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MAY 2008

Watershed Management Approaches, Policies, and Operations: Lessons for Scaling Up

Salah Darghouth, Christopher Ward, Gretel Gambarelli, Erika Styger, and Julienne Roux

The World Bank, Washington, DC

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Water Sector Board

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CONTACT INFORMATION

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ACRONYMS AND ABBREVIATIONS

BNWPP	Bank- Netherlands Water Partnership Program
CO_2	Carbon dioxide
CIFOR	Center for International Forestry Research
DFID	U.K. Department for International Development
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
FIRR	Financial internal rate of return
FONAG	Fund for the Protection of Water (Quito, Ecuador) *Fondo para la Protección del Agua*
GEF	Global Environment Facility
GIS	Geographic Information System
ICR	Implementation Completion and Results Report
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
M&E	Monitoring and evaluation
NGO	Nongovernmental organization
ODI	Overseas Development Institute
PAD	Project Appraisal Document
PES	Payment for Environmental Services
PPAR	Project Performance Assessment Report
SAR	Staff Appraisal Report
SEA	Strategic Environmental Assessment
VDC	Village Development Committee
Y	Yuan

UNITS OF MEASURE

ha	Hectare
m	Meter
m^2	Square meter
mm	Millimeter
km	Kilometer
km^2	Square kilometer
t	Ton
yr	Year

PREFACE

After three decades of experience of watershed management, it is timely to take stock of what has been learned and to draw out pointers that can help define future development paths. This report has therefore been prepared as a contribution to a process of stocktaking and looking forward.

The first generation of watershed management operations in developing countries in the 1970s and 1980s gave priority to protection of downstream assets, particularly reservoirs, and tended to adopt engineering solutions. In the 1990s, a new generation of developing country watershed management operations focused more on the problems of natural resource management and poverty reduction in upland areas, using farming systems and participatory approaches. The objective of this report is to evaluate the experience of this second generation of watershed management operations, to summarize the current state of knowledge, and to assess outstanding issues and possible future directions.

The report has drawn on two consecutive exercises conducted by the World Bank in 2005 and 2006. The first exercise reviewed the experience of World Bank–financed watershed management projects implemented over the last 15 years. The second broadened the review to incorporate the contribution of recent academic and empirical studies to thinking about watershed management in developing countries. These two exercises have been drawn together as part of the Energy, Transport and Water's (ETW's) Economic and Sector Work (ESW) Program for FY07. Although the analysis and conclusions are, to a large extent, based on experiences in the World Bank-financed projects, it is hoped that the fusion of project-based lessons and broader expert thinking will make clear the overall achievement of watershed management approaches in developing countries to date and highlight perspectives for future development and scaling up.

The audience for the report includes policy makers, sectoral planners, and program managers within developing countries together with practitioners, international financial and technical institutions, and bilateral donor organizations.

The report begins with definitions of watersheds and watershed management, a characterization of the problem of watershed degradation, and a short history of watershed management operations and policies (Chapter 1). The following four chapters discuss the findings from experience with implementing watershed management programs over the last 20 years based both on the project review and on the literature. Chapter 2 discusses the findings on watershed management approaches and methodologies. Chapter 3 looks at findings on institutions for watershed management. Chapter 4 reviews the economics of watershed management. In Chapter 5, issues of watershed management interactions with the environment and the water cycle are discussed, as well as the challenge of climate change. A brief final chapter (Chapter 6) summarizes the principal conclusions and recommendations of the report.

EXECUTIVE SUMMARY

The objective of the report is to summarize the current state of knowledge, to evaluate experience of World Bank–financed watershed management operations in recent years, and to assess outstanding issues, draw lessons, and suggest possible future directions. The report draws on a review of recent academic and empirical studies, and on an evaluation of World Bank–financed watershed management projects implemented during the 15-year (1990–2004) period.

Although the origins of modern watershed management can be traced back to the 19th century, the approach first achieved prominence in developing countries in the 1970s in programs designed to protect downstream resources and infrastructure through improvements in upland natural resource management. Over time, watershed management approaches were tried in dryland areas also. Since the early 1990s a new generation of watershed management projects has arisen. These recent projects typically target livelihood improvements and poverty reduction objectives, in addition to resource conservation. In view of the considerable experience built up and the significant changes in approach and objectives of watershed management programs since 1990, a stocktaking review is timely.

Watersheds and Watershed Management

A *watershed* is the area that drains to a common outlet. It is the basic building block for land and water planning. *Degradation of watersheds* in recent decades has brought the long-term reduction of the quantity and quality of land and water resources, as shown in the cases of Lesotho and Morocco. Changes in watersheds have resulted from a range of natural and anthropogenic factors, including natural soil erosion, changes in farming systems, overabstraction of water, overgrazing, deforestation, and pollution. The combination of environmental costs and socioeconomic impacts has prompted investment in watershed management in many developing countries. *Watershed management* is the integrated use of land, vegetation and water in a geographically discrete drainage area for the benefit of its residents, with the objective of protecting or conserving the hydrologic services that the watershed provides and of reducing or avoiding negative downstream or groundwater impacts.

The key characteristics of a watershed that drive management approaches are the integration of land and water resources, the causal link between upstream land and water use and downstream impacts and externalities, the typical nexus in upland areas of developing countries between resource depletion and poverty, and the multiplicity of stakeholders. Watershed management approaches need to be adapted to the local situation and to changes in natural resource use and climate.

Lessons Learned from Watershed Management Projects in the 1970s and 1980s

The first generation of watershed management projects in developing countries in the 1970s and 1980s applied a soil and water planning approach to watersheds that emphasized engineering works aimed at specific on-site and downstream physical outcomes. Less attention was paid to the needs of upstream populations or to their ownership of program actions. As a result, investment costs were high and not always well justified, and the assets and benefits created often had a limited life. By the end of the 1980s, the comparative failure of this "engineering-led" approach was clear, and a major rethinking of watershed management approaches was undertaken by national and international agencies.

The Integrated and Participatory Watershed Management Approach of the 1990s

The 1990s represented a new departure for watershed management programs supported by the international community in developing countries. Although engineering solutions were not excluded where appropriate, the emphasis was placed more on farming systems and on participatory and demand-driven approaches implemented at the decentralized level. Impetus was given to this new departure by the renewed emphasis on rural poverty reduction in development programs. The move away from planned investments toward farming systems and participatory approaches was designed to seek synergies and to limit the need for tradeoffs. However, it posed two considerable challenges. First, it was not clear under what circumstances the new watershed management approach could achieve both conservation objectives *and* income increases. Second, it remained to be demonstrated whether investments made upstream under a demand-driven watershed management program could have a positive effect on downstream conditions by improving hydrological services or reducing negative externalities.

The Evolution of National Policies in Watershed Management

National policies on watershed management have tended to develop in a pragmatic and iterative fashion, with early setbacks over engineering-dominated approaches being succeeded by tests of community-based approaches and by technology packages targeting sustainable changes in land and water use practices that brought profit to stakeholders. In several countries, including Brazil, China, India, and Turkey, success in testing community-based approaches has led to adoption of broader policies for community-based watershed management. In other countries, including Morocco and Indonesia, doubts about program performance and cost have delayed the adoption of national policies.

Watershed Management Approaches and Methodologies

The Scales of intervention in Watershed Management

Watershed management programs generally adopt the micro-watershed level as the basic management unit, since this allows the integration of land, water, and infrastructure development and the inclusion of all stakeholders in a participatory process, for example, in northeastern Brazil where the approach allowed the needs and interests of local groups to be integrated. The micro-watershed has proved a flexible and practical unit for project implementation and has reduced costs. However, the definition of a micro-watershed needs to be adapted to the social, administrative, and physical context. Best practice is that choice of scale should be driven by a participatory analysis of problems throughout the watershed, preferably within a broader watershed planning framework, as was done in the Loess II Project in China (see Box 12). Based on this, programs can be clear from the beginning about the proposed scale of interventions and the socioeconomic, environmental, and technical criteria for defining the micro-catchment and for selecting which micro-catchments to target.

The micro-watershed approach also raises some difficulties when it comes to scaling up. Working at the micro-watershed scale does not necessarily aggregate or capture upstream-downstream interactions. A patchwork of upstream interventions would only have a significant impact downstream if prioritized and planned within the larger watershed context and with understanding of the spatial and hydrological links between the perceived externalities and their causal factors (for example, land and water use). The lesson is that integration of watershed management activities beyond the micro-watershed requires higher level technical planning. In best-practice approaches, planning includes an institutional mechanism where stakeholders have a voice and are able to agree on measures from the micro-watershed scale upwards that can achieve both local and larger-scale objectives. The approach also needs to deal with institutional challenges of interagency collaboration and local-regional–level coordination.

The Combination of Conservation, Intensified Natural Resource Use, and Livelihoods Objectives

Overall, project experience demonstrates that the watershed management approach can, under the right circumstances, create the synergies required both for sustainable soil and water conservation and for the intensification of resource use that will improve the livelihoods of stakeholders. Stakeholders (usually farmers and herders living in the upstream area) have adopted new technology even without subsidy, but only when it yielded tangible benefits with manageable risk, and when they had the resources to invest in and to manage it. Projects had fewer problems in achieving both conservation and livelihoods objectives when the watershed was highly degraded, since no tradeoffs were required. Where scope for intensification was limited, some projects also financed nonfarm activities as an alternative to out-migration, but with mixed results.

Some best-practice examples, such as China Loess Plateau Project (see Box 16), indicate factors that make for a successful combination of the conservation, intensified natural resource use, and livelihoods objectives. Upfront stakeholder analysis helps identify who would be *winners and losers* from change in management practices, and participatory approaches help in developing and adopting the most *appropriate technologies*. Incentives to participate are improved by a focus throughout on *generating positive income streams* through natural resource use intensification, agricultural diversification, downstream processing and marketing, and the creation of new income-generating activities, for example, in Morocco Lakhdar, Tunisia Northwest Mountains, or Turkey Eastern Anatolia Projects. The best results are obtained where *conservation techniques that are profitable for farmers* can be developed, and a menu of interventions can be offered that combines income and conservation objectives. Giving stakeholders a *secure stake* in common pool resources like forests and pastures and ensuring that all users, and especially the poor, have *viable income alternatives* when closure is involved is also important. *Reducing risk* also creates an incentive for stakeholders, for example by improving water sources.

However, finding these synergies is not always straightforward. *On-site intensification is not always consistent with natural resources conservation*. For example, higher stocking rates for animals can exacerbate soil loss, and intensified use of mineral fertilizers is risky for groundwater and downstream water pollution. *There can be high costs to stakeholders in adopting conservation investments*. Despite some outstanding examples of reconciliation of conservation and intensification objectives (for example, the China Loess Plateau Project), conservation may not always be to the stakeholder's profit, and local interests may conflict with downstream interests. In fact, a number of watershed management projects reviewed had difficulty in establishing incentives for sustainable soil and water conservation and pasture improvements, as seen in the Indonesia Yogyakarta Project. Restricting access to forests or rangeland can work when all users, and especially the poor, have access to alternative income-generating activities, but in practice *programs have not always left the communities better off*. The lesson is that watershed management programs need careful analysis of social and environmental dynamics in a watershed, and also well-grounded and perhaps creative solutions to some inevitable tradeoffs between livelihood and conservation objectives.

Applied Research in Watershed Management

The most successful applied research and knowledge sharing in watershed management programs worldwide have been based on a participatory and partnership approach. In this approach, stakeholders are full partners in the research process at all the stages of identification, design, implementation, and evaluation, and technologies are offered as a range of choices to be adapted rather than as prescriptions. Many of the projects reviewed successfully used this approach to develop technical packages for intensification and conservation, for example, the applied research component in Tunisia Northwest Mountain Areas Development Project (see Box 18). Best practice shows the need to avoid overcomplexity, and to ensure that scientists work within a framework conducive to partnership and dissemination and that they have both research and communication skills, which was not the case in Indonesia Yogyakarta Project. A participatory and partnership approach is indicated, but this requires careful institutional organization up front to coordinate research agencies at various levels and to factor in other stakeholders, including farmers and the private sector. A significant gap in applied research on watershed management has been the failure to measure off-site and downstream impacts, although there have been recent improvements in quantitative measurement techniques (see below on externalities and monitoring and evaluation).

Institutions for Watershed Management

The Use of Participatory Approaches in Watershed Management

Participatory approaches and community watershed management plans have been widely used, with varying success, to reconcile the overlay of human activity on naturally defined watersheds. In the projects reviewed, participatory approaches were employed to establish micro-watershed management plans. The participatory processes succeeded where there were common purposes that could interest all or most of the population, as in the India Hills Project and the Brazil Land Management I, where the participatory process was flexible and provided for capacity building and genuine empowerment, for example, in Turkey, and where there were income and livelihoods incentives. Where communities could see the economic benefits and were empowered, they were willing to invest in long-term conservation.

Participation does not, however, guarantee specific outcomes, and it is not a neutral concept: it involves shifts in decision making power between the state and local communities, and also between different segments of the local community. Participatory processes therefore have to be designed for the specific development and distributional outcomes intended. Participatory approaches impose a demanding set of requirements: political commitment and equitable rules, time for the process to mature, careful sequencing, inclusion of all stakeholders in the process, public agencies that understand the rationale and process of participation, and sustained capacity building at all levels for both stakeholders and public agencies.

The Role of Public Institutions in Watershed Management

The integrated and participatory watershed management approach adopted in recent years has driven new institutional arrangements amongst public agencies and with local communities. Successful operations typically created a decentralized delivery structure that could effectively partner local communities. In best-practice examples, the institutional framework is focused on the local level, with clear arrangements for integration within permanent agencies and for interagency collaboration, as seen in the Turkey Eastern Anatolia Project (see Box 26). Government commitment to the program and simplicity and clarity on responsibilities are also important factors in success: the interface between local government, technical agencies, and community organizations needs to be carefully defined and managed, and capacity building at all levels is essential. Local level participatory approaches require decentralization or "deconcentration" of technical functions, and thought needs to be given to how this can reinforce—rather than conflict with—broader processes to decentralize responsibilities for local development.

The Policy and Legal Framework of Watershed Management

Watershed management works best when there is a supportive policy and legal framework, particularly (a) policies that facilitate decentralized and participatory development, (b) institutional arrangements that allow and encourage public agencies at all levels to work together, and (c) an approach to access to natural resources that reflects local legislation and tenure practices and problems. Land tenure and common pool resources are a particular challenge for watershed management, and there needs to be a clear understanding of the policy and legal framework and local practices and of how a project can work within this framework to promote investment. Lack of such an understanding in the Turkey Eastern Anatolia Project led to failure of the pasture improvement component. Operations can also help in the process of preparing for and implementing reforms.

Watershed Management and Poverty Reduction

Although poverty reduction is usually an objective of watershed management programs, empirical evidence of poverty reduction impacts is weak. Most projects reviewed included poverty reduction among their objectives, but there was little evidence of any ex ante analysis of poverty that would have helped to improve project design, and actual impacts were rarely measured. The poor may even be at risk from programs: for example, landless people dependent on common natural resources for their livelihood may suffer from conservation interventions, such as rangeland closure, as observed in upper watersheds in India (see Box 32). However, targeting only the poor has proved difficult, as efficient watershed management has to be inclusive of all stakeholders in the watershed. In best-practice examples, poverty concerns are introduced through the participatory process, the role of stakeholders is analyzed within a watershed, and. institutional mechanisms and the stakeholder communication process are designed to include the poor. In these cases, investment programs also include income-generating activities that benefit the poor. When management issues arise in the larger watershed, programs may be able to strengthen the voice of upstream communities so that they—and the poor within them—do not bear the cost of providing environmental services to downstream. Basin committees that empower stakeholders through participatory processes are one possible approach.

Economics in Watershed Management: Profitability, Externalities, and Incentives

Profitability and Economic Viability of Watershed Management Interventions

Profitability is key to engaging stakeholders in conservation, yet watershed management interventions may not in themselves be profitable for stakeholders. Establishing accurate estimates of costs and benefits, both at the farm level and beyond, has proved difficult. Often technical choices have been made without due consideration of financial profitability—or of economic value to society. Yet financial and economic analysis can help design investment packages that achieve both livelihoods and broader conservation objectives: for example, the Peru Sierra Project proposed an economic cutoff point for investments in soil and moisture conservation measures (see Box 35). Although there is little best practice to go on, it is possible to draw up a pragmatic methodology for analysis of costs and benefits of different investments at the farm level, which could serve in future operations as a building block for designing investment packages and setting the incentive structure.

Watershed Management Externalities and Their Valuation

One of the main attributes of watershed management is the potential to improve the natural resource impacts downstream—"externalities"—resulting from land and water interactions. Watershed management interventions in themselves may also have unintended negative consequences downstream. In the projects reviewed, improving downstream impacts was often an objective, but the relationship between upstream investments and downstream impacts was rarely clarified and monitored. The economic analysis rarely valued environmental benefits of watershed management programs. Clearly, accounting for externalities is needed to show the real costs and benefits of watershed management interventions and to provide their economic justification.

Upstream-downstream linkages are certainly complex, especially at the larger scale, and the information required to understand the interactions has until recently proved difficult and costly to collect. However, the recent rise of dynamic modeling at the basin level coupled with more affordable monitoring tools, such as remote sensing, will provide future watershed management operations with better capability to define upstream-downstream relations, set and monitor targets, and value benefits.

The Incentive Structure in Watershed Management

Valuation of externalities is also important for defining the incentive structure, which may "internalize externalities," especially when conservation practices are not readily attractive to upstream communities. Investment subsidies are the most commonly used incentive, but there are real problems of sustainability, and nonfinancial approaches, such as awareness creation or regulation, have often not proved effective either. Ideally the incentive structure needs to be built on a quantified assessment of externalities, but no examples of this were found during the review of Bank projects. Clearly, this is an area for further work.

Market-based contracting approaches—"payment for environmental services"—have been used in some cases, in particular in Latin America in small-scale initiatives involving water services. At the local level, deals can be organized with little outside intervention, but as scale and complexity increase, contracts require both good scientific knowledge and a developed institutional capacity. In addition, the transaction costs need to be substantially lower than the benefits, which is difficult at a large scale with multiple uses of watersheds and unclear upstream-downstream linkages.

Monitoring and Evaluation of Watershed Management Operations

Although an effective monitoring and evaluation (M&E) system can help to track performance against objectives and can provide information to help managers at all levels with implementation, M&E in the projects reviewed was generally very weak, with a few notable exceptions, such as the China Loess Project. Some projects did measure on-site impacts but, as said above, measurement of externalities has been particularly fragmentary and inadequate (see Box 43).

Remarkably little best practice in watershed management M&E is available to draw on, but it is clear that systems should be as simple and as low cost as possible, providing information needed to track performance against targets. Stakeholders who have a "need to know" are people living in the project area who are affected by the project, managers who need information for implementation, and promoters (government and external financiers) interested in results. Systems should call on a mix of quantitative and qualitative techniques, and *participatory M&E* is an effective way to collect and analyze information and to get stakeholders more involved. Given the complexities and externalities, the process should ideally be long term within a permanent public agency. Modeling should increasingly be used to understand watershed properties, functions, and management impacts, as was done in the Zambezi River Basin in 2006.

Environment, Water, and Climate Change in Watershed Management

Dealing with the Environment in an Integrated Way through Watershed Management

Watersheds are complex systems where water, soil, geology, flora, fauna, and human natural resource use practices interact. Hence, watershed degradation has environmental and socioeconomic effects far beyond the more obvious on-site and downstream impacts. For the same reasons, watershed management interventions may bring local, regional, and global environmental benefits. However, watershed management programs have tended to neglect environmental impacts beyond immediate land and water impacts, although some projects did target broader environmental objectives, too, such as the Tajikistan Community Agriculture and Watershed Management Project (see Box 49).

Although little guidance could be drawn from the project review or from the literature, an integrated approach to natural resource management at the watershed level could in principle be developed to address the complex system dynamics in watersheds, and to achieve global environmental benefits. This could be done, for example, by developing a watershed plan at the basin scale. Environmental impacts both on-site and downstream could be understood through mechanisms like (participatory) Environmental Impact Assessments or through a dynamic model. Any available least-cost adjustments could be made to project design to improve impacts on environmental objectives.

Effects on the Water Cycle of Watershed Management

The interactions of watershed management with the water cycle are important. However, the projects reviewed focused more on land management than on the water cycle. Hydrology and water management were neglected until recently, so that water outcomes were largely unknown—and may even have been negative in some cases. Newer projects, such as the Karnataka Project in India or the Turkey Anatolia Project, have begun tackling this challenge. In addition, scientific findings and recommendations exploring the role of some watershed management measures in improving the hydrological cycle have been little applied.

As for other externalities, best practice suggests that, where possible, the impacts of watershed management on basin hydrology need to be integrated into planning and monitoring. Again, modern tools, such as modeling and remote sensing, can help understand and study these critical phenomena. In large or complex hydrological systems, an integrated approach all along the watershed may be needed, with institutions for basinwide management. Where it is feasible, hydrological objectives need to be clearly stated and choice of management and technology adapted to those objectives.

Design of interventions should be attentive to existing scientific findings concerning the hydrological impacts of some practices and technologies. Here, further research and M&E may be needed, since the performance of some commonly used interventions, particularly forestation, has been questioned.

Watershed Management and the Challenge of Climate Change

Climate change is expected to bring both long-term structural changes to the water cycle and increased variability and unpredictability, and to have impacts on agricultural productivity. Greater frequency of high-intensity rainfall, floods, landslides, and wildfires may also increase the vulnerability of communities in many watersheds. Although structural changes and increased variability and unpredictability resulting from climate change will have economic and social costs, an integrated set of management responses, within a broad integrated basin planning framework and including watershed management, can mitigate those costs. Watershed management can also help implement a risk management approach for disaster preparedness.

Recently, watershed management projects have begun to factor in climate change, and some "dedicated climate change adaptation projects" have been designed to deal with high-risk watersheds, such as the Adaptation to the Impact of Rapid Glacier Retreat in the Tropical Andes Project. Emerging best practice in these projects shows how climate change risk analysis and adaptation options can be factored in to watershed management projects.

CHAPTER 1: BACKGROUND

This chapter defines the concepts of watershed, watershed degradation, and watershed management, and looks at how watershed management approaches have evolved over the last three decades.

Watersheds and Their Degradation

A *watershed* is the area that drains to a common outlet. It is the basic building block for land and water planning. *Degradation of watersheds* in recent decades has brought the long-term reduction of the quantity and quality of land and water resources. Degradation results from a range of natural and anthropogenic factors, including natural soil erosion, changes in farming systems, overgrazing, deforestation, and pollution. Depletion of soil productivity, sedimentation of water courses, reservoirs and coasts, increased runoff and flash flooding, reduced infiltration to groundwater, and water quality deterioration are among the main negative impacts of watershed deterioration. The combination of environmental costs and socioeconomic impacts has led to the development of watershed management approaches.

Defining a Watershed

A watershed is the area that drains to a common outlet. It is the basic building block for land and water planning.

A watershed is an area that supplies water by surface or subsurface flow to a given drainage system or body of water, be it a stream, river, wetland, lake, or ocean (World Bank 2001). The characteristics of the water flow and its relationship to the watershed are a product of interactions between land and water (geology, slope, rainfall pattern, soils, and biota) and its use and management. A watershed is thus the basic unit of water supply and the basic building block for integrated planning of land and water use.[1]

Size is not a factor in the definition, and watersheds vary from a few hectares to thousands of square kilometers. Unless a watershed discharges directly into the ocean, it is physically a part of a larger watershed that does, and may be referred to as subwatershed (Black 1991).

The hydrological cycle within a watershed is shown in Figure 1. It illustrates that rainfall is the main source of water in a watershed. Water then flows through and out of the watershed as surface or groundwater flow is incorporated into biomass, or is lost through evaporation and transpiration processes while in the watershed.

The terms basin, watershed, and catchment are often used interchangeably in the literature (World Bank 2001). Basin management typically refers to macro-management at the level of the entire watershed system, sometimes across country boundaries and with a focus on institutional and policy issues. Watershed management typically refers to management at the level of the micro- or subwatershed. Catchment is generally used synonymously with watershed. Table 1 suggests a possible classification of some characteristics of watersheds at different levels.[2]

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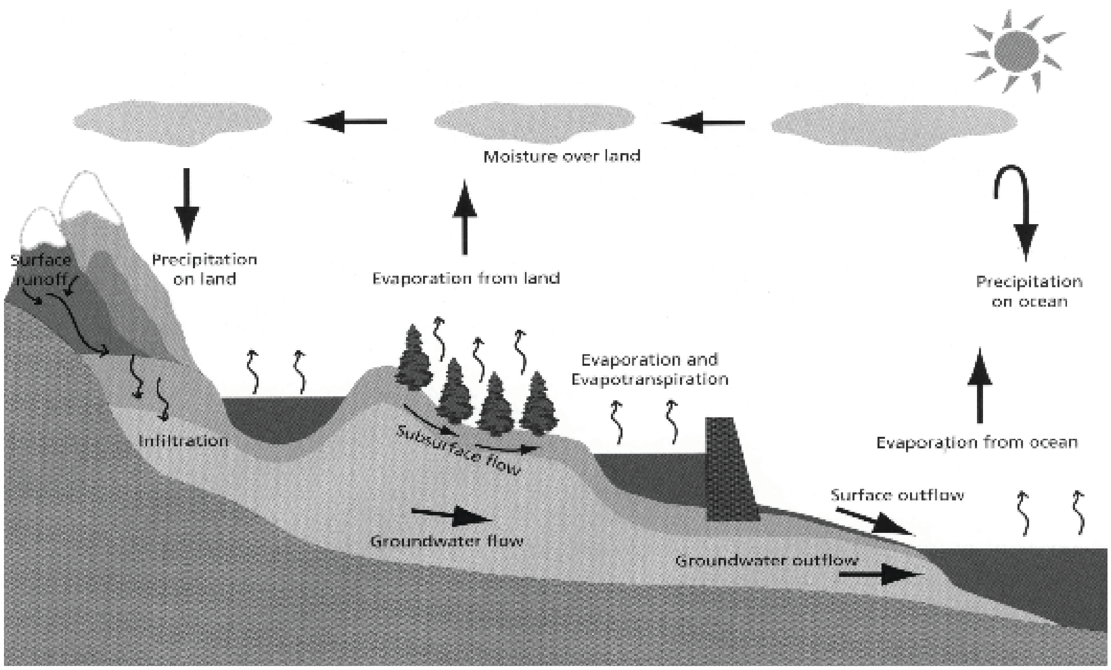
1 It is important to note that throughout this report, the analysis is limited to the rural aspects of watersheds. The important but separate questions of urban impacts on and from watersheds are not covered in the report.

2 As will be clear throughout this report, the terminology in practice is used very loosely. The table is provided only as an indication and does not underpin any conceptual approach in this report.

Figure 1: Hydrological Cycle in a Watershed



Source: http:/www.waterencyclopedia.com/Hy-La/Hydrologic-Cycle.html.

Watershed Degradation: Causes and Impacts

Watershed degradation has emerged in recent decades in many different parts of the world as one of the most serious examples of natural resource degradation, with negative environmental and socioeconomic consequences, particularly in developing countries (Box 1).

Table 1: Watershed Management Units and Characteristics

Watershed management unit	***Typical area (km^2)***	***Influence of impervious cover***	***Primary planning authority***	***Management focus***
Micro-watershed	0.05–0.50	Very strong	Property owner (local)	Best management practice and site design
Subwatershed	1–10	Strong	Local government	Stream classification and management
Watershed	10–100	Moderate	Local or multiple local government	Watershed-based zoning
Sub-basin	100–1,000	Weak	Local, regional, or state	Basin planning
Basin	1,000–10,000	Very weak	State, multistate, or federal	Basin planning

Source: Personal communication from Jim Smyle.

Box 1: Examples of Degraded Watersheds

The small country of **Lesotho** in southern Africa has historically been intensively grazed, causing accelerated levels of soil erosion. One study measured surface and gully erosion rates in a 4.9 km^2 micro-watershed. Over the period 1951–80 gully-eroded areas increased by 0.26 km^2, and 5 percent of the productive land area of the watershed was lost. The sediment trapped within the downstream reservoir was a massive 267,000 m^3.

