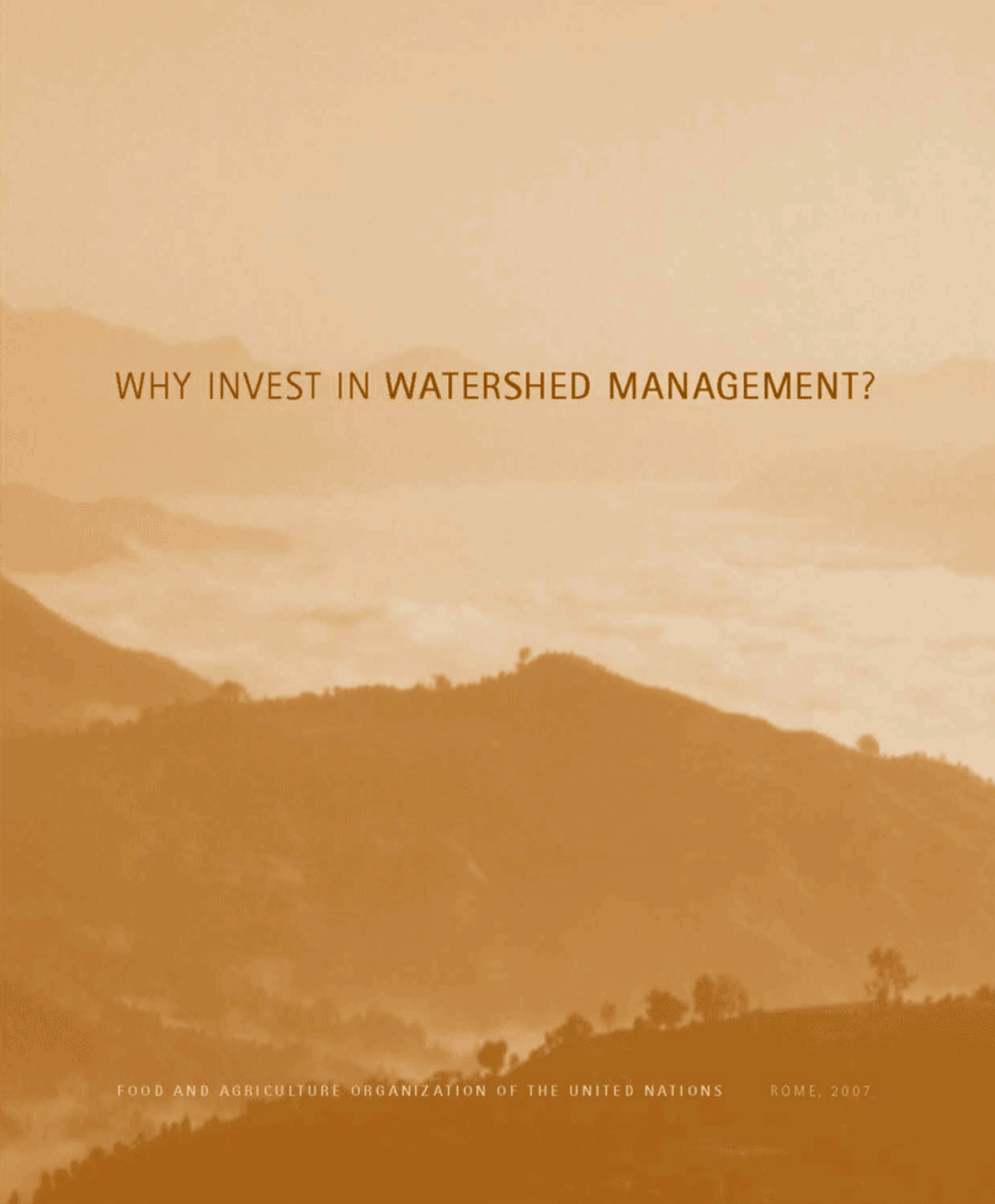
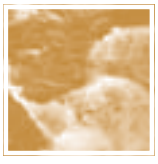
WHY INVEST IN WATERSHED MANAGEMENT?

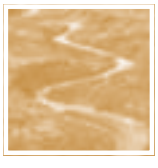
WHY INVEST IN WATERSHED MANAGEMENT?



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS ROME, 2007

CONTENTS





WHAT ARE WATERSHEDS?

Watersheds are the familiar landscapes created by mountain ranges as they slope down to valleys, with creeks and torrents flowing downstream. Also known as drainage areas or river basins, watersheds are the zones from which rain or melting snow drains downhill into a river, lake, dam, estuary, wetland, sea or ocean. A watershed can be as large as several thousand square kilometres (as in the case of major river basins), or as small as a few hectares (as in the case of farm micro-watersheds). Smaller watersheds are nearly always part of a larger watershed or river basin.

Watersheds are powered by the force of gravity, which makes water flow downstream according to the gradient of the slope. This physical process generates extra energy, which makes the watershed environment highly dynamic. Highland rainfall is collected and delivered to downstream areas. Surface and underground water resources are created and recharged. Vegetation is irrigated and animals watered. Soil is enriched by the mineral and organic sediments carried by runoff. Seeds are transported.

Depending on the climate, watersheds can host rich floras and faunas, or be deserts except for during the rainy season. Owing to their variety of altitudinal gradients, temperatures and rainfalls, most watersheds include a range of distinct vegetation belts, such as mountain rangeland, forest belt and lowland prairie. As these vegetation belts are often interlinked by water discharge, runoff flows and other biophysical processes, watersheds are complex and diverse "vertical" ecosystems that integrate a variety of ecotypes and ecological niches.

