journal of Environmental Education,* 35(1): 27–32.

Fleming B., Hufschmidt, M.M. & Hyman, E.L. 1982. Environmental and economic impacts of water conservation on a major reservoir project in Ecuador. In *Economic approaches to natural resources and environmental quality analysis.* Dublin, Tycooly Int.

FONAFIFO. 2005. Statistics from: www.fonafifo.com.

Freisem, C. 2002. *Working together in watersheds*. FAO Land and Water Development Division discussion paper. Rome, FAO.

Hofer, T. 2005. What are the impacts of deforestation in the Himalaya on flooding in the lowlands? Rethinking an old paradigm? *In* L. Tennyson and P.C. Zingari, eds. *Preparing for the next generation of watershed management programmes and projects. Water resources for the future.* Proceedings of the International Conference, Porto Cervo, Sassari, Sardinia, Italy, 22 to 24 October 2003. Watershed Management and Sustainable Development Working Paper No. 9. Rome, FAO, FORC.

Hofer, T. & Messerli, B. 2006. *Floods in Bangladesh: history, dynamics and rethinking the role of the Himalayas.* United Nations University Press.

Huber, U.M., Bugmann, H.K.M. & Reasoner, M.A., eds. 2005. *Global change and mountain regions: an overview of current knowledge.* Advances in Global Change Research, Vol. 23. Netherlands, Springer-Verlag.

INFU. 2001. *Co-operative agreements in agriculture as an instrument to improve the economic and ecological efficiency of the European water policy.* Appendix to the EU workshop report, Case Study Stevertalsperre. Dortmund, Germany, Institute of Environmental Research (INFU).

IPCC. 2001. *Third Assessment Report*. Intergovernmental Panel on Climate Change (IPCC).

Kaimowitz, D. 2004. Useful myths and intractable truths: the politics of the link between forests and water in Central America. *In* M. Bonell and L.A. Bruijnzeel, eds. *Forests, water and people in the humid tropics: past, present and future hydrological research for integrated land and water management*. Cambridge, UK, Cambridge University Press.

Kiersch, B. 2000. Land–water linkages in rural watersheds: a literature review. *In* FAO. *Land–water linkages in rural watersheds.* Land and Water Bulletin No. 9. Rome. FAO.

Kiersch, B., Hermans, L. & Van Halsema, G. 2005. *Payment schemes for water-related environmental services: a financial mechanism for natural resources management experience from Latin America and the Caribbean*. Seminar on Environmental Services and Financing for the Protection and Sustainable use of Ecosystems. Geneva. Available at: www.unece.org/env/water/meetings/payment_ecosystems/discpapers/fao.pdf.

Kotru, R. 2005. Watershed management experiences in GTZ-supported projects in India. *In* M. Achouri, L. Tennyson, K. Upadhyay and R. White, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Koyo, J.P. 2004. *Comprehensive, integrated watershed and swamp management. Watershed management case study: Burundi.* Watershed Management and Sustainable Mountain Development Working Paper No. 1. Rome, FAO, FORC.

Landell-Mills, N. & Porras, I.T. 2002. *Silver bullet or fools' gold? A global review of markets for forest environmental services and their impacts on the poor. Instruments for sustainable private sector forestry series.* London, IIED.

Makukira, H. & Mugumo. M. 2005. Water sector reforms in Zimbabwe: the importance of policy and institutional coordination on implementation. *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

McKay, H. & Nisbet. 2002. Sustainable forestry and the protection of water in Great Britain. *In* FAO. *Proceedings International Expert Meeting on Forests and Water, Shiga, Japan,* pp. 101–112. Rome, FAO,

MEA. 2005. *Ecosystems and human well-being: Synthesis*. Washington, DC, Island Press for Millennium Ecosystem Assessment (MEA).

Munasinghe, M. 1993. *Environmental economics and sustainable development.* World Bank Environment Paper No. 3. Washington, DC, World Bank.

Nemarundwe, N. 2005. Managing micro-catchment resources: institutional arrangements for water use in Chivi district, Zimbabwe. *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Neveu, G. 2005. Integrated water resource management over the world. *In* L. Tennyson and P.C. Zingari, eds. *Preparing for the next generation of watershed management programmes and projects. Water resources for the future.* Proceedings of the International Conference, Porto Cervo, Sassari, Sardinia, Italy, 22 to 24 October 2003. Watershed Management and Sustainable Development Working Paper No. 9. Rome, FAO, FORC.

Odame Abaio, K. 2005. Putting integrated water resource management into practice: Ghana's experience. *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Pearce, D. 1983. *Cost–benefits analysis*. London, Macmillan.

Pearce, D. & Turner, R. 1990. *Economics of natural resources and the environment.* Baltimore, Maryland, USA, John Hopkins University Press.

Poudel, K. 2005. Watershed management in Nepal: challenges and constraints. *In* M. Achouri, L. Tennyson, K. Upadhyay & R. White. 2005. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop. Kathmandu, Nepal. 11-13 September 2003. Watershed Management & Sustainable Mountain Development Working Paper, No 5. Rome, FAO, FORC.

Pravongviengkham, P., Khamhung, A., Sysanhouth, K. & Qwist-Hoffmann, P. 2005. Integrated watershed management for sustainable upland development and poverty alleviation in Lao People's Democratic Republic. *In* M. Achouri, L. Tennyson, K. Upadhyay and R. White. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Rademeyer, S. 2005. Processes that will influence resource allocation in the Republic of South Africa. *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Rojas, M. & Aylward, B. 2003. *What are we learning from experiences with markets for environmental services in Costa Rica?* A review and critique of the literature. London, IIED.

Ruiz Garcia, M., Lasanta, T., Valero, B., Marti, C., Begueria, S., López-Moreno, J.I., Regüés, D. & Lana-Renaul, N. 2005. Soil erosion and runoff generation related to land use changes in the Pyrenees. *In* U.M. Huber, H.K.M. Bugmann and M.A. Reasoner, eds. *Global change and mountain regions: an overview of current knowledge.* Advances in Global Change Research, Vol. 23. Netherlands, Springer-Verlag.

Sharma, S. 2005. Rethinking watershed development in India: strategy for the twenty-first century. *In* M. Achouri, L. Tennyson, K. Upadhyay and R. White, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Singh, S.L., Kharel, B.P., Joshi, M.D. & Mathema, P. 2004. *Review and assessment of watershed management strategies and approaches. Watershed management case study: Nepal.* Watershed Management and Sustainable Mountain Development Working Paper No. 2. Rome, FAO, FORC.

Sthapit, K.M. 2005. Decentralized watershed management: experiences from the soil conservation and watershed management component, Nepal. *In* M. Achouri, L. Tennyson, K. Upadhyay and R. White, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Swallow, B., Onyango, L. & Meinzen-Dick, R. 2005. Catchment property rights and the case of Kenya's Nyando basin. *In* B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Swallow, B., Okono, N., Achouri, M. & Tennyson, L., eds. 2005. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the African Workshop, Nairobi, 8 to 10 October 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC.

Tennyson, L. & Zingari, P.C., eds. 2005. *Preparing for the next generation of watershed management programmes and projects. Water resources for the future.* Proceedings of the International Conference, Porto Cervo, Sassari, Sardinia, Italy, 22 to 24 October 2003. Watershed Management and Sustainable Development Working Paper No. 9. Rome, FAO, FORC.

Thelen, K., ed. 2005. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Latin American Workshop, Arequipa, Peru, 15 to 17 June 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 7. Rome, FAO, FORC.

Uhlenbrook, S., Wenninger, J. & Lorentz, S. 2005. What happens after the catchment caught the storm? Hydrological processes at the small, semi-arid Weatherley catchment, South-Africa. *In* L. Ferraris, ed. *Advances in geosciences, ADGEO, Volume 2, Mediterranean storms,* pp. 237–241.

Upadhyay, K. 2005. Successes and failures in watershed management in the Asia–Pacific Region (1982 to 2002). *In* M. Achouri, L. Tennyson, Upadhyay and R. White, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Warren, P. 2004. La Somma: agro-tourism, new ruralness and forest management in the uplands of Umbria (Central Italy). *Policy Matters,* 13.

Warren, P. 2005. *Between the household and the market. A livelihoods analysis of SPFS-promoted seed multiplication in Eastern Guatemala.* Livelihoods Support Programme Working Paper No. 20. Rome, FAO.

Wilson, R., Amezanga, J. & Saigal, S. 2005. Policy challenges and recommendations for watershed development in India. *In* M. Achouri, L. Tennyson, K., Upadhyay and R. White, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the Asian Workshop, Kathmandu, 11 to 13 September 2003. Watershed Management and Sustainable Mountain Development Working Paper No. 5. Rome, FAO, FORC.

Zingari, P.C. 2005. Effective watershed management: a European perspective. *In* M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects.* Proceedings of the European Regional Workshop, Megève, France, 4 September 2002. Watershed Management and Sustainable Mountain Development Working Paper No. 6. Rome, FAO, FORC.

Annexes

METHODS AND RESOURCES FOR COLLABORATIVE WATERSHED MANAGEMENT: HINTS AND TIPS FOR PRACTITIONERS

These annexes give brief descriptions of innovative methods and resources for collaborative watershed management.

The aim of these descriptions is to help the non-specialist practitioner assess the relevance, usefulness and feasibility of each method or resource for a particular watershed situation. Following an overview of the method or resource, key concepts are briefly discussed and relevant tools listed. Conditions for the successful use of the method or resource are identified and, whenever possible, rough estimates of the costs are given. Most descriptions include an example to illustrate how the method or resource has been applied in the field. References and Internet addresses are provided for readers who want to know more about the subject. A list of key Web sites on collaborative watershed management is also included.

The annexes do not provide step-by-step instructions on implementing or using these methods and resources. Instead, they enable practitioners to decide whether to seek specific professional assistance, and indicate what to expect if they do so.

WOCAT: a methodology for documenting and evaluating soil and water conservation

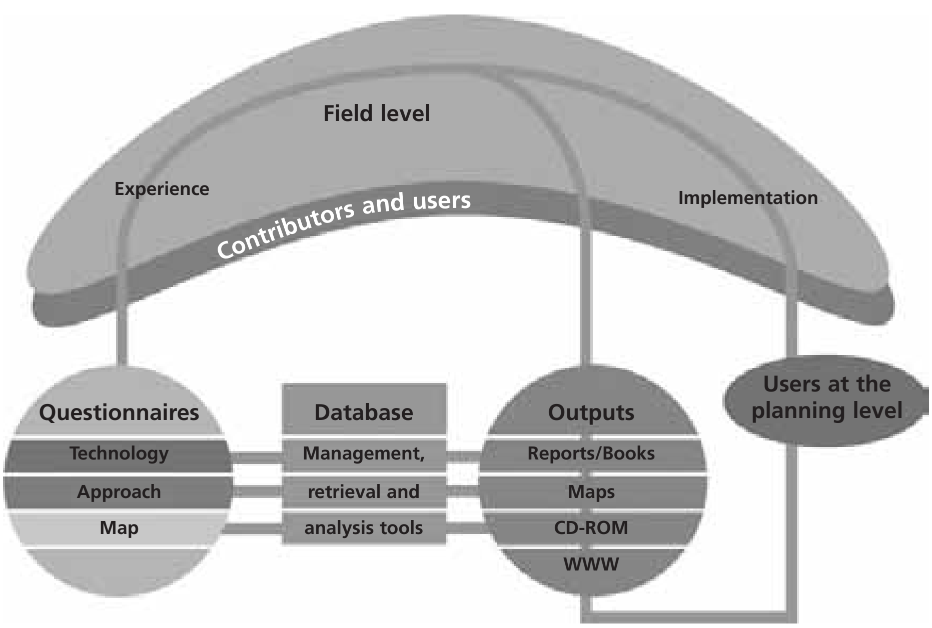
WHAT IS WOCAT?

The World Overview of Conservation Approaches and Technologies (WOCAT) is a global network of soil and water conservation specialists comprising 35 national organizations and several international and donor organizations, such as FAO, ICIMOD, the United Nations Environment Programme (UNEP), the Swiss Agency for Development Cooperation and the Danish International Development Agency (DANIDA). WOCAT's mission is to support knowledge sharing among soil and water conservation specialists, to help them identify appropriate technologies and approaches, and to support the planning and implementation of these in the field.

WHAT SERVICES DOES WOCAT PROVIDE TO FIELD PRACTITIONERS?

Knowledge about soil and watershed conservation is extensive, but scattered and not easily accessible. This is one of the reasons why soil degradation continues in many parts of the world, despite decades of efforts and large investments in soil and watershed conservation. WOCAT documents and disseminates knowledge so that practitioners can learn from each others' experiences via a source of reliable information covering many geographic and subject areas. The information gathered helps to identify research needs and suggests how ongoing practices can be improved.

FIGURE A1
Services delivered by WOCAT



WOCAT QUESTIONNAIRES

WOCAT has developed three questionnaires to capture information about soil and water conservation technologies and field-level approaches. As the questionnaires are complex, WOCAT also offers training on how to use them and the associated database.

The WOCAT methodology, questionnaires, database and outputs have been evaluated at national and regional workshops, and have been continuously revised since the first questionnaires were developed in 1994. More than 30 national training workshops since 1999 have confirmed that the current questionnaires are practical and useful, although some collaborators feel they are too complex.