Studies in the 1980s and 1990s showed that the storage capacity of 34 large reservoirs in **Morocco** was threatened by excessive soil erosion and sedimentation. It was estimated that 50 million m^3 of reservoir capacity was being lost each year, 0.5 percent of the total. In addition, excessive soil erosion was causing the productivity of soils to decline. Annual loss of soil nutrients in agricultural areas located northwest of the Rif mountains was valued at US$20/ha per year, more than local farmers invested yearly in fertilizers.

Sources: Brooks and Tayaa 2002.

Watershed degradation is the long-term reduction of the quantity and quality of land and water resources in a watershed.

Although watershed degradation is sometimes taken to refer to water resources only (Mazvimavi 2002), it is best understood as the degradation of both soil and water in a watershed because of the interactions between the two discussed above. Thus, for the purpose of this report, watershed degradation is understood as the long-term reduction of the quantity and quality of land and water resources in a watershed. Changes may be caused by a range of natural and anthropogenic factors, the most important of which are discussed in the following paragraphs.

Changes in farming systems, overgrazing, deforestation, roads and road construction, and the invasion of alien plants are among the most common causes of rural watershed degradation.

Changes in farming systems in the watershed are commonly a very significant contributor to watershed degradation. These changes come about through pressures on the typically poor farming systems that prevail in uplands in developing countries. In some countries—Yemen, for example—the maintenance of age-old terraces for cereal production is no longer economic. In the same country, the development of market-oriented agriculture has led to overexploitation of groundwater in upland areas and to the consequent depletion of the groundwater table and drying up of streams. In many countries, new upstream diversions have reduced water availability downstream and affected the watershed ecosystem. In other countries—Madagascar, for example—high population growth rates and poor economic opportunities in urban areas have led to widespread cultivation on steep and highly erosion-prone slopes. In Lesotho and Zimbabwe, pressure on uplands arises from inequitable land distribution and the resultant overloading of carrying capacity (Darkoh 1987). In some cases, "good" cultivation practices can be replaced by "bad" ones as an answer to external shocks, such as falling crop prices. For example, in El Salvador, areas where coffee plants are traditionally grown in the shade of trees diminished by 13 percent between 1990 and 2000 in response to falling world coffee prices. Trees were felled for timber and firewood and to clear the ground for subsistence crops, bringing about significant environmental damage, such as soil erosion and species loss (Blackman, Ávalos-Sartorio, and Chow 2007). The drivers of these changes are largely institutional and socioeconomic, as shown in Box 2.

Box 2: Institutional and Socioeconomic Factors Driving Natural Resource Degradation

- *Market failure*: Where a lack of clear prices or values for natural resources, or poorly functioning markets and distorted relative prices can result in misallocation of resources, resource exploitation, and subsequent degradation.
- *Policy failure*: Where inappropriate government policies, or an absence of required policy, result in market distortions for natural resource use, aggravated market failures, and natural resource degradation.
- *Institutional failure*: Where a country lacks the necessary government structures, environmental legislation and regulations, or where a decline in traditional land use management processes occurs, resulting in natural resource degradation.
- *Implementation failure*: Where a country lacks the technical capacity and/or financial resources to properly implement and enforce sustainable development policies, programs, and legislation, resulting in natural resource degradation.
- *Population growth*: Where a country's population growth results in pressure on the land base in excess of its carrying capacity, resulting in natural resource degradation.
- *Poverty*: Where people struggling to survive tend to follow unsustainable short-term resource utilization practices in return for short-term consumption gains.

Source: Personal communication from Grant Milne.

Livestock plays an important role in the economy of watersheds in developing countries. Typically pastoral systems or mixed agropastoral systems may predominate in upper watersheds and on the steeper slopes. Demographic and economic pressures often drive domestic livestock stocking rates above the carrying capacity of the relevant area, leading to *overgrazing*. This leads to a reduction in vegetation cover and compaction of soils through trampling, which causes a reduction in water infiltration rates, an increase in runoff, and hence an acceleration of soil erosion, with potentially serious consequences on dry season low flows. Heavily overgrazed watersheds, even in humid climates, may look semiarid when soil compaction affects a significant part of the watershed. In the mountains of Nepal, for example, degraded grazing lands are losing soils by as much as 100 t/ha each year (Carson 1992).

Deforestation can be caused by expansion of cultivated areas, unsustainable fuelwood and timber harvesting, bushfires, and the development of settlements and infrastructure. Deforestation is occurring in every region of the world. Examples from Asia are discussed in Box 3. South America is also a region with very rapid deforestation: Ecuador has one of the world's highest rates of deforestation, estimated at more than 300,000 ha (3 percent of current forest land) per year.

Box 3: Deforestation and Soil Erosion in Watersheds in Asia

In Asia, the practice of slashing and burning forests for crop cultivation has taken a toll on forest resources and accelerated the pace of soil erosion as settlers have shortened the fallow period. In **Laos**, about 4.9 million ha of land, most of which is in the mountains, is under shifting cultivation, and a further 300,000 ha of forest are cleared every year. As a result, in the Nam Ngum watershed, 28.6 million tons of soil are lost each year at the rate of 36.6 tons/ha. In the Siran watershed of **Pakistan**, 8.3 percent of forests were completely lost in just seven years between 1985 and 1992.

Sources: Chazee 1994 and Thapa 2004.

Expansion of the *road network* can have as great an impact on watersheds as farming or herding. Road construction removes vegetation, leaving the area susceptible to surface erosion. In some parts of Kenya, erosion has been estimated at 250 tons/ha per year for roads, as compared to 16 tons for grazing land (Swallow, Garrity, and Van Noordwijk 2001). Because road surface infiltration rates are usually very low (owing to compaction), overland flow is generated relatively quickly on road surfaces even during low-magnitude rainfall events. Roads thus transport sediments in the stream system during most of the rainy season (Ziegler, Giambelluca, and Sutherland 2000). Also, runoff that drains from roads can initiate landslides or gullies, and roads may increase peak flows by modifying the mechanism and timing of hill slope flow (Jones and Grant 1996; LaMarche and Lettenmaier 2001 in Coe 2004). A number of guidelines have been issued on techniques to reduce the negative impacts of roads on watersheds (see, for example, the U.S. Environmental Protection Agency manuals[3]) and these concerns should be further mainstreamed in the transport sector.

The invasion of *alien plants* is an often ignored cause of watershed degradation which can seriously alter soil and water conditions (see Box 4). Effects include a reduction in available water resources through increased evapotranspiration, destruction of the plant structure in the watershed, and destabilization of slopes (Loope and Kraftsow 2001). In South Africa and Lesotho, alien plants cover about 10 million ha (more than 8 percent of total land area), and are spreading at 5 percent per year (Versveld, Le Maitre, and Chapman 1998).

Box 4: The Threat of Non-Native, Invasive Plants to the Water Supply

In **South Africa**, the invasion of pines and other woody plants in a shrubland ecosystem has resulted in substantial water loss through evapotranspiration and a reduction in the quantity of water produced by the important watersheds in the vicinity of Cape Town.

On East Maui in **Hawaii**, the storage function of the watershed, crucial for water supply, is highly vulnerable because of the steep slopes in the watershed, which must be stabilized by tree roots. From the mid-20th century, plant invasions destroyed the forest structure, shaded out the water-holding understory layer, and created unstable slope conditions. The weedy vine banana poka (Passiflora mollissima) climbed over tree crowns, occluding sunlight and reducing photosynthesis, growth, and reproduction of the host tree. The result has been tree death and forest collapse.

Sources: Loope and Kraftsow 2001; Stevens 1987; La Rosa 1992.

Soil erosion, sedimentation of water courses, reservoirs, and coasts, increased runoff and flash flooding, reduced infiltration to groundwater, and water quality deterioration are among the main negative impacts of watershed deterioration.

Watersheds in their natural state are subject to continuous processes of change—erosion, sedimentation, flooding, and change in water quality. The problem of watershed degradation is that these processes of change are accelerated and their negative impacts become more pronounced. For example, *soil erosion* is a natural process, but it can be accelerated by overgrazing, deforestation, the expansion of road networks, and inadequate soil and moisture

3 Available from http://www.epa.gov/nps/roadshwys.html.

conservation measures on cultivated lands. The more rapid erosion quickly reduces the depth of fertile topsoil, creates gullies in the land, and causes sedimentation of streams.

Sedimentation too is a natural phenomenon, but human activities such as cultivation, grazing, or road construction within a watershed often disturb the equilibrium between materials delivered to a stream and its carrying capacity.[4] The main consequences are decreased water quality and reduced capacity of water bodies, both natural and manmade. Reservoir sedimentation is a major problem in many parts of the world, causing drastic reductions in storage capacity, and high economic costs for sediment removal or construction of new dams. It is estimated that more than 0.5 percent of the total reservoir storage volume in the world is lost annually as a result of sedimentation (White 2001). This translates into the need to add some 45 km^3 of storage per year worldwide. Costs would be on the order of US$13 billion per year and the associated environmental and social impacts significant (Palmieri 2003). A survey of 132 small and medium dams in the Masvingo province of Zimbabwe revealed that 16 percent of the dams had entirely silted up, whereas a further half had lost 50 percent of their storage capacity (Elwell 1985). Storage capacity reduction from sedimentation is higher on steeper slopes and in rainier regions, especially in Southeast Asia. When sediments reach the coast, deltas may expand, turning sand beaches into dumps of river sediments, with potential economic losses from tourism, fisheries, and shipping.

Deforestation and clearance of vegetation will generally result in an *increase in annual runoff* from watersheds, with reduced annual evapotranspiration, increased peak flows, and increased base flow.[5] These impacts will diminish, however, over several years if secondary regrowth is allowed. It is when land uses subsequent to the deforestation cause significant degradation that runoff generation processes can be permanently and severely impacted, such that downstream areas may suffer from increased frequency of *localized flash floods*. Dry-season flows on the other hand may diminish and groundwater recharge diminish as a result of *decreased water infiltration*.[6]

Transportation of eroded soils by runoff, pollution from agricultural fertilizers (especially phosphorus and nitrogen) and pesticides, and the disposal of domestic, animal, and industrial wastes tend to be the principal causes of *water quality degradation* in rural watersheds. Downstream, waterborne pollutants can cause eutrophication in reservoirs and lakes and create dead zones in river mouths and on coral reefs, with high economic costs (see Box 5).

Box 5: Impacts of Pollution on Downstream Waters

When nutrients reach natural or artificial reservoirs, they can cause eutrophication of these water bodies, that is, the excessive growth of algae leading to oxygen depletion and fish death (this happened in Lake Erie and many other lakes around the world). When nutrients reach seas and oceans, they may again act as a fertilizer for phytoplankton and marine algae, creating algal blooms and then oxygen depletion during die-off and decomposition. Massive dead zones near river mouths are caused this way. Algae also compete with corals for space on coral reefs and too much algae can cause a shift in the ecosystem from a coral-dominated to an algae-dominated reef. Such a system loses all value for tourism and for most commercial fisheries. Overall, some 80 percent of the pollution load in the oceans originates from land-based activities.

Sources: UNEP 2006 and personal communication from M. Hatziolos.

4 *Sedimentation* refers to the combined processes of soil erosion, entrainment, transportation, deposition, and compaction of sediments.
5 Several experimental catchment studies have demonstrated this effect—see Bullock 1992.
6 The effects of deforestation on flows during the dry season are less well understood. They are typically more location-specific. See the section, *Considering the Effects on the Water Cycle*, in Chapter 5 below.

These impacts can have profound effects on public and ecosystem health, the economy, and livelihoods of the population, both in the already poor upland areas and in the downstream areas. *It is the combination of the environmental costs and the socioeconomic impacts that have led to the development of special watershed management approaches in recent years.*[7]

Watershed Management: Drivers and Approaches

The key characteristics of a watershed that drive management approaches are the need for integrated land and water management, the causal link between upstream land and water use and downstream impacts, the typical nexus in upland areas between resource depletion and poverty, and the multiplicity of stakeholders.

Watershed management is the integrated use of land, vegetation, and water in a geographically discrete drainage area for the benefit of its residents, with the objective of protecting or conserving the hydrologic services the watershed provides and of reducing or avoiding negative downstream or groundwater impacts. Watershed management approaches need to be adapted to the local situation, and alternatives may need to be considered.

The key characteristics of a watershed that drive management approaches are the need for integrated land and water management, the causal link between upstream land and water use and downstream impacts, the multiplicity of stakeholders and the typical nexus in upland areas between resource depletion and poverty.

From the description above of watersheds and the nature of the degradation processes they have undergone, four important characteristics emerge that drive management approaches.

1. *The need for integrated land and water management*: Land use, vegetative cover, soils, and water interact throughout the watershed, so that management approaches must consistently address them together. Therefore, typically, watershed management programs adopt *integrated resource management approaches*.
2. *The causal link between upstream land and water use and downstream impacts*: Upstream land and water management inevitably has impacts on the downstream environment, not only on the quantity and quality of water flows and on the operation of downstream assets, such as reservoirs and irrigation schemes, but also on other "environmental services," such as water quality, biodiversity, carbon sequestration, natural disaster vulnerability reduction, amenity values and, under some circumstances and at some scales, reduced localized flash flooding. Because of the direction of these effects—from upstream to downstream—watershed management programs are typically *oriented toward problem solving in upland areas.*
3. *The multiplicity of stakeholders*: Watersheds provide many important services to an extensive range of stakeholders, and changes in land and water management and in watershed hydrology will directly or indirectly affect many or all of them (Kerr 2002b). Many people use upper and lower reaches for multiple purposes, and a plethora of public and private agencies are typically involved: organizations dealing with agriculture, animal husbandry, forestry, water, irrigation, rural development, physical planning, land tenure; local governments; community institutions, NGOs, and so forth. This institutional density creates a management challenge and requires watershed management approaches to create *broad and inclusive institutional platforms*.

7 Impacts on downstream areas are further compounded by socioeconomic development downstream, such as encroachment of urban development into flood plains, wetland areas, and natural drainages. These "urban" aspects of watershed management are, however, outside the scope of this report.

4. *The resource depletion and poverty nexus*: Upland areas of developing countries are typically more fragile and less productive environments where natural resource management and rural poverty are commonly linked (see Box 6). With frequently extensive land use practices and a more fragile resource base, uplands are vulnerable to overexploitation and depletion of natural resources (water, vegetation, forests, and soils). With land degradation, agricultural productivity declines, often aggravating the poverty problem. As a result, improving the management of natural resources in upland areas and influencing downstream impacts requires attention to the problems of the population of the poor upland areas, particularly poverty reduction and local institutional development (World Bank 2001). Thus, watershed management programs generally have to *focus on the farming systems of the poor in upland areas* in order to achieve *poverty reduction and conservation objectives simultaneously*.

Box 6: The Special Character of Natural Resource Management in the Uplands

Upland natural resource management is technically more challenging than in downstream areas. Uplands are often areas with steep slopes where land and water interactions are more dynamic. Soil fertility management is more challenging on these slopes where the thin soil surface layers are vulnerable to erosion. With larger variation of biophysical conditions, uplands compared to lowlands are less suitable to large-scale investments, such as large irrigation schemes.

A higher concentration of the poor and marginalized is usually found in upland areas. Uplands are remote areas that are commonly underserviced, for example, by roads, markets, and extension services, and they are politically often not a priority in contrast to urban and lowland agriculture. Isolated communities of rural poor often predominate in these areas.

The uplands ecology is often both special and vulnerable. The agro-ecological diversity is higher then in the lowlands. Often the remaining primary forests are located in the upper watersheds, fulfilling important ecological services and harboring biodiversity.

Land use is diverse and land tenure is complex, often with a predominance of common pool resources. Diverse forms of land use systems exist to deal with the range of natural resources—arable land, forests, rangeland and streams, and lakes. Stakeholders and especially the rural poor depend often on nonarable, common pool resources, such as forests and grass lands, and much of the uplands are common land. Although it is usually the state that legally "owns" the land, stable communities with a significant history of land tenure often regulate its access and use under some set customary rules. Conversely, where communities are relatively new and community institutions are weak (for example, along the agricultural frontiers), the situation tends to be even more complex, such that putting rules and controls in place is extremely difficult. In both cases, finding solutions to conflicts over access and use between the state and the local populations will generally be a central objective in order to create conditions for watershed management. In these situations, it will often require attention to the institutional frameworks as, depending on the land use and objectives, several different agencies may have jurisdiction and responsibilities for land, natural resource, and/or water management.

Source: Authors.

Watershed management is the integrated use of land, vegetation, and water in a geographically discrete drainage area for the benefit of its residents, with the objective of protecting or conserving the hydrologic services the watershed provides and reducing or avoiding negative downstream or groundwater impacts.

The watershed management approach has evolved to respond to the complex challenges of natural resource management using the watershed as a practical unit of implementation. Watershed management programs typically adopt integrated natural resource management approaches with a focus on upland areas where they target the twin objectives of resource conservation and poverty reduction. They also target improvements in downstream environmental services. Because of the multiplicity of stakeholders, watershed management programs tend to be complex and "institution intensive." Because of the public good aspects of watershed management—the prevalence of externalities and the poverty reduction imperative—watershed management programs typically involve government actions and subsidies and/or market based mechanisms (see Chapter 4).

A typical watershed management program is thus likely to aim at the following:

- Improving the management of land and water, and their interactions and externalities.
- Increasing the intensity and productivity of resource use in the upland area with the objective of reducing poverty and improving livelihoods.
- Improving environmental services and reducing negative externalities for downstream areas.
- Addressing technical, institutional, and policy issues needed to ensure equitable sharing of benefits among stakeholders and sustainable watershed management.

Watershed management approaches are adapted to the local situation, as well as to changes in resource use and climate, and alternatives need to be considered.

The adoption of a watershed management approach depends on the specific objectives of the program and on the specific economic and institutional context. Watershed management programs therefore can take many forms. As a minimum, watershed management is defined by its *integrated approach to land and water resources and by its tackling of the causal links between upstream actions and downstream impacts*. The approach needs to be flexible enough to adapt to changing patterns of resource use and climate. However, where land and water interactions and upstream-downstream impacts are not critical issues, a broader rural development approach may be a more cost-effective way to tackle upland problems (see Chapter 6 for a fuller discussion of the criteria for selecting a watershed management approach).

Evolving Approaches of Watershed Management in Developing Countries

The first generation of watershed management projects in developing countries in the 1970s and 1980s applied a soil and water planning approach to watersheds, which emphasized engineering works aimed at specific on-site and downstream physical outcomes. Less attention was paid to the needs of upstream populations or to their ownership of program actions. As a result, investments were high cost and not always well justified, and the assets and benefits created often had a limited life. By the end of the 1980s, the comparative failure of this "engineering" approach was clear, and a major rethinking of watershed management approaches was undertaken.

From the 1990s, watershed management programs supported by the international community in developing countries typically targeted livelihood improvements and poverty reduction objectives in addition to resource conservation. Operations aimed at these twin targets typically adopted integrated farming systems and participatory and demand driven approaches implemented at the decentralized level. The move away from planned investments toward farming systems and participatory approaches was designed to seek "win-win" solutions, but posed two considerable challenges: Could the new approach achieve both conservation objectives *and* income increases? Could a *demand-driven* program upstream have a positive effect on downstream conditions?

National policies on watershed management have tended to develop in a pragmatic and iterative fashion. In several countries, including Brazil China, India, Tunisia, and Turkey, success in testing participatory approaches has led to adoption of broader policies for community-based watershed management. In other countries, including Madagascar, Morocco, and Yemen, doubts about program performance and cost have delayed the adoption of national policies.

Lessons Learned from Watershed Management Operations in the 1970s and 1980s

The watershed management approach became prominent in developing countries in the 1970s in programs designed to improve upland natural resource management in order to protect downstream resources and infrastructure.

The origins of modern watershed management can be traced to several parallel and independent movements: the restoration of the Alps, which started in the last quarter of the 19th century; the conservation movement in the United States in the 1930s; and the watershed rehabilitation activities of colonial governments in Africa.[8] The watershed management approach became prominent in developing countries in the 1970s and 1980s when the problems of watershed degradation first became apparent.[9] A particular concern was the damage to downstream infrastructure caused by degradation in the uplands. National and regional programs were set up to address the problems. For example, in 1976 Indonesia created a National Watershed Development Program (Regreening and Reforestation). From the mid-1970s, Brazil launched soil conservation programs that evolved by the mid-1980s into the Integrated Soil and Water Management Program in Microcatchments. In 1990 India created the National Watershed Development Program for Rainfed Areas.

8 There is a rich literature on this for Kenya and Zimbabwe, for instance, where the experience had long-term and profound impacts on how these countries have taken to watershed management types of activities. It is perhaps one reason why conventional "watershed" projects are rare in Africa (Peter Dewees, personal communication).

9 This section is based on the review of World Bank projects and on the literature review, and the analysis covers the broad experience of watershed management in developing countries.

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In the 1970s and 1980s, an "engineering" approach characterized the first generation of watershed management programs. During that period, watershed management projects were largely conceived as technical packages with purely physical measures designed to manage soil and water resources in medium or large river valleys and to stabilize uplands through erosion control infrastructure. The objectives were to prevent rapid runoff of water, slow down siltation of reservoirs, and limit the incidence of potentially damaging flash flooding. Targets were fixed in relation to physical outputs rather than economic and natural resource outcomes, and a top-down planning approach was generally adopted.

The need to improve the livelihoods of the poor upland population was not completely ignored, but the technical improvements for agricultural production introduced usually focused on costly vegetative and mechanized technologies. Watershed planning was based on land capability rather than on the capacities and needs of local people who lived there. People were hired as manual labor, and projects provided subsidies to stakeholders as incentives to participate. There was little involvement of the communities in planning and implementation, which often resulted in weak commitment to the project. Benefits were expected to trickle down to the local population, although this generally happened only on a limited scale.

The projects were often managed from centralized units. These units were generally poorly placed to react to complex and highly specific local conditions, and managers were unable to react to lessons learned during implementation. High government staff turnover and poor supervision resulted in inconsistent project management and unaccountable implementation arrangements. Projects often ignored crucial intersectoral linkages, resulting in lack of collaboration and communication across sectors.

Over time, watershed management approaches were tried in dryland areas also.

Over time, the watershed management approach was extended from rainy upland areas into dryland areas. For example in 1982, the Indian Council for Agricultural Research initiated 46 projects on the watershed management model in dryland areas across India. In Sub-Saharan Africa in 1989, the *Club du Sahel* endorsed the "*terroir*" management approach: this comprised integrated land and water management in specific dryland areas using approaches based on those developed in watershed management programs.

By the end of the 1980s, the comparative failure of the "engineering-led" approach was clear, and national and international agencies undertook a major rethinking of watershed management approaches.

By the late 1980s, the disappointing results and the poor sustainability of the "engineering-led" approach led to the search by national and international agencies for a better approach to watershed management. Key to the change in thinking was the finding that watershed management restricted to *conservation* of soil, water, and vegetation was not sustainable, since it did not change the land and water management practices of upland farming systems. The lesson was that programs also needed to address the *productivity of resources and the related income streams* for the upland communities that managed these resources. The challenge was to develop management practices that, while not excluding engineering solutions where appropriate, were at once ecologically sustainable and economically attractive, with a sound institutional basis that would ensure their continuation (Magrath and Doolette 1990; Farrington, Turton, and James 1999).[10] Impetus was given to this new departure by the renewed emphasis on rural poverty reduction in development programs.

The Integrated and Participatory Watershed Management Approach of the 1990s

From the 1990s, watershed management operations typically targeted resource use productivity, livelihood improvements, and poverty reduction objectives in addition to resource conservation.
As a result of this rethinking, watershed management programs supported by the international community in developing countries from the 1990s not only sought to conserve soil, water, and vegetation, but also targeted increases in productivity of resource use in ways that were ecologically and institutionally sustainable and that benefited the local population and reduced poverty (Kerr 2002b). The enlargement of objectives broadened the appeal of watershed management, and a number of participatory watershed research and management projects were financed by development agencies and international donors, particularly following the 1992 Earth Summit (Rhoades 1999).

Operations aimed at these twin targets typically adopted integrated farming systems and participatory and demand-driven approaches implemented at the decentralized level.
The first innovation developed in this new generation of watershed management programs was to identify and execute interventions within an *integrated farming systems approach*, including lowland and upland agriculture, pasture, and forest management. The approach started from a diagnostic led by farmers and the community and based on existing farming practices. Interventions were to be problem oriented and demand driven, with proposed technologies first tested and adapted to local conditions before being introduced on a large scale. Farmers were to be given more control over the choice of technologies, with a broad menu of technical options. Within this approach, the promotion of low-cost vegetative techniques for erosion control replaced or complemented the previous "mechanical" techniques that had relied on heavy construction and had proved expensive to build and difficult to maintain.

The second innovation was to adopt a *participatory and demand-driven development* approach, which was influenced by emerging theories of "farmer first" (Chambers 1983; Chambers, Pacey, and Thrupp 1989). This new approach led watershed management programs to seek ways to build on existing social structures and institutions and to support planning and implementation by community institutions. Parallel movements under which governments had begun to decentralize administrative and technical responsibilities made it easier in these new projects to set up decentralized implementation structures that could partner more closely with community groups.

10 An example of this rethinking was a colloquium on watershed management organized in 1989 by the World Bank and attended by a broad range of national and international agencies. The objective was to deepen collective understanding of watershed management challenges. The focus was operational, and the colloquium involved practitioners from member countries. Six working papers were prepared (published in *Watershed Development in Asia*, Magrath and Doolette 1990). The papers proposed methodological approaches to project analysis, summarized solutions to technical problems and discussed institutional and social processes. The recommendations of the colloquium contributed to a change of orientation in the second generation of watershed management operations implemented in the 1990s.

The move away from planned investments toward farming systems and participatory approaches was designed to seek synergies and to limit the need for tradeoffs, but posed two considerable challenges: Could the new approach achieve both conservation objectives and income increases? Could a demand-driven program upstream have a positive effect on downstream conditions?

Implicit in the new approach were assumptions that synergies could be generated and the number of tradeoffs limited. The first assumption was that the package of measures which was implemented could achieve synergy between conservation *and* agricultural production increases, and thus improve livelihood conditions for upland farmers. The hope was that investments that conserved resources could also be financially profitable for stakeholders. In the event, this did not always prove possible, which posed the question for programs: How to build incentives for sustainable conservation investments into watershed management programs (see the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4 for a discussion of this issue)?

The second synergy assumed was that the investments made upstream under a demand-driven watershed management program would have a positive effect on downstream conditions by improving hydrological services or reducing negative externalities. For instance, soil erosion control through hedgerow planting along contours can have a positive *in situ* effect for improved agricultural production, while at the same time producing positive externalities of reduced downstream sedimentation. What was not clear was whether the investments selected by upstream communities would be optimal—or even effective—in their impacts on downstream areas (see the section, *The Use of Participatory Approaches*, in Chapter 3).

In addition, as environmental pressures increase, there are examples of local level natural resource management and rehabilitation carried out by local people with little outside encouragement

A number of countries as diverse as India, Kenya, and Nigeria have seen environmental rehabilitation carried out almost spontaneously as population pressure increased or environmental degradation, particularly erosion, reached high levels. For example, Tiffen, Mortimore, and Gichuki (1994) explored the relationship between increasing population density, productivity, and environmental degradation through a case study in southeast Kenya. They showed that population increase combined with market opportunities stimulated local investment and innovation in dryland farming and environmental recovery of heavily degraded land.

The Evolution of National Policies

National policies on watershed management have generally been driven by program experience rather than vice versa.

Initially watershed management programs were adopted in the 1970s and 1980s by governments as pragmatic responses to natural resource degradation and the related social and economic costs. These programs developed in an iterative fashion, with early setbacks over approaches dominated by engineering being succeeded by tests of community-based approaches targeting sustainable changes in land use practices. Now, in several countries success in testing community based approaches has led to adoption of broader policies for community-based watershed management.

In China, following growing success with combining conservation with productivity gains and poverty reduction, watershed management approaches have been incorporated into policy and regionwide programs.