Top: Glacier watershed in the Swiss Alps
Centre: Seasonal torrent in a pre-Atlas watershed, Tunisia
Bottom: Downstream wetlands in the Danau Sentarum river basin, Indonesia

Opposite page: Himalayan watershed landscape

READING A WATERSHED LANDSCAPE

Observation and interpretation of landscape features can help to understand the functioning of watershed ecosystems. In this picture of the upper Indus river watershed (Pakistan), four main landscape units can be identified:

1. The horizon is made up by the peaks of the Himalayan ranges. Precipitation is temporarily stored in the glaciers or the snow caps. Glacial and snow melt contribute to the perennial discharge of the Indus river and its tributaries, which is of particular relevance during the dry season when there is little downstream rain.
2. These south-facing and steep slopes are part of the middle mountains of the Himalayas. Their geological layers are parallel to the slope, which makes these hills highly exposed to erosion. Over the millennia, tectonic movements and rain showers have shaped this landscape, weathered the slopes, dug torrents and triggered landslides. These processes have been reinforced by the southern all-day-long exposure to the sun rays, and by human-made deforestation and overgrazing.
3. On the eastern side, the geological layers are at right angles to the slope and there is less direct exposure to the sun. Accordingly, these slopes are more stable and are covered by vegetation. Differentiated erosion has created natural terraces, which local farmers have extended over the centuries to practise agriculture and agroforestry.

4. Confined by a large meander bend of the Indus river, this almost flat alluvial terrace is formed by an ancient rockslide and by fertile sediments deposited over millennia by the Indus river and its tributaries. Availability of surface and underground water allows for a dense vegetation cover. As evidenced by the presence of settlements, agricultural fields and infrastructure, this area offers considerable potential for human livelihoods.

Humans are often part of watershed ecology, and traces of human activities are clearly visible in watershed landscapes. For 5 000 years, humans have been manipulating streams and slopes in order to irrigate fields, control floods and drought and supply drinking-water to villages and towns. Watershed management works, such as terraces, irrigation works and aqueducts, have significantly contributed to the development of human civilizations.

Since the end of the nineteenth century, modern technology has made it possible to implement huge hydraulic works at inaccessible mountain sites. Dams have been built upstream for generating hydroelectric power and supplying water to local and downstream users. Watersheds have thus become an essential source of water, energy and other natural resources for modern agricultural, industrial and urban development.

KEY TERMS

A **watershed** is the geographical area drained by a water course. The concept applies to units ranging from a farm crossed by a creek (a micro-watershed) to large river or lake basins.

A **river basin** corresponds to the complex system of watersheds and sub-watersheds crossed by a major river and its tributaries while flowing from the source to the mouth.

Watershed management is any human action aimed at ensuring a sustainable use of watershed resources.

Below: An artificial lake and its dam in Turkey

SERVICES PROVIDED BY WATERSHEDS

Watersheds offer multiple services to human societies. The world's supply of freshwater for domestic, agriculture and industry uses depends very much on flows that are created and regulated by watersheds. Agriculture and food security largely depend on surface water and sediments, collected and transported by the slopes of watersheds. Watershed forests are an important source of timber and fuelwood. Symbolic or recreational value is often attached to the natural and cultural landscape of watersheds. And last but not least, many rural people directly depend on watershed natural resources for their lives and livelihoods.

Watersheds capture most of the 110 000 km³ of rain that falls to earth every year. Thanks to their basin shape, watersheds also store most of the renewable freshwater reserves in the form of underground water and soil moisture. Watersheds do not simply collect water, however. Rain is initially absorbed by watershed soil. Part of the precipitation flows rapidly downstream as runoff; the other part is evaporated or retained by the vegetation and filtered into the water table (which feeds springs and wells), or — at high altitude — transformed to snow and ice (which slowly melt during the hot season). Watersheds regulate water flows, preventing floods and droughts in the nearby downstream areas.

Watershed processes also enhance water's chemical properties. By flowing over rocky soil or being stored in underground reservoirs, rainwater is enriched with the mineral salts that are essential for all living beings. Surface runoff brings downstream mineral and organic sediment, which fertilizes the lowlands. The physical and chemical

Top: Villagers digging an irrigation channel in Kabul district, Afghanistan
Bottom: Woman washing clothes at a fountain in a Nepalese village

Opposite page: Waterfalls in the Meghalaya Hills, India, one of the wettest places on earth, discharging into the floodplains of Bangladesh

FRESHWATER FIGURES

> Freshwater available on earth has a global volume of about 35 million cubic kilometres. 99.6% of this water is stored in glaciers or underground. The remaining 0.4% corresponds to atmosphere water, surface water, and soil moisture. (*)

> In humid areas, the proportion of water generated in the mountains can comprise as much as 60% of the total freshwater available in the watershed, while in arid and semi-arid areas, the proportion is much higher – up to 95%. (**)

> Of all the freshwater used by humankind, 70% is used for agriculture and 20% for industry. Domestic uses account for only 10% of the total. (*)

> Hydropower supplies 2.2% of the world's energy and 19% of the world's electricity needs. (*)

> At present 45 countries, where over 750 million people live, face a situation of water stress, which means that the renewable water resources per person are less than 1 700 m^3/ year. In 2025, this will concern 54 countries and more than 2.8 billion people. (*)

(*) *Source*: FAO. 2007. Aquastat online data base, Rome. www.fao.org/ ag/aquastat

(**) *Source*: Mountain Agenda 1998. *Mountains of the world. Watertowers for the 21st century.* Bern, Switzerland. University of Bern.

action of slope vegetation ensures optimal absorption, filtration and release of runoff. In addition, forest trees and underwood protect the soil against the impact of rainfall and deliver additional fertile organic sediment.

Watershed slopes control the strength and speed of runoff flow. Since 3 000 BC, human societies have learned to control watershed streams to feed irrigation schemes. For hundreds of years, these streams have also powered mills, timbering machinery and mining equipment. Twentieth-century hydraulics has succeeded in converting watershed force into hydroelectric power, which has become an important source of clean energy.