The three WOCAT questionnaires cover technology, approaches and mapping; data are collected, recorded and analysed in a systematic and standardized manner. The *technologies questionnaire* investigates field activities. The *approaches questionnaire* investigates the required skills and technical knowledge, the required and available resources, socio-economic and cultural aspects, and land users' perceptions and acceptance of each approach. The *mapping questionnaire* gathers geographic information about planning issues in order to build up spatial overviews of degradation and conservation in defined areas – patterns of soil degradation vary at all levels, from the village to the global scale. Responses to the mapping questionnaire show that conservation achievements are rarely mapped; such maps should be created to identify where soil and watershed conservation measures have been effective and where they are most needed and could be implemented effectively.

WOCAT DATABASE

WOCAT's database includes more than 300 technology case studies and more than 200 approaches from 40 countries (not all of which have been validated). The database can be searched for a specific technology or approach or for specific conditions in which these are applied. It also evaluates technologies and approaches. Most of the information is presented as case studies on soil and water conservation technologies and approaches in more than 35 countries. Most information comes from Africa (60 percent) and Asia (30 percent), with a few case studies from Latin America. WOCAT has recently started to gather information from Europe. WOCAT consolidates its information by subject and area to make it more useful and accessible for planning exercises and in the field.

DISSEMINATION AND TRAINING

WOCAT disseminates information via its Web site, on CD-ROMs, in articles and at workshops. All WOCAT's tools, data and outputs can be accessed at www.wocat.net. CD-ROMs contain much of the information from the Web site, including the database, questionnaires, published reports and general information.

WOCAT held its first regional training workshop in Kenya in 1995. Since then it has trained more than 400 experts in Africa, Asia and Europe. Filling in the WOCAT questionnaires encourages practitioners to analyse their achievements.

HOW WOCAT TOOLS AND DATA CAN BE USEFUL FOR COLLABORATIVE WATERSHED MANAGEMENT

The information gathered by WOCAT provides decision-makers, such as planners and coordinating organizations, with an overview of achievements, approaches and technologies.

WOCAT promotes the use of good-quality, up-to-date information on water and soil for extension, research and education. Its tools and processes are used by government departments, project staff, scientists and extension workers from across the world to:

- monitor and evaluate individual technologies and approaches, and quantify costs and benefits;
- document, identify and transfer technologies and approaches from one area to another;
- identify key topics and knowledge gaps that need further research;
- evaluate the results of research trials, and assess the biophysical and socio-economic suitability of research-derived technologies and approaches;
- disseminate information as an educational data resource.

CONDITIONS FOR SUCCESS

One of WOCAT's main concerns is the quality of the data it collects. A study on the potential for improving data (Douglas, 2003) suggested that WOCAT should focus less on the correct filling in of questionnaires and more on transferring to practitioners the skills to evaluate the impacts and cost-effectiveness of their own activities.

Improving data quality requires respondents to be more critical about their own knowledge and to fill in questionnaires properly. In particular, respondents need to:

- review their knowledge and experience of technologies and approaches critically and systematically;
- recognize and challenge their technical preconceptions and biases, which often lead to wrong assumptions about problems and the effectiveness of technologies or approaches;
- avoid assuming that implementing a technology or approach automatically controls land degradation;
- understand fully how land degradation processes operate under specific local conditions.

When filling in questionnaires, respondents should take care to:

- complete them in close consultation with other experts;
- undertake field verification and discussions with land users;
- provide detailed descriptions specific to the technology being documented, rather than generalized descriptions that could apply to similar technologies;
- give adequate details of the technical specifications that explain how a technology performs;
- differentiate between the characteristics of the wider area in which the users of a technology operate and those of the specific sites where the technology has been adopted;
- provide detailed cost breakdowns, as omitting key cost elements leads to underestimated actual costs;
- use secondary data from project documents and technical manuals to document and check technical specifications and the costs and benefits of particular technologies and approaches.

INTERNET RESOURCES

Further information on WOCAT services, research tools and achievements can be found at www.wocat.net.

FURTHER READING

Douglas, M.G. 2003. Improving WOCAT data quality – some observations and suggestions. In *Proceedings of the Eighth International Annual Workshop and Steering Meeting (WWSM8), 4 to 8 November 2003, Kathmandu.* Berne, Switzerland, Centre for Development and Environment, Institute of Geography, University of Berne.

Liniger, H.P. & Schwilch, G. 2002. Better decision-making based on local knowledge – WOCAT method for sustainable soil and water management. *Mountain Research and Development Journal*, 22(1).

Liniger, H.P., van Lynden, G.W.J. & Schwilch, G. 2002. Documenting field knowledge for better land management decisions – experiences with WOCAT tools in local, national and global programs. In *Proceedings of ISCO Conference 2002, Vol. I,* pp. 259–167. Beijing.

Liniger, H.P., Cahill, D., Thomas, D.B., van Lynden, G.W.J. & Schwilch, G. 2002. Categorisation of SWC technologies and approaches – a global need? In *Proceedings of ISCO Conference 2002, Vol. III*, pp. 6–12. Beijing.

Van Lynden, G.W.J., Liniger, H.P. & Schwilch, G. 2002. The WOCAT map methodology, a standardised tool for mapping degradation and conservation. In *Proceedings of ISCO Conference 2002, Vol. IV*, pp. 11–16. Beijing.

WOCAT. 2003a. *Questionnaire on SWC technologies. A framework for the evaluation of soil and water conservation (revised).* Berne, Switzerland, Centre for Development and Environment, Institute of Geography, University of Berne.

WOCAT. 2003b. *Questionnaire on SWC approaches. A framework for the evaluation of soil and water conservation (revised).* Berne, Switzerland, Centre for Development and Environment, Institute of Geography, University of Berne.

WOCAT. 2003c. *Questionnaire on the SWC map. A framework for the evaluation of soil and water conservation.* Berne, Switzerland, Centre for Development and Environment, Institute of Geography, University of Berne.

Action research

WHAT IS ACTION RESEARCH?

Action research is a process aimed at generating and sharing the knowledge needed to understand development problems and identify socially acceptable solutions. Action research is driven by a pluralist group of participants, usually comprised of people who are directly affected by the problem (i.e., local actors), technical experts and a facilitator (often a social scientist). Local actors provide their real-life, everyday experience of the problem, including their strategies for taking advantage of opportunities and minimizing threats. Professional researchers provide scientific advice and technical expertise for possible improvements. Facilitators support communication among participants, systematize progress and disseminate action research findings and recommendations among decision-makers and the public.

THE FEATURES OF ACTION RESEARCH

The main features of action research are:

- the involvement of both lay people and professional researchers;
- a focus on identifying the best combination of experts' and lay people's views of the problem at stake;
- a functional link to a social change process, such as a collaborative watershed management programme;
- the direct feeding of research results into planning and action, with minimum time gaps between data collection, analysis and use;
- built-in awareness raising and adult education.

ACTION RESEARCH AND PRA

Action research has been applied to deal with a variety of educational and social service problems worldwide since the 1930s. In the 1990s, the participatory rural appraisal (PRA) movement made action research popular with development organizations, which have used it in many natural resource and watershed management projects over the last 15 years. Although PRA and action research have much in common, action research is a deeper and more analytical approach, based on merging local and scientific knowledge into a social learning process. Unlike much current "quick-and-dirty" PRA practice, action research is generally a relatively in-depth and long-term process.

HOW CAN ACTION RESEARCH BE USEFUL FOR COLLABORATIVE WATERSHED MANAGEMENT?

Action research can support collaborative watershed management by providing relevant and ready-to-use information for decision-making, and by contributing to process and impact monitoring. Compared with other approaches – conventional research, participatory appraisal, on-farm research, environmental monitoring, etc. – action research has the added value of providing socially validated information that is meaningful to both local stakeholders and scientists.

Common uses for action research in collaborative watershed management include:

- needs assessments and diagnostic studies;
- field testing and validation of improved technology and practices;
- social and environmental impact assessment;
- landscaping;
- design of hydraulic works;
- education and awareness raising processes.

TECHNIQUES AND TOOLS

Action research is based on qualitative social research methods, including participant observation, interviews and facilitated group discussions. Within this framework, action research facilitators use PRA group work tools, such as transect walks, participatory mapping, ranking exercises and life histories, to elicit local actors' views and opinions and to generate working hypotheses.

Quantitative research techniques such as questionnaire surveys, GIS-based analysis, erosion and runoff measurements and economic valuations are used in the action research process to validate working group hypotheses. Many of the methods for collaborative watershed management that are presented in this annex can be incorporated into action research.

In order to involve lay people in the interpretation of research findings, interactive analytical tools (e.g., problem and objective trees, future scenario imaging, and strengths, weaknesses, opportunities and threats [SWOT] analysis) are used in group work to facilitate the formulation of conclusions and recommendations.

CONDITIONS FOR SUCCESS

Action research is a sensitive social process. Its success depends on local authorities and stakeholders accepting an action research initiative. Preparatory work should aim to build rapport and trust. Local stakeholders' timing and pace should be respected and "managerial" behaviour avoided. In-kind incentives, such as transport, meals, hosting and personalized technical assistance, can be offered to local action research participants as a (partial) compensation for their time and commitment.

Action research needs very good facilitation to succeed. Facilitators should be (and be perceived to be) relatively neutral actors with no vested interest in the issues at stake. This is easier to achieve when facilitation is entrusted to an external professional, but a good facilitator must also be sensitive to local culture and society. Many applied social scientists with experience in PRA and other participatory research methods have the basic skills needed to manage an action research process to support collaborative watershed management.

COSTS AND TIMING

The costs of action research include the salaries of facilitators and scientific advisers, incentives for local stakeholders, and transport and logistic costs. The total cost depends on the objective of the action research exercise and the time needed to achieve it; small, focused action research exercises can be completed in six weeks. As shown in the following example, an action research needs assessment at the sub-watershed level can be completed in four months. Action research is best used as a long-term process, however, paralleling collaborative watershed management initiatives on a continued basis.

A PRACTICAL EXAMPLE: DIAGNOSTIC ACTION RESEARCH IN SAN CARLOS SUB-WATERSHED, BOLIVIA

The following description of watershed planning in Bolivia in 2000 illustrates how action research can contribute to collaborative watershed management. The project was carried out within the framework of FAO's Inter-Regional Project for Participatory Upland Conservation and Development (PUCD).

The San Carlos sub-watershed covers 31 km^2 of the Piraí River basin. It lies in the municipality of El Torno, about 30 km from Santa Cruz de la Sierra, one of Bolivia's most dynamic towns. It has a population of 800 people, half of whom are subsistence farmers. Colonists and the beneficiaries of agrarian reform have been settling in this rural area since the 1950s. Land clearing for crops and rangeland caused forest cover to decrease from 72 percent in 1967 to 39 percent in 1997. The impact of this on runoff has been exacerbated by the construction of roads and trails and by oil exploration and exploitation (which is also a major source of pollution). Since the late 1980s, the San Carlos torrent has been unpredictable. Every year, sudden spates and landslides during the rainy season damage downstream infrastructure and property, while local farmers experience increasingly severe drought during the dry season.

In 1999, the territorial management plan of El Torno municipality made controlling the San Carlos torrent's hydrological regime a priority. The mayor requested technical assistance from the Piraí River Watershed Service and the PUCD project. A field visit to the area suggested that local farming and forestry practices were the causes of hydrological imbalances in the watershed. Conversations with farmers, however, suggested that these practices should be viewed in the context of evolving local livelihood strategies and external interests in watershed resources – oil, speculation on peri-urban lands and trends in the Santa Cruz food market.

A three-month action research process was launched to study the linkages among these factors. This exercise involved the PUCD project facilitation team, senior municipal staff and selected representatives of village-level grassroots organizations. Experts in forestry, land and soil science, and agriculture from the International Centre for Tropical Agriculture (CIAT) and the University René Gabriel Moreno (Santa Cruz) were also involved.

The action research team focused on five complementary subjects:

- population dynamics, with particular attention to in- and out-migration flows;
- land cover, i.e., the spatial distribution of natural and human-made vegetal formations (forests, rangeland, agricultural land, etc.) and how it changes over time;
- livelihood strategies, i.e., the way in which people from different social strata gain a living (including on-farm, off-farm and non-farm activities);
- social stratification, i.e., differences in wealth, status and ethnicity among local social groups;
- political linkages, i.e., the relationships among farmers, village-level organizations, the municipality and departmental/national institutions.

Analysis of the historical interplays among these factors identified the socio-economic factors that underlie environmental degradation in San Carlos and the issues on which the new watershed management plan should focus.

The following research activities were conducted:

- analysis of demographic trends, based on available census data;
- multi-stakeholder discussions of watershed land cover and soil use maps (generated by GIS) for 1967, 1987 and 1997;
- individual life history interviews with key informants, focusing on the evolution of land use in San Carlos over the last 30 years;
- group interviews with members of grassroots organizations to elicit their perceptions of differences in social conditions and livelihood strategies in San Carlos;
- in-depth analysis of a small sample of households, selected as examples of the major livelihood strategies identified in group interviews.