In China, policy in the 1980s was based on environmental concerns to address the causes of flooding, deforestation, and erosion, and included campaigns such as those in the Loess Plateau to terrace slopes, plant trees, and build dams in the gullies to intercept sediment runoff. However, these interventions were not integrated with efforts to improve agricultural productivity and farm incomes, and so were difficult to sustain, since they did nothing to alter land use practices.

As population pressure continued, the need for a policy that combined both poverty reduction and sustainable environmental practices became more urgent. By the late 1980s experiments with comprehensive development of small watersheds proved promising in both treating soil erosion and raising farm incomes. In the 1990s the Eighth and Ninth Five-Year Plans (1990–2000) put improved productivity in arid and semiarid rainfed zones (accounting for 30 percent of total arable land) at the top of the agenda, and development strategies, for example in the Loess Plateau, began to emphasize comprehensive and integrated planning of small individual watersheds in close consultation with the beneficiaries.

Investment in the 1990s showed that land conservation was compatible with sustainable and productive agriculture and that they could be mutually reinforcing. This approach was incorporated in China's 1999 National Ecological Environment Development Plan.

Turkey has built on local and regional experience to formulate policies for community-based watershed management in poor upland areas.

The Turkish rural economy has been characterized by a high incidence of poverty, particularly in upland areas. The consequent growing pressures on forests and pasture have reduced vegetative cover and diminished soil fertility and the carrying capacity of rangeland. This has contributed to reductions in infiltration rates and to increases in peak river flows, flooding, and sedimentation problems.

Beginning in the late 1980s, Turkey tested an integrated and participatory approach to watershed management in a number of micro-watersheds, and from 2004 expanded the approach to three major river basins. Policy is now based on a community-driven approach to natural resource management, integrating forestry, soil and water conservation, and crop and livestock production. The government shares the cost of a mutually reinforcing package of resource use productivity enhancing and conservation measures. This policy has driven institutional change, particularly the coordination and integration of the activities of different government departments at the micro-watershed level and the development of watershed-based forest resource management plans.

In Brazil, successful combination of economic and conservation objectives created strong farmer demand and led to state-level policies and laws promoting watershed management.

Intensification of agriculture in Brazil has brought increasing pressure on natural resources. Symptoms of land degradation are widespread: loss of soil structure, excessive runoff, sheet and gully erosion, flooding, siltation of riverbeds and reservoirs, and rising production costs and falling yields as nutrients are lost.

In the 1980s, studies of the effects on hydropower, for example, in São Paulo state, alerted government to the downstream impacts of degradation in the upstream watershed, and states began on a pilot scale to provide incentives to mechanical soil conservation practices, mainly terracing. From 1989, programs were broadened, for example in Parana and Santa Catarina states, to a participatory approach organized around local micro-watersheds with full involvement of local stakeholders, municipal governments, and the private sector. Some of these programs were so successful that they served as models for other countries in Latin America and Africa and were widely replicated in Brazil.

The key was to promote farmer investments that brought both private profitability and public resource conservation benefits. Innovative approaches to reducing soil degradation and erosion and to improving soil fertility, moisture, and storage capacity proved to be both profitable and economically viable to the extent that farmers nationwide began to adopt the approach.

States, for example Santa Catarina and São Paulo, have begun to incorporate the lessons into their agriculture and rural development strategies and to provide a legal basis to the incentive and regulatory framework. Principles of the integrated and participatory approach to watershed management are now being widely adopted in Brazil: micro-watersheds as the planning unit; stakeholder participation; combined income-generating and conservation technology; and multisectoral and multi-institutional approaches.

Some countries have, however, been more reluctant to adopt national policies, since the results of watershed management programs have not been seen by governments as sufficiently convincing.

Morocco has implemented several pilot watershed management programs over the last decade, but has yet to incorporate the lessons from these programs into a comprehensive institutional approach to the problems of upland poverty and watershed degradation

The rest of this report will assess the experience of watershed management in recent years. The methodology adopted for the study (see the Foreword) was based on a literature review and on a review of "second generation" watershed management operations financed by the World Bank and implemented between 1990 and 2004 (see Box 7).

Box 7: A Review of Watershed Management Operations Financed by the World Bank

The review of watershed management operations focused on 24 "dedicated" watershed management projects (in which watershed management was the sole or predominant activity) financed by the World Bank and implemented between 1990 and 2004. A further 29 nondedicated projects had watershed components. The main objectives and approaches of the dedicated projects were broadly similar: (a) sustainable and integrated management of the natural resource base as a basis for agricultural production increase, leading to income increase and poverty reduction (80 percent of projects), and (b) reversal of environmental degradation (50 percent of projects). Annexes 1, 2, and 3 give details of these projects.

The distribution of the 24 dedicated projects by World Bank Region was as follows:

East Asia and Pacific Region had the most watershed management projects (six), of which three were in China, two in Indonesia, and one in the Philippines. In China, the Loess Project, which started in 1994, was succeeded by the follow-up Loess II Project in 1999. The 1994 China Second Red Soils Project was a successor to the First Red Soils Project implemented in the 1980s.

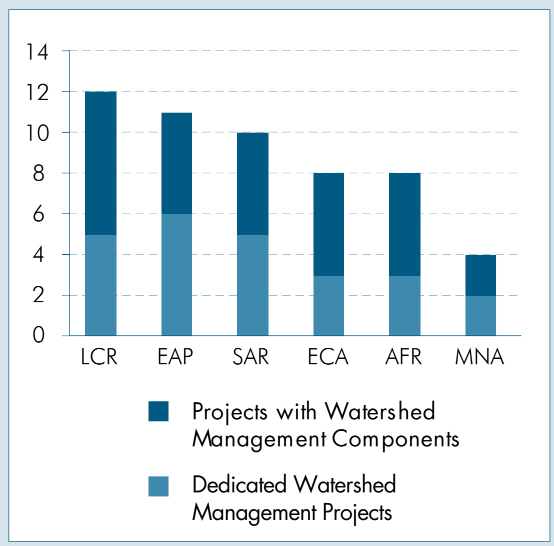
In the *Latin America and Caribbean Region*, four out of the five watershed management projects were implemented in Brazil. Of these four projects, all of which were state-level rather than national projects, three followed a similar approach: Land Management I (Parana), II (Santa Catarina) and III (São Paulo).

In *South Asia*, the five projects were all in India. The sister projects Plains and Hills were succeeded by Hills II.

In *Europe and Central Asia*, the Turkey Anatolia Project, which began in 2004, was a follow-up to the earlier Eastern Anatolia Project. The Tajikistan Watershed Management Project was the first dedicated watershed management project in the Former Soviet Union.

In *Sub-Saharan Africa* no watershed management projects per se could be identified. Nonetheless, three natural resource management projects with a holistic and spatial approach (the terroir approach) were included in the region.

In the *Middle East and North Africa Region*, only two watershed management projects were implemented: in Tunisia, a country long experienced in watershed management, and in Morocco, executing a first-time pilot watershed management project.



Source: Authors.

CHAPTER 2:
WATERSHED MANAGEMENT APPROACHES AND METHODOLOGIES

This chapter discusses three findings of the review regarding watershed management approaches and methodologies: scale of intervention, the combination of conservation and livelihoods objectives, and applied research approaches.[11]

Scales of Intervention

Watershed management programs generally adopt the micro-watershed as the basic management unit, since this allows the integration of land, water, and infrastructure development and the inclusion of all stakeholders in a participatory process. The micro-watershed has proved a flexible and practical unit for project implementation and has reduced costs. However, the definition of a micro-watershed needs to be adapted to the social, administrative, and physical context. Ideally, choice of scale should be driven by a participatory analysis of problems throughout the watershed, and programs should be clear from the beginning about the proposed scale of interventions and the criteria for defining the micro-catchment and for selecting which micro-catchments to target.

The micro-watershed approach also raises some difficulties when it comes to scaling up. Working at the micro-watershed scale does not necessarily aggregate up or capture upstream-downstream interactions. A patchwork of upstream interventions would only have a significant impact downstream if prioritized and planned within the larger watershed context and with understanding of the spatial and hydrological links between the perceived externalities and their causal factors (for example, land and water use). The lesson is that integration of watershed management activities beyond the micro-watershed requires higher level technical planning. In best-practice approaches, planning includes an institutional mechanism where stakeholders have a voice and are able to agree on measures from the micro-watershed scale upward that can achieve both local and larger scale objectives. The approach also needs to deal with institutional challenges of interagency collaboration and local-regional level coordination.

International experience shows that watershed management programs generally adopt the micro-watershed as the basic management unit.

A watershed can be defined at various levels (see the section, *Watersheds and Their Degradation*, in Chapter 1). International experience (such as the Indian case analyzed by Turton, Warner, and Groom (1998), and Sakthivadivel and Scott (2005)) shows that the micro-watershed has generally been the preferred scale of implementation for watershed management. This scale enables a program to respond to human needs and natural resource problems at the local level. Thus, projects in northeastern Brazil that implemented watershed management at the micro-watershed level were generally successful because the decentralized approach allowed the needs and interests of local groups to be integrated (Kerr 2004). Watershed management at this micro level has proved to be both ecologically and institutionally sustainable, and capable under the right conditions of empowering weaker sections of the population (Farrington, Turton, and James 1999).

11 In this and the subsequent three chapters (Chapters 2–5), the material in each section is generally presented in three parts: (a) an introduction to the topic, generally based on the literature; (b) the results of the review of the 24 World Bank–financed projects; and (c) an issues-based discussion, called *Challenges and Options*, summarizing lessons and good practices, and setting out open questions and problems.

International experience also points to the need to place micro-watershed interventions within overall watershed planning.

However, the core of the watershed management approach (see the section, *Watershed Management: Drivers and Approaches*, in Chapter 1 above) is an integrated approach to land and water management throughout the watershed. This implies that programs adopting the micro-watershed as the basic building block need to have institutional and technical mechanisms to ensure that planning and investment at the micro-watershed level are integrated within overall watershed planning (see, for example, Sakthivadivel, Bhattacharya, and Scott 2004). As will be seen from the experiences discussed below, different programs have addressed this issue in varying ways and with varying degrees of success.

Results of the Project Review

The projects reviewed generally selected the micro-watershed as the basic management unit, but there was disparity and lack of clarity on the definition.

Most of the projects reviewed worked with the micro-watershed as the preferred spatial unit for project implementation. The reporting on the size of the micro-watershed was not done consistently for all projects and, where it was recorded, the variation in average size of a "micro-watershed" was very large: from 240 ha (Red Soils II, China) to 6,200 ha (Tunisia). Inevitably, the definition of a micro-watershed and its size will vary, depending on the geographic features and the topography in relation to settlement patterns and land use. However, most project reports did not give much detail on the criteria adopted to decide on the scale of intervention.

In the projects reviewed, the micro-watershed approach facilitated integrated and participatory approaches and institutional development and coordination, and also reduced costs.

The micro-watershed approach made *integration* of land, water, and infrastructure development easier, particularly because soil, water, and overall physical conditions were generally homogenous. At the micro-watershed level, land tenure (although often a problem; see the section, *The Policy and Legal Framework,* in Chapter 3) could be better analyzed and solutions more readily worked out. Land management problems could be assessed and locally adapted solutions derived, not only on private land, but also on common and state-owned land (see Box 8).

At the micro-watershed level, it proved easier to engage in *participatory approaches* with all stakeholders, to identify needs and to establish micro-watershed plans (see the section, *The Use of Participatory Approaches*, in Chapter 3 below). Stakeholders proved ready to organize at community and sometimes even at intercommunity level. Consensus building among the stakeholders on even such thorny issues as the management of common land became possible. *Capacity building and technical assistance* proved to be effective and of relevance to communities and local institutions, since the scale allowed the content to be tailored to local needs. At the micro-watershed level, too, *existing nongovernmental community organizations and local public institutions* could be more readily involved. Finally, collective actions at the micro-watershed level proved to result in *lower costs*, and in better use of financial and human resources, especially for the management of common resources.

Difficulties encountered with the micro-watershed approach were caused by a range of specific design and implementation problems rather than to weaknesses in the approach itself.

In some cases, *institutional conditions* were not suitable, for example, where conditions were too heterogeneous, such as land capability classes, low production potential, complex land tenure

Box 8: The Micro-Watershed as the Successful Project Intervention Unit

In the Brazil Parana Land Management I Project, the road improvement program at the level of the micro-watershed proved to be the core theme around which all the other land management-related problems and solutions could be discussed with the community. This program was therefore key to farmer organization, and it was also decisive for motivating the support of local government for the project. The road subprojects were integrated in the overall micro-watershed land management plan. The role of the extension agents in this made them respected and well known by the community.

The erosion control practice of terracing was another element that contributed to participatory action based on the micro-watershed as the management unit. It brought small and large farmers together as complementary elements of a single expanded farming system. Terraces planned at the micro-watershed level crossed farm boundaries, eliminating fences and refilling boundary gullies. In addition to blocking runoff, the terraces contributed to expanded arable area and provided the entry point for introduction of the whole package of improved soil management practices promoted by the project.

Source: World Bank 1998a (Brazil Land Management I Project ICR).

arrangements, and diverging stakeholder interests. In other instances, *social conditions* were not propitious, for example, where communities were unwilling to organize or were reluctant to work with the program. In some cases, social assessments were inadequate to allow the existing social organization to be understood.

Sometimes, there was a *capacity problem*. In some cases, villagers were not able to assume the responsibilities expected of them. For example, they were not able to establish priorities or to control the execution of agreed plans and activities. In some cases, the problem arose from inadequate capacity building for local organizations. In several cases, there was *inadequate preparation and execution*. There were examples where the micro-watershed scale and the participatory approach were imperfectly understood by project staff and stakeholders. In some cases, this contributed to considerable delay in project implementation (for example, Peru: Sierra Natural Resource Management Project).

However, it was not always clear whether some higher-level planning or institutional structure was supposed to manage and monitor upstream-downstream interlinkages...

Most land and water interventions of the projects reviewed were managed at the micro-watershed level. In most cases, project documentation did not discuss whether there was any higher level of watershed management planning. It was not clear what the basis was for micro-watershed selection within a region, how the units selected were geographically or hydrologically linked, or if an analysis at a higher scale in the watershed was undertaken to coordinate activities and impacts.[12] In the case of India, micro-watershed approaches are adapted to conform to national government policies about project size and decentralized development.[13] There were, however, notable exceptions. The China Loess II Project, for example, set conservation objectives on a large scale in the upper and middle reaches of the Yellow River basin and then targeted interventions to particular "hot spots" where the project then worked on a participatory basis with local people (see Box 12 below).

12 The same concern applies for the micro-watershed management plans, the basic building block of watershed management programs (see the section, *The Use of Participatory Approaches*, in Chapter 3 below).

13 Personal communication from Grant Milne. On the issue of locally planned decentralized development in relation to watershed management programs, see the section, *Public Institutions*, in Chapter 3.

…nor was it always clear how a patchwork of interventions in upstream micro-watersheds was expected to have significant positive downstream impacts.

In some projects reviewed, the cumulative scale of interventions in micro-watersheds upstream was not adequate to be able to show real downstream impacts. For example, the staff of the Turkey Eastern Anatolia project argued that the implementation area of upland protection needed to be greatly expanded in order to achieve any significant results on reducing basin sedimentation. By contrast, the China Loess I Project did report a significant impact on sediment reduction for the Yellow River in China from its actions in only limited parts of the watershed.[14]

Recommendations

The definition of a micro-watershed needs to be adapted to the context and programs should be clear up front about the criteria adopted to select the proposed scale of interventions.

Selecting the most suitable scale for a watershed intervention and the mechanism for scaling up within a larger planning framework are clearly key elements in the design of watershed management programs (for a definition of *plan*, *program*, and *project*, see Box 9). Many evaluations identified appropriate scale of intervention as being a key factor in success. It is therefore essential to know what factors contribute to "right sizing" the scale of intervention.

Project experience has been that these aspects of program design have often not been clearly analyzed. The variations in the scales selected are considerable: in the projects reviewed, the number of micro-watershed management programs varied from a modest 50 (Tunisia) to an enormous 2,433 (Brazil Land Management I), and it was not clear what criteria were adopted. The definition of a micro-watershed needs to be adapted to the context, and programs should be clear up front about the criteria used to select the appropriate scale of interventions and about the ways in which the chosen scale fits within the broader planning framework. Clearly, program documents need to provide a consistent definition to guide implementation.

Box 9: Watershed Management Plans, Programs, and Projects

Although terminology varies widely, the following commonly used terms have been adopted for the purposes of this report:

- A watershed management plan sets the overall objectives of watershed management interventions and defines the land and water management policies, institutions, and investments needed to achieve the objectives.
- A watershed management program operationalizes the plan by defining the specific policy and institutional changes and investments to be made and the areas to which they will be applied within a specific period. The program quantifies and costs inputs, outputs, and outcomes.
- A watershed management project is an investment operation within the program, usually over 5–7 years, with specific performance indicators.

Source: Authors.

14 In addition to this question of the *scale of intervention* needed to have a measurable downstream impact are the question of the *scientific basis* for establishing upstream/downstream linkages (see the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4 below) and the question of *measurement* of those linkages (see the section, *Monitoring and Evaluation*, in Chapter 4 below). See also Box 42 in the section, *Monitoring and Evaluation*, in Chapter 4 below, for a discussion of how far the achievement of the China Loess I project were backed up by scientific evidence.

The delimitation of micro-watershed boundaries should be done flexibly and may have to be adapted to land use, human settlement, or administrative boundaries.

Adopting the physical boundaries of a watershed may not always make sense when social organization or other boundaries do not coincide (such as ethnic or religious groups, political boundaries, conservation parks, or individual farms). In some cases, the implementation of watershed management projects may be easier if the area is aligned to boundaries defined by human settlement patterns or administrative units. This may facilitate stakeholder organization and collaboration (Kerr 2004. See Box 10). Nevertheless, the chosen area should form an appropriate management unit from a hydrological point of view.

Box 10: Contrasting Project Experiences with Delimiting the Basic Watershed Management Unit

The Turkey Eastern Anatolia Project adopted the village as the basic management unit within the micro-watershed, and where human land use did not match the micro-watershed boundary, the village land area took precedence. This generally worked well, but it meant that some villages that used land within a micro-catchment were left out of the project because they were situated "over the ridge." This resulted in complaints from the communities.

By contrast, under the terroir approach adopted in the Sahelian countries, boundaries are drawn according to social boundaries, but are then adjusted by the limits of the major land use systems or the watershed.

Thus, depending on the settings and characteristics of the project zone, the question of what unit of implementation makes most sense may vary and should be evaluated thoroughly during the project design. The project zone may finally be defined by a hydrological (physical) unit, an administrative (political) unit, or a set of villages or social unit.

Source: World Bank 2004c (Turkey Eastern Anatolia Project PPAR).

Integration of watershed management activities beyond the micro-watershed scale requires a suitable institutional structure, technical planning, and a participatory approach.

Although the project experiences analyzed bore out international experience that the micro-watershed is the most practicable scale for the basic management unit, the challenge of integrating micro-watershed programs into an overall plan at the larger scale of the watershed has generally not been met. The project review provided only limited evidence of an institutional basis for setting objectives at the larger watershed scale, for targeting the upstream areas according to their possible contribution to broader scale objectives, or for managing the micro-level interventions so that they contribute to the objectives at the watershed scale.[15]

There have, however, been some positive experiences in integrating the micro-scale into a larger watershed scale:

- *Building up to higher-level participatory institutions* that can set objectives and agree interventions beyond the micro-watershed scale. Box 11 describes one successful case in Sri Lanka. This bottom-up approach is, however, likely to be applicable only on relatively small watersheds.

15 The problem of managing watershed interventions at different scales in order to achieve the larger-scale objectives of downstream impacts is further complicated by the adoption of participatory approaches, which essentially give communities—and not planners—the choice of interventions. See the section, The Use of Participatory Approaches, in Chapter 3 for a full discussion of this topic.

Box 11: Watershed Management Planning by Multicommunity Groups in Sri Lanka

A multilevel approach to participatory water resources planning was used in a small tank rehabilitation project in Sri Lanka. Meetings were held with farmers in local communities to get an initial information base and to introduce the planning approach and concepts. Participants from different local communities within a subwatershed then met at participatory planning sessions to exchange information about local conditions and needs. The participants used the enlarged information base to prepare water resources development plans for the whole subwatershed. This approach ensures that all local interests are reflected in the plans. Such mechanisms need to be supported by an institutional framework and by capacity building.

Source: Jinapala, Brewer, and Sakthivadivel 1996.

- *Starting with a watershed management program and objectives at the scale of the larger watershed,* then targeting key areas within the watershed and working with communities in micro-watersheds to agree on packages that both improve livelihoods and contribute to conservation objectives at the local and the larger watershed scale. This is essentially the approach being adopted in the China Loess II Project described in Box 12.

Box 12: Articulating Various Watershed Scales in the China Loess II Project

The Loess Plateau covers an area of some 640,000 km^2 in the upper and middle parts of the drainage basin of the Yellow River. The objective of the project is to help achieve sustainable development in the Loess Plateau by increasing agricultural production and incomes, and improving ecological conditions in tributary watersheds of the Yellow River, in particular by reducing sediment overload in the river.

The project area contains about 1,100 micro-watersheds with areas ranging from 1,000 ha to 3,000 ha. Counties and micro-watersheds were selected for inclusion in the project based on a variety of criteria. These included severity of soil erosion, poverty level, experience with soil and water conservation works, development potential and repayment capacity, strong leadership and commitment at the local government level, and proximity to science and research organizations involved in soil and water conservation. Also, the intent was to establish activities in a range of different but typical areas of the Loess Plateau.

The approach combined top-down and bottom-up processes. The project management team first identified the areas facing the greatest difficulties. Then, it designed sustainable local development plans with the communities. Throughout the life of the project, extensive use is being made of maps, both to monitor progress in micro-watersheds and to get an overview of impacts over the whole basin.

Source: World Bank 1999b (China Loess II Project PAD) and personal communication from Juergen Voegele.

Extrapolating from experience, it seems that watershed management approaches should try to combine three essential components:

1 At the overall watershed level, to have a *plan* that identifies key problems, intervention areas, and objectives and the mechanisms to achieve them. Ideally the plan should be developed through a participatory process.
2 At the micro-watershed level, to engage in *dialogue* with stakeholders to identify different or conflicting interests, to evaluate possible synergies and the minimum tradeoffs required,

and to identify a set of options to achieve both broader public interest objectives and local objectives.[16]

3 To ensure that *incentives* are present to encourage stakeholders to contribute to both sets of objectives (see the sections, *Profitability and Economic Viability of Watershed Management Interventions* and *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4 for a full discussion of incentives for conservation).

This approach clearly has to be adapted to the local physical and institutional context. The balance between the *top down* and the *bottom up* decision-making processes, and between the *downstream* and the *upstream* targeting will vary according to the balance of objectives. The approach does, however, provide a template from which to start. Landscape planning approaches used in conservation can be usefully adapted, for example, to this context (see Box 13).[17]

The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives

Overall, project experience demonstrates that the watershed management approach can, under the right circumstances, achieve both sustainable soil and water conservation and the intensification of resource use needed to improve stakeholders' livelihoods. Stakeholders adopted new technology without subsidy, but only when it yielded tangible benefits with manageable risk, and when they had the resources to invest in and to manage it. Technology was also adopted when it combined both conservation and income objectives. Generally, adoption was successful when communities selected from a menu of interventions and when a good mix of investments was proposed that yielded both short- and long-term benefits. Not surprisingly, projects had fewer problems in achieving both conservation and income objectives when the watershed was highly degraded, since there were no tradeoffs required. Where scope for intensification was limited, some projects also financed nonfarm activities as an alternative to out-migration.

Further work is needed in a number of areas in order to confirm the conditions for sustainability and scaling up of watershed management programs. Finding synergies is not straightforward and needs careful analysis of social and environmental dynamics in a watershed, and also well-grounded and sometimes creative solutions to resolve potential tradeoffs between income and conservation objectives. In the projects reviewed, some had difficulty in establishing sustainable incentive frameworks for soil and water conservation and pasture improvements. Restricting access to forests or rangeland will only work when all users, and especially the poor, have access to alternative income-generating activities. However, when these activities have been included in projects, they have not always left the communities better off. Environmental impacts of resource use intensification need to be carefully analyzed and mitigated. Programs in general focused on on-site benefits and neglected the setting and measuring of quantifiable downstream benefits.

Investments designed both to achieve sustainable natural resource management and to improve livelihoods through intensification of resource use are at the heart of watershed management programs. Meeting the two objectives at the same time can be challenging, and careful consideration of tradeoffs and creative solutions will be necessary to avoid project failure on one

16 See the section, *The Use of Participatory Approaches*, in Chapter 3 for a discussion of how this might be accomplished through the participatory planning process.

17 See also the following: World Conservation Union 2005 and World Wildlife Fund 2004.

Box 13: Landscape Planning Approaches

The purpose of landscape planning is to develop conservation management strategies that respond to scientific understanding of natural systems, that link to sustainable community development, and that are adaptive to changing societal conditions and values. A number of approaches have been developed and applied for this purpose, including, for example, the "protected landscape approach" used by the International Union for the Conservation of Nature and Natural Resources.

The US Department of Agriculture Forest Service has prepared guidelines to operationalize a "desired condition and zoning" approach. Through the setting of objectives, the desired condition describes the compositional and structural characteristics of the biological and physical features desired across the landscape. It also accounts for the social and economic needs of stakeholders who depend on landscape resources. Important steps to operationalize the approach are as follows:

1. Identify planning team members and define individuals' specific roles. Commonly required skills in a planning team include biologist, hydrologist, social scientist, economist, and forester.
2. Identify existing and needed information on the landscape. This should enable analysis of the demographic, political, and governance situation on the landscape, as well as the physical, biological, and ecological conditions to determine current condition and future trends. Data gathering should be an ongoing process and should feed back into adaptive management of the landscape. Whenever possible, processes for data gathering should involve stakeholders.
3. Define a public participation strategy. Sound strategies for landscape planning incorporate multiple opportunities for involvement by local communities, government, and other stakeholders.
4. Formulate the Landscape Plan. It should include the following:

   - Description of the landscape, including how it was delineated and what features make it a priority.
   - Characteristics of the landscape, including the existing uses in the landscape and the different groups involved in those uses, as well as an inventory of resources. This characterization should use tables and maps as much as possible to describe the physical, ecological, and socioeconomic conditions; identify influences outside the landscape that could affect the important values of the landscape; identify and evaluate applicable laws within the landscape; and identify key information gaps.
   - A vision statement, describing the desired future condition for the landscape and landscape objectives, together with the key principles for effective management of the landscape. The objectives should be unambiguous, measurable, and have a time line.
   - Zoning of interventions in the landscape. Zoning decisions are often considered the heart of a land use plan and can be contentious. They should be based on all quantitative and qualitative information gathered. The zoning process often has to follow an iterative approach because as data is gathered and stakeholder interests are identified, the planning team refines zone boundaries to come up with a configuration that best responds to the vision, objectives, and priorities of the landscape.
   - Plan implementation schedule, providing a work plan with a timeline and a budget.
   - Monitoring protocol, to determine whether the landscape plan is effectively contributing to the achievement of the landscape vision and objectives.

Source: World Bank, Forest Sourcebook (forthcoming).

or both objectives. The investments in the projects reviewed fall into two basic categories: (a) investments in soil and water conservation; and (b) investments in intensification of resource use. The following paragraphs summarize these investments as a basis for discussion of the results of the project review and of the challenges and options arising.

Investments in Soil and Water Conservation

Upstream investments in soil and water conservation targeted both on-site and downstream benefits

Investment in sustainable soil and water conservation—for example, stabilization of soils and prevention of erosion—is an accompaniment and an essential precondition to on-site investments in intensification of resource use, such as soil fertility improvement. In the projects reviewed, investments in soil and water conservation generally made up a large part of the investment budget: for instance, 81 percent in the India Hills Project and 71 percent in the India Plains Project. These investments generally had two objectives: (a) to stabilize soils in the uplands and so create "*in situ* benefits"; and (b) to improve water management and reduce downstream damage such as sedimentation, flooding, and infrastructure destruction ("*ex situ* benefits").