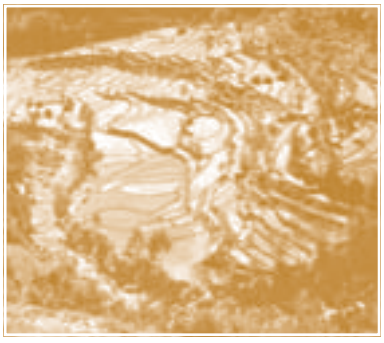
A regulated water flow is certainly the most outstanding service that watersheds provide to societies, but it is not the only one. The water-rich soil of watershed slopes often encourages the growth of shrubs and trees. This vegetation cover slows runoff erosion – i.e. the removal of soil as it is washed out by water. In particular, the deep and tangled roots of forest trees contribute to the cohesion of land surface layers. Tree trunks are an effective barrier against landslides and avalanches.

WATERSHED ENVIRONMENTAL SERVICES AND THEIR USERS

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

The role of watershed natural resources in upland farming, ranching and timbering should not be forgotten. Through a complex adaptation process, upland cultures have developed sophisticated livelihood practices that allow local people to make a sustainable living in the special (and sometimes harsh) environment of watersheds. Watersheds also contribute to the welfare of society at large by supplying upland crops and foods, wood products, minerals and a source of bio- and cultural diversity. The socio-economic importance of watersheds is twofold: for local inhabitants and for lowland users of watershed produce.

Subsequently, watersheds have also attracted industrial-scale business. Mining has been a major industry in the uplands for a long time. Hydropower plants and dams have been built in many watersheds over the last 50 years. The tourism industry has also mushroomed, taking advantage of watersheds' natural and cultural landscapes. Public funds have been invested in building roads and infrastructure, and the real estate market has developed in many upland areas.



Top: Forest belt protecting a settlement and fields from avalanches in Val Müstair, Switzerland
Centre: Downstream irrigated terraces in the Hilkot watershed, Pakistan
Bottom: A hydropower plant in the Eastern Andes, Ecuador

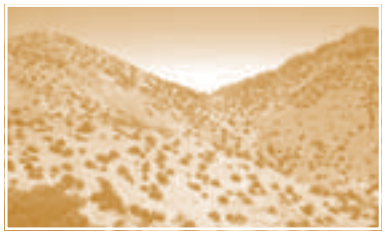
Opposite page: Springtime torrent carrying sediments downstream in the Ourika Valley, Morocco

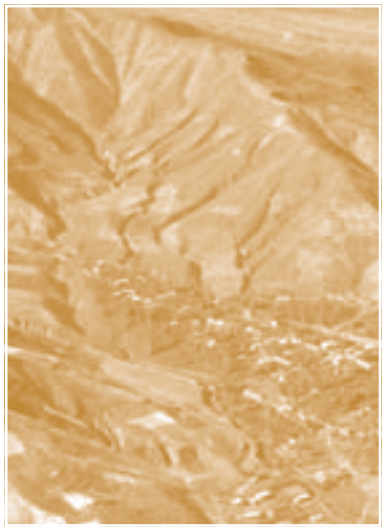
RISKS AND THREATS TO WATERSHEDS

Watershed ecosystems are relatively stable and solid. Throughout history, there are very few instances of watershed collapse due to human activities. However, starting in the twentieth century, unsustainable development has often threatened the ecology of watersheds in many parts of the world.

In many cases, local population growth (resulting from better health status and education) has played a primary role in this process. To support the lives of ever-increasing numbers of people, upland forests have been cleared and turned into agricultural or grazing land. Large-scale timbering and fuelwood collection have contributed to watershed degradation. Loss of forest cover has increased upstream erosion and downstream sedimentation. Because of these changes, many watersheds are losing their capacity to regulate runoff. Subsequently, upland soil has become more arid, and nearby lowland areas more exposed to seasonal flooding. Landslide threats have also increased.

Combined with the adoption of inappropriate technologies, uncontrolled population growth has sometimes made upland livelihoods unsustainable and insecure. The majority of upland inhabitants migrate to towns or the lowlands. In the regions that first experienced this process (e.g. the Mediterranean), this has eventually led to depopulation of many highly degraded watersheds. Such depopulation has not proved beneficial for watershed ecology. Without land husbandry, erosion increases, stream regulation decreases and forest fires become more frequent. Sustainable human activities are essential to the ecological balance of watersheds.





Top: Overgrazed and devegetated uplands in the High Atlas mountains, Morocco
Centre: Mechanized timbering on steep slopes, Bhutan
Bottom: A degraded watershed in Tajikistan

Opposite page: Gully erosion on arable land caused by upstream overgrazing in Southern Lesotho

Top: Expansion of residential areas on the slopes of the Quito Valley, Ecuador
Bottom: Urbanized watershed in the Syrian Arab Republic

Opposite page: The impact of a flash-flood on infrastructure in Paznau Valley, Austria

Ill-designed hydraulic engineering is another leading cause of watershed degradation. Many dams and reservoirs have been built on the basis of inaccurate estimates of water reserves and runoff, and with insufficient attention to the roles that forest and other vegetation cover play in controlling the speed and composition of these flows. Residential areas, roads or tourist resorts built on steep slopes contribute to the increase and acceleration of runoff. Natural and artificial basins have often proved incapable of retaining this flow. Many of them have been filled by sediment, and some have overflowed, causing downstream disasters.