The following were the main findings of the action research:

- The immediate cause of torrents and landslides in San Carlos is the deforestation of critical areas such as hilltops, very steep slopes and river shores (7 percent of the total area). As these areas have marginal importance to local livelihoods, the action research group agreed that a stricter forest conservation regime must be established by the municipality and enforced through legal and social fencing means.
- Earth movements related to oil operations and the construction of large houses and access roads on the hillside were confirmed as additional (but relatively self-contained and localized) causes of the watershed's hydrological imbalance. It was recommended that the municipality's territorial management plan include a soil movement monitoring and supervision service, capable of preventing abuses.

- The most important cause of hydrological imbalance was found to be removal of the forest, agroforestry and sugar cane cover that had survived on medium-steep hillsides until the 1980s. This change occurred between 1987 and 1997 and was driven by several demographic and livelihood trends, including: pest and disease epidemics affecting fruit trees; a drop in the sugar cane price on Santa Cruz market; the loss of household labour as young people out-migrated to town; the subsequent conversion of many farms to extensive cattle ranches; and the parallel shift of landless workers from agricultural wage labour to charcoal production (promoted by farmers who wanted to convert forest and agroforestry land to rangeland).

The action research team concluded that the best way of addressing the environmental situation in San Carlos was to create new sustainable livelihood opportunities for farmers and local landless workers. Fruit and vegetable production, medium-scale poultry raising, the introduction of milk cow breeds and the development of a cooperative dairy were identified as the most promising alternatives for raising farmers' incomes and creating job opportunities for the landless. Refrigerator plants and the industrial three-phase power these require were identified as the basic infrastructure needed to implement these changes.

The action research team recommended that the municipality of El Torno address the problem of torrent spates from a multi-sectoral perspective. The municipality environmental office should issue clear regulations to protect critical areas and decrease the environmental impact of roads, buildings and oil infrastructure. The local police should be trained to monitor major earth movements and motivated to report and fine abuses. The rural development office should promote linkages between local farmers and organizations that offer technical assistance and credit for agroforestry, milk livestock rearing, poultry and greenhouse vegetable production. The infrastructure office should negotiate with the power supply company for an extension of the three-phase power line. The financial office should commit the municipality's share of government royalties from oil extraction to supporting these and other collaborative management activities in the watershed.

INTERNET RESOURCES

Participatory Action Research Network
www.bath.ac.uk/carpp

Action Research on the Web
www.beta.open.k12.or.us/dennis/arowhelp/index.htlm

Community Action Research Network (University of New Anglia, United Kingdom)
www.uea.ac.uk/care/carm

FURTHER READING

Stringer, E.T. 1999. *Action research.* (Second Edition). London and New Delhi, Sage Publications.

A comprehensive step-by-step handbook for designing action research exercises.

Barton. T., Borrini-Feyerabend, G., de Sherbinin, A. & Warren, P. 1997. *Our people, our resources. Supporting rural communities in participatory action research on population dynamics and the local environment.* Issues in Social Policy Series, Gland, Switzerland, IUCN, Social Policy Service.

A field handbook for non-specialists, focusing on the interplay between population dynamics and natural resources.

Warren, P. 2000. *Ordenamiento territorial municipal. Una experiencia en el Departamento de Santa Cruz, Bolivia.* Field Report No. 6. In collaboration with P. Groppo, R. Roca Steverlyinck, J. Escobedo Urquizo and A. Rojas Guzmán. Rome, FAO, GCP/INT/542/ITA Coordination Unit.

The case study from which the example in this note was taken.

Livelihoods analysis

SUSTAINABLE LIVELIHOOD APPROACHES AND LIVELIHOODS ANALYSIS

Sustainable livelihood approaches (SLAs) put people at the centre of the development process and its objectives, scope and priorities. Livelihoods thinking started in the mid-1980s, since when a number of development agencies have adopted SLAs in their poverty reduction policies and programmes.

Over the last decade, the word "livelihood" has been used in many different ways. According to Chambers and Conway (1991) "a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living". Livelihoods analysis is therefore primarily for understanding how people make a living in a particular context. In most societies, households are the basic productive (and reproductive) social units, so the structure, functioning and change of household economics are the primary subjects of livelihoods analysis.

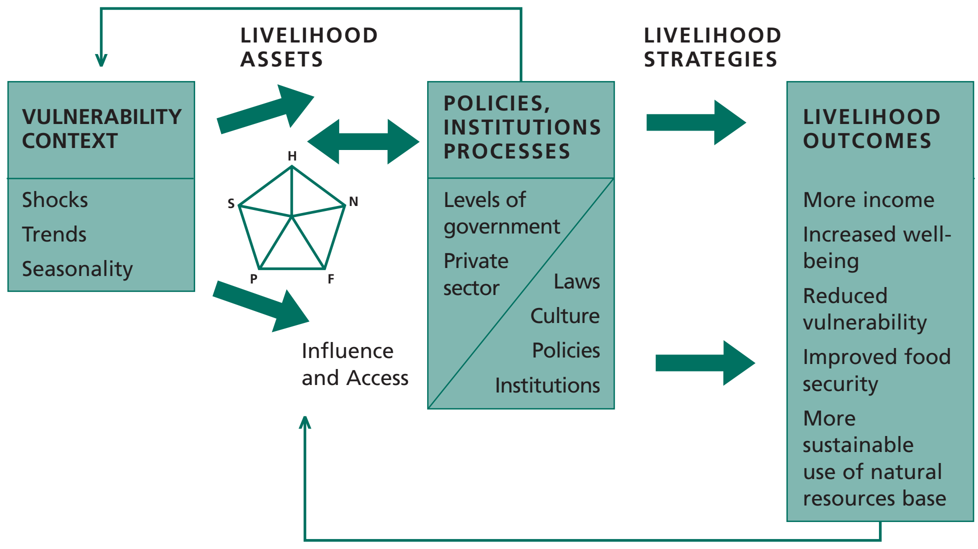
THE LIVELIHOOD ANALYTICAL FRAMEWORK

Many livelihoods analysis exercises address household economics through the analytical framework presented in Figure A2.

The following are the main components of the livelihood framework:

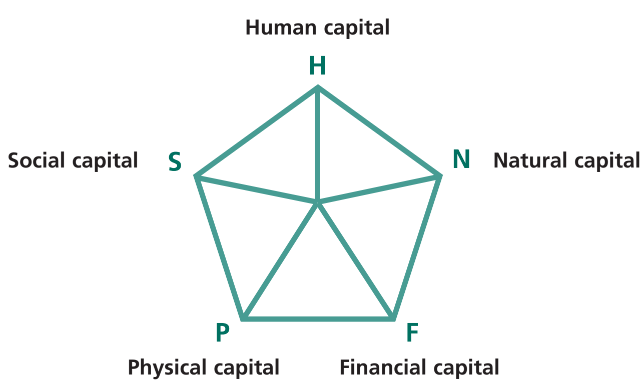
- *Capital (or livelihood) assets* (the pentagon on the left side of the framework; see also Figure A3) are the mix of endowments on which a household relies for its living. Capital assets can be *natural* (land, planting materials, water availability, etc.), *physical* (housing, agricultural equipment and tools, infrastructure, etc.), *human* (the working capability of household members, education, agricultural expertise, access to extension and technical assistance, etc.), *social* (interhousehold cooperation and safety networks, cooperatives, associations, etc.) or *financial* (income, credit, subsidies, etc.).
- *The vulnerability context* (the rectangle on the extreme left of Figure A2) consists of the natural and social factors that influence the ways in which households obtain and use their assets. These include exposure to natural, economic and political risk factors and shocks (loss of soil fertility, drought, floods, disease, inflation, wars, etc.).
- *Policies, institutions and processes* (the central rectangle in Figure A2) include all the socio-political factors and actors that aim to offer the household better opportunities to make a living.
- *Livelihood strategies* (the linking arrow between the left and right blocks of Figure A2) are the mix of productive (and reproductive) activities that household members undertake to make a living. Livelihood strategies tend to optimize the use of household capital assets, in the light of risks and constraints posed by the vulnerability context, and opportunities made available by policies, institutions and processes.
- *Livelihood outcomes* (the block on the right of Figure A2) are both the productive and reproductive objectives a household aims at, and the actual results it achieves via its livelihood strategy. Livelihood outcomes can be secure (when immediate household needs are satisfied) or insecure (when the household is affected by poverty, disease or misfortune). They can also be sustainable (when current outcomes do not decrease household endowments) or unsustainable (when making a living in the present is at the expenses of future performance and outcomes).

FIGURE A2
Sustainable livelihood analytical framework



KEY: H = human capital, N = natural capital, F = financial capital, P = physical capital, S = social capital

FIGURE A3
The capital (or livelihood) assets pentagon



HOW CAN LIVELIHOODS ANALYSIS BE USED IN COLLABORATIVE WATERSHED MANAGEMENT?

Livelihoods analysis can help to clarify the role of local livelihoods in the human ecology of a watershed. For instance, findings from livelihoods analysis can help watershed managers to:

- identify and assess (*ex-ante* and *ex-post*) the impact of watershed management measures on local livelihoods;
- identify interventions and physical works that may promote more secure and sustainable livelihood strategies and outcomes, and include them in watershed plans;
- identify and address those environmental risks and trends that are particularly critical for local livelihoods;
- promote more sustainable use of household natural capital endowments and other watershed natural resources.

Livelihoods analysis can be useful at all stages of the collaborative watershed management process. At the beginning, it can help ensure that local people's points of view, needs, problems, expectations and capabilities (including their knowledge of natural resource management) are considered in the identification and design of collaborative watershed management activities. During implementation or at the end of a particular phase of the process, livelihoods analysis can help to assess the changes that collaborative watershed management are promoting in household economies, society and culture.

METHODS, TECHNIQUES AND TOOLS

Livelihoods analysis is usually undertaken as an action research exercise (see previous section), in which members of the concerned group collaborate with technical experts (agronomists, soil and water scientists, foresters, economists, social scientists, etc.) with the support of a facilitator. In some regional studies, an "extractive" version of livelihoods analysis forms part of a research exercise aimed primarily at providing information for decision-makers; this approach, however, does not fit very well with the inspiration and philosophy of collaborative watershed management and SLAs.

Most livelihoods analysis exercises are fed by information obtained from a mix of quantitative and qualitative research methods, including:

- reviews of secondary (already existing) data;
- analysis of selected environmental and social indicators;
- sample surveys;
- in-depth interviews;
- interactive PRA exercises;
- benefit–cost analysis of the livelihood strategies or activities at stake;
- market research;
- analysis of the policy and institutional context.

The particular mix of research methods to be adopted in a livelihoods analysis exercise is identified during the initial design stage, according to the objectives, scope and focus of the exercise.

CONDITIONS FOR SUCCESS

Livelihoods are complex and multidimensional, so livelihoods analysis should be carried out by an interdisciplinary team including a social scientist, an economist, an expert in natural resource management and, depending on the focus and scope of the exercise, other experts. For instance, if education or health are key vulnerability factors in the local context, an expert in adult education or public health should also be incorporated in the team.

As it is expensive to hire a full team of livelihood analysts, a social scientist is often contracted as the full-time coordinator and facilitator, while other team members are involved on a part-time basis, taking maximum advantage of the human resources already available within the programme area. The ideal coordinator/facilitator for livelihoods analysis in collaborative watershed management processes is an applied sociologist or anthropologist, with previous experience of the local socio-cultural setting and a threefold background in livelihoods analysis, human ecology and action research facilitation.

COSTS AND TIMING

A comprehensive and detailed livelihoods analysis can be expensive and time-consuming. Narrowing the scope of the exercise to critical social groups and issues of special relevance to the collaborative watershed management process makes it possible to conduct a "fairly quick and fairly clean" livelihoods analysis in a relatively short time, at a relatively low cost. For instance, in 2004, FAO's Special Programme for Food Security analysed the livelihood impacts of project-promoted best practices in four weeks, with US$15 000 (including remuneration and travel for an international consultant).

A REAL-LIFE EXAMPLE: THE LIVELIHOOD IMPACTS OF INDIAN WATERSHED MANAGEMENT PROGRAMMES

A study of the livelihood impacts of watershed development (WSD) programmes carried out in India during the 1990s (Turton, 2000) provides examples of the information generated by livelihoods analysis, and its relevance to watershed management.

During the 1990s, Indian rural development policies increasingly decentralized the responsibility for natural resources management to the community level. At the end of the 1990s, micro-watershed development was attracting more than US$450 million of central government funding a year, for numerous projects implemented by NGOs.

Watershed management in India has evolved since the 1970s and early 1980s, when it was based on biophysical criteria. In the late 1980s, this changed to an emphasis on WSD. The Ministry of Rural Areas and Employment issued WSD guidelines, which covered productive, social, ecological/environmental and equity objectives.

In the late 1990s, livelihoods analysis was used to study the impact of WSD on rural livelihoods, focusing on the extent to which WSD activities result in new livelihood opportunities and the degrees to which these opportunities are equitably distributed and sustainable.

The study found that WSD's potential impact on household *assets* had increased as WSD approaches evolved from externally imposed biophysical interventions towards greater participation and a broader range of activities. This affected all five asset types in the sustainable livelihood framework, but benefits were not always evenly distributed. For example, WSD-promoted soil and water management works (physical assets) benefited better-off landholders disproportionately, because they were able to take advantage of the enhanced availability of natural capital assets.