Soil and water conservation technology nowadays combines both structural and lower-cost vegetative measures, with an increasing emphasis on the latter.

Between the 1980s and early 1990s, soil and water conservation technologies developed from earlier emphasis on purely structural and engineering treatments to include lower-cost vegetative measures and cultural practices as well (see the section, *Watershed Management: Drivers and Approaches*, in Chapter 1 and the section, *Profitability and Economic Viability of Watershed Management Interventions*, in Chapter 4). In the project review, some *purely structural measures* were still employed, particularly for water management: water harvesting and storage facilities such as small reservoirs, ponds and dams, gully control, absorption and drainage canals across plot boundaries, sediment control dams, and the fencing of pastures (China, Red Soils II; China, Loess I; Mali, Natural Resources Management Project).

In most projects reviewed, *structural and vegetative measures* were used together. For example, terracing was done mechanically by bulldozers (China Loess I Project), manually, or by using vegetation (multipurpose trees, grasses, and legumes) planted on contour lines to initiate the natural formation of terraces (Indonesia Yogyakarta Project). In many cases, *vegetative measures alone* were used to protect and stabilize upland soils through afforestation, improved management of natural forests, revegetation of barren lands and degraded pastures, and through planting of vegetative barriers, hedges, and fodder banks (India Hills Project; China Loess I Project). Other management interventions employing largely vegetative measures included fixation of sand dunes, windbreaks, and fire breaks to prevent bushfires and protect the natural vegetation (Mali natural resources management Project, Niger natural resources management Project). Agronomic practices, such as conservation tillage, were also featured in a number of projects (Turkey Eastern Anatolia Project).

Investments in Intensification of Natural Resource Use

Measures to improve livelihoods primarily concerned intensification of natural resource use in rainfed agriculture, livestock production, and forestry.

In line with the general approach of the second generation of watershed management operations, the projects reviewed targeted not only soil and water conservation, but also increases in the productivity of farming systems in the micro-watershed, including agriculture, horticulture, livestock and rangeland, and forest management. In most of the projects reviewed, the primary focus was on intensification of rainfed agriculture and to a lesser extent on investment in irrigation. Livestock production and forestry were also important investment areas.

In agriculture, investments targeted productivity improvements through intensification, diversification, integration of crop and livestock production, and improved water management. Downstream processing and marketing investments also featured in some projects.

In agriculture, *intensification measures* included improved crop husbandry practices and soil fertility management techniques, and the adoption of improved varieties. Programs that targeted *diversification* of food and cash crops produced significant shifts in many projects from annual to perennial cropping systems, including cultivation of fruit trees, perennial cash and fodder crops, and trees for both fuel and timber. Cropping intensities were increased by the development of intercropping practices. For example, the China Red Soils II Project promoted fruit trees, such as peach and plum, citrus, chestnut, longan, lychee, and ginkgo, and also developed intercropping systems with tea, mulberry, or grapes. The *integration of crops and livestock* was especially emphasized in project areas with poor soils or with widespread livestock production where the integration was essential for soil improvements. In upland *improved water management*, water harvesting, conservation tillage, and small-scale irrigation were key investments (such as Morocco Lakhdar, Tunisia Northwest Mountains, Turkey Eastern Anatolia Project). A few projects also worked on drainage issues (China Red Soils II Project).

Investments in downstream *processing and marketing activities* were also important ways to increase incomes in poor farming communities. A number of projects financed farm-to-market roads and improved processing facilities (Morocco, Tunisia).

Intensification and diversification of livestock production and improved rangeland management were also important investments.

Livestock production was promoted in a number of projects with emphasis on *intensifying the production system* through stall-feeding, forage production (including the establishment of fodder banks) and storage (hay production), genetic improvement, and animal health services. *Diversification of the livestock economy* was also an important component of some projects, for example, the development of a dairy industry, or the introduction of new livestock. Under the China Red Soils II Project, new ruminants, pigs, chickens, ducks, geese, and aquaculture were all introduced. Apiculture provided an interesting additional source of income in the Turkey Eastern Anatolia Project. *Improved rangeland management* aimed at restoring and sustaining vegetative cover. Techniques were rotational grazing (by establishing enclosures and rotating animals among plots), seeding of improved forage species, and fertilization of degraded rangelands (for example, in projects in Mali and Tunisia). The increase in fodder availability was also expected to reduce pressure on the rangeland (in Tunisia, for example).

The aim of investment in forestry was to protect and improve forest cover while creating associated revenue streams for local people.

In many projects, forest management was part of the spatial watershed management approach, with the twin objectives of maintaining or increasing forest cover and creating incentives for sustainable management by local people. Investments were both in *natural forest management*, and in *reforestation and afforestation*. In some projects, for example, Morocco Lakhdar, forestry management plans were developed using participatory approaches to ensure that local people had a stake.

Several projects also financed nontraditional activities as an alternative to out-migration.

In poor hill-farming communities, there is a limit to the agricultural intensification process and a point at which *nontraditional economic activities* are the only alternative to out-migration or natural resource depletion. Several projects financed *nonfarm activities*, such as artisanal activities for women (for example, Morocco Lakhdar). Other projects provided *alternative use rights*: Andhra Pradesh in India provided fishing rights to herders to compensate for grazing area restrictions, water rights to the landless, and conversion of cultivated land to pasture. Many projects also promoted *labor-intensive implementation*, creating employment opportunities in planting vegetation or installing conservation structures.

Results of the Project Review

Many of the projects reviewed achieved their targets and established both sustainable land and water management systems and associated improvements in livelihoods.

Physical targets set at the outset of the projects were in most cases achieved or exceeded. In *soil and water conservation*, the on-site soil and water conservation objectives were generally attained. The Brazil Land Management I Project achieved 116 percent of its *output* targets for the number of micro-watersheds and the land area treated, and the follow-up Land Management II achieved 103 percent. The vast Turkey Eastern Anatolia Project achieved an extraordinary 162 percent of its physical output targets. Projects also recorded success in conservation outputs: the China Red Soils II Project achieved a 25–78 percent reduction in soil loss, and the Brazil Land Management II achieved a 10–50 percent reduction. Often positive and substantial environmental and development *impacts* were claimed beyond the project area (although the monitoring of these was inadequate; see the section, *Monitoring and Evaluation*, in Chapter 4 below).

The *intensification of resource use* components generally performed well. In *agriculture*, yield improvements in agriculture were considerable. In the Indonesia Yogyakarta Project, rice yields doubled from 1 to 2 t/ha, and in the India Hills Project, yields increased 75 percent for maize and doubled for wheat. Increases in horticultural production were particularly significant in the China Loess I Project, where fruit production increased by 430 percent. Diversification of the cropping system, especially through tree-based systems, allowed farmers to manage risks better and to increase the cultivated area. Diversification also provided a buffer against uncertain climatic conditions and against market risk (China Loess Plateau Project, China Red Soils II Project, and Tunisia Northwest Mountain Project). *Rangeland and livestock improvements* yielded benefits for both soil and water conservation (through restored vegetative cover) and for farmer incomes through intensified livestock production and integrated crop-livestock systems: stall-feeding of animals, manure collection in stalls applied to crops, fodder plant cultivation (China Red Soils II and Loess).

Programs resulted in substantive *income increases* for farmers: four times in the China Loess I Project (from Y 360 to Y 1,263); double in China Red Soils II Project (from Y 1,200 to Y 2,450). In Tunisia, farm incomes went up 30 percent, and on-farm employment doubled (Box 14). In the Turkey Eastern Anatolia Project, annual net income increased by 136 percent over a three-year period, with a higher-income increase for poorer farmers.

In some cases, especially in forestation, the achievement of both resource conservation and livelihood improvement objectives was challenging and not always successful.

Forest management interventions had to confront the potential conflict between the economic interest of the local community and the public conservation interest. Projects often faced a legacy of state policing and friction with the community and had to develop new approaches. In some cases, this challenge was successfully met. In *Turkey*, for example, an agreement was forged

Box 14: Income and Employment Benefits from Soil and Water Conservation in Tunisia Northwest

In the Tunisia Northwest Mountain Area Development Project, soil and water conservation measures increased infiltration rates. This resulted in higher crop and tree survival rates and higher adoption rate for perennial crops. Increased agricultural production raised on-farm employment opportunities. The number of days spent on-farm increased from the 1996 baseline of 136 per year to 285 per year in 2000, an important result for a region with high unemployment and underemployment.

Source: World Bank 2003c (Tunisia Northwest Mountain Area Development Project PPAR).

between government and villagers for the sustainable use of the existing natural forest, and new planting was also undertaken with indigenous species. In the Land Management I Project in *Brazil*, erosion-prone slopes were reforested for commercial purposes and investments were made in parks and forest reserves, raising awareness of biodiversity protection in the region. However, when agreements beneficial for the communities were not reached, conservation measures failed. For example, where reforestation and afforestation were promoted with a command-and-control approach (bans on grazing and cutting trees on common land), restrictions were often not respected, even when a regime of sanctions was established.[18] Project experience has been that alternative viable income-generating activities have to be offered, or attempts to restrict access will either not work or will simply further impoverish the poor (see Box 15).

Box 15: Compensation for Restricted Access in India

Livestock herders in many watershed villages complained that they had suffered from loss of access to their traditional grazing lands, which were sealed off to promote regeneration. All project interventions in these villages had provided employment generation opportunities, but herders said these were inadequate to compensate them for their losses. This problem was particularly acute in Maharashtra, where landless people (typically scheduled castes and tribes) are a small minority in the village, so that their voice was not heard. In other places, herders simply ignored grazing restrictions, protecting their immediate livelihoods, but undermining project objectives.

On the other hand, some projects, especially in Andhra Pradesh, have explicitly aimed to develop innovative solutions to the problem of managing common lands, trying to build the interests of different groups into the project at the outset. These solutions have often targeted landless people, providing rights to engage in other economic activities (such as fishing and water trading). In many of these cases, villagers responded with much greater frequency that employment creation opportunities resulting from the project had arisen compared to other villages.

Source: Kerr and others (2007).

Not surprisingly, when the watershed was highly degraded, projects had fewer problems in achieving both objectives.

Synergies were most evident when the starting point was one of a highly degraded watershed, with communities making their living from a narrow range of low income–generating activities, such

18 Although no example was found in the review of World Bank–financed projects, this situation has commonly occurred, for example, throughout India (see Kerr 2006).

as subsistence agriculture and grazing. Under these conditions, projects did not generally have to deal with substantial tradeoffs and opposition from communities, since people could only expect to be better off with the project, especially when the package of incentives was appealing (for example, land property rights, and improved soil quality) and when vegetation activities targeted "wasteland." The Loess Plateau Watershed Rehabilitation Project (Loess I) in China is an example of such a win-win outcome (see Box 16).

Box 16: The "Win-Win-Win" Outcome from Soil and Water Conservation in China

In the China Loess Plateau Watershed Rehabilitation Project (Loess I), soil and water conservation measures had a significant impact on the incomes of local people. They also brought significant environmental benefits to downstream areas—a "win-win-win" outcome.

Terracing of loess soils resulted in the doubling of crop yields with only slightly higher input costs. This led to an almost immediate increase in incomes. In some of the drier areas, where terracing was combined with irrigation, very high yields were secured, since soils and climate conditions make the Loess Plateau one of the most fertile areas in the world. The new terraces and access roads gave farmers the opportunity to grow a wider range of crops. In particular, temperate fruit and nut trees grew very well, which had a significant impact on agricultural incomes, although the benefits took longer to accrue.

Parallel improvements in farming practices and technology resulted in labor saving in crop production and improved labor productivity overall. As a result, stakeholders could take up new employment and income opportunities, both on-farm and off-farm. Some took up more outside employment, and others started new farming activities particularly in livestock and fruit production. These new opportunities allowed a better labor distribution over the year with increasing work during the off-season. Employment of women and female labor productivity particularly benefited from new on-farm opportunities.

Project measures reduced risks and income variability for farmers and increased average incomes. Terracing improved water retention in situ, which lowered the variability of yields significantly. This was proven during years of severe drought experienced during project implementation. In years with average rainfall, grain yields on terraces reached two to three times those on slopelands. The diversification of production also helped reduce the variability of income. Livestock and trees provided a buffer in difficult times. Irrigation, although a small part of the project, also protected against drought.

A combination of rangeland improvement and improved animal husbandry increased the productivity of livestock systems. An enforced grazing ban was successfully adopted. The areas under treatment showed a dramatic increase in vegetative cover even in drought-affected areas. Despite the droughts, natural shrubs, grasses, and trees reestablished themselves on steep slopes that had previously been grazed bare. The erosion control benefits from these measures were substantial. Livestock productivity and incomes rose sharply as farmers moved to more intensive production system. Farmers invested in animal sheds and pen construction, fodder processing equipment, and animals suitable for pen feeding.

The project also recorded significant environmental benefits to the downstream areas. Sediment inflow to the Yellow River and its tributaries was reduced with several benefits: (a) irrigation systems and downstream reservoirs suffered less from sedimentation, (b) river channels were more stable and maintenance costs were reduced, and (c) the rise of the riverbed in the Yellow River was slowed and the cost of raising the flood embankments could be deferred.

Source: World Bank 2003a (China Loess I Project ICR).

Stakeholders adopted new technology without subsidy only when it promised tangible benefits with manageable risk, and when they had the resources to invest in and to manage it. Technology was also successful when it combined both conservation and income objectives. Generally, adoption was successful when communities could select from a menu of interventions and when a good mix of investments was proposed that would yield short- and long-term benefits.

Implementation of new technologies was successful when they were seen as profitable and manageable by the beneficiaries. Thus, technologies were quickly adopted even without subsidy when the benefits were clear and when they were adapted to the local conditions and capabilities. In many cases, the most successful technologies built upon stakeholder's current practices. Furthermore, adoption was successful, when communities could select from a menu of interventions and when a good mix of investments was proposed that would yield short- and long-term benefits. These approaches ensured that the proposed new techniques satisfied stakeholders' preferences and also responded to varying ecological conditions. The evidence shows that where these conditions were fulfilled and technologies created immediate benefits, they were widely adopted, spreading inside as well as outside the project area (such as under the Brazil Land Management II Project). Technology was also successful when it combined both conservation and income objectives. For example, where terraces were constructed, labor input for crop production decreased, so that farmers had an incentive to invest in what was at once a conservation and a production investment.

However, in some cases there was difficulty in developing viable technical solutions that gave stakeholders incentives to invest.

A number of projects had *difficulty in developing or implementing viable soil and water conservation technologies*. Farmers resisted adopting conservation techniques if they were too expensive or too labor intensive or if they did not correspond to their priorities. Often, subsidies were used to advance implementation of more expensive technologies. The inevitable consequence was that the techniques never spread beyond the project intervention zone, and with the cessation of subsidies, no further adoption took place (Indonesia Yogyakarta Project). In Burkina Faso, conservation technologies were promoted by subsidies during implementation, with the result that, at the end of the project, it was still not known whether the interventions could be economically viable.[19] Sometimes, conservation technologies proved much more expensive than expected. In the Indonesia National Watershed Management Project, investment costs were 60 percent higher than expected. In some cases, it proved difficult to execute the works to the required standard. In the China Red Soils II Project, a rapid pace of construction resulted in substandard works that required considerable repair and reconstruction.

Improving pastures proved problematic in some projects, for example, in Turkey where the seeding of fodder plants was too costly. The most successful techniques proved to be the simple closure and protection of pastures (rotational grazing, grazing bans).

Some technologies presented too much risk or did not meet stakeholder capabilities or livelihood objectives. In some cases, insecure land tenure made farmers hesitate to adopt improved techniques. In others, farmers would not invest because proposed technologies yielded benefits only in the longer term. In some cases, the problem was not with the production packages, but with the lack of outlets for marketing increased production and new products, or with lack of appropriate agroprocessing technology.

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19 See the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4 for a discussion of sustainable incentive structures in watershed management.

In other cases, programs did less well because the implementation teams could not fully deliver the sometimes complex watershed management programs.

In several programs (India Plains and Hills Projects, Indonesia Yogyakarta Project), despite good technical and economic packages, the technical assistance provided to stakeholders under the project was inadequate in quality to respond to stakeholders' needs, priorities, and problems, and adoption rates remained unsatisfactory.

Recommendations

Programs demonstrated that the watershed management approach can under the right circumstances achieve both sustainable soil and water conservation and the intensification of natural resource use needed to improve stakeholders' livelihoods.

Many of the projects successfully invested in the conservation of natural resources and the gradual intensification of their use and showed significant beneficial impact on livelihoods in the upland regions. Some of the more significant factors in success included the following:

- *Participatory approaches* to developing and adopting new technologies.
- *A sound social analysis,* such as a stakeholder analysis aimed at assessing losses to be incurred by different community groups because of conservation practices.
- A focus on *generating positive income streams* for farmers and other groups (such as herders) through intensification, diversification, downstream processing and marketing, and the creation of new income-generating activities.
- Giving stakeholders a *secure stake* in common pool resources, such as forests and pastures, and ensuring that all users and especially the poor have *viable income alternatives* when closure is involved.
- Promoting interventions that *reduced risk*, such as improving water sources.
- Identifying *conservation techniques that were profitable* for farmers and offering a menu of interventions combining income and conservation objectives.

However, conditions for sustainability and scaling up of watershed management programs were clearly not yet present in a number of areas.

Many of the projects reviewed experienced common weaknesses that could make sustainability and scaling up problematic:

- *On-site intensification is not always consistent with natural resource conservation*. There can be a risk of conflict between on-site intensification objectives and natural resource outcomes. For example, higher stocking rates for animals, especially when free to circulate, can exacerbate soil loss in steep uplands, and intensified use of mineral fertilizers are risky for groundwater and downstream water pollution.
- *There can be high costs to stakeholders in adopting conservation investments*. Despite some outstanding examples of reconciliation of conservation and intensification objectives (for example, the Loess Plateau, see Box 16), conservation may not always be to the stakeholder's profit, and local interests may conflict with downstream interests.[20] In fact, a number of

20 This was the conclusion of a recent review of Global Environment Facility (GEF) projects that had been designed to achieve global environmental benefits while improving local community livelihoods: "Expectations of win-win situations for global and local benefits proved unrealistic in many cases. Many interventions require trade-offs to be made between environmental conservation or restoration and existing local resource uses" (GEF Secretariat 2006).

watershed projects reviewed had difficulty in establishing incentives for sustainable soil and water conservation and pasture improvements. Here, project preparation needs to include *technical analysis* of the potential for improving resource conservation within farming systems, *social analysis* to identify potential winners and losers, and *financial analysis* to establish the basis for project incentives (see the section, *Profitability and Economic Viability of Watershed Management Interventions*, in Chapter 4 below). Projects need to have clarity on how the use of subsidies to improve incentives will create sustainable watershed management, and also on how benefits will be provided equitably to compensate losers, particularly the poorest (see the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4). Local research and development can also help to construct least-cost and maximum-benefit technical packages.

- *Incentives for sustainable forest or rangeland management need to compensate for lost income streams*. When forest or rangeland closures apply, or when land previously used for grazing or cultivation is selected for revegetation, commitment of communities to conservation needs to be assured through a menu of alternative income-generating activities or other economic incentives (see the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4). Equity issues need to be considered in targeting beneficiaries of alternative income-generating activities, since the landless are generally those who are most damaged by restrictions on the use of common land.
- *Programs have focused on on-site benefits and have generally neglected the setting and measuring of quantifiable downstream benefits*. Most program activities and monitoring concentrated on on-site benefits, and very little on what impact programs had on the broader environment. In project design, it was often assumed that downstream environmental benefits would accrue because of project activities, but outcomes were rarely monitored (see the sections, *Watershed Management Externalities and Their Valuation and Monitoring and Evaluation*, in Chapter 4 for a full discussion of this issue).

Applied Research and Knowledge Sharing in Watershed Management

The most successful applied research and knowledge sharing in watershed management programs worldwide have been based on a participatory and partnership approach. In this approach, stakeholders are full partners in the research process at all the stages of identification, design, implementation, and evaluation, and technologies are offered as a range of choices to be adapted rather than as prescriptions. Many of the projects reviewed successfully used this approach to develop technical packages for conservation and intensification. Lessons from failures were to avoid overcomplexity, and to ensure that scientists worked within a framework conducive to partnership and dissemination and had both research and communication skills. A participatory and partnership approach requires careful institutional organization up front to coordinate research agencies at various levels and to factor in other stakeholders, including farmers and the private sector.

In recent years, the most successful applied research and knowledge sharing in watershed management programs worldwide has been based on a participatory and partnership approach drawing on both stakeholder knowledge and on research findings.

Until the 1980s, land and water management approaches to technology development and transfer were based on the assumption that knowledge originated in modern agricultural science and that development followed from transmitting such knowledge. Technologies were transferred from the research stations through the extension service to farmers. Emphasis was put on teaching the new technologies and providing farmers with technical support to adopt these technologies.

In recent years, a participatory and partnership approach to applied research and knowledge sharing has been introduced: a "new paradigm that involves many actors in a multipolar process of knowledge generation," a process in which stakeholders and other practitioners act as partners with researchers (Pretty and Uphoff 2002). In participatory research, stakeholders are encouraged to take initiatives rather than be mere recipients. Partners learning from each other and interacting with each other is held to be a surer way than teaching the creation and dissemination of new knowledge. The relationship among actors "becomes circular rather than linear" (Pretty and Uphoff 2002).

Results of the Project Review

This participatory and partnership approach was implemented in a number of the projects reviewed, but in others more traditional research approaches were adopted.

Research approaches in the projects reviewed ranged from short-term, demand-driven applied research on important technical and socioeconomic issues (Mali, Tunisia), to action-research to develop location-specific technologies (Indonesia Yogyakarta), to on-farm technology displays providing a menu of technology options on farmer-managed plots (Indonesia Yogyakarta), and finally to the more traditional on-station technical research, such as germplasm testing and economic evaluation of technologies. A significant gap in applied research on watershed management was the failure to measure off-site and downstream impacts, although there have been recent improvements in quantitative measurement techniques (see the sections, *The Role of Externalities in Defining the Incentive Structure* and *Monitoring and Evaluation*, in Chapter 4 below).

The participatory and partnership approach worked well, especially when technical teams were competent and when stakeholders were integrated throughout the research process, including in dissemination.

The experience of the projects reviewed showed the value of research results when they were produced in a timely fashion, when research topics were demand driven, and when messages were based on existing local technology. Where exchanges between researchers, extensionists, and stakeholders were intensive, results were quickly disseminated during the project period. The quality of technical knowledge and the staff were vital components. Well-trained technicians and competent extension staff in multidisciplinary teams were essential to successful research and knowledge programs (see Box 17).

Box 17: The Importance of the Quality of Knowledge for Project Success

In the Brazil Parana Land Management I Project, two decades of studies and accumulated field experience from extension programs had built up a considerable stock of knowledge about the land and water potential and about land management problems. Research programs had also developed a range of relevant technologies.

Building on this substantial base, the project was able to formulate a clear technical strategy. The stock of relevant land management technologies was further enriched during implementation by the generation of new techniques. This technical knowledge proved to be fundamental to the success of the project. All these technologies were systematically documented in a technical manual for the daily use of the extension agents, which facilitated the diffusion of the recommended practices.

Source: World Bank 1998a (Brazil Land Management I Project ICR).

In Tunisia, farmers were integrated in the research process and in the dissemination of techniques (Box 18). They received special technical assistance and were able to convey complex messages and topics well to the local farming community.

Box 18: The Dissemination of Quick-Response Research by Farmers in Tunisia

The Tunisia Northwest Mountain Areas Development Project had an applied research component supporting demand-driven, short-term research on technical and socioeconomic development constraints and alternative land use strategies. One hundred and fifty village demonstration plots and 111 nurseries were created. Research activities were contracted out to existing research organizations. Overall, 13 research themes on improved technologies were satisfactorily implemented.

Interaction with farmers and dissemination of results were greatly helped by the fact that the project implementation unit was decentralized. The project employed full-time subject matter specialists and extension workers (*animateurs/animatrices*) who consulted with the target communities. Female extension workers helped reach more women beneficiaries.

One key innovation was that the project not only used demonstrations on farmers' lands, but also trained local farmers to disseminate messages to the local community. This permitted regular dissemination as demand arose, without awaiting the presence of extension officers. The short-term nature of the research, combined with the dissemination techniques, particularly demonstrations, resulted in reasonable adoption rates. However, the adoption rates could have been better if the research had considered whole farming systems as opposed to specific themes within a system.

The conclusion of the post-evaluation of the project was that the demand-driven and "quick" nature of the research was appropriate as results were available early in the project and were readily transferable through the project's relatively intensive extension activities, including the "farmer to farmer" extension.

Source: World Bank 2003c (Tunisia Northwest Mountain Areas Development Project PPAR).

Causes of failure in research and knowledge components were overcomplexity and a weak framework for partnership and disseminating knowledge.

In the Yogyakarta project in Indonesia (see Box 19), although there were demonstration plots and an action-research approach, scientists designed techniques without sufficient interaction with extension workers and farmers. On-farm technology displays had very limited impact because of poor technical quality and little interaction between research and extension agents. In the end, the new techniques stayed behind on the research stations, and the multitude of apparently useful results was not effectively translated into practice. In some cases, the technological complexities of soil-water interactions were simply too great. In the Plains Project in India, the capacity of the some agricultural research institutions was too weak to address location-specific technological problems in the project areas. Even where good results were obtained, as in Rajasthan, the project proved too rigid to incorporate the location-specific recommendations.[21]

21 Personal communication from John Kerr.

Programs that supported the creation of a national or regional information system on watershed management worked best when they were not too complex, were anchored in permanent institutions, and met a real demand for information.

In Burkina Faso, a National Environmental Monitoring System was designed to assess the extent of resource degradation nationwide and to understand the causes, dynamics, and trends. It also included the analysis of environmental change over time through satellite imagery and the analysis of water, agriculture and livestock data. However, the attempt proved too ambitious: the system was not operational at the end of the project because of a delay in technology acquisition, delay in planned institutional reforms, and the slow pace of procurement procedures. In the China Loess Plateau Project, a regional natural resources information and monitoring system integrated a GIS database with social and economic data. The system was set up for each subwatershed, and data were aggregated at regional level. A multidisciplinary team in the field complemented the computer-based monitoring system. This system worked well and was integrated into governmental agencies. It continued to function after the project ended and provided feedback to the provincial and county soil and water conservation bureaus.

Box 19: Successful Adaptive Research in Indonesia Compounded by Weak Dissemination in Indonesia

Under the Indonesia Yogyakarta Upland Area Development Project (Bangun Desa II), the Ministry of Agriculture created the first ever upland agriculture research station in the country. Research focused mainly on technical, agronomic, and economic aspects of improved cropping systems, erosion control, and on-farm water storage. One hundred and sixty-two research topics were addressed during the project's lifetime. On-farm technology demonstrations were set up in 140 villages. These provided an array of technology options for improved land management, and local farmers could choose according to their specific farm conditions, and finance and labor constraints.

Overall, the post-evaluation of the project concluded that the project was successful in establishing the technical parameters for the conservation and utilization of the upland areas. However, the limited interaction between research and extension restricted adoption of the results. The demonstration plots were not used effectively to promote new technologies, and there was little spread to surrounding areas. The full potential of the technological changes developed by research has yet to be translated into reality on the ground.

Source: World Bank 1998b (Indonesia Yogyakarta Upland Area Development Project ICR).

Recommendations

The most successful programs to date have been those where stakeholders were partners in the research process at all the stages of identification, design, implementation, and evaluation, and technologies were offered as a range of choices to be adapted rather than as prescriptions.

The lesson of experience is that potential technological strategies should be tested through on-farm research where stakeholders are supported to adapt the technologies to the site-specific conditions. This step-by-step process of technology development allows labor and input costs to be spread out over time, reducing the risks for stakeholders. Technology choices should be offered as principles, methods, components, and as a basket of choices to be adapted, rather than as prescriptions. Stakeholders should be given training and support in innovating, in evaluating results and in disseminating lessons. In general, projects should work closely with stakeholders on the lookout for indigenous innovations already occurring and be ready to build on stakeholders' ideas and practices.