Reforestation and the eviction of local people from critical areas such as forests, steep slopes or wetlands have been the most common measures to prevent watershed risks and threats. Conventional conservation policies have not always been successful, however. Reforestation with rapid-growing, exotic species has altered watershed

THE VAJONT TRAGEDY

In the 1950s, Italy was still recovering from the Second World War. Urbanization and industrialization were the engines of an accelerated development process. Demand for electricity was increasing, and major public investments were made to build dams and turbines in the Alps and Apennines. The environmental and social costs of these works were underestimated or simply disregarded.

To power the industrial development pole of Porto Marghera (Venice), a major hydroelectric plant was built in the Vajont valley, an impressive canyon in the eastern Alps. Local people who suffered expropriations and resettlements were sceptical about the technical viability of the work: they knew that the surrounding mountains were unstable and prone to landslides, particularly Mount Toc (which means the "fragmenting mountain" in the local language).

On 9 October 1963, a landslide of 260 000 m^3 broke off from Mount Toc and fell into the dam reservoir. The gigantic wave caused by the landslide by-passed the dam and flooded the downstream valley. Two thousand people died, and half of the inhabitants in the valley lost houses and fields. The watershed management works – terraces, irrigation and drainage channels, and tree plantations – that local farmers had made over the centuries were destroyed in a few minutes.

The Vajont tragedy had a major impact on Italian public opinion and politics. The country understood that any work affecting the geological and hydrological balance of watersheds requires strict and sound security regulations. Many people also realized that economic growth cannot take place at the expense of the environment.

Source: www.vajont.net

ecology, with unknown long-term consequences that are still not fully understood. Local biodiversity has been partially lost. Evictions of watershed inhabitants from forests, meadows and riverbanks have worsened people's livelihoods, enhanced social conflict and taken critical environments out of community control. In general, State-enforced, "top-down" conservation measures have not proved to be very useful in the management of watersheds.

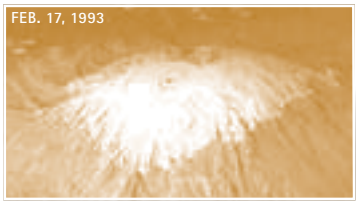
Global climate change is also contributing to watershed degradation. Because of global warming, glaciers and perennial snow melt more quickly, reducing this important freshwater reserve and altering down-slope flows. Changes in vegetation that are connected with changes in temperature and water availability can be observed. Areas that were once fertile have become barren and unproductive.

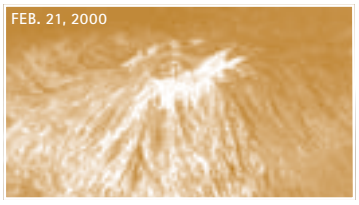
KILIMANJARO'S "PERENNIAL" SNOWS

Ernest Hemingway's story "The snows of Kilimanjaro" made this African mountain famous for being perpetually shrouded in snow, despite its location in the equatorial belt. The glaciers on Mount Kilimanjaro have persisted for at least 10 000 years. But as a result of the combined effect of global climate change and modification of local practices (including changes of land use), they lost 80% of their area during the twentieth century. In 2000, images from Landsat (see below) presented an alarming picture.

They showed that much of the snow and glacier at the Kilimanjaro summit had disappeared in just ten years. If the current trends are not inflected, the loss of more than half a metre in thickness each year will likely lead to the complete disappearance of the Kilimanjaro ice fields in less than 15 years, with significant consequences on downstream hydrological flows.

Source: Based on UNESCO World Heritage Centre. 2007. *Case studies on climate change and world heritage.* Paris, UNESCO.



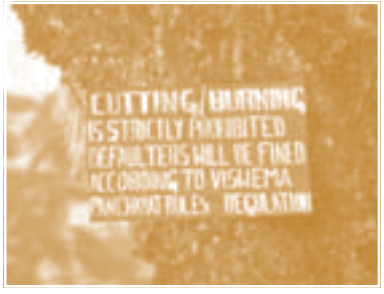


COLLABORATIVE WATERSHED MANAGEMENT

Watershed degradation can be prevented and degraded watersheds restored by appropriate watershed management. Modern watershed management was born during the twentieth century as a technical practice, largely based on major hydraulic engineering and forestry interventions. However, experience has shown that technical measures alone are not enough to address watershed problems.

Owing to the pivotal role of human population in watershed health and balance, local livelihoods are a major issue in sustainable watershed management. Conservation agriculture has to be encouraged. Alternative income-generating activities should be promoted to divert the pressure on land resources. These socio-economic interventions require awareness raising and capacity building at different levels — farmers, extension staff, administrators, etc. In some contexts, education, health, social security, ethnicity and land rights issues are also closely related to watershed management. Although water and runoff are the main focus of watershed management, most experts nowadays agree that relevant programmes need to be embedded in broader sustainable development processes.

Watershed management requires the participation of different stakeholders, such as forest users, farmers, landholders, local government and line agencies. As watershed management always has economic and social costs, consensus on the sharing of these costs should be reached. Negotiation, mediation and compromise within the local political arena are an essential part of watershed management practice. They are best addressed through a



Top: Agricultural terracing has shaped the steep landscape of the Cinque Terre watersheds, Italy
Centre: Panchayat (local government) sign prohibiting timbering and fuelwood collection on common land, India
Bottom: Discussing watershed management activities in a Bhusunde Khola village, Nepal

Opposite page: Farmers digging terraces with hand tools in a watershed management programme in Sichuan Province, China

KEY TERMS

Collaborative management – also called joint management – embeds the management of natural resources in local livelihoods, culture and governance. In collaborative management, stakeholders 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.