A particular concern of the study was poorer groups' access to common pool resources (CPRs). WSD projects established rules of access to CPRs and collaborative agreements for their community management, but the study questioned the extent to which the poor retained access to CPRs after these interventions, and the extent to which short-term losses of access to CPRs were outweighed by longer-term gains.

In terms of *livelihood strategies,* WSD initiatives opened up new opportunities by supporting agricultural intensification processes. New labour opportunities were created by increased crop intensity and, particularly, changes in the livestock sector, where restricted access to CPRs encouraged more stall-feeding of both large and small ruminants. The intensification strategies also had important intrahousehold implications, however: while men usually appropriated the gains from increased production of cash crops such as sugar cane and cotton, women bore most of the increased workload.

WSD initiatives also provided new opportunities for households to diversify their livelihood strategies. NGO projects promoted diversification through self-help groups for women, the landless and other marginal groups, with activities ranging from traditional crafts (leaf plate making, weaving, basket making, etc.) to mushroom cultivation and forestry activities. These products generally have inelastic demand, however, so their scope for increasing incomes was limited.

The study also assessed the compatibility of WSD with existing livelihood strategies. In India, migration is one of the most important means of diversifying rural livelihoods for the poor. WSD initiatives that involved new institutions such as watershed committees therefore ended up excluding many of the poorest people, who had migrated and were absent from their villages.

Overall, the study concluded that watershed-based approaches have led to improvements in rural livelihoods. They should not be considered as a panacea, however: the productivity gains of pilot projects have been less extensive at the wider scale, and links between productivity gains and livelihoods are complex and poorly understood. Of most concern was the fact that productivity gains can work against the livelihood strategies of certain groups, particularly the poor. The greatest challenge seems to be in achieving distributional equity between the poor and the better-off and between men and women. This requires careful and continuous vigilance.

From a methodological point of view, the study demonstrated that a livelihoods perspective can promote more explicit analysis of the ways in which watershed management directly and indirectly affects people's lives. It encourages broader and more structured assessment of the impacts relevant to local people. This can help practitioners and decision-makers to adjust their approaches and enhance the socio-economic impacts of watershed management activities, although these may be incremental and subject to other sectoral goals.

INTERNET RESOURCES ON SLAs AND LIVELIHOODS ANALYSIS

A comprehensive site with a research engine dedicated to livelihood approaches and many downloadable papers and materials is at: www.livelihoods.org.

The following FAO/DFID Livelihoods Support Programme (LSP) working papers and briefing notes on livelihoods and natural resource management are downloadable from: www.fao.org/sd/dim_pe4/pe4_040501a_en.htm.

Baumann, P. 2002. *Improving access to natural resources for the rural poor: a critical analysis of central concepts and emerging trends from a sustainable livelihoods perspective.* FAO, LSP WP 1, Access to Natural Resources Sub-Programme. Rome, FAO.

Baumann, P. 2002. *Poverty and access to natural resources: insights from a sustainable livelihoods perspective*. LSP Briefing Notes, Access to Natural Resources No. 1. Rome, FAO.

Baumann, P. 2002. *Can the sustainable livelihoods approach improve the design and implementation of projects to enhance access to natural resources for the poor?* LSP Briefing Notes, Access to Natural Resources No. 2. Rome, FAO.

Cotula, L. 2002. *Improving access to natural resources for the rural poor: the experience of FAO and of other key organizations from a sustainable livelihoods perspective*. FAO, LSP WP 2, Access to Natural Resources Sub-Programme. Rome, FAO.

Biggs, S.D. & Messerschmidt, D. 2003. *The culture of access to mountain natural resources: policy, processes and practices*. FAO, LSP WP 7, Access to Natural Resources Sub-Programme. Rome, FAO.

Ellis, F. & Allison, E. 2002. *Linking livelihood diversification to natural resources in a poverty reduction context.* LSP Briefing Notes, Access to Natural Resources No. 4. Rome, FAO.

Ellis, F. & Allison, E. 2004. *Livelihood diversification and natural resource access.* FAO, LSP WP 9, Access to Natural Resources Sub-Programme, Livelihood Diversification and Enterprise Development Sub-Programme. Rome, FAO.

Fisher, R.J., Schmidt, K., Steenhof, B. & Akenshaev, N. 2004. *Poverty and forestry: a case study of Kyrgyzstan with reference to other countries in West and Central Asia.* FAO LSP WP 13, Access to Natural Resources Sub-Programme. Rome, FAO.

Hodgson, S. 2004. *Land and water – the rights interface*. FAO, LSP WP 10, Access to Natural Resources Sub-Programme. Rome, FAO.

Norfolk, S. 2004. *Examining access to natural resources and linkages to sustainable livelihoods.* FAO LSP WP 17. Rome, FAO.

FURTHER READING ON LIVELIHOODS ANALYSIS

Chambers, R. 1997. Poor people's realities: local complex, diverse, dynamic and unpredictable. In *Whose reality counts? Putting the first last*, Chapter 8. London, Intermediate Technology Publications.

Chambers, R. & Conway, G. 1991. *Sustainable rural livelihoods: practical concepts for the 21st century*. IDS Discussion Paper No. 296. London, Institute for Development Studies (IDS).

Basic references on SLAs.

DFID. 2001. *Sustainable livelihoods guidance sheets.* London. Available at: www.livelihoods.org.

A comprehensive and detailed guide to SLAs.

Ellis, F. 2000. *Rural livelihoods and diversity in developing countries.* Oxford, UK, Oxford University Press.

A theoretical and methodological guide to livelihood diversification issues.

Turton, C. 2000. *Enhancing livelihoods through participatory watershed development in India.* London, Overseas Development Institute. Available at: www.livelihoods.org.

The article on the livelihood impacts of watershed management in India from which the example in this note was taken.

System-Wide Programme for Collective Action and Property Rights (CAPRi)

WHAT IS CAPRi?

The System-Wide Programme for Collective Action and Property Rights (CAPRi) is one of several inter-centre initiatives of the Consultative Group on International Agricultural Research (CGIAR). CAPRi examines the formation and effectiveness of voluntary, community-level organizations and property institutions as they relate to natural resource management, particularly the linkages among collective action, property rights, technological change, natural resource management and poverty alleviation. CAPRi addresses these through an interdisciplinary approach that combines insights and methodologies from social and physical scientists, technical experts and practitioners. Through collaboration among CGIAR centres, national research institutions and NGOs, the programme integrates a wide range of knowledge from both academics and practitioners, bringing together the diverse range of researchers necessary to examine the environmental impact of institutional change.

Watersheds are a main focus of CGIAR and CAPRi research. Watersheds connect land units through lateral flows of water, nutrients and sediment, linking farmers, fishers and urban dwellers in intricate cause and effect relationships. Externalities among the people who share a watershed depend on both the biophysical attributes of the watershed and the institutions that shape people's interactions within the watershed.

CAPRi RESEARCH ON COLLECTIVE ACTION AND PROPERTY RIGHTS IN WATERSHED MANAGEMENT

According to the CAPRi approach, many of the critical challenges confronting watershed management – organizing local communities, internalizing environmental externalities, negotiating use rights over resources, and resolving conflicts among stakeholders – are captured by the concepts of collective action and property rights.

Collective action is action that is taken voluntarily by a group, either directly or by an organization acting on its behalf, in pursuit of group members' shared interests. Although it may not be needed when individual, farm-level technologies are being adopted, collective action becomes more necessary when natural resource management addresses larger spatial units, such as watersheds. Collective action involves designing rules and undertaking action, participating in processes and enforcing rules that are perceived as beneficial to the group. Many of its benefits are non-material, but material benefits also influence the emergence of collective action.

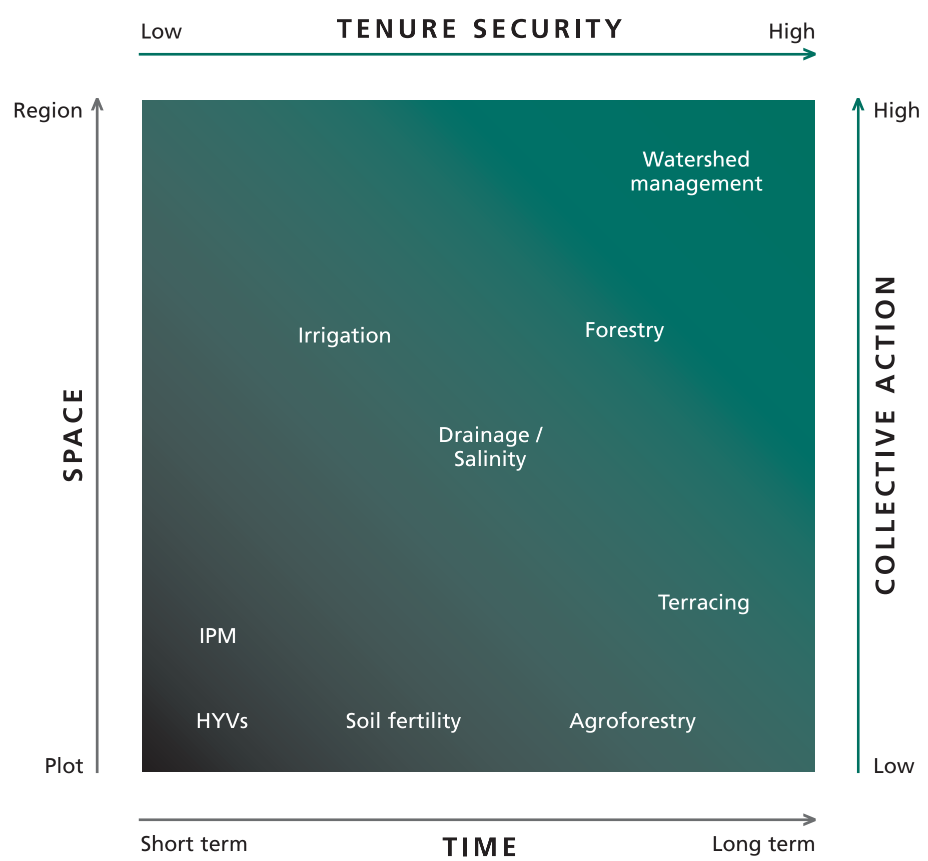
CAPRi defines collective action as "the capacity to call on the collective to stand behind one's claim to a benefit stream" (Bromley, 1991). Property rights require institutions or rules to back claims, but these need not be government-backed legal institutions. Entitlements can be defined by cultural norms or customary rights. Property rights need not constitute ownership of a resource, but can instead be a bundle of rights, including access to a resource (e.g., the right to enter a farmer's field) or withdrawal of benefits from a particular resource (e.g., water from a stream or fruit from trees). There are also rights to control, exclude and manage a resource, part of a resource or multiple resources (Schlager and Ostrom, 1992). As well as their spatial characteristics, natural resources also embody temporal features that affect production and management. Whereas some economic activities involving natural resources produce returns in a short period, others do so over a long period. Property rights that offer security of tenure are important incentives for investing in natural resource management technologies that generate returns over a longer period. Many watershed management activities fall into this category (Figure A4).

GOAL AND OBJECTIVES OF THE CAPRi PROGRAMME

The CAPRi programme contributes to policies and practices that alleviate rural poverty by analysing and disseminating knowledge on the ways that collective action and property rights institutions influence the efficiency, equity and sustainability of natural resource use. Its specific objectives include:

- increasing knowledge of the emergence and performance of voluntary, self-governing and self-adapting community organizations and property institutions for natural resource management;
- identifying the positive and negative features of different types of institution in different resource and socio-economic conditions, and comparing the effects of different property institutions across different resources and regions;

FIGURE A4
Collective action and tenure security in watershed management



- identifying concrete policy instruments to facilitate and encourage the formation, improved functioning, resilience and spontaneous evolution of users' organizations and property institutions that assure optimal resource use;
- promoting partnerships among local organizations, States, civil society and private entities, to limit the duplication of efforts to achieve these goals;
- strengthening the capacity of national and international research centres, NGOs, universities and local organizations to carry out research on collective action and property rights issues, and forging and strengthening linkages in order to capitalize on the synergies created through collaborative effort.

CAPRi SERVICES FOR NATURAL RESOURCE AND WATERSHED MANAGEMENT PRACTITIONERS

The CAPRi programme sponsors research on collective action and property rights by associated centres and national partners, develops broad conceptual frameworks, sponsors workshops, training and panels on priority research themes, directs face-to-face meetings with researchers and experts, edits books and working papers presenting members' research on collective action and property rights, coordinates an e-mail network for information exchange, and supplies literature reviews, an annotated bibliography and publications.

CAPRi offers research grants and Ph.D. field research fellowships to build the capacities of associated centres to undertake research on collective action and property rights issues, and to strengthen or establish collaboration between CGIAR and a range of partners. Research grants fund innovative empirical research on property rights and collective action issues by associated centres and national partners, while Ph.D. field research fellowships provide students who already have a solid academic background in collective action and property rights theory and methodology with the opportunity of undertaking research in collaboration with a CGIAR project.