A participatory and partnership approach requires careful institutional organization up front to coordinate research agencies at various levels and to factor in other stakeholders, including farmers and the private sector.

The coordination of research should be encouraged at national, regional, and local level. The division of responsibilities between the various agencies involved in soil and water conservation research needs to be clearly defined to avoid gaps and overlaps. Integration of various partners and stakeholders, including the private sector, in undertaking research should be promoted. Dissemination of results between projects and scientists is vital. The tendency in India is to repeat research in new projects rather than to capitalize on the wealth of existing research results.[22]

22 Personal communication from Grant Milne.

CHAPTER 3:
INSTITUTIONAL ARRANGEMENTS FOR WATERSHED MANAGEMENT

This chapter reviews the institutional arrangements that have been used for watershed management, including the use of participatory approaches, issues on the role of public institutions, the need for a supportive policy framework, and poverty reduction objectives and impacts.

The Use of Participatory Approaches

Participatory approaches and community watershed management plans have been widely used with varying success in reconciling the overlay of human activity on naturally defined watersheds. In the projects reviewed, participatory approaches were employed to establish micro-watershed management plans. The participatory processes succeeded where there were common purposes that could interest all or most of the population, where the participatory process was flexible and provided for capacity building and genuine empowerment, and where there were income and livelihoods incentives. Where communities could see the economic benefits and were empowered, they were willing to invest in long-term conservation.

Participation does not, however, guarantee specific outcomes, and the process must be designed for the development and distribution outcomes intended. Although a watershed management project will have targets for inputs, outputs, and outcomes, these targets have to be flexibly interpreted, since the community has the ultimate decision over the management plan. However, the planning process has to allow both community interests at the micro-watershed level and the larger resource conservation objectives to be included. Participatory approaches impose a demanding set of requirements: political commitment and equitable rules, time for the process to mature, careful sequencing, inclusion of all stakeholders in the process, public agencies that understand the rationale and process of participation, and sustained capacity building at all levels, for both stakeholders and public agencies.

Recent years have seen a move in watershed management programs from top-down approaches to participatory approaches designed to create ownership.

Participatory management has been defined as a process whereby those with legitimate interests in a project both influence decisions that affect them and receive a proportion of any benefits that may accrue (Turton, Warner, and Groom 1998). In recent years, participatory approaches have been broadly adopted in watershed management programs in response to the failure of previous programs characterized by a top-down engineering approach and poor sustainability. The central control and external conception that drove previous approaches were considered to have led to lack of incentives and weak ownership of interventions by those ultimately in charge of local land and water management, the resident community (see the section, *Evolving Approaches of Watershed Management in Developing Countries*, in Chapter 1 above). Participatory approaches were therefore adopted in order to ensure community ownership. Under this vision, watershed management programs create the incentives and bring the resources to encourage the local population to organize around the improved management of watershed resources (Rhoades 1999; Kerr 2004).

Participation is also seen as a good way of resolving the challenge of the sometimes haphazard overlay of human activity on naturally defined watersheds. With participatory approaches, the human-managed space can, in most cases, be reconciled with the hydrological unit as the planning area.

Ideally all stakeholders should be involved in the participatory process. Stakeholders are thus first and foremost the local population, but also NGOs, government agencies, universities, international organizations and the private sector.

Although the approach is relatively recent, and natural resource management programs are slow maturing and can only be fully evaluated in the long-term, there is some empirical evidence that participatory approaches produce better outcomes, with the important caveat that the poor and landless may suffer, unless proper provision is made for them (see Box 20).

Box 20: The Success and Risks for the Poor of Participatory Projects in Protecting Upper Catchments

In a study in Maharashtra, India, five different approaches to watershed management were evaluated, and participatory projects were indeed found to be more successful in protecting upper catchments. Seventy villages were randomly sampled, stratified by five categories: four with different project types, and a fifth category with no projects:

1. *Ministry of Agriculture projects* focused primarily on technical aspects of developing rainfed agriculture, including soil and water conservation.
2. *Maharashtra Department of Water Conservation projects* focused on technical aspects of water harvesting, through construction of percolation tanks, contour bunds, and other structures.
3. *NGO projects*, which placed greater emphasis on social organization and less on technology relative to government programs.
4. *Jointly supported NGO-government projects* seeking to combine the technical approach of government projects with the NGO orientation toward social organization.
5. *Control*: villages with no watershed projects.

Econometric analysis related various indicators of watershed performance (erosion, use of common lands, irrigation benefits) to project interventions and to village-level socioeconomic and agroclimatic characteristics.

The study found that the more participatory projects were, the more they were successful in protecting upper catchments. On the other hand, the study found that "too often protection of upper catchments came at the expense of landless people whose livelihoods relied heavily on them."

Source: Kerr 2001.

Participation, however, is not straightforward. Project management has to foster participation, and benefits must be apparent to the local people. In addition, participation is not a neutral concept. It involves shifts in decision-making power between the state and local communities, and also between different segments of the local community. Participatory processes therefore need equitable rules—and they have to be designed for the specific development and distributional outcomes intended.

Participation is not a straightforward concept. A number of conditions are necessary for people to actually participate in watershed management programs. First, the watershed program must include demand-driven activities. Then, people must be aware of the advantages of collective action in conserving and managing natural resources, and they must be empowered to plan, implement, and manage the programs. Finally, people should expect private economic benefits (Joshi and others 2005; Sharma and others 2005).

Theoretically, the participatory approach allows all stakeholders to come to agreements on allocating rights and responsibilities and on the sustainable use of the natural resource base. However, *participation is not a neutral concept*. Rural societies are plural and stratified, with divisions based on gender, caste, and religious groups, and on socioeconomic status, including land tenure. Participation involves a set of political issues concerning who has decision-making power, who has access to resources, and who benefits from resource use (Farrington, Turton, and James 1999). Finally, participation will not just happen. Project management has to create a framework and then actively ensure participation of all groups in the community (Sharma and Scott 2005).

Participatory processes therefore need equitable rules, and they have to be designed for the specific development and distributional outcomes intended. Thus it is important to have a critical look at the design of the participatory process, whether it helps achieve project objectives, and how the process can be improved. This is particularly important where the social structure is uneven. For example, after implementation of watershed management projects in Maharashtra (India), many landless herders said that the decision to close common lands had been based on the majority-rule vote, so that their interests were neglected. As a consequence, they claimed that they were worse off with the project. Even where a consensus-reaching approach was used, landless people stressed in group interviews that it was not feasible for them to stand up to the will of a more powerful majority (Kerr, Pangare, and Pangare 2002).

Results from the Project Review

In watershed management programs, the principal application and output from the participatory approach is the establishment of micro-watershed management plans.

In all watershed management projects reviewed, the principal participatory activity was the preparation, implementation, and monitoring of community micro-watershed management plans. The objective of these plans is to integrate the concerns and interests of the stakeholders, and to come to an agreement within the community and then between the community and the program on a set of interventions that aim at both sustainable natural resource management and livelihoods improvements. The plan is also the instrument by which the watershed management program seeks to factor in program objectives beyond the micro-watershed—that is, downstream benefits and externalities.

In most projects, the community sets up a committee to design plans with the assistance of a multidisciplinary team of technicians. Once agreed, the plan becomes the basis of a contractual agreement between the community and the program, with assignment of responsibilities and cost sharing. Micro-watershed management plans can be done at various levels from farm level upwards, although the complexities and risks increase with scale. Examples of micro-watershed planning from Brazil and Turkey are given in Boxes 21 and 22.

In the projects reviewed, participatory processes succeeded where there were common purposes that could interest all or most of the population, where the participatory process and organizations were flexible and provided enough time and resources for capacity building and genuine empowerment, and where there were income and livelihoods incentives.

Participatory processes succeeded if there was a *common purpose*, such as roads, water development, or erosion control, as in the India Hills Project and the Brazil Land Management I Project. Where there were divergent or inconsistent interests, the approach and the menu of

Box 21: The Contribution of the Participatory Watershed Planning Approach in Developing Both Micro-Watershed Plans and Individual Farm Plans in Brazil

In the Brazil Parana Land Management I Project, the use of the micro-watershed as the project's geographical planning unit permitted farmers and extension workers to understand and synthesize the land management problems and solutions better. Planning at the micro-watershed scale stimulated the integration of the participating institutions and the organization of the farmers around a common objective. It motivated group discussions and participatory action and allowed more rational use of human and financial resources. Once a micro-watershed management plan was created, annual work plans were agreed upon with well-defined responsibilities for implementation agencies and beneficiaries.

In addition, the project supported individual farm plans. These summarized the farmer-extensionist joint analysis of farm potential and problems, and outlined a phased program of actions aimed at eliminating existing land use conflicts and at optimizing land use through the introduction of adequate technologies to be progressively implemented within the broader micro-watershed plan according to the farmers' resources.

Source: World Bank 1998a (Brazil Land Management I Project ICR).

investments needed to be flexible if it was to gain participation from various stakeholder interests and population segments, as in the Niger Natural Resource Management Project.

The success of participation also depended on *design and management of the participatory process*. In successful cases, sufficient time was provided at the beginning of the project for initiating the participatory processes. A preliminary phase was generally needed in which community capacity building and institutional development took place before participatory planning started (for example, in Turkey). In the process, stakeholder empowerment was a factor critical to success: local people's priorities and needs were taken as the point of departure, and communities were able to become active partners and gain ownership in the development process. Where this process was properly conducted, communities were subsequently more willing to invest in the long term and to operate and maintain their investments properly (Tunisia, Turkey).

As in all participatory processes, considerable *time* has proved necessary—for capacity building, institutional development, stakeholder dialogue, and inclusion of the poor and of women. In India Karnataka, the process from first contact to approved micro-watershed plan initially took a year or more. With experience, the time taken for establishing new micro watershed plans has fallen to nine months.

Box 22: The Farmer-Centered, Problem-Census, Problem-Solving Approach of the Eastern Anatolia Watershed Rehabilitation Project

The Turkey Eastern Anatolia Project successfully implemented the participatory planning approach at the micro-watershed level. The project developed an *interactive micro-watershed planning tool*, using a "Farmer-Centered, Problem-Census, Problem-Solving" approach that involved discussion of farmers' perceptions of problems, a menu of treatment options as a basis for agreement on possible solutions, and a flexible design to incorporate lessons of experience and the results of adaptive research and demonstrations. Plans for each village in the micro-watershed were the building blocks of the micro-watershed plans and annual budget requests. The project focused on quality, showed considerable flexibility, and applied a learning-by-doing approach.

Source: World Bank 2004c (Turkey Eastern Anatolia Project PPAR).

Participatory approaches need *flexible local-level organizations* (see the section, *Public Institutions*, in Chapter 3 below) to provide all the facilitation needed. Successful experiences in India, however, have all been on a small scale, and there are doubts about scaling up within bureaucracies. In some projects, NGOs were involved and showed particular aptitude for fostering participatory processes.[23]

Success also required *incentives for participation*. These can be land tenure reforms, the profitability of proposed interventions, economic incentives, risk reduction or management, or the prospect of palpable improvement in living standards (Tunisia Northwest, China Loess I).

Participatory processes that did not take account of local social dynamics or did not genuinely empower local communities were unsuccessful.

Where stakeholder interests and the local social organization were not sufficiently understood and taken into account, participatory approaches were unsatisfactory. In some cases, the participatory approach was theoretically adopted, but in reality there was no genuine empowerment, and the approach remained "top-down" in its nature. Ingrained habits in project agencies were basically at fault here. In Burkina Faso, for example (Box 23), villagers were not given full responsibility for establishing the watershed management plans. As a result, ownership was weak and the eventual sustainability of the activities was compromised. In other cases, stakeholder organizations did not survive beyond the end of the project. Lack of economic incentives and lack of technical capacity are typical causes.

Box 23: Lessons about Empowerment in the Participation Process from the Burkina Faso Project

The Burkina Faso Environmental Management Project had only limited success with its participatory approaches, but it failed to genuinely empower stakeholders. Key lessons from the ICR include the following:

- *Decisions on financial resource allocation should ultimately lie with the community, but projects need to provide full information and training, and guide communities in considerations such as equity*. Community organizations should be given greater responsibility and strengthened, so that communities can establish their priorities by type of investment within a set budget. This will help to channel resources to the highest priorities. Organizations need guidance on how to guarantee fair access of community members to project-related benefits.
- *Communities need to be equipped with financial management skills where revenue-earning assets are created*. It is important to incorporate the financial dimension into the natural resource management approach, especially for those activities that generate revenue, and to strengthen the capabilities of target communities in this respect (for example, preparation of budgets and cash management) in order to create the conditions conducive to the long-term sustainability of project investments.
- *Sustainability requires building on existing social structures and organizations*. The social aspects of the local organizations used to implement the village investment plans in the project were not adequately considered or monitored. This may help to explain the cessation or slowing of many activities as project-supported (and subsidized) investment came to an end.

Source: World Bank 1999a (Burkina Faso Environmental Management Project ICR).

23 Personal communication from Grant Milne.

Recommendations

Although projects will have targets for inputs, outputs, and outcomes, these targets have to be flexibly interpreted, since the community has the ultimate decision over the choice of investment.

Watershed management projects will usually have a menu of interventions from which communities may choose, mix, and match, and they may also have objectives for outputs and outcomes. However, targets related to inputs, outputs, or outcomes need to be interpreted flexibly when a participatory approach is employed, since communities ultimately have to decide on project investments, and the investments selected may or may not match preconceived ideas and may or may not contribute to achieving the expected outcomes. Flexibility is essential: accommodation of demand-driven adjustments and changes during the project need to be possible. Flexibility is also required to allow reallocation of funds to support activities that may need extra resources because of higher demand by target groups.

The planning process must allow both community interests at the micro-watershed level and the larger resource conservation objectives to be included.

Any participatory planning process requires project planners to "let go" and to surrender ultimate determination of the micro-watershed plan to the local community. Plainly this process needs to be organized within clear parameters, since public subsidy is involved and the project has larger objectives beyond the micro-watershed scale (see the section, *Scales of Intervention*, in Chapter 2 for how bottom-up planning needs to be reconciled with larger-scale objectives). The planning process therefore has to be designed so that the interests of both the program and of the community are clear and are reflected in the agreement on the plan. For example, where there is an over-riding off-site objective, such as reducing reservoir sedimentation, the selection of sites eligible for intervention should focus on micro-watersheds posing the most threat to downstream areas in combination with on-site considerations, such as poverty levels and local commitment (see Box 12 in the section, *Scales of Intervention*, in Chapter 2 on the Loess II project, China). Then, when the process of participatory planning with stakeholders at the micro-watershed level begins, this should include an examination of the impact of local land and water management on the downstream objective. Basic to this process are effective communication techniques that can, for example, present complex higher-level watershed data in a way that is intelligible and accessible to local communities. If draft upstream plans do little or nothing to contribute to downstream objectives, a process of negotiation will be required to arrive at the correct balance, with sustainable incentives for the upstream community built in. In practice, this process has proved difficult, but feasible (see Box 24).

Key requirements for success in implementing participatory approaches are careful sequencing, inclusion of all stakeholders in the process, political commitment, public agencies that understand the rationale and process of participation, and sustained capacity building at all levels for both stakeholders and public agencies.

As discussed above, participation needs careful design and implementation if it is to achieve its development and distributional outcomes. In addition to well-thought-out and equitable rules at the design level, several factors are important at the implementation level. The *sequencing* of activities can be a decisive factor in the success of project activities. For instance before projects engage in big investments, it is essential to make sure that communities are ready and committed to contribute to and sustain these investments. Well-thought-out communications campaigns are needed. *Inclusion* of all stakeholders in the participatory processes will be important for ensuring equity and sustainability, and mechanisms may be needed to ensure the inclusion of women and marginal groups (see Box 25).

Box 24: Matching Community Expectations and Program Objectives in the Morocco Lakhdar Project

The Morocco Lakhdar Project was developed to test in one watershed the feasibility of a broad national watershed management approach aimed at the twin objectives of improving livelihoods in the poor upland areas and reducing the rate of siltation of Morocco's important reservoir system.

A balanced menu of intensification and conservation measures was offered to the communities. Initially communities opted entirely for the intensification components, particularly for irrigation improvement. A balanced program had to be negotiated, with the financial allocations to the intensification measures capped and with agreement from the communities that they would implement the conservation measures—but only in the latter years of the project. In the event, many of the conservation measures—terracing, check dams, and fruit tree planting—turned out to be economically attractive, so that by the end of the project, some degree of sustainable momentum for the conservation measures could be detected.

Source: Authors.

Only if there is *political commitment* to the empowerment process and if this is taken on board at all levels in the *thinking and behavior of project agencies* can participatory approaches really succeed. *Capacity strengthening* is required at all levels of public agencies from frontline extension, research, and project staff to government bureaucrats and decision makers. In addition, the communities themselves should receive appropriate technical, financial, and organizational training and support in order to develop full ownership and responsibility for implementation.

Watershed management projects share many approaches in common with community driven development programs, and there is scope for mutual learning.

There is a growing convergence in approach between participatory watershed management projects and the broader movement in rural development projects toward *community-driven development*. The Morocco Lakhdar project, for example, adopted a methodology based on community-driven development approaches. There is scope for learning between the two approaches to mutual benefit.

Watershed management programs need to allow time for partnership approaches to evolve, since the gestation period can be lengthy, particularly for joint management of common resources.

Enough time in the beginning of the project must be allowed to assure the full involvement of stakeholders. Some projects painstakingly developed approaches to forest management based on cooperation in mutual interests (see the Brazil and Turkey examples in the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2 above). In other cases, a single project period proved too short for partnership approaches to develop fully. In Morocco Lakhdar, for example, the project initiated cooperation between state and communities on forest management, but the actual formalization of a new set of mutual rights and obligations and planning for joint management of forests took place after project completion, and it was uncertain whether they would be fully implemented.

Box 25: Lessons from the Tunisia Northwest Project on Participation

The Tunisia Northwest Mountain Area Development Project was generally successful in its participatory approaches. Important lessons from this success were to start early, take a multidisciplinary approach, and employ women if gender inclusion is a target:

- *Participation should begin from project identification and should involve all stakeholders*. Participation from the early stages of project preparation of all stakeholders, including the implementing agency, local communities, and civil society is needed to ensure the success of the participatory approach. Ownership is strengthened when stakeholders participate in the project from the design stage. Consultations also promote transparency in decision-making processes, which is crucial in a demand-driven type project.
- *A multidisciplinary approach is essential*. A participatory approach has to be backed by multidisciplinary teams that can work across sectors to fully take into account beneficiary demands and achieve agreed development objectives.
- *Women extension agents are necessary to ensure women's participation in projects*. Women beneficiaries benefited from the project's emphasis on women's development. Communities preferred activities that were integrated as a part of the overall project activities to those that were women specific, and integration significantly reduced resentment for "women's activities" by the rest of the population. However, the lack of specific targeting measures for other disadvantaged sectors of the population, such as the landless and the young, meant that they remained fairly vulnerable, and overall the benefits they received were limited.

Source: World Bank 2003c (Tunisia Northwest Mountain Area Development Project PPAR).

Public Institutions

The integrated and participatory watershed management approach adopted in recent years has driven new institutional arrangements among public agencies and with local communities. Successful operations typically created a decentralized delivery structure that could effectively partner local communities. The institutional framework needs to be focused on the local level, with clear arrangements for integration within permanent agencies and for interagency collaboration. Government commitment to the program and simplicity and clarity on responsibilities are key factors in success. The interface between local government, technical agencies, and community organizations needs to be carefully defined and managed, and capacity building at all levels is essential. Local-level participatory approaches require decentralization of technical functions, and thought needs to be given to how this can reinforce—rather than conflict with—broader processes to decentralize responsibilities for local development. Watershed management programs should also be part of a framework for overall watershed or sub-basin planning and management.

The integrated and participatory watershed management approach adopted in recent years has driven new institutional arrangements among public agencies and with local communities.

Responsibilities for development within a watershed are typically distributed across a number of government agencies. Under earlier watershed management approaches, the typical approach was for a single public agency to focus on the implementation of physical investments on public and private land, often with a predominant single technical solution, and on encouraging the adoption of conservation-oriented farming practices on private land (Magrath and Doolette 1990). The integrated and participatory watershed management approach adopted in recent years (see the section, *Scales of Intervention*, in Chapter 2 and the section, *The Use of Participatory Approaches*, in Chapter 3) has driven new forms of organization and collaboration among government departments, local government, village development committees, and individual stakeholders.

The fundamental challenges have been to get public organizations to work together on integrated program driven by community needs, and to devise a planning framework that reconciles the decentralized and demand-driven nature of upstream investment choices with the need for a minimum of directive planning to meet downstream natural resource management objectives. The resulting institutional arrangements have been necessarily experimental and have often been set in a context where public organizations are organized along sectoral lines, or where governments are in any case reorganizing services for local development, with a frequent emphasis on administrative and fiscal decentralization. The experience of watershed management programs in this dynamic situation and the lessons for the future are summarized below.

Results from the Project Review

Projects that created a decentralized delivery structure that could effectively partner local communities were generally more successful.

The emphasis in most watershed management programs on community responsibility for land and water management in the local micro-watershed (see the section, *The Use of Participatory Approaches*, in Chapter 3) has driven the need for a "partner" frontline presence at the micro-watershed level of the public agency or agencies responsible for watershed management. Much effort has therefore gone into creating a structure that can deliver at the front line, and in many projects this has been successful.

One finding of the review was that the more successful projects in fact adopted a genuinely "bottom-up" approach to institutional development, giving priority to institution-building needs at the local level (community organizations and frontline public agencies) and from there working up the scale, strengthening government capacity on a needs basis also at the regional and national levels. Working through decentralized structures allowed for effective and efficient project implementation and greatly enhanced interaction with local communities. Usually, existing decentralized structures could be used. This worked well if they were supported by adequate training and equipment. However, where decentralization was not already operational at the local level, it proved difficult to set up the decentralized process, particularly where watershed management required concerted and converging actions from several governmental services at community level.

An important element in integrating different levels of the structure from field level back up to headquarters was the establishment of management information systems that permitted coherent data capture, analysis, and M&E (see the section, *Monitoring and Evaluation*, in Chapter 4). Effectively, decentralized approaches worked best where adequate information was available at the local, regional, and central levels to allow managers to follow progress and make informed decisions at the appropriate level.

Effective interagency collaboration characterized the most successful projects.

A typical impediment to integrated approaches to development is the existence of several public agencies with mandates for different parts of the program. The successful projects reviewed were able to set up institutional arrangements that allowed for multidisciplinary and multiagency collaboration and across ministries. This "matrix" approach allowed for effective implementation and also contributed to breaking up the "silo" mentality of single-sector approaches (see Box 26).

Box 26: Stimulation of Multi-Institutional Collaboration at the Local Level in Turkey

Implementation of the Turkey Eastern Anatolia Project was the first time that different departments and bureaus, such as soil and water conservation, agriculture, livestock and animal husbandry, environment, and forestry, made joint efforts in planning and implementing integrated watershed development works.

Institutional development took place within the *three implementing agencies*, which were exposed to new technologies and good practices in multiple fields, including environmental surveys, cultural heritage awareness, and community mobilization. The agencies developed the capacity to coordinate their activities and so deliver a more effective service. They also gained experience in communicating and collaborating with farmers, which marked an important shift in the relationship between government and the rural population.

Another main impact on institutional development happened at the *village level*. The capacity of farmers to collaborate with each other was strengthened by working together on management and conservation of project-financed investments and community land resources. Similar effects have been reported for the China Loess I Project.

Source: World Bank 2004c (Turkey Eastern Anatolia Project PPAR).

Where projects were able to integrate within permanent agencies and structures, chances of sustainability of investments and scaling up of program actions were increased.

In many of the successful projects, the project management structure was integrated within governmental line agencies at all levels from local to national. This increased the prospects both of the sustainability of project investments and of subsequent scaling up (see Box 27 on the China Loess II project). This integration also facilitated the integration of project activities into broader regional and country programs, enhancing the fit with regional and national strategic objectives. By contrast, where project implementation units were formed outside the existing institutional structures, they left little impression on the institutional memory of authorities at regional and local level, and were faced with closure at the end of the project. This was the case in the First Red Soils Area Development Project (China). Consequently, the approach was revised for the Second Red Soils Project, under which responsibility for project management was assigned to existing institutions (suitably strengthened), rather than creating a new management structure.

Box 27: The Positive Effects of Integrating the Project Management Structure within Governmental Agencies at All Levels

The Loess II project in China broadened and consolidated the institutional development impact of Loess I. Both projects were strongly built on the existing institutions in the government and public administration. Project Leading Groups (which formulate project related policies and plans, approve project feasibility studies, and organize counterpart funds) and Project Management Offices (in charge of project implementation and progress reports) were established at the central, provincial, prefecture, and county levels.

Integrating the project management structure within permanent public agencies not only ensured sustainability, but facilitated the replication of good project experiences. The project's management methodologies have already been introduced in other national programs.

Source: World Bank 2005 (China Loess II Project ICR).

Government commitment to the project was an important ingredient for project success.

Government commitment, often led by "champions," was a basic feature of successful projects reviewed. For example, this commitment was essential to ensure a policy environment favorable to decentralized watershed management and interagency "matrix" management arrangements (see the section, *The Policy and Legal Framework*, in Chapter 3 below). Implementation was also often highly dependent on government commitment to the selection of professional and committed staff, and to staff continuity. In addition, government commitment—and here "champions" played an important role—was needed to build up institutional memory and to develop broader regional and national watershed management strategies and programs based on the emerging experience (see Box 28).

Box 28: Government Commitment as a Key Factor for Success in Brazil and China

The Brazil Land Management I Project was considered a priority by all three administrations that governed the State of Parana during the project period. The continuity given by having the same Secretary of Agriculture for most of the implementation period contributed to a regular funding flow, with only short interruptions reflecting occasional overall state budgetary difficulties. In addition, the effective integration of project activities with the various rural development programs promoted by the Secretariat of Agriculture into one single program contributed to an enhanced impact of the project.

In the Red Soils II Project in China, the central government paid much attention to the project and issued preferential policies for it. Local governments regarded this project as a model for agricultural and economic development and provided support for establishing the project management offices, for timely disbursement of counterpart funding, for facilitating coordination among the relative departments, and for solving key problems of project implementation.

Source: World Bank 1998a (Brazil Land Management I Project ICR) and World Bank 2003b (China Red Soils II Project ICR).

Decentralization and multiagency collaboration did not work so well when it was dominated by a single institution.

Problems surfaced in Indonesia, in the National Watershed Management and Conservation Project, where the Forestry Department played a dominant role in setting the technical standards and did not create an environment motivating the participation of farmers and communities. This dominance reduced the input from the Agriculture Department and resulted finally in weak policy development, rigid technical guidelines, ineffective planning, weak ownership, and poor implementation. Even today, these problems persist in Indonesia. The Ministry of Forestry's National Movement for Land and Forest Rehabilitation, for example, aims at improving 3 million ha in 68 degraded watersheds through the planting of trees. However, there are serious problems with the top-down nature of the program. Stakeholders have different views on how the trees will help the environment and the community; there are questions over the suitability of the species for local agro-ecosystems; the incentive framework looks inadequate to guarantee that the local community will maintain the trees; and most importantly, local livelihoods risk being disrupted because of changes in land use systems.[24]

24 Personal communication from Shobha Shetty.

The post-project sustainability of institutional arrangements depended on adequate capacity building during the project.

In the India Plains Project, responsibilities among the line agencies overlapped within the watershed, and project design did not provide for a clear allocation of responsibilities. Integration worked best at the front line at the project team level, which had secondees from most line agencies involved. At project completion however, secondees moved back to their original position, and cooperation between line agencies halted. Village Development Committees (VDCs) were to assume responsibility for calling on the services provided by the various line agencies by voicing "demand" as the need arose. However, in practice this has not worked well, because the VDCs had not received adequate capacity building. For example, on one Orissa site, the project team had simply not had enough time during the two years in which they were working in the watershed to build up the capacity of the VDCs—they were busy working around the clock during the dry season to construct the various cement structures along the drainage lines.[25] In other cases, a single project—often a pilot project, as in the case of Morocco Lakhdar—initiated a process of institutional change that was not sustained once the project ended.