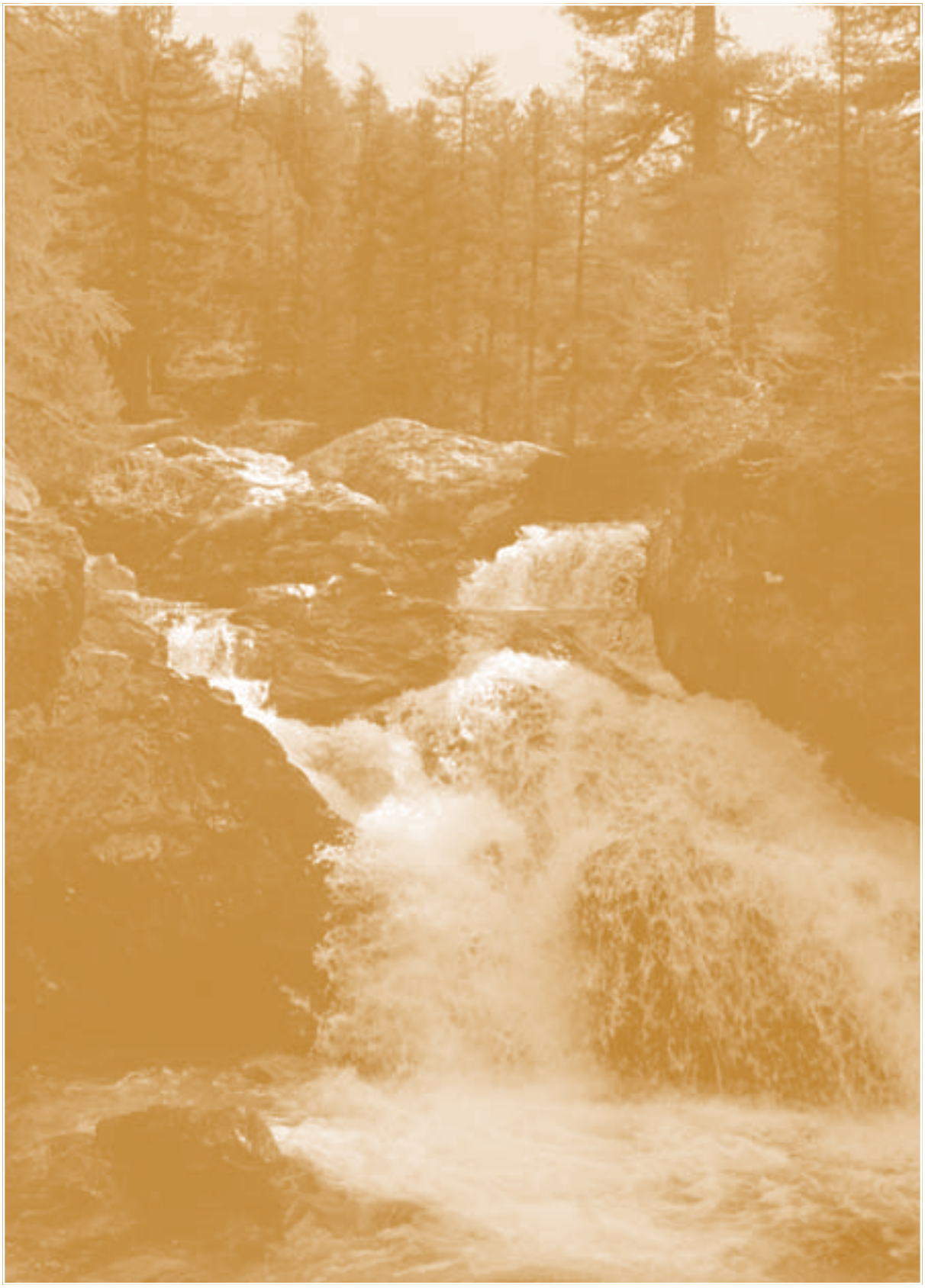
Upstream/downstream linkages are the environmental, socio-economic and cultural flows, synergies, exchanges and conflicts between the upper and lower parts of a watershed.

Above: GIS experts assessing the situation on the ground, Azerbaijan
Above/right: Community forestry extension for watershed protection in Ecuador

Opposite page/top: Harvesting an upstream forest in Nepal
Opposite page/bottom: Downstream farming in Bhusunde Khola watershed, Nepal

collaborative approach in which technical resource people, high-level decision-makers, local administrators and local stakeholders share the responsibility of assessing the local situation and undertaking the necessary action.

One of the main goals of collaborative watershed management is to ensure balanced and sustainable upstream/downstream linkages. For instance, upland forest use (which is often vital for local people) must be made compatible with the need for continued provision of essential environmental services, such as landslide protection, erosion control, and regulation of discharge and water quality in lowland irrigated areas. Experience suggests that balanced upstream/downstream linkages are achieved when policies are able to buffer the socio-economic disadvantage generally affecting upland people, and lowland stakeholders are willing to pay for upstream environmental services.



WATERSHED ECONOMICS

One reason for imbalance in upstream/downstream exchange is that watershed environmental services are often treated as pure "public goods". Unlike other watershed resources, such as timber, livestock products or minerals, the value of these services is seldom expressed in monetary terms and there are no markets where they can be bought or sold. Nevertheless, upland water, sediment, hydropower, vegetation cover, and disaster prevention services have quantifiable market values, even though none of these are fully taken into account in upstream/downstream financial exchanges. The market value should include the opportunity costs borne by upstream stakeholders for limiting their use of critical resources (e.g. land, forest), or for their disadvantaged living conditions (e.g. lack of roads, distance from marketplaces). Watershed environmental services are therefore better addressed as environmental "externalities" — values that the market fails to include — rather than as pure "public goods".