Researchers can exchange ideas and feedback on topics of mutual interest via the CAPRi e-mail network, which facilitates greater interaction between academics and practitioners. Discussion topics concern priority themes, and information such as upcoming conferences and relevant literature is posted frequently.

HOW TO JOIN THE CAPRi PROGRAMME

CAPRi services are available to member institutions. Membership includes all the researchers at CGIAR centres and collaborating institutions who are involved in property rights and/or collective action research. All members and other interested researchers or policy-makers can join the CAPRi e-mail list by sending a request to: capri@cgiar.org.

INTERNET RESOURCES

Most CAPRi materials can be downloaded from: www.capri.cgiar.org.

FURTHER READING

Ashby, J., Braun, A.R., Gracia, T., del Pilar Guerrero, M., Hernández, L.A., Quirós, C.A. & Roa, J.I. 2000. *Investing in farmers as researchers: experience with local agricultural research committees in Latin America*. CIAT Publication No. 318. Cali, Colombia, CIAT.

Bromley, D.W. 1991. *Environment and economy: property rights and public policy.* Cambridge, Basil Blackwell.

Knox, A. & Gupta, S. 2000. *CAPRi Technical Workshop on Watershed Management Institutions. A summary paper*. CAPRi Working Paper No. 8. Washington DC, IFPRI.

Knox, A., Meinzen-Dick, R. & Hazell, P. 1998. *Property rights, collective action and technologies for natural resource management: A conceptual framework*. CAPRi Working Paper No. 1. Washington, DC, IFPRI.

Ravnborg, H. & Ashby, J. 1996. *Organizing for local level watershed management: lessons from Rio Cabuyal watershed, Colombia*. AGREN Paper No. 65. London, Agricultural Research and Extension Network (AGREN).

Ravnborg, H., Guerrero, M.P. & Westermann, O. 1999. *Collective action for managing natural resources: a manual for identifying stakeholders*. CIAT Publication No. 316. Cali, Colombia, CIAT.

Rhoades, R.E. 1998. *Participatory watershed management and research: where the shadow falls.* London, IIED.

Schlager, E. & Ostrom, E. 1992. Property rights regimes and natural resources: a conceptual analysis. *Land Economics*, 68(3): 249–262.

Swallow, B., Garrity, D. & van Noordwijk, M. 2000. The effects of scale, flows and filters on property rights and collective action in catchment management. Paper presented at the Technical Workshop on Watershed Management Institutions, Managua, Nicaragua, 13 to 16 March 2000.

Negotiation and mediation techniques for natural resource conflict management

THE FAO/DFID GUIDE TO NATURAL RESOURCE CONFLICT MANAGEMENT

Negotiation and consensus building on natural resource issues is a key element of collaborative watershed management. The FAO/DFID Livelihoods Support Programme (LSP) has recently issued a guide that provides step-by-step advice on working with many different stakeholders to reach mutually satisfactory agreements in collaborative natural resources management. It offers practical guidance on how to establish and manage a process of consensual negotiation in collaborative natural resource management and other livelihood projects involving multiple stakeholders.

NEGOTIATION AND CONSENSUS

The guide focuses on two key concepts: negotiation and consensus. When people talk with one another in an effort to resolve their opposing interests, they are *negotiating.* Some negotiations are simple and some complex. Those who are involved in a negotiation are called the parties; a negotiation can involve two parties (e.g., two individuals or groups negotiating land use, control over woodland or devices used for fishing) negotiating for themselves or representing others, or it can involve multiple parties. In some negotiations, the parties in dispute are so entangled in their differences that they are no longer able to find any constructive solution by themselves. In such cases, a third party facilitator or mediator might be able to help. The role of the facilitator/mediator is to assist individuals and groups in negotiating and reaching agreement successfully.

The other key concept is *consensus.* Consensus does not mean that everyone gets what they want or that there is a unanimous decision about an agreement, nor does it imply voting to obtain a majority. Consensus means that all parties feel that their interests have been addressed and that they can live with the agreement – they may have wanted a bit more here or a bit less there, but they can accept the outcome of the negotiation. The purpose of consensual negotiations is to achieve the best possible outcome for the most people, or at least an outcome that everyone can accept. Consensus building is a critical characteristic of collaborative natural resource management when many different stakeholders, such as the State, communities, NGOs and the private sector, have to negotiate how best to share the management, entitlements and responsibilities arising from particular natural resources, such as a forest, a river, the sea coast or grazing land.

CONFLICT AND CONFLICT MANAGEMENT

Many successful collaborative arrangements have developed from consensus solutions to long-standing conflicts over natural resources. Such conflicts originate in differing interests concerning the use of natural resources and/or power imbalances among stakeholders. Most natural resource conflicts are rooted in competition among individuals and groups over material goods, economic benefits, property and power. When conflicting parties feel that their needs cannot be met, or perceive that their values, needs or interests are being threatened, it may become necessary to intervene; some form of conflict management may be needed to avoid escalation into destructive and violent conflict. Anticipating and managing conflict are therefore critical ingredients of collaborative natural resources management. The challenge is to manage conflicts so that the advantages they bring can be maintained (e.g., opportunities to understand other people's views, expand livelihood options or create change and development), while the disadvantages are reduced or mitigated (e.g., extreme disruption, lack of development or even violence). The aims of conflict management are to:

- identify latent conflict and address it constructively;
- prevent existing conflict from escalating;
- make use of conflict in promoting positive social change.

HOW THE FAO/DFID GUIDE CAN BE USEFUL FOR COLLABORATIVE WATERSHED MANAGEMENT

The FAO/DFID guide focuses on conflict situations where a third party (mediator) assists so that consensual negotiations can take place and work effectively. This is a common situation in collaborative watershed management. As it is important to choose an appropriate strategy for addressing a particular conflict, the guide introduces and discusses some of the advantages and disadvantages of a range of conflict management approaches (legal, customary, etc.), to help watershed managers and other practitioners assess which may best suit the specific situation. In particular, it makes suggestions and recommendations for:

- facilitating negotiations and agreement among individuals, groups or institutions that believe they have incompatible objectives;
- broadening people's understanding of their own and others' interests and needs;
- encouraging people to think beyond their own often entrenched and emotional positions.

Table A1 presents a number of tools that may aid stakeholders in conflict analysis.

HOW TO USE THE GUIDE

The guide explains how to establish and manage a negotiation process. The suggested *process map* is subdivided into ten steps, and is not a rigid blueprint; the actual process is not linear, but moves forwards and backwards as needs and capacities change. This requires flexible handling of the steps according to how the process develops. Conflict management is a shared learning process. Users of the guide are encouraged to adopt a learning approach by testing and adapting different techniques and strategies. Managing conflict is a process of analysis, action and – above all – reflection.

TABLE A1

Conflict analysis tools from the FAO/DFID guide

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

CONDITIONS FOR SUCCESSFUL USE

Consensual negotiations are more effective in addressing some types of conflicts than others. For example, conflicts arising from differing interests concerning resource use are negotiable, whereas basic needs, such as identity, security, recognition or equal participation within the society, are usually non-negotiable. Negotiation techniques are therefore less useful in resolving underlying structural tensions and identity conflicts than they are in resolving disputes over declining resource availability. Because underlying structural tensions often operate at the regional or national level (competing or overlapping legal orders, real or perceived inequalities inherent in the wider socio-economic or political system, etc.), managing them tends to involve measures such as policy reform, structural adjustments, democratization and/or international conventions or protocols.

The successful use of consensual negotiation is limited by two additional factors:

- the intractable nature of some environmental conflicts (nothing that anyone does seems to improve the situation); for example, in some instances, conflicts cannot be resolved in win–win ways – resource availability may be limited, and increasing the resource use of one party may mean less resource being available for another;
- major differences in power among the people, groups and agencies involved, e.g., a local community, local NGOs, government agencies, a multinational company; consensus building is based on the premise that power imbalances among the different parties are not so substantial that a third party cannot bridge them in the negotiation process.

NEGOTIATION AND MEDIATION TECHNIQUES IN ACTION: THE DIVERSION OF BOSOKE RIVER IN THE AMANSURI WETLAND, GHANA

The local context

The Amansuri wetland lies on the western coastline of Ghana, within the eastern and western Nzema traditional areas and the East Nzema and Jomoro districts. It is about 360 km west of Accra, and its closest large urban centres are Axim and Half-Assini. It has an equatorial monsoon climate, and lies within the wet evergreen forest zone. The wetland and its catchments cover more than 1 000 km² and consist of ten sub-catchments ranging from 18 to more than 140 km² each. The region forms the watershed for Amansuri Lake and includes the drainage areas for several rivers and the coastal floodplain north of Beyin. The wetland itself covers more than 100 km², including small areas of open water (Amansuri Lake). The region's coastal lagoon is a Ramsar Wetland of International Importance.

The original inhabitants of the conflict area are Nzemas, but Fantes and Ewes fishers have settled in some coastal communities. In the western Nzema traditional area, family heads own the lands under several different landholding systems, but the paramount chief has final authority on land issues. The 18 communities bordering the wetland depend heavily on its resources for their livelihoods (fishing, palm wine, farming, agroprocessing and general trading).

The Ghana Wildlife Society (GWS), an NGO, is implementing the Amansuri Conservation Integrated Development (ACID) Project, in partnership with the Western Nzema Traditional Council, in the western Nzema traditional area's portion of the Amansuri wetland. The project's ultimate aim is to conserve the wetland system so that ecological functions and scenery are maintained, alongside low-impact resource use based on the principles of sustainable management.

The conflict

Two major and three minor rivers drain into Amansuri Lake. The Bosoke is the largest of these and serves as the shortest access route from Old Nzulezo to communities within the wetland such as Gyamozo and New Nzulezo. The people of Old Nzulezo use the river as a route to their farms and palm wine tapping and alcohol distilling areas. Between late 2001 and early 2002, the people of Gyamozo diverted part of the Bosoke river through a natural channel so as to avoid having to wade through the swamps. This drastically reduced the volume of water flowing into Amansuri Lake.

In March 2002, the people of Nzulezo, who were the most affected by the river diversion, informed the people of Gyamozo of its effects and asked them to restore the river to its original course. Nothing was done, so the elders of Nzulezo reported the case to the ACID Project Management Committee (PMC), which did not take action either. The people of Nzulezo then issued threats and ultimatums to the people of Gyamozo, insisting that they redivert the Bosoke. In August 2002, the PMC reported the case to Jomoro District Assembly (JDA), in whose administration the conflict area falls. Existing by-laws prevent the diversion of natural watercourses without authorization, but even after several attempts, JDA could not resolve the issue. In January 2003, quarrels and violence between people from the two villages started to break out over the most minor issues. Some people from Old Nzulezo said that "if the assembly cannot solve the problem, we will solve it in our own way" (meaning by force).

Stakeholder analysis

It was at this point that an ACID staff member suggested using a collaborative approach to resolve the conflict. ACID staff members assumed the role of mediators in an internal meeting to assess the current situation in the area. They determined who the stakeholders were (Table A2) and planned a strategy for entering the conflict setting, including whom to contact first.

Root cause analysis

Subsequently, the mediators invited people to conduct a root cause analysis in Old Nzulezo. Two opinions emerged as potential reasons for people in Gyamozo to divert the river: (1) to secure access in times of flooding; and (2) to destroy the palm wine that some people from Old Nzulezo obtained from nearby forests. To make sense of these views, the mediators conducted an analysis of the effects of diversion on stakeholder livelihoods and interests (Table A3).

Negotiation of a win–win solution

The mediators presented their preliminary findings at a public meeting in Old Nzulezo. The initial response from villagers was that Gyamozo should redivert the river and should be punished for having diverted it in the first place. After the analysis, the villagers realized that sticking to this position would not help them. At the end of the meeting, the people of Nzulezo softened their position and suggested that the only way of moving forward to resolve the conflict was to ask the elders of New Nzulezo (who had good relations with Gyamozo) to convince Gyamozo villagers to attend a negotiation meeting.

TABLE A2
Stakeholders involved in the conflict

Primary stakeholders	Secondary stakeholders	Interested parties
Old Nzulezo	GWS	Miegyinla
New Nzulezo	JDA	Ngelekazo
Gyamozo		Ekebaku
Beyin		Ebonloa

The people of Gyamozo had already refused several times to become involved with the mediators, however. The family head of New Nzulezo sent a linguist to the community to invite its members to meet on common ground. Traditionally such an invitation has very strong implications, and three men from Gyamozo attended a meeting. They explained that they wanted access to the road. They presented their case in a moderate way, arguing that access to their village was extremely difficult during the rainy season.

The mediators asked them whether they were aware of the effects that the river diversion had had on the other communities, and showed them the effects analysis. The people from Gyamozo had not been aware of the severity of these effects. At the following negotiation meeting, the mediators allowed each party to make its statement. Different and sometimes diverging views were expressed, and the mediators invited the parties to consider a solution that was acceptable to both.

People from New Nzulezo argued that the river should be rediverted One person from Gyamozo said: "We have done more harm than good. We did not understand the seriousness of the effects, and we should redivert the water. If there is a funeral in Old Nzulezo, we cannot go because of this issue". This was a turning point in the negotiation process, and other people from Gyamozo agreed. Once general agreement had been reached that rediversion was essential, the family head suggested that the three communities should work together to restore their relationships.