Integration within existing institutions worked less well when institutional arrangements were too complex.

The Indonesia Yogyakarta Project built on past experience and provided for working through existing agencies rather than for creation of ad hoc structures. In general, this worked well. However, the complex design of the project was overlaid on a plethora of local government and technical organizations. The resulting dense institutional structure led to coordination problems and some duplication in efforts (see Box 29).

Box 29: Overcomplexity and the Duplication of Effort in the Indonesia Yogyakarta Project

Implementation arrangements for the Indonesia Yogyakarta Project were designed to operate within the structure and functions of existing government institutions rather than through new project-specific institutions. Project implementation was undertaken by a total of some 24 focal coordination and management units, four each in the four districts (*kabupaten*), seven at the provincial level, and a national coordination unit in the Ministry of Home Affairs. The submanagement units reflected existing functional responsibilities in provincial and district administration, and they performed well. The project made significant contributions toward achieving the objective of strengthening local level institutions and improving multisectoral planning at the provincial and district levels.

However, at the grassroots level, problems emerged. Both the village projects and *kecamatan* (subdistrict) projects, at two different decision levels, supported the implementation of the same activities (such as village roads, small irrigation and water supplies, and goat distribution) for and by the same set of people, that is, the villages. The assignment of responsibilities to both the villages and the *kecamatans* for the same interventions led to a costly duplication.

Source: World Bank 1998b (Indonesia Yogyakarta Upland Area Development Project ICR).

25 Project Performance Assessment Report 2000.

Recommendations

The institutional framework needs to be focused on the local level and preferably located within permanent agencies, with clear arrangements for integration between local and higher level agencies, and for interagency collaboration. Simplicity and clarity on responsibilities are key factors in success.

Lessons learned from these experiences underline the need for the correct framework for public institutions and for longer-term support to consolidate that framework. Many of the less successful project experiences occurred because attempts at decentralization, collaboration, and incorporation within permanent institutional structures were not well designed or executed, or a single project proved to have too short a time span to effect permanent institutional change. There is a need, during project design, to establish an institutional framework with focus on the local level and to clarify the linkages and support needed from higher-level government. It is important to keep the organizational and coordination structures for project implementation as simple as possible, and not to overload institutional capacity. The institutional framework should also be amenable to replication in other areas, and consideration should be given to sustained support over a number of years.

Ideally, watershed management programs should also contribute to creating a framework for overall watershed planning and management.

Despite this essential emphasis on the local level and on the need for simplicity, watershed management programs also have to link upstream and downstream and to assure integration of micro interventions within a larger watershed framework. Ideally, the institutional framework should be capable of linking the micro-watershed management plans (see the section, *Scales of Intervention*, in Chapter 2 and the section, *The Use of Participatory Approaches*, in Chapter 3 above) to the broader scale of the watershed as a whole. A range of institutional mechanisms is available, from simply maintaining an information system to identify externalities, through the creation of platforms for dialogue between upstream and downstream communities, to building higher-level watershed planning institutions.[26]

The interface between the decentralized delivery structure for watershed management, local government, technical agencies and community organizations needs to be carefully defined and managed, and capacity building may be needed for all stakeholders.

In working with village communities, the decentralized "frontline" delivery structure that is fundamental to successful watershed management must be able to partner other institutions flexibly and at different levels of intervention. However, sometimes other institutions operate at different levels and with different perspectives. For example, *local government institutions* are responsible for local administration and are therefore stakeholders in local watershed management, but often their mandate and perspective are different, and they are generally organized at a higher level than the community in a micro-watershed. In the case of Mali, for instance, the commune is the lowest level of government, yet the watershed management program undertakes planning and implementation at the village level. In addition, the *technical agencies* that contribute to watershed management may be decentralized at varying levels, and coordination and integration of programs and budgets may be complicated,

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26 For example, externalities could be identified, and an information management system could be put in place to increase the knowledge pool about hydrological parameters in the basin (preferably from the mountain to the coast), and monitor major impacts. In the case of negative externalities, such as reduced flows downstream, downstream communities in particular should be able to participate in the planning process upstream. See the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4 for a fuller discussion of externalities.

An important factor is *capacity building* at all levels to help stakeholder government agencies of all kinds understand the challenges, and to equip them to play their role in planning, implementing, and monitoring locally based initiatives. Even agencies, such as a ministry of finance, may need this kind of training, so that they understand the need for flexible budgeting and fast-track disbursement procedures.

Local-level participatory approaches require decentralization of management decisions and technical functions, and thought needs to be given to how this can reinforce—rather than conflict with—broader processes to decentralize responsibilities for local development. Decentralization is currently an ongoing process in many developing countries. Governments are implementing policies to transfer decision making and program implementation from central agencies to levels closer to communities. One approach is to decentralize line departments and shift the balance of operating staff from headquarters to local offices. Another approach followed in some countries is to devolve responsibility for program implementation from central line agencies to local authorities. Decentralization within line departments to the local level fits easily into the watershed management approach. By contrast, decentralization to local authorities may prove problematic. An example from India provides some insights into the issues involved, in the specific context of a country that is giving responsibility for local investment programs to local government from the village level upward (see Box 30).

Box 30: The Debate in India on How to Fit Watershed Management Programs into the Government's New Policy of Decentralized Development through Local Authorities

In India, under the Constitution (73rd Amendment) Act of 1992, local authorities or "Panchayati Raj Institutions" have been established at village, subdistrict, and district levels in most states. Panchayats have the authority to prepare plans and implement programs for economic development and social justice. State governments, such as Karnataka, have recently passed laws to implement these constitutional amendments.

There is now a debate on how watershed development projects, which are traditionally implemented through state agencies and strong community user groups, can be fitted into this broader decentralized development approach. A number of specific issues are emerging:

- More clarity is needed on the roles and responsibilities of local authorities involved with watershed activities.
- Financial management systems in most local authorities require strengthening to absorb expanded fund flows from watershed projects.
- Most local authorities lack adequate technical capacity to simply take over effective implementation of watershed projects.

Various options are being explored to address these issues. For existing projects, members of community groups could form subcommittees of local authorities with project funds flowing to Panchayat bank accounts and then to communities. This approach minimizes midcourse changes in project implementation, while still operating under the spirit of the decentralization law. State agencies and NGOs could continue leading social development and field implementation with communities.

For new projects, however, both flow of funds and implementation will need to be channeled through local authorities. In these cases, significant capacity building would be needed. Project design must offer additional resources to support this training and also accept a longer implementation period. Alternatively, a statewide program focused solely on building local authority capacity could be linked with watershed projects on a pilot basis to learn lessons and then be scaled up. At the same time, line agencies would need to shift more technical resources to the field level to provide backstopping to both communities and local authorities.

Source: Personal communication from Grant Milne.

The Policy and Legal Framework

Watershed management works best when there is a supportive policy and legal framework, particularly: (a) policies that facilitate decentralized and participatory development; (b) institutional arrangements that allow and encourage public agencies at all levels to work together; and (c) an approach to access to natural resources that reflects local legislation and tenure practices and problems. Land tenure and common pool resources are a particular challenge for watershed management, and there needs to be a clear understanding of the policy and legal framework and local practices and of how a project can work within this framework to promote investment. Operations can also help in the process of preparing for and implementing reforms.

Watershed management works best when there is a supportive policy and legal framework, particularly (a) policies that facilitate decentralized and participatory development; (b) institutional arrangements that allow and encourage public agencies at all levels to work together; and (c) an approach to access to natural resources that reflects local legislation and tenure practices and problems. Projects may need to contribute to the development of more supportive policy frameworks.

A supportive policy and strategic framework is needed for watershed management. A number of important policies are required if an integrated approach to watershed development is to be adopted, particularly policies that facilitate decentralized and participatory development. These policies need to allow, for example, for decentralized planning and budgeting, for empowerment of communities to take a lead role in decisions on financial and physical resource allocation, and for difficult "matrix" arrangements for collaboration between public agencies at all levels. In addition, projects may require agreement to changing policies on access to and use of public assets, for example, on use of publicly owned natural forests by local communities. Two particular areas of public policy have proved vital to effective watershed management: land tenure and policy on common pool resource management.

Results from the Project Review

The importance of supportive policies was highlighted by most projects reviewed, but few projects included support to government to develop an improved framework.

The importance of a supportive policy framework was highlighted by most projects reviewed, but in only a few cases was a component included in a project to help policy analysis and to develop a more supportive policy and legal framework. One project that did include a component of this kind was the Mali Natural Resource Management Project, which supported the development of the National Environmental Action Plan. Another case is the Indonesia project, which had a large component (US$22 million) to help improve guidelines, policies, overall coordination, and operational support for the National Watershed Development Program (Regreening and Reforestation).

Land tenure was a major determinant for success or failure of land improvement activities in many of the projects reviewed.

In all the projects reviewed where land tenure was insecure, the local people were unwilling to invest in medium- or long-term land improvement. This delayed several projects. In one case—Turkey Eastern Anatolia Project—the lack of understanding in project design of existing legislation on rangeland ownership led to the failure of the pasture improvement component. Only toward the end of the project was more supportive legislation on rangelands introduced. By contrast, where favorable land tenure reforms were introduced, this created strong incentives for participation in the program and for investment in land improvement: this was the case in China under the Loess I Project and the Red Soils II Project, and also in Tunisia (see Box 31).

Box 31: The Contribution of Land Tenure Security to Achieving Watershed Management Goals

The China Loess I Project benefited from land tenure reforms, which created strong incentives for investment in land improvement. These reforms were part of a generally promarket agricultural policy environment that helped achieve project livelihoods objectives. Productive new technologies were available, and improved communications removed regional marketing constraints and provided farmers with countrywide market channels.

The policies required are not always evident at the outset, and a progressive approach may be needed. For example, the Tunisia Northwest project did not initially provide for work on land tenure issues, but the land tenure and fragmentation constraint emerged from the demand-driven process. As a result, the project started to support land consolidation of small fragmented farms. By the end of the project, a total of 2,100 ha was under review or already mapped, and titles for approximately 1,200 ha had already been issued.

Source: World Bank 2003a (China Loess I Project ICR) and World Bank 2003c (Tunisia Northwest Mountain Area Development Project PPAR).

However, projects generally did not satisfactorily analyze or deal with land or water tenure issues.

Despite the importance of land tenure for watershed management, none of the projects reviewed had a land tenure component, and although it has emerged as a significant problem, land tenure has not received increased emphasis in the design of more recent projects. In addition, although watershed management is in principle intended to deal with problems of both water and land resources, not one of the projects reviewed addressed the issue of water rights, even though downstream uses would plainly be affected by the management changes introduced upstream (on water, see the section, *Considering the Effects on the Water Cycle*, in Chapter 5 below).

Nonetheless, there have been opportunities for reform during projects.

In India Karnataka, government was reluctant to address up-front policy and legal issues relating to land. However, there were subsequent opportunities for reforms. When constraints emerged during implementation, the project supported a legal review of common land resource management, and subsequently helped to develop a new memorandum of understanding signed between the community and land agency (for example, forestry and local authority) that set out guidelines for management and benefit sharing. With the questions of future benefit sharing resolved with greater clarity, communities are now less reluctant to invest time and money in managing common resources developed through the project.[27]

Common pool resources covering large areas of watersheds of interests are common in many countries; their sustainable management is complex and difficult. However, little knowledge on issues and how to tackle them could be gleaned during the review.

Very sparse information was available in any of the project documentation covered in the review on the management of common pool resources and how they were integrated in the overall watershed

27 Personal communication from Grant Milne.

management approach. Common-pool resources (forests, pastures) make up large areas within the watershed, and their sustainable management is often more complex and difficult than for individual resources. Specific issues relate to the legal framework, social organization, traditional access and rights to resources, land tenure, conflicts of interest among stakeholders, and equity issues. Several projects did address the issues—the examples of forest management in Brazil, Morocco, and Turkey were discussed above (the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2 and the section, *The Use of Participatory Approaches*, in Chapter3)—but in general, project documentation gives little information on implementation issues, problems, successes, and lessons learned.

Recommendations

Watershed management projects need to have a clear understanding of land and water rights and common pool resource issues and how they are going to work within them. They can also help in the process of preparing for reform of land tenure policies.
Watershed management programs should include the land tenure and common pool resource questions in the initial diagnostic and problem analysis. Since land tenure issues can be very complex and since they need longer-term commitments from the government and donors, it may be unrealistic to expect a relatively short-term project to tackle all the issues. However, if possible, project design should highlight the nature of the land tenure questions and demonstrate how the project will work within existing constraints. Project design should also show an understanding of how the land tenure question should be dealt with over time, and propose an itinerary for tackling it. This itinerary could include: initial empirical work, such as research or pilots, further in-depth studies and surveys, and institutional development support to government to develop reform measures over time. These steps do not necessarily have to be supported under the project; they may be more suitable for a long-term partnership between government and donors. Where governments are initially reluctant, as in India Karnataka, a flexible approach could be pursued that diagnoses problems as they arise and provides scope for open debate leading to decision. Questions of impact on downstream water rights need to be addressed within watershed management plans and programs where downstream impacts—positive or negative—are likely (see the section, *Considering the Effects on the Water Cycle*, in Chapter 5 for a full discussion of watershed management and the water cycle).

Watershed Management and Poverty Reduction

Although poverty reduction is usually an objective of watershed management programs, empirical evidence of poverty reduction impacts is weak. Most projects reviewed included poverty reduction among their objectives but there was little evidence of any ex ante analysis of poverty that would have helped to improve project design, and actual impacts were rarely measured. The poor may even be at risk from programs. For example, landless people dependent on common natural resources for their livelihood may suffer from conservation interventions, such as rangeland closure. However, targeting only the poor has proved difficult, since efficient watershed management has to be inclusive of all stakeholders in the watershed.

In best-practice examples, poverty concerns are introduced through the participatory process, analyzing the role of stakeholders within a watershed and then designing the institutional mechanisms and the stakeholder communication process to include the poor. Investment programs then include income-generating activities that benefit the poor. When management issues arise in the larger watershed, programs may be able to strengthen the voice of upstream communities, so that they—and the poor within them—do not bear the cost of providing environmental services to downstream. Basin committees that empower stakeholders through participatory processes are one possible approach.

Although watershed management could be expected to reduce poverty, there are risks with the approach.

Most watershed management interventions in developing countries take place in poor upland areas, and they typically have poverty reduction as an objective (the section, *Watershed Management: Drivers and Approaches*, in Chapter 1). However, watershed management interventions can create benefits and costs that are unevenly distributed among stakeholders. According to Kerr (2002b), it is likely that improving the productivity of assets and natural resources will benefit different segments of the population unequally, unless institutional mechanisms are developed to ensure that all parties benefit. Landowners are expected to be the first to benefit from area development programs, whereas landless people or poor farmers unable to pay their share of the cost of investments would, in the absence of targeted programs, benefit only from trickle-down effects in the economy. Where projects offer a subsidy to landowners for soil and water conservation in India, it is reported that "it is the larger farmers downstream who can best afford to participate."[28] In fact, several reviews on the performance of watershed development projects in India (Sharma and Scott 2005) have concluded that the landless and marginal farmers often benefit little or not at all from watershed programs, and that inequities have increased. In some cases, the poor may not only not benefit, but even bear the costs of benefits to others (Box 32).

Box 32: The Poor and the Costs of Watershed Management

Upper watersheds in India often contain a large proportion of uncultivated common land that is denuded. Protecting these lands against erosion requires revegetation programs, which in turn means placing limits on grazing and firewood collection. This imposes costs on poor, often landless people who rely on these lands the most. Water harvesting benefits, meanwhile, accrue disproportionably downstream to the wealthiest farmers who typically own most of the irrigable land. Under these conditions, watershed projects ask the poor people who use upper watersheds to provide an environmental service to the wealthier neighbors in lower watersheds.

Source: Kerr 2002b.

Results from the Project Review

Most watershed management projects reviewed included poverty reduction among their objectives, but actual impacts were not measured.

In most of the projects reviewed, a poverty reduction objective was set, alongside objectives of overall improvements in livelihoods and in average household incomes in project communities. The targets for increased incomes were generally achieved (see the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2), but there was little or no reporting of the achievement of the poverty reduction objective.

There is very little evidence of any ex ante analysis of poverty that would have helped to improve project design, and there is little discussion of what projects did to benefit the poor.

The project documentation provided very little information regarding the poverty distribution within communities and the project region. An ex ante analysis could, for example, have documented

28 Personal communication from Grant Milne.

access to natural resources, tenure regimes, and management practices by different groups within the rural population. Nor were project reports specific about which groups in society actually benefited (or did not benefit) from watershed management project interventions, nor about the measures projects took to reach the poorest in society. In one case, the "winners" seem definitely to have been the better-off stakeholders (Box 33). The social analysis done was also generally silent on how the poor were integrated into project governance structures and on any conflict resolution strategies developed to respond to the divergent interests of the various stakeholders, including women and the poor.

Box 33: Winners and Losers from Improved Water Management Investments in the Turkey Eastern Anatolia Project

Under the Turkey Eastern Anatolia Project, there was a program to improve the use of water from springs. As water rights from these springs were already owned by certain farmers, only those farmers were able to benefit from the project-financed improvements. With a limited community budget, this meant that those farmers "won" to the detriment of other members of the community, particularly the landless and the poor. Some, but by no means all, of the potential losers, were accommodated with other investments.

Source: World Bank 2004c (Turkey Eastern Anatolia Project PPAR).

Recommendations

To achieve watershed management objectives, it is generally necessary to include all stakeholders of a watershed, rather then focusing on the poor alone. Participatory processes therefore have to be inclusive of all stakeholders.

In order to achieve watershed management objectives, it is generally more efficient to include all stakeholders, not just the poor (Perez and Tschinkel 2003). A focus on the poor alone tends to promote site-specific, isolated, and dispersed interventions that are limited to soil management at the field and farm levels. It is thus important for a project to analyze the role of the stakeholders within a watershed systematically and to define a strategy for priority setting and stakeholder involvement that is inclusive of all stakeholders.

Therefore, if the poor are to benefit from a watershed management project, special efforts need to be undertaken beyond the common application of participatory methods.

If participatory processes have to be inclusive of all stakeholders, special provision needs to be made for poverty target groups, such as the landless and women. As discussed above (the section, *The Use of Participatory Approaches*, in Chapter 3), the participatory process has to be designed for the development and distributional outcomes intended. This requires that the role of stakeholders within a watershed be analyzed. The poor need to be integrated in the stakeholder communication process and institutional arrangements for project implementation should enable the poor to voice their resource management priorities. In this way, the community plan developed (see the section, *The Use of Participatory Approaches*, in Chapter 3 above) can be inclusive and provide for an equitable sharing of benefits. Technological choices can be favored that protect the rights of the poor and create economic benefits for them, for example, improving assets, such as rangeland, to which the poor have access, promoting labor-intensive and non–land-based activities, thrift groups, or specific capacity building initiatives which target the poor (Kerr 2002a; Farrington, Turton, and James 1999; and the World Bank Participation Sourcebook).

Programs may also need to ensure that upstream communities—and the poor within them—do not bear the cost of providing environmental services to downstream.

Where there is a risk that poor upstream communities may bear the cost of providing environmental services to downstream, project agencies will need to help those communities to negotiate their claims, and will have to ensure that the voice of the poorer segments (especially the landless, marginal farmers, and woman-headed households) *within* those upstream communities is heard and that their interests are protected (Kerr 2002b).[29] Basin committees that empower stakeholders through participatory processes are one possible approach.

29 Mechanisms for compensating upstream communities for "watershed services" provided are discussed in the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4.

CHAPTER 4:
ECONOMICS IN WATERSHED MANAGEMENT: PROFITABILITY, EXTERNALITIES, AND INCENTIVES

This chapter reviews aspects of the economics of watershed management: the profitability and economic viability of watershed management interventions, the quantification of externalities, the role of externalities in defining a sustainable incentive structure, and the characteristics of M&E of watershed management programs.

Profitability and Economic Viability of Watershed Management Interventions

Profitability is fundamental for engaging stakeholders in conservation, yet watershed management interventions may not in themselves be profitable for stakeholders. Establishing accurate estimates of costs and benefits, both at the farm level and beyond, has proved difficult. Often technical choices have been made without due consideration of financial profitability—or of economic value to society. Yet financial and economic analysis can help design investment packages that achieve both livelihoods and broader conservation objectives. The main problem has been getting the information needed. For the farm-level financial analysis, a simple step-by-step methodology can help in getting the information needed. For other impacts, quantification and valuation should be pursued, but this is difficult.

Profitability is fundamental to engaging stakeholders in conservation.

The profitability of watershed management interventions to upland stakeholders is the main incentive for both investment decisions and sustainability. If an intervention is not profitable, there is a great risk that a stakeholder will not adopt or maintain it. The challenge is more acute because many soil and water conservation and reforestation practices can be very expensive (involving mechanized terracing and tree planting, for example) and high risk for poor stakeholders, while some of the benefits may be uncertain, or difficult to quantify, or may benefit stakeholders other than those who bear the costs. As discussed above (the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2), watershed management programs everywhere have confronted this problem, and some have devised investment packages that conserve natural resources while being financially attractive to stakeholders.

Yet many watershed management interventions may not in themselves be financially profitable.

Evidence suggests, however, that in many cases soil and water conservation practices, in the absence of subsidies or other forms of payments, are in fact not profitable for stakeholders. A review of the profitability of conservation measures throughout Central America, for example, even found that *most* were not profitable from the farmers' perspective (Lutz, Pagiola, and Reiche 1994).

Establishing accurate estimates of financial costs and benefits, both at the farm level and beyond, has proved difficult.

Financial analysis of watershed management programs, generally carried out for costs and benefits for farms in upland areas, has been dogged by unrealistic estimations of negative effects on agricultural productivity arising from soil degradation, or overly optimistic predictions about productivity gains once the conservation measures have been established. For example, erosion rates are generally claimed to have highly negative impacts on productivity, but evidence on the magnitude of these effects is hard to find, and they may sometimes even be surprisingly small.[30] Conversely, soil and water conservation measures—beyond their direct investment costs—often imply a loss in the cultivated area, because of revegetation, terracing, and so forth. Beyond the farm, quantification and valuation of expected positive impacts are equally complex, or more so (see below).

Often technical choices have not been matched with financial profitability—or the economic value to society.

Watershed degradation can be slowed or arrested by a large range of methods. Implementing any of these techniques can be costly, either directly in investment requirements or indirectly in forgone production, and some measures are better suited than others to specific conditions (see, for example, Prato and Dauten 1991). Yet economic and financial analysis has rarely been used to evaluate a range of alternatives from the standpoint of either financial profitability for the stakeholder or economic value to society. Where this analysis has been carried out, it has yielded powerful results that can be used to support the design of financially profitable and economically viable investment packages (see Box 34).

Box 34: Economic Analysis of Conservation Measures

Conservation techniques include the following:

- *Cultural practices*, such as contour plowing, minimum tillage, changes in timing or pattern of cropping, and intercropping.
- *Vegetative practices*, such as grass strips, strip-cropping, and vegetative barriers.
- *Mechanical measures*, such as terraces, cutoff drains, infiltration furrows, earth banks, and land leveling.
- *Land use changes and improvements*, such as afforestation and sustainable rangeland management (with fertilization, plantation, and deferred grazing).

Each of these techniques will have its own cost and benefit characteristics in each local situation. For example, a 1990 review based on more than 200 studies globally found that vetiver grass technology displays much higher rates of return than earthen bunds, mainly because of its cost advantage. Structural approaches usually require high investment costs. Costs for terracing in Indonesia are estimated to range from US$400 to US$1,000/ha, and construction of earth bunds in India is estimated to cost between US$23 and US$150/ha depending on soil type and slope. Costs for establishing vetiver grass hedgerows in India are estimated to be only US$18/ha. The study concludes that soil and moisture conservation and agricultural productivity enhancement measures in Asian upland areas should make more use of emerging, low-cost methods of vegetative soil and moisture conservation.

Economic Analysis of Alternative Soil and Water Conservation Technologies (percent)

Technology	Yield increase	Erosion loss prevented	Economic rate of return
Vetiver Grass	50	0.95–1.25	95
Earthen Bunds	35	0.95–1.25	28

Sources: Magrath and Doolette 1990, Lutz, Pagiola, and Reiche 1994.

30 Lutz, Pagiola, and Reiche (1994), for example, found that erosion rates in the Tierra Blanca area in Costa Rica's Cartago Province are extremely high, but the effect on productivity is minor because soils in that region are deep (up to 1 m in some places) and contain a high percentage of organic matter. Moreover, the subsoil is itself productive, although less so than the topsoil. Conversely, areas with shallow soils or unfavorable subsoils, such as the Turrubares area in Costa Rica, can be very sensitive to even limited rates of erosion.

Results of the Project Review

Financial and economic analysis for the projects reviewed usually focused on comparing agricultural and livestock production in the upstream area "with the project" and "without the project." Because of data limitations, projects generally did not look at impacts on the wider economy in the project area, and they rarely valued positive or negative externalities. Analysis at project completion typically used the same methodology, often without much new empirical data.

The building block for the financial and economic analysis in projects reviewed was agricultural activity in the project area. The analysis identified a number of farm types or agro-ecological zones and used farm budgets to model future cropping patterns "with the project" and "without the project". The resource flows were then compared and matched to the project costs. A majority of projects also listed other expected benefits in the analysis, including reduction in sedimentation, control of landslides, natural resources benefits, improved water quality, food security, employment, or empowerment. In a few cases, these effects were quantified and valued, in particular reduction in sedimentation (see the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4). At project completion, the analysis proceeded along the same lines, with refined assumptions and sometimes more benefits valued (such as carbon sequestration in Loess Project, China, and reduced road maintenance for Land Management II Project, Brazil).

Projects introduced both soil and moisture conservation measures and agricultural productivity enhancement investments. However, few projects valued the cost or benefits of conservation measures or their financial profitability to stakeholders.

Project documents typically listed a range of soil and moisture conservation measures. Some projects did detail specific costs of the measures considered (see examples in Table 2), but very few assessed these measures from the perspective of their economic value or of their financial profitability to stakeholders. Only one project, the Peru Sierra Natural Resources Management and Poverty Alleviation Project (see Box 35), proposed an economic cutoff point for investments.

Evidence was mixed on the extent to which conservation investments were in themselves profitable for stakeholders, and hence sustainable.

The project review yielded evidence of varying profitability of conservation investments. In many cases, the investments were only adopted because they were heavily subsidized (for example, the India Hills and Plains Projects, Indonesia Yogyakarta, and Burkina Faso: see the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2 above), and adoption rates generally dwindled when subsidies ended. In other cases—Brazil and China, for example—there seems to have been more success in implementing conservation investments that proved profitable for stakeholders.

Recommendations

Financial and economic analysis is an important tool for designing watershed management investment programs.

Financial and economic analysis in watershed management projects can plainly make a vital contribution to project design and implementation, and to subsequent sustainability. The financial analysis from the *perspective of the upland farmer* will reveal which techniques are profitable and low risk enough to be attractive. The economic analysis—which will correct the financial analysis by shadow pricing inputs and outputs and by bringing in "externalities," that is, costs and benefits not accruing directly to the farmer—will allow investments to be assessed from the *perspective of*

Table 2: Investments in Soil and Moisture Conservation Measures in Projects

Project	Conservation measure	Cost US$/ha
China	Terracing	950
Second	Afforestation and vegetation cover	133
Loess	Artificial grassland	90
Plateau	Natural revegetation	60
China New terrace development	726	
Second Red	Terrace rehabilitation	87
Soils	Grass and soil conservation	731
Peru Natural	Bench terraces	1,800–4,850
Resources	Slow formation terraces	574–2,162
	Infiltration furrows	340–638
India	Bunding and planting around arable land	110
Karnataka	Reforestation	400
	Development of pasture and scrub land	490
Mali Natural	Quickset hedge	44/km
Resource	Windbreak	514/km
Management	Grass contours	147
	Rehabilitation of natural forests	393

Source: World Bank Project Appraisal Documents.