Top: An irrigation scheme in arid northern Senegal
Bottom: Selective timbering for sustainable forest use in Belém, Brazil

Opposite page: Mountain freshwater discharge has a major economic value

WATERSHED MANAGEMENT AND GLOBAL TRADE: THE PANAMA CANAL

For each transiting ship, 200 litres of freshwater are needed to operate the locks of the Panama Canal. Every year, 14 000 ships pass through the canal, and freshwater demand has become unsustainable for the canal watersheds, which are highly degraded. Scientists at the Smithsonian Tropical Research Institute in Panama think that reforesting the watersheds would help regulate the water supply and decrease the amount of sediment and living matter in the canal's engineering. More trees would trap sediments and nutrients and regulate the supply of freshwater. The effect of reforestation around the Panama Canal would be comparable to those of conventional engineering works such as reservoirs and filtration beds.

Every year, 192 million tonnes of cargo and 700 000 people are transported along the Panama Canal. If the canal has to stop operating because of inadequate watershed management, the costs of transporting people and cargo around South America will increase, and there will be significant increases in the prices of goods throughout much of the world. Viewed this way, sustainable management of the canal watershed is an investment in world trade infrastructure.

Source: Based on Environmental economics: Are you being served?, *The Economist*, 23 April 2005.

Right: One of the Andean lakes that supply water to the city of Cuenca, Ecuador

Opposite page: Forest protection sign at the entrance of the capital town of Himachal Pradesh, India

KEY TERMS

Payment for Environmental Services (PES) schemes are direct compensation mechanisms by which environmental service providers are paid by service users for the provision of a given environmental 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 positively affects the availability and/or quality of downstream water resources.

Environmental public goods are environmental goods (e.g. air, water or landscape) that are available to everybody on a non-rivalry (i.e. use does not diminish access for other users) and non-exclusion (i.e. use does not prevent other users from benefiting from the good) basis.

Externalities occur when a fraction of the economic value of a good is not captured by its market price. For instance, water tariffs seldom include the costs of conserving the forested watershed from where the water comes.

Recovering these "externalities" is essential to ensure a steady and continued source of financing for watershed management programmes. In affluent countries, public sector subsidies and incentives are made available to upstream stakeholders as compensation for their environmental services. But economic and political constraints prevent most developing countries from delivering subsidies. Direct payment for some of these services has been successfully tested, particularly for the provision of drinking-water supply. Watershed trust funds have also been created, with bonds sold to private investors and parts of the profits used to operate watershed works.

Payment for watershed environmental services is affected by technical, cultural and political factors. At the outset, there is a major difficulty in estimating the actual value of watershed externalities. Site-specific assessments are necessary to identify the benefits that are provided in a specific social and economic context, and the scales at which they can be detected and have economic significance. Next, the capacity and willingness of lowland beneficiaries to pay should be assessed and promoted. A legal and administrative mechanism should be put in place to control the quality of the services provided, collect payments and ensure that benefits are eventually transferred to watershed management activities. This complex process needs sensible and competent local governance.

A MUNICIPAL WATERSHED INVESTMENT FUND

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 the 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 collaborative management plan, which is adapted to the environmental plans of the two ecological reserves.

Since 2000, FONAG has been 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% of potable water sales, and 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.


REPUBLICA DE EL SALVADOR EN LA

WATERSHED GOVERNANCE AND POLICIES

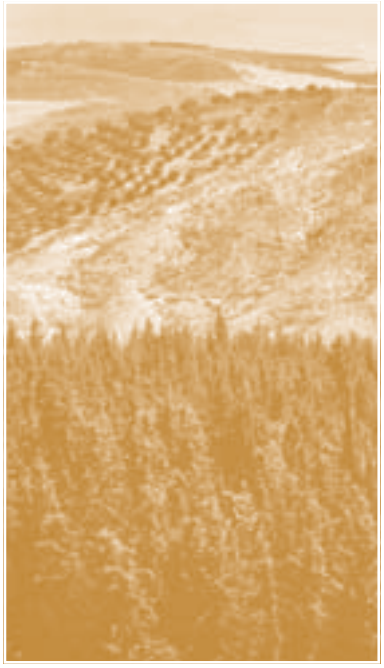
Municipality and district-level authorities are often the primary bodies responsible for household water supply. In some cases, management of drinking-water distribution has been linked to other water uses, such as hydropower or irrigation, as well as to forest management and land administration. This has given many municipalities and districts a pivotal role in watershed management.

Following political reforms in many countries during the 1990s, decentralization has strengthened local governments' mandate for watershed management and facilitated the involvement of civil society organizations and grassroots stakeholders. However, it has often been 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. In many places, it is necessary to enhance the capacity of local governments and civil society stakeholders to deal with the organizational issues related to collaborative watershed management.

Although local participation, consensus and political will are vital, these factors alone are not enough to manage watersheds. Technical expertise is also needed to address the variety of engineering, forestry, agricultural, social and legal problems involved. The downstream impacts of local decisions have to be considered in policy-making, and external investments are needed to tackle upstream problems. Watershed management can therefore rarely be confined within the local governance arena. In cases where

Top: Watershed planning meeting in Gorkha district, Nepal
Centre: Participatory watershed mapping in Kanak Valley, Pakistan
Bottom: Collaborative watershed management workshop in Bellavista, eastern Bolivia

Opposite page: Municipal watershed planning in San Francisco de Lempa, El Salvador



Above: The role of forest plantations in protecting watershed has often been misconceived and exaggerated (Tunisia)

watersheds overlap the territories of more than one administrative unit, watershed management institutions are needed to harmonize the interests and needs of different sites and different locations.

Watershed governance is unlikely to succeed if a supportive policy environment is lacking. Watershed management policies should be based on a sound understanding of watershed processes and their actual costs and benefits. Policy-makers often find it difficult to accept the uncertainty about long-term watershed planning, however, and tend to rely on outdated, oversimplified models. This can result in false assumptions and misconceptions about policies' expected short-term impacts. Many experts now believe that for decades watershed management policies were based on myths or common wisdom, rather than on concrete, scientific evidence. For instance, the role of forestry plantation in regulating water flows has been often overestimated and oversimplified.