At a subsequent meeting in New Nzulezo, the parties agreed on the procedure to follow – first a footbridge would be constructed so that Gyamozo would remain accessible during the rainy season, and then the water would be redirected. The negotiators acknowledged that the agreement involved costs for materials, a chainsaw operator, fuel and labour, and asked JDA and the ACID project to provide funds for the bridge construction. The agreement is now being drafted, but no development funds have yet been raised, so the parties cannot implement it. In the meantime, the negative effects continue.

TABLE A3

Effects of the river diversion on stakeholders

Stakeholder	Effects
Old Nzulezo	Reduced freshwater fish catches for fishers. Low levels of water in the waterway, affecting transport by boat to farms, palm wine tapping and local gin distilling areas during the dry season. Changed composition of plant species downstream, resulting in fears that the raffia palm for palm wine tapping and building will be displaced.
New Nzulezo	Destruction of some farms. Effects on boat travel from New Nzulezo to Old Nzulezo.
Gyamozo	Creation of water channel to provide easy access to farms, palm wine tapping and local gin distilling areas, and to make it easier to transport produce to the main local markets.
Beyin	Reduced freshwater fish catches in the floodplain.
GWS	Difficult tour guiding within the wetland during the dry season because of low water levels in the Beyin–Amansuri Lake waterway.
JDA	Reduced income from tourism during the dry season.
Interested parties	Reduced fish supply and reduced income from tourism during the dry season.

REFERENCES

Engel, A. & Korf, B. 2005. *Negotiation and mediation techniques for natural resource management.* DFID/FAO Livelihood Support Programme. Rome, FAO.

Parker Mckeown, J. & Ntiri, E. 2005. Conflict in the diversion of the Bosoke river in the Amansuri Lake. *In* Engel and Korf, 2005.

Valuation of environmental services of watershed management

WHAT ARE THE ENVIRONMENTAL SERVICES OF WATERSHEDS?

Watersheds provide human societies with many goods and services, including provision of clean water, erosion control, carbon sequestration, conservation of biodiversity and maintenance of landscape beauty. The value of these is rarely expressed in monetary terms, however, and there are no markets where they can be bought or sold. As the providers of these environmental goods and services do not receive any compensation for providing them, they do not take them into account when making land-use decisions, which may endanger continued provision in the future.

HOW CAN VALUATION BE USEFUL FOR COLLABORATIVE WATERSHED MANAGEMENT?

The economic valuation of environmental services from watersheds makes the value of the services transparent by expressing it in monetary terms that can easily be compared with other values. Both the production and the use of a service can be valued.

The economic valuation of environmental goods and services can be useful in raising awareness about public goods whose supply people generally take for granted. It can help set priorities for the activities of watershed management programmes. Valuation is an important basis for establishing payment schemes for environmental services in watersheds, which may improve the distribution of benefits and costs among upstream and downstream water users in a watershed context.

There are numerous ways of deriving the monetary values of environmental services. The following paragraphs give a brief overview of common methods for estimating the supply of and demand for environmental services.

VALUATION OF THE SUPPLY OF ENVIRONMENTAL SERVICES

Many valuation studies are based on *opportunity cost* estimations. The opportunity cost refers to the income that a service provider could earn from productive activities that are to be avoided or transformed in order to provide environmental services. This value indicates the approximate amount of compensation required to provide an effective incentive for changing or maintaining a soil use. The opportunity cost can be estimated through surveys among local producers.

Models that estimate the marginal change in service provision associated with a land-use change are also useful for estimating the actual supply of environmental services.

VALUATION OF THE DEMAND OF ENVIRONMENTAL SERVICES

Most valuation studies use the *contingent valuation method*. This analyses beneficiaries' willingness to pay for a given service, and their perception of the values of the environmental services they use. The availability of information, and other social and economic factors such as strategic bias among participants, may influence the results of this method.

Another common direct method is the *cost avoided method*, which compares the cost of maintaining the flow of an environmental service with the cost of an alternative engineering solution, such as a water treatment plant.

Indirect methods estimate the economic value of an environmental service as an input to local economic processes. The *travel cost method* determines the investment that people make to use a particular resource, for example, the time and resources spent to visit a national park. The *hedonic price method* determines the value of an environmental service by comparing the prices of other goods with varying degrees of access to that service. For example, the value of water resources can be determined by comparing the prices of landholdings as a function of their access to water resources. Comparing the prices of properties in a scenic environment with those of properties in less attractive settings determines the value of a landscape.

CONDITIONS FOR SUCCESS

Valuation techniques should only be used when service users and providers are used to attaching monetary values to goods and services. When this is not the case, it may be possible to use valuation techniques, provided that the values are expressed in units that people can relate to, for example, as an equivalent of days worked.

For valuation techniques to work, it is important to have a sound understanding of the biophysical linkages between land use and water resources in the watershed, in order to be clear that a change or preservation of a specific land and water use in the upstream part of a watershed will be beneficial to downstream water users in terms of water availability or quality. As discussed in Chapter 2, the links between land use and water resources are often not well understood. Such understanding is crucial when valuing the supply of water-related services.

In order to achieve realistic results, economists with experience in valuation should conduct the study, design the interviews, etc. It is also important to document the assumptions on which a valuation is based, for example, assumptions about land–water linkages and the costs of inputs and labour.

The following are some of the most common errors in the economic valuation of water-related services:

- The use of secondary sources to provide market values. For instance, using values from contingent valuation studies of other locations.
- Valuating a total environmental service in an area (e.g., establishing the total value of a water supply to the watershed's population), instead of valuating the *marginal* effect of a given land-use change on that environmental service (e.g., water availability).
- Failure to valuate alternative ways of guaranteeing the service in demand, such as through the treatment or transfer of water resources. Such valuations are important because they help to assess the cost-efficiency of the different options (e.g., changes in upstream land use compared with an engineering solution).
- Attributing water scarcity – actual or perceived – to changes in land use upstream, when it is rather the result of an inefficient system for water provision and sewage treatment downstream.
- Valuating the expected benefits of land-use changes, but not the costs associated with such changes, e.g., production losses.

COSTS AND TIMING

It is necessary to hire qualified personnel to carry out the valuation study. The valuation team should have a background in economics and social sciences, and experience in quantitative surveys. It is very helpful to have an environmental expert to analyse the linkages between land use and water-related environmental services, particularly when valuating the supply of a service.

The time frame for a valuation study should consider the following stages: appraisal of the specific case; adaptation of methodology and survey design; data gathering; data analysis; and presentation of results.

Costs and timing depend to a great extent on: the availability of data; the size of the sample population; and the complexity of the case, for example, the number of alternative land uses to be considered. Demand-side studies are generally more straightforward and require less time than supply-side studies. A contingent valuation survey to determine the demand for water in a small rural community may take two months, while studies assessing the supply of water-related services in a watershed with complex land-use patterns may take more than a year to complete.

INTERNET RESOURCES

Aylward, B. & Tognetti, S. *2002. Valuation of hydrological externalities of land use change: Lake Arenal case study, Costa Rica.*
www.fao.org/landandwater/watershed/watershed/papers/papercas/paperen/costa1.pdf
Case study valuating the impacts of livestock production and forest regeneration on water yield for hydroelectric production in the Rio Chiquito watershed of the Lake Arenal area in Costa Rica.

Barbier, E.M., Acreman, M. & Knowles, D. 1997. *Economic valuation of wetlands: a guide for policy makers and planners.* www.ramsar.org/lib/lib_valuation_e.htm
Practical guidelines for the application of valuation methods for wetlands, which can also by applied in the wider watershed context. Case studies illustrate the application of different methods in Africa, Europe and North America.

Bassi, L. 2002. *Valuation of land use and management impacts on water resources in the Lajeado São José micro-watershed, Santa Catarina, Brazil.*
www.fao.org/landandwater/watershed/watershed/papers/papercas/paperen/brazil.pdf
Case study on the off-site benefits of changed land management practices – zero and minimum tillage, contour tillage, crop rotation, cover crops, green and organic manure, level terracing and forestation, etc. – in a watershed area in terms of water quality and reduced water treatment costs for downstream users.

FAO. 2004. FAO Latin American Regional Electronic Forum on Payment for Environmental Services in Watersheds (April/May 2004.)
Final report: www.rlc.fao.org/foro/psa/pdf/report.pdf
Complete proceedings and case studies: www.rlc.fao.org/foro/psa
Proceedings of the forum, including case studies on the application of valuation techniques in a watershed context in Latin America.

FAO. 2004. Regional Forum for Payment for Environmental Services in Watersheds Arequipa, Peru, 9 to 12 June 2003
Final report: www.fao.org/documents/show_cdr.asp?url_file=/docrep/004/y3618e/y3618e00.htm
Case studies: www.rlc.fao.org/prior/recnat/foro.htm
Proceedings of the forum, including case studies on the application of valuation techniques in a watershed context in Latin America.

FURTHER READING

Barbier, E. 1991. *The economic value of ecosystems: 2 – Tropical forests.* Environmental Economics Centre Gatekeeper Series No. 91-01. London, IIED.

Cornes, R. & Sandler, T. 1996. *The theory of externalities, public goods and club goods.* Second edition. Cambridge, UK, Cambridge University Press.

Daily, G.C., ed. 1997. *Nature's services: societal dependence on natural ecosystems.* Washington, DC, Island Press.

Gregersen, H.M., Brooks, K.N., Dixon, J.A. & Hamilton, L.S. 1987. *Guidelines for economic appraisal of watershed management field projects.* FAO Conservation Guide No. 16. Rome, FAO.

Munasinghe, M., ed. 1993. *Environmental economics and natural resources management in developing countries.* Washington, DC, World Bank.

Pearce, D. & Turner, T. 1990. *Economics of natural resources and the environment.* Baltimore, Maryland, USA, Johns Hopkins University Press.

Payment for environmental services (PES) in watersheds

WHAT ARE PES IN WATERSHEDS?

As the positive externalities, or environmental services, provided by watershed systems become increasingly scarce, the beneficiaries of these services are beginning to recognize their value and are willing to invest in their continued provision. Four main services can be distinguished: watershed protection, carbon sequestration, biodiversity conservation, and landscape. In the watershed context, water-related services are of particular importance.

Payment for environmental services (PES) schemes are flexible, direct compensation mechanisms by which service providers are paid by service users for the provision of a given service. PES schemes in watersheds usually involve the implementation of market mechanisms to compensate upstream landowners for maintaining or modifying a particular land use that affects the availability and/or quality of downstream water resources.

Table A4 gives an overview of the services, beneficiaries and users in a watershed context.

WHAT ARE THE MAIN FEATURES OF PES IN WATERSHEDS?

In the watershed context, a typical PES scheme has the following features: one or more upstream service *providers* supply a well-defined water-related environmental service to downstream *beneficiaries*, who *compensate* the providers for the service provision through the payment scheme, either directly or through an *intermediary*.

TABLE A4
Watershed services, beneficiaries and users

Services	Beneficiaries	Providers	Land uses
Watershed protection			
Regulation of water flow in rivers Maintenance of water quality Control of sediment yield Reduction of flood risks	Drinking-water suppliers Irrigation schemes Hydroelectric producers Beverage industry	Upstream landholders: farmers, forest owners, administrations of protected areas	Reforestation, forest management, conservation agriculture
Carbon sequestration			
Climate regulation through assimilation of atmospheric CO_2 in biomass	Governments Private companies	Landholders in general	Reforestation Agroforestry
Biodiversity conservation			
Existence value of species Bioprospecting Ecosystem resilience	Conservation organizations Private companies (e.g., pharmaceuticals)	Landholders, administrations of protected areas	Habitat protection (use restrictions) Habitat restoration
Landscape beauty			
Maintenance of typical landscapes Maintenance of landscape features such as wildlife	Tourism operators Tourists	Administrations of protected areas	Landscape protection and use restrictions (e.g., hunting bans)

Because the direct assessment of water-related environmental services is technically difficult and costly, compensation is usually based on the area covered by a land use that is assumed to provide the desired service, and is calculated on a per-hectare basis. The land uses vary according to the services provided, but typically include:

- forest conservation;
- reforestation;
- conservation of natural grassland;
- soil- and water-conserving agricultural practices, such as maintenance of permanent soil cover, mulching, no-burning;
- reduction of water pollution, such as treatment of coffee pulp residues, no grazing near watercourses (Kiersch, Hermans and Van Halsema, 2005).

Other forms of compensation include covering the administrative costs for protected areas.

The amount of compensation is generally decided through negotiation among the participants. At a minimum, the compensation needs to cover the opportunity cost to service providers of switching to a more profitable land use. The maximum depends on the beneficiaries' willingness to pay.

The institutional set-up of PES schemes typically consists of several entities:

- the beneficiaries, and possibly an organization that represents them, such as a municipal water supply company;
- the service providers, and possibly an organization that represents them;
- an intermediary organization whose tasks may include making payments to providers, making contracts with individual providers on the scheme's behalf, and monitoring compliance with PES contracts;
- the fund that collects fees from beneficiaries and administers payments to providers, overseen by a committee that may comprise representatives of beneficiaries and the local authorities.

Depending on the scale and size of the scheme, not all of these entities are necessary for the functioning of a PES scheme: in some cases, the beneficiary organization itself administers the fund, for example. When there are very few beneficiaries and providers – there may be as few as one of each – there may be no intermediary.