Box 35: Soil and Moisture Conservation Measures in the Peru Sierra Project

The project document detailed the range of investment costs per hectare for soil conservation measures and set maximum costs reflecting economic viability:

- *Bench terraces* on 2,350 ha: Investment costs vary from US$1,800 to US$4,850/ha. The maximum cost (including labor) allowed under the project was US$2,979/ha, beyond which the activity becomes economically unviable.
- *Slow formation terraces* on 10,000 ha: Investment costs vary from US$574 to US$2,162/ha. Construction costs per hectare must not exceed US$2,298/ha in the upper Sierra, US$1,532/ha in the central band, and US$553/ha in the lower areas.

The Project Completion Report notes that, for the rural investment component as a whole, the use of these economic cutoff rules resulted in grants being efficiently used.

Source: World Bank 1997 (Peru Sierra Project PAD) and World Bank 2004a (Peru Sierra Project ICR).

society as a whole. The economic viability of investments will thus differ in important respects from their financial profitability insofar as it captures the extra value or cost to society of the watershed management interventions that is not reflected in the farmer's own livelihood.

Financial and economic analysis of different watershed management interventions is thus an important tool for determining (a) what investments the farmer is likely to adopt and sustain;

(b) what investments are not sufficiently profitable or low risk for the farmer, but which are of sufficient value to society that the farmer should be given incentives to adopt and sustain them; and (c) what investments are neither profitable nor of sufficient value to society and should be dropped.

Project preparation, therefore, can use financial and economic analysis for (a) designing a least-cost, financially profitable, and economically viable investment package (with, for example, the kind of cutoff point set in the Peru project); (b) designing an incentive structure to ensure adoption and sustainable management of investments not immediately profitable for stakeholders; and (c) establishing the overall economic value of the project and compare returns for different policy options.

The main problem has been in getting the information needed. A simple step-by-step methodology can help for farm-level analysis. For other impacts, in particular externalities, quantification and valuation should be pursued, but this is difficult. Economic analysis could help in this case to choose between different policy options.

It may be surprising that such an important analysis has been understated in watershed management programs. The reasons evidently are the difficulty of gathering the information, particularly on costs and benefits both on-site and downstream. The section, *Watershed Management Externalities and Their Valuation*, in Chapter 4 below explores the difficulty of measuring and valuing the downstream costs and benefits, and the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4 discusses difficulties involved in translating an assessment of costs and benefits into a structure of sustainable incentives. Box 36 sets out a paradigm of steps drawn from best practice that might be adapted for farm-level financial analysis of future watershed management programs, and that serve as a building block for design of the investment packages and of the incentive structure.

The economic analysis usually builds on the financial analysis by summing up farm benefits across the entire area. It should also list other expected benefits and costs to the project, including environmental impacts. Some of these could be quantified or even valued (see the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4 below), in which case they will be integrated into the analysis. When a comprehensive economic analysis that encompasses all major expected costs and benefits is available, it is a powerful, yet underutilized, tool for comparing policy options.

Watershed Management Externalities and Their Valuation

One of the main attributes of watershed management is the potential to improve the natural resource impacts downstream—"externalities"—resulting from land and water interactions. Watershed management interventions in themselves may also have unintended negative consequences downstream. In the projects reviewed, improving downstream impacts was often an objective, but the relationship between upstream investments and downstream impacts was rarely clarified and monitored. The economic analysis rarely valued environmental benefits of watershed management programs. Clearly, accounting for externalities is essential to show the real costs and benefits of watershed management interventions and to provide their economic justification.

Upstream-downstream linkages are certainly complex and the information required to understand the interactions has until recently proved difficult and costly to collect. Yet the rise of dynamic modeling at the basin level coupled with more affordable monitoring tools allows for better understanding of watershed properties, functions, and management impacts.

Box 36: Best-Practice Farm-Level Financial Analysis to Help Tailor Watershed Management Investments

1. Perform the analysis for a range of typical farms in the area. For example, different slopes and soil types mean very different profitability of conservation measures (different costs and benefits).
2. Assess soil characteristics for each farm type, including effects of soil erosion on productivity.
3. Derive a plausible "no project" scenario with respect to productivity impacts of soil degradation.
4. Starting from the least expensive ones, assess different conservation options in respect of their suitability to the area's specific conditions and to the project's objectives within and downstream of the project area.
5. For the high-efficacy measures, determine the costs of the interventions, including foregone production from construction (for example, in case of rock terracing as much as 10 percent of cultivated land is lost).
6. For the most cost-effective options, compare the with project and the without project profitability, after choosing a suitable time horizon for the farmers (which might depend on external factors, such as land property rights security).
7. Check the realism of assumptions with specialists in the area, and consult with stakeholders to ensure that costs and benefits to them have been well identified (for example, convenience of bullock operations or dual benefits of boundary-based barriers in the form of demarcating property boundaries).
8. Determine whether the best conservation practices under current circumstances are likely to be profitable and sustainable under different economic and climatic scenarios (sensitivity analysis).
9. Assess the likely impact of the chosen practices on downstream objectives to determine whether there is a "public good" benefit.
10. Choose the alternative that proves to be the most profitable and sustainable, that is most technically feasible and acceptable to farmers, and that meets public good objectives.
11. Design an incentive package that improves the financial attractiveness to farmers of investments where there is a public good.

Source: Authors and personal communication from John Kerr.

One of the main attributes of watershed management is the potential to improve the management of externalities resulting from land and water interactions.

An externality can be defined as the effect of one party's actions that impose a cost or benefit on another party, without that cost or benefit being accounted for in the market (World Bank 2001). Because externalities operate outside of markets, there is often no incentive for parties to account for the externalities they generate. In a watershed, the classic example of a negative externality is the sedimentation of canals and dams that may result from accelerated erosion caused by inappropriate farming or grazing practices in the uplands. The efficiency and lifespan of the canals and dams are reduced, imposing high costs on downstream users and on the national budget without the upstream imposer of those costs being called to account (World Bank 2001).

Watershed management projects are generally expected not only to deliver local on-site benefits at the micro-watershed level (see the section, *Scales of Intervention*, in Chapter 2), but also to provide a means of correcting these downstream negative externalities within the larger watershed. They may also provide positive externalities in the form of beneficial environmental services downstream, such as maintenance of existing hydrological services and reduction of sedimentation, scenic beauty, or even global environmental services, such as increased biodiversity and carbon sequestration (see Box 37 for impacts and externalities of tree buffers). *An important challenge for watershed management is therefore to identify the downstream objectives—such*

Box 37: On-Site and Off-Site Impacts of Vegetative Buffers in Riparian Zones and Upper Watersheds

On-site impacts:

- Reduced erosion: Vegetative buffers (trees, understory, and groundcover) combat soil erosion as they protect the soil from erosion processes, allow greater infiltration of water, and trap the sediment entering from cultivated areas. Appropriately designed windbreaks can also significantly reduce soil loss from fields by reducing wind velocity.
- Dryland salinity: There is a critical level of salinity beyond which crop yields are reduced. Where root-zone salinity caused by high water tables is a problem, plantations can be strategically placed in recharge and shallow groundwater areas to reverse trends in rising water tables.

Off-site impacts:

- Reduced sedimentation: Riparian buffer zones, when properly maintained, can remove up to 97 percent of sediments before they enter a stream.
- Hydrological services: Buffers may have a limited impact in reducing peak flows and, therefore, localized flash flooding at very local scales and for short return period storms by slowing water flow and increasing infiltration of water into soils.
- Mitigation of stream contamination: Vegetative buffers, especially in riparian zones, can also protect water supplies by removing fertilizers and pesticides from field runoff, mitigating direct health risks to those drinking the water and reducing treatment costs for urban residents.
- Carbon sequestration.

On- and off-site impacts:

- Biodiversity and wildlife: Buffers also provide direct environmental benefits, such as increasing the biodiversity of flora and fauna and providing habitat for wildlife.

Sources: Lovell and Sullivan 2006; Cacho 2001.

as reduction in sediment, smoothing of flows, and water quality—and to work back up the causal chain to the corresponding upstream measures.

Watershed management interventions themselves, however, may also have unintended costs downstream.

Despite their evident objective of improving natural resource conditions in a watershed, watershed development programs may actually do harm to downstream areas.[31] How watershed management interventions produced perverse outcomes is illustrated by examples from Karnataka and Andhra Pradesh in India, where the promotion of forestry, irrigation, and soil and water conservation measures, including water harvesting in the upper watersheds, produced serious water shortages in the lower part of the catchment. With the lowering of the groundwater table

31 "It should be noted here that these projects were specifically watershed *development* projects, in which it was assumed that by developing the watersheds using "good" practices, the end result would also be "watershed management." This was, however, incorrect since the projects only accounted for land resources and not water resources in the design and implementation (Jim Smyle, personal communication).

downstream, wells needed to be drilled more deeply, which the poor could often not afford, leading to inequitable water distribution and use (Calder 2005).[32]

Results of the Project Review

The projects reviewed generally targeted externalities, but the relationships between upstream investments and downstream impacts were rarely clarified and monitored.

A major justification for the projects reviewed was the expectation that they would reduce negative externalities and provide beneficial environmental services for the downstream area—for example, reduced flooding and sedimentation. At completion, many projects recorded impressive technical achievements in restoring degraded hillsides into productive uplands, with local impacts on reduced soil loss and reduced localized flash flooding. However, the projects most often focused on such on-site interventions and their benefits. Whether these measures were of benefit also to the downstream environment or were the optimal approach to reducing negative externalities was often not considered. Few projects provided much clue as to whether they achieved the intended longer-term impacts downstream, and in many cases, it remains uncertain whether project investments translated into the expected beneficial externalities. Only recently have projects begun to bring attention to these issues (see the section, *Monitoring and Evaluation*, in Chapter 4).

The economic analysis rarely valued environmental benefits.

The review found that in most cases the economic analysis was limited to on-site costs and benefits and rarely took externalities into account. Out of the 24 dedicated watershed management projects reviewed, only seven carried out some form of economic valuation of environmental benefits. Among these, just one used these estimates to partially internalize off-site positive environmental impacts, through a cost-sharing mechanism (see Box 38).[33]

Recommendations

Accounting for externalities is needed to show the real costs and benefits of watershed management interventions, which is important to their economic justification.

The existence of so many externalities in watersheds is key to economic justification of watershed management projects. Many upstream investments cannot be justified by their on-site benefits alone and can only pass economic tests when downstream benefits are factored in. Conversely, upstream intensification investments may result in costs for downstream areas. These costs also need to be accounted for in the economic evaluation. Watershed management operations should therefore be explicit about the externalities which they are expected to generate. Where conservation investments are not in themselves profitable for stakeholders (the section, *Profitability and Economic Viability of Watershed Management Interventions*, in Chapter 4), valuation of positive externalities can lay a basis for providing economic incentives (see the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4 below).

However, upstream-downstream linkages are complex, especially at the larger scale, and the information required to understand the interactions is still little available and costly to collect. Yet

32 The example is cited here to illustrate how negative externalities may be caused by watershed management interventions. For a full discussion of the interactions between watershed management programs and basin hydrology, see the section, *Considering the Effects on the Water Cycle*, in Chapter 5 below.

33 On the issue of the use of valuation of externalities as the basis for internalizing them, see the section, *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4 below.

Box 38: Economic Analysis in the China Loess Plateau

Foreseen benefits: At appraisal the project was expected to produce benefits (a) within the project area—an increase in the net value of production; (b) downstream in the Yellow River—reduction of sediment inflow, lower variability in water flows, and reduced flood risk; and (c) global and regional benefits in the long run—turning bare slopeland into forests or orchards would lead to a fixation of carbon in subsurface and surface biomass, helping to reduce the build up of CO_2 in the atmosphere. Moreover, a dense vegetative cover in the Loess Plateau was expected to have a long-term positive impact on the climate in the region. In particular, it was anticipated that rainfall would increase and become more evenly distributed, and temperatures would moderate.

Valuation of on-site costs and benefits: The economic analysis quantified inputs and outputs and estimated a net value of production for an entire area or watershed over a certain period. All investments, including purely conservation investments, were factored in. The estimated economic net cash flow was derived from comparing the "without" and the "with project" net value of production.

Valuation of the downstream benefits: Tons of sediment retained were estimated and valued at Y 1 per ton, equal to the cost of removing 1 ton of sediment from the dams. The sediment retention impact from dams and terraces was expected to occur immediately after construction. The sediment retention from vegetative measures, such as trees, shrubs, or natural revegetation, was estimated to build up over a period of 6–10 years.

Valuation of Global benefits: The carbon storage benefit was estimated in a range from 50 to 200 tons per hectare and was expected to accrue over a period of 40 years. Carbon permanently stored was valued at Y 5 per ton, but no justification for this unit price was provided.

Ex ante and ex post economic results: The overall EIRR of the project at appraisal was estimated at 21 percent, which was confirmed by the ICR. Of this, the benefits from sediment retention contributed about 1.5 percent, and the benefit from carbon storage contributed about 0.5 percent to the EIRR of the overall project.

From recognition of externalities to cofinancing: The high financial profitability of the interventions for farmers (FIRR estimated between 30 percent and 44 percent depending on the farm characteristics) was considered a sufficient guarantee of long-term sustainability. Nevertheless, in addition to the commitment at the central government level, many other parties, from the provinces through the prefectures, counties, townships, villages and individual households were strongly committed to the project because of the positive externalities to be expected from the interventions. This commitment materialized in cofinancing arrangements. For example, downstream counties agreed to finance part of the soil rehabilitation measures through local taxes because of the reduced risk, thanks to reduced siltation, of dikes breaking up and of consequent flooding.

Sources: World Bank 1999b (China Loess II Project PAD), World Bank 2005 (China Loess II Project ICR), and personal communication from Jurgen Voegele.

the rise of dynamic modeling at the basin level, coupled with more affordable monitoring tools, allows for better understanding of watersheds properties, functions, and management impacts.

Scientific data on environmental upstream-downstream relationships are often limited to relatively small scales. For instance, the relationship between upland forest cover and increased water peak-flows has only been demonstrated for a scale of maximum 10 km x 10 km, but not beyond

(Kaimowitz 2005).[34] In fact, at larger scales, such as the watershed, there is yet little evidence available on the impacts of upstream watershed management on downstream externalities. Rigorous assessment becomes more difficult with increasing scale. This is partly a reflection of the diversity of conditions encountered. Hydrological services, for example, depend on the rainfall regime, the type of soil, and topography. Land use change from a forest to a nonforest or a managed or intervened forest situation can have multiple, often contradictory impacts, making the net impact on water services hard to determine. For example, while infiltration rates will often decline, water consumption generally will also decline because of reduced evapotranspiration. The net impact of these changes (both on annual flows, and particularly on seasonal low flows) depends on the balance between these effects—and the balance is generally a function of soil hydrologic characteristics, geology and climatic regime—which has rarely been determined by empirical studies. As a rule of thumb, however, one can assume that the impacts will tend to be greater in drier climates and where subsequent land uses significantly reduce infiltration (through soil compaction by grazing or by creation of impervious cover as in urban areas) on the watershed scale. Available empirical evidence from urban watersheds tends to place a 15 percent threshold on creation of impervious cover, that is, once impervious cover begins to exceed 15 percent, negative hydrologic impacts begin to become apparent. Negative impacts will be greatly increased when subsequent land uses degrade natural drainage ways, riparian zones, and wetlands.

In addition, some impacts materialize only slowly and in the long term, and significant results may not be perceived during the project life. Thus the larger the project area and the longer the impacts take to become apparent, the more difficult it becomes to relate upstream actions to downstream impacts. In addition, external factors that affect downstream outcomes may intervene, and they are very difficult to take into account. Plainly an important challenge for the future of watershed management is to improve knowledge through scientific research and broader and longer-term program monitoring. Recent developments in monitoring, remote sensing, and dynamic modeling offer important opportunities for better understanding of watersheds properties, functions, and management impacts (see the section, *Monitoring and Evaluation*, in Chapter 4 and the section, *Monitoring and Evaluation*, in Chapter 5 below).

The Role of Externalities in Defining the Incentive Structure

Valuation of externalities is also fundamental to defining the incentive structure, which may “internalize externalities,” especially when conservation practices are not readily attractive to upstream communities. Investment subsidies are the most commonly used incentive, but there are real problems of sustainability, and nonfinancial approaches, such as awareness creation or regulation, have often not proved effective either. Ideally the incentive structure needs to be built on a quantified assessment of externalities, but no examples of this were found during the review Clearly this is an area for further work.

Market-based contracting approaches—”payment for environmental services”—have been used. At local scales, deals can be organized with little outside intervention, but as scale and complexity increase, contracts require both good scientific knowledge and a developed institutional capacity. In addition, the transaction costs need to be substantially lower than the benefits, which is difficult at a large scale with multiple uses of watersheds and unclear upstream- downstream linkages.

34 Recent advances in these domains have been made by Van Noordwijk, Richey, and Thomas (2003), and by Bonell and Bruijnzeel (2004). See the section, *Considering the Effects on the Water Cycle*, in Chapter 5 below for a full discussion of the impact of watershed management on hydrology.

Valuation of externalities is also important in defining the incentive structure in watershed management.

The question who pays and who benefits from improved externalities is crucial to the design of financial arrangements in watershed management projects, and in fact to the whole sustainability of the watershed management approach. As discussed in the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2 above, a number of programs have had difficulty in establishing incentives for sustainable soil and water conservation and pasture improvements, in part because stakeholders correctly perceived that they were being asked to create positive externalities for downstream users (or to reduce negative ones) without being compensated.

Of the various ways to internalize externalities, investment subsidies are the most commonly used, but there are real problems of sustainability after the investment period is over.

There are a number of approaches to "internalizing externalities"—that is, to compensating those who generate positive externalities and charging those who create negative ones. These approaches include tying the adoption of conservation practices to other benefits, such as access to credit (Pagiola 2002), full subsidy to the cost of adoption, or partial subsidy, that is, "cost sharing." In addition, there are innovative approaches, such as payments for environmental services.

Investment subsidies, particularly cost sharing, have been the most commonly applied measures, and it has proved easy to obtain cooperation with project activities by paying subsidies. However, one study on the Indian experience found investment subsidies to be the least effective instrument (Kerr and others 2007). Subsidies for specific measures create the risk of backing the wrong kind of technology and may lock farmers into approaches that impose high costs with relatively little benefit. There is very little research that shows what the best investments are from both the farmer's viewpoint and from the watershed perspective. Elsewhere, experience suggests that subsidies, if not sustained, do not achieve long-term changes in conservation practices. Once the projects end and the subsidies cease, land users have often reverted to their previous land uses where they neglect the conservation measures they had adopted, or even actively destroy them (Lutz, Pagiola, and Reiche 1994).

Alternatives to a "compensation" approach have also encountered many problems.

In order to sidestep the evident problems of a "compensation" approach, watershed management programs that were not perceived as profitable by farmers or herders have adopted a variety of nonfinancial approaches to convince stakeholders to engage in conservation practices. Some have proposed alternative income generation activities to compensate for lost income because of conservation practices (see the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2), and some have depended on a hoped-for "demonstration effect"—assuming that conservation practices could ultimately prove beneficial to stakeholders who would adopt them of their own accord once their benefits had been demonstrated (Pagiola 2002).[35] Others have used approaches, such as awareness creation, moral suasion, and regulatory limits and fines. Generally these measures have not proved effective (Enters 1997; Pagiola 1999). The alternative income-generating activities approach has had mixed outcomes, as discussed in the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter

35 See Box 22 (the section, *The Use of Participatory Approaches*, in Chapter 3) for an example of this effect in the Morocco Lakhdar project.

2. The demonstration effect has often failed because the assumption that conservation practices were profitable to upland stakeholders was often not the case (see the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2). Regulatory approaches are often extremely difficult to enforce and may impose high costs on poor land users by forcing them to adopt land uses that generate lower returns.

Results of the Project Review

Projects were rarely clear on the rationale for the incentive structure, although this proved important to project success and sustainability.

It could be expected that the projects reviewed would show evidence of upfront analysis of the costs and benefits, both on-site and off-site, and would use this as a basis for incentive arrangements under the project. However, just as the financial analysis (the section, *Profitability and Economic Viability of Watershed Management Interventions*, in Chapter 4) and evaluation of externalities (the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4) were generally weak, the analysis needed to design the incentive structure for watershed management programs was generally poorly handled in the projects reviewed. The distribution of costs and benefits was unclear and the rationale for the project incentive structure at best fuzzy. In fact, it was often even unclear from the documentation *who actually paid for investments*. Were they subsidized? Was there free labor contribution? Which people financially contributed? These questions often went unanswered in the documentation. Yet it is clear from project experiences that incentives were important to project success and sustainability. Box 39, for example, illustrates how the China Loess I Project struggled with stakeholders' refusal to pay the cost of creating benefits that would accrue largely to downstream users through reduction in sedimentation.

Box 39: Unwillingness of Farmers in China to Pay for Public Goods

In the China Loess I Project, upland farmers were not motivated to put a lot of effort into increasing the vegetation cover on hillsides, since they understood that the main benefit would accrue to people downstream through reduction of sedimentation flow into the Yellow River.

One of the lessons learned from the project was that the public goods should be fully recognized, and the financial obligations should be distributed among the concerned stakeholders, especially if benefits are created outside the project area. The project recognized the implications. If the government was aiming at a public good, it had to take more financial responsibility for the cost of restoring the vegetation cover. Only in that way could people be motivated to contribute to the project's objective of reducing sediments. These insights were integrated into the Loess II (1999) project where public funding was increased for activities creating public goods.

Source: World Bank 2003a (China Loess Plateau Project ICR).

Recommendations

Sustainable watershed management usually requires interventions to set an incentive structure that will motivate stakeholders.

It will be clear from the discussion above that there can be no assumption that conservation measures will be financially attractive to stakeholders. Plainly, sustainable watershed management requires an incentive structure supported by economic instruments that ensure that stakeholders are motivated to continue sustainable resource management practices.

The incentive structure needs to be built on a quantified assessment of externalities.

A quantified assessment of externalities is essential to building an incentive structure. Analysis of whatever information is available for both on-site and off-site costs and benefits can help determine how much of a direct net benefit interventions are to the upland population and how far upland dwellers are expected to bear the costs of creating benefits for others downstream or for global society (for example, carbon sequestration or biodiversity). Participatory applied research on costs and benefits of investments and on upstream-downstream interlinkages, together with good M&E, are needed to build the knowledge required to underpin the chosen structure (see the section, *Applied Research and Knowledge Sharing in Watershed Management*, in Chapter 2 above on research and the section, *Monitoring and Evaluation*, in Chapter 4 below on monitoring and evaluation).

Some promising approaches attempt to move toward cost sharing based on market-based contracting.

Investment subsidies do not guarantee the long-term sustainability of conservation practices. Alternative ways to internalize externalities by mimicking market-based transaction contracts have been developed and used by some conservation projects. These approaches, referred to as "payment for environmental services" (PES), work on the principle that those who provide environmental services should be compensated for doing so and that those who receive the services should pay for their provision. This approach has the further advantage of providing additional income sources for poor land users upstream, helping to improve their livelihoods. Several countries are already experimenting with such systems (Landell-Mills and Porras 2002).

In cases where there are few players involved and linkages between upstream activities and downstream impacts are clear, locally brokered deals can be organized with little external intervention beyond facilitation. This works best at small scales.

Locally brokered deals can include voluntary certification and direct purchase of land, as well as direct payment schemes between offsite beneficiaries of watershed services and landholders responsible for the services (Fahmuddin and van Noordwijk 2004). These contractual agreements tend to work better at smaller scales, since this allows for face-to-face negotiations and ensures low transaction costs. Local-level arrangements also enable stakeholders to value the service, because they are more certain about the links between watershed management actions and their consequences. In Indonesia, for example, the state-owned water supply company rewards communities in this way for protecting endangered water springs (Fahmuddin and others 2004). These locally brokered deals may require only simple external facilitation. Deals like these can also be made more easily where there are clear property rights and enforceable contracts.

In most cases, although a PES approach is intuitively appealing, putting it into practice is far from simple. The approach can be used only if several building blocks are in place: an understanding of the relationships between land use and service generation, an economic analysis of the benefits and costs is needed, and creation or strengthening of institutions.

Several building blocks need to be in place (Pagiola and Platais 2006):

- *A strong understanding of the underlying relationship between land use and service generation and the ability to monitor changes*: The quality and especially the quantity of the environmental services generated by different kinds of land uses are still imperfectly understood. For example, although forests are widely believed to provide a variety of hydrological services, the evidence is often far from clear (see the section, *Considering the*

Effects on the Water Cycle, in Chapter 5). PES requires good scientific knowledge and good monitoring capability.

- *An economic analysis of the benefits these services provide to users and of the cost to land users of providing them*: Even if the kind of benefit that a given land use generates is known, one must also know how much of that benefit is being generated, and value it in economic terms. On the cost side, changing land uses imposes opportunity costs from the foregone land use and may also impose direct costs (for example, for reforestation). Yet financial and economic assessment of watershed management costs and benefits has proved difficult (see the sections, *Profitability and Economic Viability of Watershed Management Interventions* and *Watershed Management Externalities and Their Valuation*, in Chapter 4).
- The creation or strengthening of institutions: PES simulates a market, and hence requires clarity over property rights, a legal contract system, and collectively organized parties with acceptable transaction costs. Property rights need to define who owns the environmental services generated by a certain land use (such as water flows, carbon sequestered, or genetic information of biodiversity), or at least the underlying land, and there has to be a reasonable degree of land tenure security. Otherwise these services cannot be bought and sold. In some cases, definition can be an obstacle, for example, when ownership is assigned to the state and the state is unable to enforce its rights. Water or forests formally belong to the state in many countries, for example, yet wide—often informal—use rights have been established. In addition to the question of rights, the institutional basis for contracting for environmental services needs to be set up. Typically, central government can establish the institutional framework (for example, legal basis, standardized contracts, research to provide the needed data base), but contracting generally needs to be done at a lower level where the cost and benefit relationship can be empirically demonstrated better. In some cases, regional authorities have implemented their own approaches. In practice, the most efficient level for actually contracting for PES has proved to be at the local level through small-scale initiatives (that is, single watershed), although within a broader institutional framework. Finally, upstream and downstream stakeholders will have to act collectively in the PES scheme. They need to be organized in specific groups for negotiating, implementing, and enforcing the scheme. Transaction costs on large-scale or densely populated watersheds, and in conditions where collective action is difficult, can be too high as compared to benefits to envisage setting up a PES scheme.

Box 40 lists some of the main advantages and limits of the PES approach.

Experience with PES to date has been largely in Latin America in small-scale initiatives involving water services.

Many of the PES experiences to date have been implemented in Latin America, and particularly in Central America. Two countries (Costa Rica and Mexico) have created nationwide PES programs (Pagiola 2002 for Costa Rica; Bulas 2004 for Mexico). The vast majority of PES initiatives, however, have been for smaller-scale initiatives at the scale of individual watersheds. The bulk of PES programs to date have focused on water services, reflecting both the urgency of addressing water issues in many developing countries and the relative ease with which the users of water services can be identified (see Box 41). The PES approach has also been used for biodiversity and carbon sequestration benefits in a few cases. In these cases, the global community, and not specific stakeholders, benefit from the conservation practices or land use change. Hence, payments have to come from ad hoc funds linked to the government budget or international donors. A few other cases have been identified in Asia where the approach is gaining momentum (see Fahmuddin and others 2004).

Box 40: Advantages and Limits of Payment for Environmental Services

Advantages

- *Efficiency*: PES conserves only what is considered worth conserving from the economic standpoint. It can make differentiated payments according to the degree to which services are provided.
- *Sustainability*: PES generally requires that service providers be paid indefinitely for the services they provide. This requires that service users be satisfied that they are receiving the services they are paying for. Hence, sustainability depends on objectively verifiable quality of service.
- *Autofinancing*: PES generates its own funding without requiring substantial budgetary outlays from the government.