THE SASSARI DECLARATION

In 2002-2003, FAO carried out an inter-regional review of watershed management policies and practices. The review process culminated in a conference at Sassari, Italy, where a final declaration was issued.

According to this declaration: "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.

"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; 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."

During the last 15 years, most national governments and regional organizations have addressed watershed management in the framework of their water, soil and forest conservation policies. In some cases, watersheds have been used as the territorial units for implementing rural poverty alleviation and food security programmes. Subsequently, strong links have been made and developed between watershed management and sustainable agriculture and rural development policies in upland areas. The International Year of Mountains (2002), the International Year of Freshwater (2003) and the 2003 International Mountain Day played a catalytic role in this trend.

Watershed management experts have recently recommended that water supply should be the central point at which different sectors — such as agriculture, irrigation and forestry — should converge. Several national governments are now reviewing their policies according to a watershed management perspective.

Above: Poster for the first International Mountain Day, 11 December 2003

SOUTH AFRICA'S NATIONAL WATER POLICY

In 1997, the Government of South Africa adopted a national water policy with three objectives: equitable access to water, sustainable use of water, and efficient and effective water use. Based on these objectives, the National Water Act (1998) was issued to provide for the development, conservation, management and control of South Africa's water resources. The National Water Resource Strategy describes how water resources have to be managed in accordance with the policy and law. It includes the following provisions:

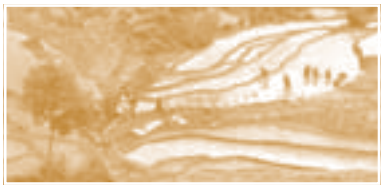
- Water will be regarded as an indivisible national asset. National government will act as the custodian of the nation's water resources, and its powers in this regard will be exercised as a public trust.
- Water required to meet basic human needs and maintain environmental sustainability will be guaranteed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

A vital element of the National Water Resource Strategy is the creation of catchment management agencies, which are in charge of developing watershed management strategies in collaboration with water user associations.

Source: Based on S. Rademeyer. 2006. Processes that will influence resource allocation in the Republic of South Africa. In Watershed Management and Sustainable Mountain Development Working Papers No. 8. Rome, FAO.

MATTERS OF SCALE

Watershed management can be implemented at scales that range from small upland watersheds to entire river basins. Most watershed management programmes focus on relatively small territorial units, however, generally corresponding to sub-watersheds. As these small-scale pilot projects have a limited impact on the larger watershed or river basin, the scaling-up of successful local experiences is a critical challenge for watershed management programmes. This is further complicated by the technical difficulties of extrapolating information and experiences from small watersheds for application in major watersheds or river basins.



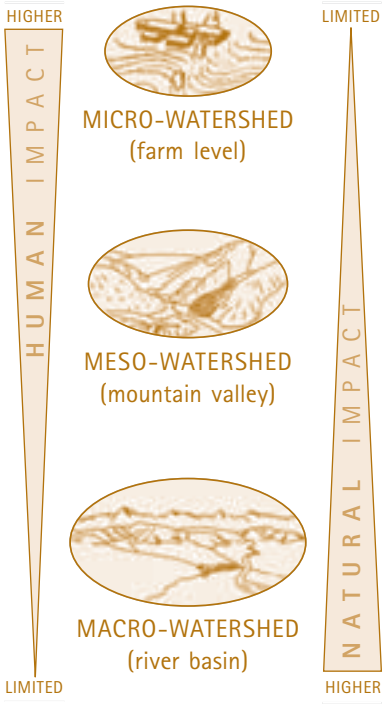
Top: A farm-level micro-watershed in Nepal
Bottom: A meso-watershed in the Swiss Alps

Opposite page: A macro-watershed in the eastern Peruvian Andes

HUMAN VERSUS NATURAL IMPACTS ON WATERSHED PROCESSES: A MATTER OF SCALE

According to their size, watersheds can be classified as "micro" (less than 50 km^2), "meso" (from 50 to 20 000 km^2) or "macro" (bigger than 20 000 km^2) scale. Although the lower and upper limits of these three watershed categories are arbitrary, this classification is useful to assess within a watershed the potential impact of human activities (such as farming, forest harvesting, grazing, etc.) compared with that of natural events (such as geological movements or extreme weather events). Research has shown that in micro-scale units the impact of human activities on watershed processes tends to be higher than that of natural events. In meso-scale units, natural processes are as critical as human factors. This makes meso-watersheds particularly vulnerable to environmental degradation. Finally, in macro-watersheds (i.e. river basins), the site-specific effects of human-made interventions are overwhelmed by the dimension of the natural processes involved. In particular, floods and other extreme events occurring in alluvial plains depend on major and long-term geological and climatic processes and should not be attributed to inappropriate watershed management practices upstream.

Source: Based on G. Ives and B. Messerli. 1989. *The Himalayan dilemma. Reconciling development and conservation.* London and New York, Routledge.



Top: An upstream Himalayan watershed in Nepal
Centre: A terraced watershed in the Middle Hills of Nepal
Bottom: Crossing a river in the Terai lowlands, Nepal

The optimal scale of a watershed programme depends on several factors, including the watershed's strategic value, the existing demand for watershed services, the ecosystem situation, disaster risks, 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. Local programmes should also consider the "big picture" of upstream/downstream linkages within the whole watershed and river basin. This is best achieved by addressing major watershed management programmes as a "mosaic" of site-specific projects that share a common institutional, methodological and operational framework.

To manage the river basins shared by more than one country, strong international and subregional fora for discussing and negotiating upstream and downstream interests and priorities are needed. In several areas of the world, transboundary watershed management agreements are becoming important mechanisms for regional integration, based on synergy among national agencies and ruled by ad hoc international bodies. Exchange of knowledge and experiences among the countries that share a river basin is often instrumental in the development of a common policy framework, and facilitates long-term commitment and continual and consistent funding from international institutions and donors.