Mechanisms for monitoring and compliance control are important aspects of PES schemes. Clear rules must be established for the monitoring of compliance with obligations under the PES scheme, for example, to ensure that service providers use the land according to the requirements of the contract. Mechanisms also need to be established to regulate sanctions in case of non-compliance and for conflict resolution among participants.

HOW CAN PES BE USEFUL FOR COLLABORATIVE WATERSHED MANAGEMENT?

PES schemes have many positive features that make them an option for watershed managers to consider:

- PES schemes are a tool for internalizing the positive externalities provided by upstream land users to downstream stakeholders in a watershed context. They can therefore help to make resource allocation more efficient, and can tap into resources for beneficiaries that were previously underutilized by watershed management programmes.
- As initiatives that are tailored to the specific situation in the watershed and financed by local funds, PES schemes may have greater local acceptance than large watershed programmes funded from outside.
- PES schemes can help raise watershed residents' awareness about interactions at the watershed scale.
- By establishing links between upstream and downstream stakeholders, PES schemes may serve as a platform for resolving conflicts about resource allocation at the watershed scale.

TECHNIQUES AND TOOLS

The heterogeneous nature of watersheds and the different constellations of service providers and beneficiaries make it difficult to draw up simple guidelines or blueprints for the establishment and operation of a PES scheme in watersheds. Watershed managers willing to adapt a PES strategy should consult the case studies available (see the resource section at the end of this annex).

Answers to the following questions can help to structure the complex issues and determine the feasibility of a PES scheme in a watershed.

- What is/are the environmental service(s) in demand?
- Who are the users of the environmental services?
- How many are there?
- How much are the users willing to pay for the service?
- How is each service generated, and in what quantity?
- Who is generating the service?
- What are the costs to the providers of generating the service in demand?
- What payment mechanism is used?
- How do users pay?
- How do providers receive payments?
- For how long?
- What are feasible mechanisms for compliance control?
- What is the institutional and legal framework?
- Which institutions and legal instruments facilitate the establishment of a PES scheme?
- Which political and economic issues should be considered?
- How effective is the PES scheme in ensuring the continued supply of environmental services compared with other alternatives, such as engineering solutions?
- How efficient is the system in terms of the costs for establishing and operating the scheme?
- What are the likely environmental impacts?
- What are the likely social impacts?

CONDITIONS FOR SUCCESS

Although there are many possible applications for PES schemes in watersheds, the schemes should not be seen as a panacea for financing natural resources management. The successful implementation of a PES scheme depends on several conditions.

- ***Sufficient demand.*** There needs to be sufficient demand, i.e., at least one beneficiary in the watershed is willing to pay for the continued provision of one or more clearly defined environmental services. If there is no demand for environmental services, or beneficiaries are unable or unwilling to pay, the implementation of a PES scheme will be difficult. For a PES scheme to be viable, the estimated users' demand must be higher than the amount needed to compensate service providers effectively for the intended change in land use. The absence of demand for environmental services in a watershed does not mean that the area should not be conserved, only that PES is not a useful tool for this case.
- ***Clear understanding of land–water linkages.*** As discussed in Chapter 2, the links between land use and water-related environmental services depend on many site-specific factors, and are often poorly understood. Particularly regarding forest–water linkages, there are many generalizations that do not hold true in all situations, for example, that forests regulate stream flow. It is therefore crucial to identify which land uses providers should adopt to secure delivery of the environmental services demanded by beneficiaries. If the services are not delivered, the scheme will collapse.
- ***Sustainable financing arrangements.*** The development of a PES scheme comes at a price. The institutional framework has to be established, monitoring and

enforcement arrangements implemented, and providers and beneficiaries have to bear the costs of participating in the scheme, such as travel to the scheme's office, the drawing up of legal contracts, and design of land-use plans. These *transaction costs* may be considerable. The funding sources for transferring payments under the scheme must be sustainable in the long term. Many functioning PES schemes have been established within the framework of technical cooperation projects. Although external funds from donors may play a crucial role in covering the initial costs of establishing a scheme, they must not be used to cover any recurrent administrative costs or incentive payments, as this will undermine the financial sustainability of the scheme.

- ***Land tenure security***. Land tenure needs to be reasonably secure. When there are conflicts over land tenure, PES schemes can aggravate them as landholders struggle to gain control over land that is eligible for incentives under the scheme (Wunder, 2005). In frontier areas where deforestation is occurring, PES programmes may actually increase the pressure on land as new settlers move in to benefit from incentives paid by the scheme. Land titles are not a necessary prerequisite for PES schemes, however (Pagiola, Bishop and Landell-Mills, 2002). When land tenure is secure, landholders may see PES contracts as a welcome recognition of their claim to the land.
- ***Cultural acceptance of PES***. There must be consensus that it is reasonable for beneficiaries to pay providers for the continued provision of environmental services. This can be problematic in situations where it is considered unacceptable to pay for water-related services, or where cultural or religious values are at stake, for example, in the preservation of a mountain or lake that is considered sacred by local people.
- ***Legal issues***. A legal framework specifically tailored to PES is not a prerequisite for the functioning of a PES scheme. It helps, however, if the scheme is recognized by local legislation, as this generally raises credibility among participants. An existing legal framework for PES and functioning PES scheme at the national level may stimulate the formation of private PES agreements, by providing a blueprint for establishing the schemes and by reducing the transaction costs for service providers and buyers, who may choose to link into the national scheme instead of setting up a separate institutional framework. Both effects can be observed in Costa Rica (Boxes 17 and 20 in Chapter 2).

SOCIO-ECONOMIC IMPACTS OF PES SCHEMES

Whether and how PES schemes can alleviate poverty in upland watersheds depends on many factors. Although the objective of PES is not poverty alleviation but improving the flows of environmental services, PES schemes may in principle improve equity in watersheds by transferring revenues from richer lowlands to poorer upland areas (Pagiola, Bishop and Landell-Mills, 2002). Empirical evidence of the impact on the rural poor is sketchy, however, and the results are mixed. In some cases (e.g., Pimampiro in Ecuador: Box 18), incentive payments are reported to make up a significant share of the food, education and medical expenses of participating poor households (Echavarría, 2002). There are, however, several factors that make it difficult for the poor to benefit from PES programmes: (1) the transaction costs involved in joining the scheme – preparing the necessary documentation, travel time to the office, legal costs, etc. – are comparatively higher for poor small farmers than for richer landholders; (2) small farmers may lack the funds to invest in the activities required by the PES scheme, such as reforestation; (3) small farmers may be determined to commit to the long-term conservation of their property owing to risk aversion; and (4) the transaction costs of a PES scheme are higher if the scheme has to deal with many dispersed smallholders than when there are only a few large landholders, so schemes may restrict access for smallholders. In the FONAFIFO programme in Costa Rica (Box 20), for example, areas of as little as 1 ha may qualify for PES payments, but in practice the scheme adopts a minimum threshold of 10 ha, thus excluding small farmers.

PES schemes do not automatically improve equity in the watershed context. In fact, there may be trade-offs between reaching the environmental goals of the scheme in an economically efficient manner and contributing to poverty alleviation. It may be more cost-effective for schemes to target large landholdings in order to reduce transaction costs, but this reduces the potential impact on equity and the possibilities of including the poorer strata of a watershed population. If the PES scheme is to achieve social objectives, its design must be carefully tailored to include poor and small landholders, and this may reduce the attractiveness of a PES scheme as an efficient tool for environmental sustainability (Kiersch, Hermans and Van Halsema, 2005). Paying a large part of the incentive up-front, or improving participants' access to credit schemes, may improve poor households' chances of participating (Pagiola, Bishop and Landell-Mills, 2002), but funding sources would need to be identified to cover the additional costs arising from such a policy.

Costs and timing

The following establishment and operating costs of a PES scheme need to be considered:

- ***establishment costs,*** including: initial feasibility studies (land–water linkages, valuation of demand and supply); definition of rules and regulations; set-up of the institutional framework; training of staff in administration, monitoring and compliance control;
- ***operating costs,*** including: administration of the fund; collection of payments from service users; disbursement of funds to service providers; establishment of contracts with service providers; compliance monitoring;
- ***costs to providers for formalizing contracts,*** including: legal expenses; travel time and expenses; establishment of land-use plans.

Drawing up a PES scheme in a watershed context is an interdisciplinary effort. Experts in economics, hydrology, forestry, agronomy and social sciences have to be consulted during the planning process and operation of the scheme.

The PES scheme should be conceived as a long-term programme. Contracts with providers may initially be drawn up for three to five years, but should be renewable to ensure continued provision of the services and to allow the scheme to adjust payments and land-use requirements as new findings on land–water linkages emerge. Financial sustainability is a key aspect of this. Care must be taken to design the scheme so that the transfer payments and the operational costs are covered by the contributions of service beneficiaries. External funding sources should only be used to cover recurrent costs if they can be transformed into a sustainable funding mechanism, such as an endowment fund.

INTERNET RESOURCES

Ecosystem Marketplace

www.ecosystemmarketplace.com/

Features news, tools and case studies on market development for ecosystem services worldwide.

FAO Latin American Regional Electronic Forum on Payment for Environmental Services in Watersheds (April/May 2004.)

Final report: www.rlc.fao.org/foro/psa/pdf/report.pdf

Complete proceedings and case studies: www.rlc.fao.org/foro/psa

Proceedings of the forum, including lessons from ongoing PES experiences in a watershed context in Latin America and case studies.

Regional Forum for Payment for Environmental Services in Watersheds Arequipa, Peru, 9-12 June 2003

Final report: www.fao.org/documents/show_cdr.asp?url_file=/docrep/004/y3618e/y3618e00.htm

Case studies: www.rlc.fao.org/prior/recnat/foro.htm

The proceedings include various case studies of PES schemes in watersheds in Latin America.

FAO Land–water linkages in rural watersheds

www.fao.org/landandwater/watershed

Resources on:

- impacts of land-use systems and practices on hydrological regime and water quality;
- instruments for valuating water-related environmental services;
- case studies on PES schemes in watersheds.

International Institute for Environment and Development (IIED) Forestry and Land Use Programme

www.iied.org/nr/forestry/index.html

Includes background material and publications on PES.

Rewarding Upland Poor for Environmental Services (RUPES)

www.worldagroforestry.org/sea/networks/rupes/

A programme for developing mechanisms to reward the upland poor in Asia for the environmental services they provide. Contains background information on PES programmes and case studies in Asia with a livelihoods focus.

World Bank Environmental Economics Programme

www.worldbank.org/environmentaleconomics

Includes a useful section on PES.

FURTHER READING

Echavarría, M. 2002. Financing watershed conservation: the FONAG water fund in Quito, Ecuador. *In* S. Pagiola, J. Bishop and N. Landell-Mills, eds. 2002. *Selling forest environmental services: market-based mechanisms for conservation and development.* London, Earthscan.

FAO. 2000. *Land–water linkages in rural watersheds.* Land and Water Bulletin No. 9. Rome.

FAO. 2004. *Payment schemes for environmental services in watersheds.* Land and Water Discussion Paper No. 3. Rome.

Kiersch, B., Hermans, L. & Van Halsema, G. 2005. Payment schemes for water-related environmental services: a financial mechanism for natural resources management. Experiences from Latin America and the Caribbean. Paper presented at the UNECE Seminar on Environmental Services and Financing for the Sustainable Use of Ecosystems, Geneva, 10 to 11 October. Available at: www.unece.org/env/water/meetings/payment_ecosystems/discpapers/fao.pdf

Koch-Weser, M. & Kahlenborn, W. 2002. Legal, economic, and compensation mechanisms in support of sustainable mountain development. Draft background paper B1 for review by the Mountain Forum.

Landell-Mills, N. & Porras, I. 2002. *Silver bullet or fools' gold? A global review of markets for forest environmental services and their impacts on the poor.* Instruments for Sustainable Private Sector Development Series. London, IIED.

Pagiola, S., Bishop, J. & Landell-Mills, N., eds. 2002. *Selling forest environmental services: market-based mechanisms for conservation and development.* London, Earthscan.

Rojas, M. & Aylward, B. 2003. *What are we learning from experiences with markets for environmental services in Costa Rica? A review and critique of the literature.* London, IIED.

Wunder, S. 2005. *Payment for environmental services: some nuts and bolts*. CIFOR Occasional Paper No. 42. Bogor, Indonesia, Center for International Forestry Research (CIFOR).

Watershed management on the Web

FAO, FORESTRY DEPARTMENT

www.fao.org/forestry/index.jsp

The FAO Forestry Department helps nations to manage their forests in a sustainable way. The Organization's approach balances social, economic and environmental objectives so that present generations can reap the benefits of the earth's forest resources while preserving them to meet the needs of future generations. In helping member countries to conserve and utilize their forest and tree resources sustainably, FAO works in partnership with governments, international organizations and agencies, NGOs, the private sector, communities and individuals. FAO helps countries to develop economically viable approaches to the sustainable use of forest products and services and to account for the economic and environmental benefits that forests provide. FAO assists member countries with national forest policy formulation and the strengthening of forest-related institutions, including support for extension and community forestry.

FAO, LAND AND WATER DEVELOPMENT DIVISION

www.fao.org/ag/agl/watershed/watershed/en/mainen/index.stm

FAO's Land and Water Development Division is concerned with the development of technology, strategy and policy, and the provision of advisory and technical services to FAO members to ensure more productive and efficient use of land and water resources and plant nutrients in order to meet present and future food and agriculture demands sustainably. FAO's programme on hydrological services in watershed management explores the extent to which different land-use systems and practices affect hydrological regime and water quality, the scales and contexts where impacts are of importance, instruments to valuate the resulting benefits and costs to resource users, and institutional, economic, regulatory and social mechanisms that can be applied to achieve an equitable sharing of these benefits and costs by upstream and downstream resource users in a watershed context.

INTERNATIONAL CENTRE FOR INTEGRATED MOUNTAIN DEVELOPMENT (ICIMOD)

www.icimod.org/index.htm

ICIMOD is an international organization committed to improving the living conditions of mountain inhabitants in a sustainable way. It was established in 1981 based on an agreement between the Government of Nepal and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The centre is multidisciplinary, area-focused and mountain-based; it concentrates mainly on the Hindu Kush-Himalayan region. ICIMOD offers much to this region and to other mountain regions facing similar problems. In cooperation with regional and international partners, the centre develops and provides integrated and innovative solutions that foster action and change to overcome mountain people's economic, social and physical vulnerability.

EUROPEAN OBSERVATORY ON MOUNTAIN FORESTS (EOMF)

www.eomf.org/

EOMF has the task of developing a policy for mountain forests in Europe with the cooperation of all stakeholders. It was established in 1996 as an outcome of the first International Workshop of the European Project for Mountain Forests (Saint Jean d'Arvey, Savoie, France, 11 to 13 September).

The observatory's main mission is to unite different specialists in mountain forests in supporting resource conservation, sustainable economic and employment development, and the integration of national and international principles and recommendations.

WORLD AGROFORESTRY CENTRE (ICRAF)

www.worldagroforestry.org

ICRAF's mission is to advance the science and practice of agroforestry in order to transform them throughout the developing world. The centre has been working with smallholder farmers in Africa, Asia and Latin America for three decades.

ICRAF contributes to the protection of watershed services through agroforestry-based solutions that reward the poor for providing environmental services, improve the health and nutrition of the rural poor, build human and institutional capacity in agroforestry research and development, and conserve biodiversity through integrated conservation and development based on agroforestry technologies.

LATIN AMERICAN WATERSHED MANAGEMENT NETWORK (REDLACH)

www.fao.org/regional/lamerica/redes/redlach

REDLACH was created in 1980 with support from the FAO regional office for Latin America and the Caribbean. The network has the characteristics of both private and public institutions. Its main objectives include planning watershed management resources, promoting sustainable development concepts in Latin America and the Caribbean, increasing the technical capacity of member countries through the exchange of experience and knowledge, technical cooperation, and promoting watershed projects.

MOUNTAIN PARTNERSHIP

Water: www.mountainpartnership.org/issues/water.html
Watershed: www.mountainpartnership.org/issues/watersheds.html

The Mountain Partnership is a voluntary global alliance of partners dedicated to improving the lives of mountain people and protecting mountain environments around the world. It builds on the interest in mountain issues that has grown up since the Earth Summit of 1992. Launched at the World Summit for Sustainable Development in 2002, the partnership taps its members' diversity of resources, information, knowledge and expertise to support positive change in mountain areas. Its initiatives on the ground cover specific themes – policy and law, sustainable livelihoods, watershed management, research, gender, education, sustainable agriculture and rural development in mountains – in geographic areas that include the Andes, Central America and the Caribbean, Central Asia, East Africa, Europe and the Hindu Kush-Himalaya.

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

http://freshwater.unep.net/ | www.unep.org/

UNEP's mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing and enabling nations and people to improve their quality of life without compromising that of future generations. It was established in 1972, after the UN Conference on the Human Environment. UNEP supports national governments' participation in international negotiations, helping them to fulfil their obligations under international agreements, develop institutions and formulate and enact legislation to protect the environment. UNEP promotes dialogue and cooperation among stakeholders, the exchange of best practices and success stories, and the transfer of knowledge and technology. It develops policy guidelines for addressing major environmental issues, such as the increasing scarcity of freshwater, degradation of the marine environment and pollution of the atmosphere.

WORLD MOUNTAIN PEOPLE ASSOCIATION (WMPA)

www.mountainpeople.org/en/actions/eau.php | www.mountainpeople.org/

WMPA emerged from the World Mountain Forum, held at UNESCO (Paris) and in Chambéry, France in June 2000, to provide mountain people with a platform for their opinions and desires. It is present in more than 70 countries on four continents, and is organized into regional and national bodies of local institutions, NGOs, scientists, small-scale enterprises, etc. WMPA has three major objectives: to increase the understanding of mountains internationally, regionally and nationally; to organize North–South and South–South exchange and cooperation among mountain territories and populations in sharing knowledge, means and experience; and to support and develop the local initiatives of its members and partners.

CENTRE FOR DEVELOPMENT AND ENVIRONMENT (CDE)

www.cde.unibe.ch/themes/wm_th.asp | www.cde.unibe.ch/

CDE's mission is to contribute to sustainable development through research partnerships, education and training, the development of concepts and tools, awareness raising and policy advice. It focuses on the management of natural resources, integrated regional development and interventions that mitigate the symptoms of global change. It employs disciplinary and interdisciplinary approaches, links analysis and synthesis, and combines high-end and low-end methods, such as GIS-based observations and participatory field-based approaches. CDE supports the principles of subsidiarity, empowerment and partnership, while acknowledging the importance of research, planning and decision-making at the regional, national and international levels.

MOUNTAIN FORUM

www.mtnforum.org/index.cfm

The Mountain Forum is a global network of individuals and organizations concerned with the well-being of mountain people, their environments and their cultures. It was founded in 1996 with the participation of mountain stakeholders, and is a global network of networks guided by a Board of Directors. The Mountain Forum seeks to bring the lessons and experiences of mountain people into policy discussions at the national and international levels with the aim of improving their livelihoods and promoting the conservation of mountain environments and cultures.

MOUNTAIN STUDIES INSTITUTE (MSI)

www.mountainstudies.org/databank/datalinks.asp?category=hydrology
www.mountainstudies.org

MSI is an independent, non-advocacy, non-profit mountain research and education institution and high-altitude field station established in 2002 in Silverton, Colorado, the United States. Its mission is to enhance understanding and sustainable use of the San Juan Mountains through research and education. While focusing on a distinct mountain range, MSI activities serve the global mountain community and have broader applications to the study of mountain systems – mountain environments, mountain people and their interactions. MSI serves students, educators, researchers, land and environmental managers, elected officials and the public, within the region and beyond. It uses research and education as a sustainable economic development model for mountain communities.

CONSORCIO PARA EL DESARROLLO SOSTENIBLE DE LA ECORREGION ANDINA (CONDESAN)

www.condesan.org/iniciativas.htm | www.condesan.org/

The CONDESAN initiative was born in 1992 at a meeting of academics in Lima. It is a consortium of more that 75 research institutions, universities, NGOs, businesses, producer groups and government agencies. Its main objective is to create a new form of cooperation in the Andina region to include all the actors that contribute to protecting the ecosystem. Other objectives include improving the market situation in this area, enhancing the capacity of local people and ensuring that information reaches the grassroots.

AFRICAN MOUNTAIN ASSOCIATION (AMA)

www.madagascar-mountain.org/bassins.htm | www.madagascar-mountain.org/ama.htm

AMA's main aim is to improve knowledge about mountain environments in Africa and to highlight their importance as resources that should be used carefully for posterity. It was founded in 1986 during a workshop for African and non-African researchers held in Ethiopia. It aims to establish cooperation among mountain territories for knowledge and experience sharing to benefit mountain inhabitants and to promote recognition of the problems facing mountain populations. AMA emphasizes the need for national and international development.

MILLENNIUM ECOSYSTEM ASSESSMENT (MEA)

www.maweb.org//en/index.aspx

MEA is an international programme of work designed to meet the needs of decision-makers and the public for scientific information concerning the consequences of ecosystem change on human well-being and the options for responding to such change. It was launched by the UN Secretary-General in June 2001 and completed in March 2005. MEA focuses on ecosystem services (the benefits that people obtain from ecosystems), how changes in ecosystem services have affected human well-being, how ecosystem changes may affect people in future decades, and response options that might be adopted at local, national or global scales to improve ecosystem management and thereby contribute to human well-being and poverty alleviation.

MEA is an instrument for identifying priorities for action. It helps identify options for achieving human development and sustainability goals, and has helped build individual and institutional capacity to undertake integrated ecosystem assessments and act on their findings.

CENTRE FOR INTERNATIONAL FORESTRY RESEARCH (CIFOR)

www.cifor.cgiar.org/

CIFOR is an international research and global knowledge institution committed to conserving forests and improving the livelihoods of people in the tropics, through collaborative, strategic and applied research and by promoting the transfer and adoption of appropriate new technologies and social systems for national development. CIFOR's high-impact research helps local communities and small farmers to gain their rightful shares of forest resources, while increasing the production and value of forest products. CIFOR's three research programmes address the needs of the rural poor as well as environmental concerns: the environmental services and sustainable use of forests programme oversees research on biodiversity, carbon, fires, watershed functions, and the sustainable management and harvesting of forest products; forest governance examines the process of making and implementing decisions about the management of forests by people and organizations beyond the scale of the individual household or small enterprise; and forests and livelihoods closely investigates how forest resources and their management, use and trade contribute to the livelihoods of the rural and urban poor.

CENTRE FOR LAND USE AND WATER RESOURCE RESEARCH (CLUWRR)

www.cluwrr.ncl.ac.uk/index.php

CLUWRR is the focus for integrated environmental management research at the University of Newcastle-upon-Tyne, the United Kingdom. Its mission is to develop integrating methodologies for linking ecology, hydrology and economics, taking account of sustainability, equity, socio-economics and stakeholder participation issues, and to apply technologies and methodologies that assist the development of plans, strategies, guidelines and policies for improved environmental, land use and water resources management at the local, regional, national and international scales.

WORLD CONSERVATION UNION (IUCN): WATER AND NATURE INITIATIVE

www.iucn.org/themes/wani/

The main goal of IUCN's Water and Nature Initiative is the mainstreaming of an ecosystem approach into catchment policies, planning and management. The initiative aims to develop a coherent set of activities that are innovative and directed at guiding future investment and actions in water resources management and nature conservation. The principles involved include: participation, which involves empowering all stakeholders to participate in water management; strategy, which involves having the maximum possible effect; transparency, which involves clarity in decision-making and management; catalytic, which involves influencing, facilitating and initiating action; and innovation, which involves developing knowledge within projects and sharing it with the widest audience possible.

INTERNATIONAL WATER MANAGEMENT INSTITUTE (IWMI)

www.iwmi.cgiar.org/index.htm

IWMI is a non-profit scientific research organization focusing on the sustainable use of water and land resources in agriculture and on the water needs of developing countries. The institute takes a multidisciplinary approach to water management research. It works through collaborative research with partners in the North and South to develop tools and practices to help developing countries eradicate poverty and manage their water and land resources better. IWMI's mission is to improve water and land resources management for food, livelihoods and nature.

WORLD RESOURCES INSTITUTE (WRI)

water.wri.org/index.cfm

WRI is an environmental think-tank that uses research to create practical ways of protecting the earth and improving people's lives. Its mission is to encourage human society to live in ways that protect earth's environment for current and future generations. Its programme tackles global challenges by using knowledge to catalyse public and private actions. The institute protects the capacity of ecosystems to sustain life and prosperity, expands participation in environmental decisions, promotes public and private actions to ensure a safe climate and increases prosperity while improving the environment. WRI tries to build bridges between ideas and actions, meshing the insights of scientific research, economic and institutional analyses and practical experience with the need for open and participatory decision-making.

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE (IDRC): WaDImena

www.idrc.ca/en/ev-57064-201-1-do_topic.html | www.idrc.ca/index_en.html

IDRC is a public corporation created by the Parliament of Canada in 1970 to help developing countries use science and technology to find practical, long-term solutions to the social, economic and environmental problems they face. Support is directed towards developing indigenous research capacity to sustain policies and technologies that developing countries need to build healthier, more equitable and more prosperous societies WaDImena is a five-year multi-donor-funded programme (2004 to 2009) coordinated by IDRC in partnership with the Canadian International Development Agency (CIDA) and the International Fund for Agricultural Development (IFAD). WaDImena contributes to effective water governance by enhancing water use efficiency, equity and sustainability.

CENTRE FOR WATERSHED PROTECTION

http://www.cwp.org/index.html

Founded in 1992, the Centre for Watershed Protection is a non-profit corporation that provides local governments, activists and watershed organizations with the technical tools for protecting precious natural resources: streams, lakes and rivers. The centre has developed and disseminated a multidisciplinary strategy for watershed protection that encompasses watershed planning, watershed restoration, storm water management, watershed research, better site design, education and outreach, and watershed training. As techniques for protecting small watersheds from the detrimental effects of sprawling development and the accompanying impervious cover continue to improve, the Centre for Watershed Protection has been at the heart of this newly emerging practice.