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 Gulf of Guinea 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 at all stages of implementation. They aim to raise the awareness and commitment of local stakeholders and to strengthen livelihoods for local people. This includes: enhanced food security; income generation and diversification; rural employment; and women's empowerment through income-generating activities and literacy.

The expected environmental outcomes of this programme 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; and a management plan for combating hydraulic erosion and siltation.

INVESTING IN OUR FUTURE

At the turn of the millennium, the international community committed itself to achieving, as soon as possible, 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 (e.g. education, health, water and sanitation) and sustainable use of natural resources. The United Nations-supported Millennium Development Goals (MDGs) urge governments to develop policies that make it possible to achieve these goals by 2015.

Watershed management has an important role in the process of meeting international sustainable development goals. Sound watershed management is essential for achieving MDG 7, ensuring

Top: A watershed landscape in South Africa
Bottom: Primary forest in the Sequoia National Park, California, United States of America
Left: Upland farming in the Andes, Bolivia

Opposite page: Tree planting in Ecuador

environmental sustainability, particularly its two targets of reversing the loss of environmental resources and 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 contribute significantly to MDG 1, the eradication of extreme poverty and hunger.

The benefits from watersheds cannot be obtained for free. Watershed management has a financial cost, which society has to bear. Governments should make funds available for watershed work and programmes, and citizens should accept appropriate taxes and

WATERSHED MANAGEMENT AND THE "ADAPTING MOSAIC" SCENARIO

In 2005, the Millennium Ecosystem Assessment (MEA) study analysed the long-term and global impact of an "adapting mosaic" development scenario. In this scenario regional, watershed-scale ecosystems are the focus of political and economic activity. This scenario sees the rise of local ecosystem management strategies and the strengthening of local institutions. Investments in human and social capital are geared towards improving knowledge about ecosystem functioning and management, which results in a better understanding of the resilience, fragility and local flexibility of ecosystems. There is optimism that we can learn, but humility about preparing for surprises and about our ability to know everything about managing ecosystems.

There is also great variation among nations and regions in style of governance, including management of ecosystem services, focused on small, watershed-based initiatives, undertaken by decentralized institutions, supported by the public sector and embedded in broader economic and political processes (...). Eventually, the focus on local governance leads to failures in managing the global commons. Problems related to climate change, marine fisheries and pollution grow worse and global environmental problems intensify. Communities slowly realize that they cannot manage their local areas because global and regional problems are infringing on them, and they begin to develop networks among communities, regions and even nations to manage better the global commons. Solutions that were effective locally are adopted among networks. These networks are expected to be especially common where there are mutually beneficial opportunities for coordination, such as along river basins. Sharing good solutions and discarding poor ones eventually improves approaches to a variety of social and environmental problems. Compared with other development scenarios considered by the same study, the watershed-based adapting mosaic scenario is expected to perform better in the long term in controlling key current ecosystem problems, such as water availability and quality, soil erosion, conservation of genetic resources, pest control, storm protection and human adaptation.

Source: Based on Millennium Ecosystem Assessment. 2005. *Ecosystems and human well-being.* Washington DC, Island Press.

tariffs as "payment for environmental services". Nurturing watersheds so that humanity can continue to benefit from their services is a collective responsibility.

Some economists believe that watershed management programmes are financially viable when they facilitate the production and marketing of commodities, such as drinking-water, crops and food, timber and tourism. It is more difficult for economists to demonstrate the financial viability of watershed benefits and services that are not included in market exchanges. Given this situation, is it financially worthwhile for a national or local government to invest in watersheds? Will today's costs be recovered in the medium and long terms? And will there be any short- or medium-term profits?

Ten years ago the answers to all these questions would have been negative. Investments in watershed management, and in natural resource management in general, were basically envisaged as non-remunerative. The carbon sequestration and global environmental goods markets are creating new financial prospects for ecosystem conservation as a whole. Some municipalities have already issued watershed management bonds, and the development of stronger linkages between watershed services and financial markets is to be expected in the future.

Whatever economists invent to make sure that environmental services are recognized and traded by the market, healthy and balanced watersheds will continue to have existence value, which can never be fully captured by financial transactions. Today, therefore, investments in watershed management should primarily aim to ensure that watersheds' existence value will also be available for coming generations. Investing in watersheds is primarily investing in the future of earth and humankind.

Top: Upland tropical forest in Eastern Bolivia
Centre: Hydropower dam, Republic of Korea
Bottom: Mountain trekking, Tibet

Opposite page: A protected water source in the Middle Hills ofNepal

This publication is printed on certified oxygen-whitened and chlorine-free paper. Italy, October 2007

TEXT

EDITORIAL SUPERVISION

DESIGN AND LAYOUT

EDITING

EDITORIAL ASSISTANCE

PHOTOS

PHOTO EDITING

By providing high-quality freshwater, regulating discharge and runoff, and hosting fertile arable land and huge forest resources, watersheds play a pivotal role in the ecology of our planet and contribute significantly to the wealth and welfare of human societies. This booklet summarizes state-of-the-art information on environmental services provided by watersheds, risks and threats currently affecting watershed ecosystems, watershed economics, watershed management policies, watershed governance institutions and programmes.

The booklet was produced in the wake of the 2002-2003 inter-regional watershed management review conducted by the Food and Agriculture Organization of the United Nations. The publication addresses primarily those policy- and decision-makers who are responsible for finding a balance between socio-economic development and environmental conservation thrusts. Based on recent research, the booklet suggests that investing in watershed management can significantly contribute to solving these often diverging concerns.