Limits

- *A good understanding of upstream and downstream linkages is needed*: PES has to be based on valuation of services provided by upstream management interventions.
- *Needs continuous readjusting*: Changes in market conditions may make a PES payment that is acceptable today insufficient tomorrow.
- *Market based*: PES can only value quantifiable services that can be priced. Externalities that cannot be quantified or priced—biodiversity, for example—may not be suitable for the approach.
- *Transaction costs* for setting up and administering the payment mechanism may be high, especially if beneficiaries are not already organized or if the watershed is large and densely populated.
- *Not necessarily a poverty reduction mechanism*: In many upper watersheds, a large proportion of the population is likely to be poor, but even within watersheds with primarily poor populations, there is no guarantee that payments will reach the poorest.
- *A substantial role for governments will remain*: A need for public financing still exists. Financing for research and monitoring is a clear role for governments. Governments also have to help develop and supervise the institutional and regulatory framework.

Source: Pagiola and Platais 2006.

Box 41: Examples of PES in Latin America

In Colombia, irrigation water user groups and municipalities in the Cauca Valley are paying to conserve the watersheds that supply them with water.

In Costa Rica, the town of Heredia has established an "environmentally adjusted water tariff," the proceeds of which are used to pay landholders to maintain and reforest watershed areas.

In Ecuador, the city of Quito has created a water fund, FONAG, with contributions from the water utility and the electric power company to pay for conservation in the protected areas from which it draws its water.

Source: Pagiola and Platais 2006.

Monitoring and Evaluation

Monitoring and evaluation has generally been weak, and measurement of externalities has been particularly fragmentary and inadequate. Watershed management programs require a broad and effective monitoring and evaluation system to track performance against objectives and provide information to help managers at all levels with implementation. Although measurement of externalities is difficult, they are fundamental to the justification of many watershed management programs, and projects should be careful to measure baseline data, define expected outcomes, and monitor results. Useful and affordable tools, such as remote sensing, are increasingly being made available for measurement of externalities. Modeling is also being used successfully, in particular to study dynamic phenomena at the basin, watershed, and even subcatchment scales.

Monitoring and evaluation (M&E) systems are designed to inform project management and counterparts whether implementation is going as planned and whether corrective action is needed. An effective management information system is an essential part of good management practice. Frequent evaluation of progress seeks to establish causality for the situations and trends recorded in monitoring.

M&E design requires identification of the main objectives and expected results of the project, related indicators, and a plan for collection, analysis, and reporting of the data (Burton and Smith 2007, draft). The M&E system is based on the "logical strategy" for the project, which links project *inputs* to *outputs, outcomes*, and *development objectives*. Results monitoring, which looks at project outcomes and achievement of objectives, is increasingly the focus of M&E systems.

For watershed management operations, the main outcomes relate to (a) on-site agricultural growth, poverty alleviation, and environmental protection or restoration; (b) institutional changes and empowerment; and (c) off-site, mostly downstream, environmental impacts. Establishment of M&E systems for *on-site* achievement of economic, environmental, and institutional objectives is relatively straightforward or well documented, and can be based on experience in other sectors, such as agriculture, community-driven development, or the environment.[36] However, there is little experience with M&E systems to track achievement of *off-site* outcomes (that is, downstream environmental outcomes)—and the challenge of measurement is much harder. Yet M&E of off-site outcomes is essential to both the justification and the management of watershed management projects. If watershed management programs are to be justified on the basis of their contribution to downstream environmental services, those services have to be measurable and to be monitored.

Results from the Project Review

To demonstrate achievements against objectives, projects need a good baseline and M&E system to measure performance against targets. However, M&E in the projects reviewed was often weak.

To measure performance against objectives, it would be expected that projects would have good baseline information and would have an M&E system capable of tracking outcomes against

36 For more information on M&E of institutional aspects, see World Bank Online Resource on Community Driven Development. Social Development Department. Available at http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALDEVELOPMENT/EXTCDD/0,,menuPK:430167~pagePK:149018~piPK:149093~theSitePK:430161,00.html.

expectations. However, M&E in the projects was often poorly done.[37] Many of the projects reviewed never established adequate baseline data, and many of the M&E systems set up were weak (Box 42). There were some notable exceptions. For example, in the China Loess Project, a thorough monitoring system was established based on a Geographic Information System (GIS) database. The system allowed spatial identification of project activities, providing project data and more general social and economic data by micro-watershed, and aggregating those data at the regional level. The project monitoring system continued after the project and is providing feedback to the Provincial and County Soil and Water Conservation Bureau.

Box 42: Common Weaknesses in Watershed Management Project Monitoring and Evaluation Systems

Many of the M&E systems of the projects reviewed were weak, because of a range of factors:

- *Delay in baseline data collection*: The project in Turkey started M&E in the third year, and in Burkina Faso only toward the end of the project.
- *Poor baseline data*: Incorrect and bad data complicated the planning process and delayed implementation in the Turkey Eastern Anatolia Project.
- *Physical monitoring bias*: M&E focused more on inputs and outputs than on outcomes and impacts.
- *Unsustainable M&E systems*: In particular, outsourced M&E tended to collapse after the project ended.
- *Systems not part of the management process*: Rarely did managers use M&E systems as a management tool, and systems were not designed and used as a support tool for project implementation.
- *Weak methodological approach on environmental impacts and externalities*: Measurements of environmental impacts and externalities often lacked quality, comprehensiveness, and clarity.

The causes of these weaknesses include a top-down planner's approach with little consultation of users on system design or information needs; a political and management culture that is rarely evidence-based; an overemphasis in design on exactness and consequent overly great complexity and unrealistic data needs; asymmetrical incentives, with data often seen by implementers as a threat rather than a management tool; and underresourcing and lack of needed skills and knowledge.

Source: Authors.

To the extent that a results-monitoring system was in place, the emphasis was on on-site impacts on natural resources productivity and livelihoods. Measurement of project externalities was generally fragmentary and inadequate.

Although most of the projects referred to positive downstream impacts in their appraisal and completion documents, there was little hard evidence of project impacts at a wider scale than the project sites. Interventions were typically focused on on-site activities and benefits (see the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2 above). Consequently, project monitoring also focused largely on on-site activities and on-site benefits. Even the on-site benefits were generally measured only in relation to increases in agricultural output and incomes, little encompassing institutional

37 This failing is not, of course, limited to watershed management projects. However, in addition to the usual problems of M&E in rural projects, specific problems of watershed management M&E appear to relate to the large number of micro-sites and interventions, the difficulty of measuring costs and benefits of each type of intervention, and the larger problem of measuring and valuing externalities.

impacts. Individual results measured in micro watersheds were summed up across the watershed area, such as income increase, land area treated, and yield increased.

Where environmental measurements were undertaken, they focused within the project area on soil loss, runoff, infiltration, surface litter, sedimentation, and water quality at the local level. Very little monitoring of impacts outside the project zone was done, and even there the actual quality and significance of the data could not be judged from the reports. Box 43 illustrates these weaknesses, drawing on the three projects where the documentation is clearest. Often positive environmental impacts were claimed on the basis of purely anecdotal evidence without measurement (for example, in the projects in Tunisia, Burkina Faso, and Indonesia), or on simplistic assumptions that improved upland management in general should have a beneficial outcome for the downstream location as well. The failure to develop an M&E system that could capture and quantify downstream impacts led one project (Turkey Eastern Anatolia Project) to the conclusion that during more than 10 years of intervention, *nothing* could be said about the project externalities.

Box 43: Examples of Weaknesses in Monitoring and Quantifying Externalities

India Hills and Plains Projects: Both projects stated that a substantial portion of positive environmental impacts from their activities occurred downstream and outside the project area, and some participating states took measurements on soil loss, runoff, infiltration, and surface leaf litter. The results showed considerable variation between sites and states, but despite inadequate data on the pre- or without-project situation, the projects nonetheless made the inference that the project impact on soil and moisture conservation was strongly positive. The project also backed these conclusions with extensive anecdotal evidence from the inhabitants of village communities throughout the project area. However, it was clear that the quantification of these benefits was imperfect, and even where the environmental benefits could be measured, it proved too complex to assign values to them.

China Loess I Project: The project monitored changes in water quality, sediment transport reduction, on-site erosion, precipitation, and changes in soil fertility. Data from field measurements were entered into the project's GIS data system. The reduction in sediment inflow to the Yellow River was reported to have been significant. However although the project claimed lower variability in water flows, reduced flood risk, and lower cost of flood protection work, it did not in fact measure water flows or floods consistently. The basis for the assumptions made was that rainfall water was retained on terraces, behind key dams and check dams, and in millions of small water-harvesting pits around each tree planted, and that all this must have contributed to a lowering of the peak runoff.

Turkey Eastern Anatolia Project: The project measured neither off-site externalities nor local erosion and sedimentation impacts of project interventions. At the community level, there was some anecdotal evidence of a favorable impact on sedimentation of small dams close to the treatment areas and of reduced localized village flash flooding in large rainfall events. However, M&E data collection was weak, and the baseline survey was done only three years before the project closed. Thus, many of the treatment impacts remain unknown. The project argued that changes may have occurred within the project area, but that the time scale for these impacts to be felt in the major reservoirs lower in the lower watershed would be very long—between 10 and 100 years or more. Another argument made by the project was that it was difficult to evaluate and separate outside influences from the treatment effect. The impact, for instance, of one of the project objectives—reduction in livestock pressure on grazing land—was hard to monitor, given the overall shrinking of the livestock sector in the area.

Source: World Bank 1999c (India Hills Project ICR), World Bank 1999d (India Plains Project ICR), World Bank 2003a (China Loess I Project ICR), World Bank 2004c (Turkey Eastern Anatolia Project PPAR).

Newer projects have just begun to address this challenge of measuring externalities. The Karnataka Project in India (2001), for example, provided at first for no measurement of environmental downstream benefits. It is now, however, introducing hydrological assessment of the catchment area. This will help the project management team track the relationship between upstream activities and downstream outcomes. In this case, the specific objective is to ensure that planned interventions will not jeopardize the resource downstream. There are also a few recent projects that apply a more comprehensive monitoring approach. For example, the Brazil Land Management III Project (1997) monitors sedimentation, water quality, and soil erosion on a pilot basis in 12 micro-watersheds. The Turkey Anatolia Project (2004) monitors impacts on the reduction of pollution for the Black Sea.

Recommendations

A good watershed management program requires a broad and effective M&E system. The choice of what to study and what not to measure depends on the main objectives of the program and must be assessed in each case.

Given the uncertain relationships and the likely time lag between investment and results, setting objectives, results, and indicators for watershed management programs in a "logical framework" requires careful study. The corresponding M&E system should be selective and as simple and low cost as possible, providing the information needed to track performance against targets and to help managers at all levels with implementation. Some data categories used to characterize a watershed can include physical and natural features, land use and population characteristics, water body and watershed conditions, sediments and pollutant, and water body monitoring data (Environmental Protection Agency 2005). These categories are useful first to assess the condition of the watershed and establish management plans, and second to monitor and evaluate implementation of the plan.

M&E systems should call upon a mix of quantitative and qualitative techniques. Useful and affordable quantitative tools, such as remote sensing, are increasingly being made available for measurement of externalities.

Good monitoring should provide support to day-to-day management, which is especially important in the multilevel matrix management structures that characterize most watershed management projects (see the section, *Public Institutions*, in Chapter 3 above). Monitoring systems should thus be set up using low-cost, easy-to-use, and effective techniques. These techniques call upon a mix of collection processes for both quantitative data (involving measurement of physical indicators and household surveys) and qualitative data (interviews and observations). In this way, hard science data assessments are matched with feedback from stakeholders.

Quantitative monitoring systems for physical parameters can be set up with simple technologies and can remain operational with minimal expert maintenance.[38] Remote sensing offers good opportunities for generating data at low cost[39] (see Box 44), and the use of maps is a good way to have an overview of project progress and to communicate with stakeholders.

Qualitative data collection processes can involve collecting information about perceived progress and challenges in project implementation.

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38 For instance, water quality measurements can be done with simple tools at low cost (a water monitoring field kit costs about US$200). Good protocols exist to have schoolchildren monitor quality trends in municipalities in Montevideo, Uruguay (Jim Smyle, personal communication).

39 Although the prices of remote sensing data are decreasing regularly, it should be acknowledged that in some countries or areas, data with enough resolution are still not readily accessible.

Box 44: Using Remote Sensing in Watershed Development Programs

In recent years, satellite remote sensing has emerged as a powerful tool for assessing natural resources, particularly for diagnostic and monitoring, since it provides reliable, accurate, and unbiased data. Remote sensing is particularly useful where speed, repetitive observation, and a synoptic view are required.

The satellite data, along with conventional data, could be effectively used for watershed development activities, such as (a) inventory and assessment of natural resources, namely, soil, land use and land cover, land capability classification, geology and geomorphology, and groundwater prospects; (b) watershed characterization, prioritization, planning, action plans preparation for developmental and conservation measures, and site selection for implementation; (c) water balance studies and runoff estimation, and groundwater resource management; and (d) M&E of developmental activities and of their impact on-site and downstream.

One example is the Karnataka project in India, where monitoring and assessment of changes in the treated watersheds is carried out using satellite remote sensing technology. The changes in biophysical parameters, such as cropped area, cropping patterns, land cover transformation to agrohorticulture and agroforestry, the number and spread of water bodies, reclamation of wastelands, and biomass changes, are observed. The information is then linked to ground-level measurements to track project impacts and outcomes.

GIS is extensively used to produce linked maps on soils, groundwater potential zones, drainage, transport network and settlement, land use, and land cover. These thematic maps are used, for example, at the community level, including individual farmers' plots, to report on activities in the micro-watershed.

Source: Personal communication from B. K. Ranganath.

Participatory M&E is a very useful way to collect information about projects, analyze information, and get stakeholders more involved.

Community involvement in M&E, ranging from simple support in data collection or analysis to genuinely participatory M&E, has particularly strong benefits. Simple hands-on approaches (such as water quality measurement) involving stakeholders may be very cost-effective and also have awareness-building and training effects. Through participatory M&E, stakeholders can be involved in setting objectives for the project, identifying indicators, designing the monitoring system, and collecting, analyzing, compiling, and sharing the information.[40] Besides determining project impacts, benefits from participatory M&E include ensuring that projects are responsive to stakeholders' needs, empowering stakeholders to take action, and strengthening transparency and accountability. Participatory data collection methods can include biophysical measurements, maps, ranking tools, interviews, or focus group discussions. Box 45 details the participatory M&E approach used in Kecamatan Development Project, Indonesia.

Projects should endeavor to monitor institutional development outputs, outcomes, and impacts.

Projects are increasingly built on institutionally complex systems, involving public institutions, community organizations, private entities, and NGOs, and they include objectives related to institutional development, such as performance and sustainability of local, provincial, and national organizations established or reformed under the project, stakeholders' empowerment, or improved

40 For more information on participatory M&E, see Burton and Smith 2007.

Box 45: Participatory Monitoring and Learning

The World Bank–financed Kecamatan Development Project is a very large community-driven development project in Indonesia. The program empowers communities by placing funds and the planning and decision-making processes directly in the hands of villagers. The project has developed an extensive M&E system that includes (a) internal monitoring, in particular reporting by government officials and field consultants, community participatory monitoring; (b) external monitoring, with NGOs and journalists providing independent monitoring; and (c) impact evaluation.

Over the years, the project encouraged different kinds of community based monitoring systems:

- *Monitoring by village councils*, which select members to monitor each phase of the project: social mobilization, planning, implementation, and maintenance. Results of this monitoring are discussed at council meetings and fed into larger village meetings.
- *Monitoring by special community teams*, members of which share responsibilities for checking financial accounts, monitoring bank transactions and material purchases, visiting suppliers to confirm the costs of goods, and monitoring subproject activities, including infrastructure construction.
- *Community participatory monitoring facilitated by NGOs*. NGOs help villagers decide what questions are important to them about the project, how to collect data to answer these questions, and how to analyze community findings.
- *Handling complaints and grievances*. The project established a complaints resolution process to ensure that communities had a forum to air complaints and resolve problems.

Source: Action for Social Advancement 2005.

legislative framework. The first task to monitor is inputs and outputs, in particular, establishment or reform of local stakeholder groups and government line agencies, definition of procedures for these agencies to operate, and implementation of capacity building programs. Outcome and impact M&E for watershed management projects is more difficult, but can be attempted with a range of techniques (see Box 46).

M&E may need to be long term, and to incorporate scientific research.

Many of the effects may be long term, and the M&E system would need to be able to capture and follow the impacts over the years. One approach that would significantly contribute to scientific knowledge would be to set up long-term evaluation of both project areas and control areas where there was no project intervention. For sustainability, these long-term monitoring systems need to be embedded within permanent public agencies.

Externalities are important to the justification of the watershed management approach, and projects should be careful to define expected outcomes and to monitor results.

The importance of monitoring externalities in watershed management projects, both for economic justification and to underpin the incentive structure, was discussed above (the sections, *Watershed Management Externalities and Their Valuation* and *The Role of Externalities in Defining the Incentive Structure*, in Chapter 4).[41] Plainly, watershed management projects should be clear about expected externalities and design an M&E system that takes them into account where they are

41 In particular, a PES M&E approach should cover (a) monitoring changes in land use, (b) monitoring the degree to which the land use changes actually create the expected benefits downstream, and (c) evaluating the impact of the project on the welfare of participants.

Box 46: Institutional Development Monitoring and Evaluation

Watershed management projects often include one or two major components of institutional development: (a) establishment of local natural resources user groups and (b) establishment or reform of government line agencies for natural resources management.

M&E of **local user groups** can assess

- whether leadership is competent and represents the interests of all.
- whether all users effectively participate in the group (attendance to general assemblies, for example, disaggregated by gender and land tenure status).
- whether the group functions in a transparent manner (up-to-date records).
- whether the group is financially sustainable (income raised compared to planned expenses).

The information can be collected through a range of techniques, from household surveys to participatory M&E.

M&E of **government line agencies** can also look at

- whether water and natural resources management laws and bylaws have been enacted.
- whether laws and bylaws are implemented by the agencies.
- whether new agencies established are functioning.
- whether quality assurance procedures are implemented.
- whether monitoring programs are implemented.
- whether communities are satisfied with the service delivered.

Data collection may rely on specific audits and self-assessment workshops, as well as on score cards.

Source: Adapted from Burton and Smith, draft 2007.

identified as essential project objectives. Monitoring of externalities can be challenging because the cause of a certain effect downstream must be distinguished between management practices upstream or other factors. For example, Richards and Grabow (2003) find that a change in sediment load would need to be of at least 7–9 percent to be detected as statistically significant against a background of short-term fluctuations that result from weather variations (reported in Pagiola and Platais 2006).

Modeling is increasingly being used to understand watershed properties, functions, and management impacts, in particular, to study phenomena at the watershed-wide scale when comprehensive monitoring of multiple small-scale watersheds would be impractical. There has been a long history of research for development of models for water and sediment transport from the small scale to the watershed scale. Tremendous advances in computing capacities and modeling software, coupled with increased data availability from remote sensing, now offer opportunities for better understanding watershed properties, functions, and management impacts at scales ranging from 10,000 km^2 or less up to large-scale basins.[42]

42 For example, the Variable Infiltration Capacity Macroscale Hydrologic Model from the University of Washington, used in the Zambezi river basin, *http://www.hydro.washington.edu/Lettenmaier/Models/VIC/VIChome.html.*
Another example is EXCLAIM (Exploratory Climate Land Assessment and Impact Management) from the University of Newcastle upon Tyne in the United Kingdom, *http://www.needs.ncl.ac.uk/exclaim/*

Models can be used to estimate the extent and severity of a problem, such as erosion, and can help target areas of greatest risk, for example, areas that get most eroded.[43] Thus, they are useful to monitor some outcomes of project implementation (see Box 47 on sedimentation). They are also critical to overcoming data limitations, either because historical data are not available (satellite images can now provide a time series of past data), or because the watershed of concern is too vast to allow for site-specific comprehensive monitoring of water parameters (see Box 48). Models can also be used to extrapolate from current conditions to potential future directions, and so help in selecting desired management options.

The use of remote sensing and modeling should in all cases be used in combination with site-specific data collection, since data are necessary to calibrate and validate the model. Over the course of a project, the predictions of the model can also be compared to actual monitoring data to confirm that the project is on track or to identify that something is amiss. Used in combination with remote sensing information, modeling can help study and analyze a range of watershed processes at different spatial scales in a cost-effective and time-effective way.

Box 47: Assessing Erosion Rates and the Impact of Interventions with Modeling

Erosion from rural areas is often estimated using the Universal Soil Loss Equation or one of its modifications (Wischmeier and Smith 1978). The equation includes factors for rainfall erosivity (the susceptibility of a surface to be eroded), soil erodibility, slope length and steepness, and land cover and management. The equation is designed to predict long-term average rates of soil losses from fields and other land uses.

The rate of soil loss is not, however, the same as the yield of eroded sediment, since a substantial amount of the eroded soil may be trapped or redeposited before reaching a water body. Therefore, in watershed models, the equation is usually coupled with an estimate of fraction of sediment delivery ("delivery ratio").

This equation can be used to estimate changes in sedimentation rates resulting from changes in land use and land cover induced by the project.

Source: Environmental Protection Agency 2002.

43 Currently, the so-called physics-based, distributed models are becoming very useful. They are based on solving well-established hydrological "laws" (for example, Darcy's, Chezy's, and Penman's) while maintaining mass balance of water (and energy), and they have model structures that allow measurements of distributed terrain characteristics to be utilized. Such distributed models can account for topographic and vegetation effects on a pixel-by-pixel basis, with a typical resolution of 30–150 m.

Box 48: Dynamic Distributed Modeling for the Zambezi River Basin

A dynamic framework of the Zambezi river basin was used for the Market Led Smallholder Development Project in Mozambique in 2006. The aim was to establish the baseline for the environmental component of the project on land cover and land use, ecosystems services, and hydrological services, and to help identify areas for targeted interventions. Remote sensing provided information on land cover and land use. Vegetative biodiversity was evaluated along ecological and land use intensity gradients in Mozambique.

The hydrological properties of the Zambezi river and the five districts were characterized through a macroscale hydrologic model that solves for water and energy balances—the Variable Infiltration Capacity model. Components of the model include a 90 m digital elevation model, soil maps, LANDSAT-based vegetation cover, and vegetative biodiversity distributions. Because climate data for the region is very sparse, a daily reanalysis product from the European Center for Medium Range Weather Forecast was used to derive daily and monthly time series of the climate variables at specific grid cells and annual and seasonal climatology. The Variable Infiltration Capacity model and components were assembled by a multidisciplinary team on Mozambican and international scientists in a six-week period (including three weeks of field data collection), and the model is now being calibrated with additional data from local sources.

Source: Personal communication from Erick Fernandes.

CHAPTER 5:
ENVIRONMENT, WATER, AND CLIMATE CHANGE IN WATERSHED MANAGEMENT

Previous chapters have reviewed the development and performance of watershed management approaches from the *human and economic perspectives*. This chapter will review performance from the *environmental and natural resource conservation perspective*. The chapter begins with an assessment of the performance of watershed management as an environmental management tool. The chapter then reviews the effects of watershed management approaches on the water cycle, and concludes by considering how watershed management may contribute to tackling the impacts of climate change.

Dealing with the Environment through Watershed Management

Watersheds are complex systems where water, soil, geology, flora, fauna, and human land use practices interact. Hence, watershed degradation has environmental and socioeconomic effects far beyond the more obvious on-site and downstream impacts. For the same reasons, watershed management interventions may bring local, regional, and global environmental benefits. However, watershed management programs have tended to neglect environmental impacts beyond immediate land and water impacts, although some projects did target broader environmental objectives, too.

An integrated approach to natural resource management at the watershed level would ideally address the complex system dynamics in watersheds, and would achieve global environmental benefits where feasible. Environmental impacts both on-site and downstream could be understood, for example, through mechanisms such as (participatory) Environmental Impact Assessments (EIAs) or through a dynamic model and, wherever possible, least-cost adjustments to project design should be made to target environmental objectives and to monitor results.

Watersheds are complex systems where water, forests, wildlife, cultivation, and other human practices interact.

Forests, farming systems, water, human communities, and wildlife form part of highly complex interconnected systems in watersheds. Watersheds can also be repositories of global environmental benefits, such as biodiversity and carbon sequestration. Moreover, upper watersheds are linked, through water flows, to downstream land and coastal areas far from the steep terrains where water flows are generated.

Hence, watershed degradation has environmental and socioeconomic effects far beyond the more obvious on-site (upstream) and downstream impacts…

Because of the complex interactions within a watershed, degradation of land and water resources can have far-reaching and unwanted impacts on the environment beyond the impacts on soil and water resources and the related economic activities discussed in Chapter 4. These impacts on the broader environment may include, for example, declining biodiversity, dwindling environmental flows, or deterioration of a far-off marine environment. These environmental impacts may also have a direct or indirect cost for different sectors of the economy, including tourism (contaminated water, algae booms, destruction of coral reefs near the coast, and ecotourism) and alternative sources of livelihood for upland communities (services generated by biodiversity).

…and for the same reasons, watershed management interventions may bring local, regional, and global environmental benefits.

Watershed management programs may, for example, include conservation of existing natural areas, regeneration of native vegetation, and replanting indigenous species; creating ecological corridors for wildlife; establishing buffers for biodiversity; or choosing trees with a good carbon sequestration potential. These programs may bring local, regional, and global benefits. However, there may be tradeoffs. For example, planting trees may be a global good, but trees may change the local water balance.

Results of the Project Review

Projects have tended until recently to focus on on-site, productivity objectives, although some did target broader environmental objectives.

As discussed above (in the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4), conservation objectives in the projects reviewed were typically linked to on-site soil and water conservation and—in some cases—to direct downstream impacts, such as sedimentation. Interactions between different ecosystems (forests and agriculture, for example) were taken into account in only some projects. One case was the Mali project where forestry interventions were part of the integrated natural resources management approach addressing agriculture, forestry, biodiversity protection, and livestock production systems. The aim was to restore ecological stability at the landscape level through sustainable land management.

However, a number of projects have included environmental objectives other than land conservation or rehabilitation. This was generally done through the addition of a Global Environment Facility (GEF) component.[44] About one project in six in the larger project sample included a GEF-financed component.[45] These GEF components had different purposes, for example, targeting environment-friendly agricultural practices, such as organic farming, integrated pest management, and nutrient reduction (Anatolia Watershed Rehabilitation Project), or protecting globally important ecosystems (see Box 49).

Box 49: Mainstreaming Biodiversity Conservation with Productivity Enhancing Investments

The valleys of Tajikistan are rich in basic genetic material for important food and fodder crops, such as wheat, grasses, and fruit and nut trees. The Community Agriculture and Watershed Management Project combines local production improvement with global environmental objectives, protecting globally significant mountain ecosystems by mainstreaming sustainable land use and biodiversity conservation within farming systems and rural development programs.

M&E of the biodiversity component comprises a baseline assessment and follow-up assessments in years 4 and 6, using a rapid survey protocol to track flora, fauna, soil nutrients, soil texture, carbon, and land use production potential.

Source: World Bank 2004b (Tajikistan Community Agriculture and Watershed Management Project PAD).

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44 The GEF finances projects or project components to improve the global environment or reduce risks to it in six areas: loss of biodiversity, climate change, degradation of international waters, ozone depletion, land degradation, and persistent organic pollutants.

45 Eight projects out of a total of 53 (including both the 23 “dedicated” and the 29 “nondedicated” watershed management projects).

Although these approaches are promising, early evidence is that the challenge of reconciling livelihoods and environmental objectives has not been fully met.

A recent review of the portfolio of GEF-financed projects (GEF Secretariat 2006) concluded that "it is unfortunate that implicit in most projects was the notion that inclusion of the GEF component would result in win-win gains in *both* development and global environmental goods. Programs, while rightfully desirous of such win-win gains, need to assess carefully the more likely need to deal with trade-off outcomes." Another weakness was found with respect to M&E, since insufficient detail was generally provided on how biodiversity benefits will be measured. However, the Tajikistan example described in Box 49 did make detailed and practical arrangements for M&E of the biodiversity component.

Recommendations

An integrated approach to natural resource management at the watershed level would ideally address the complex system dynamics in watersheds, and achieve global environmental benefits where feasible.

Plainly there are tradeoffs to be made between a holistic and fully integrated "ecosystem management" approach and a pragmatic and less costly watershed management program that matches the livelihood improvement and downstream conservation objectives and the limited institutional capacity of developing countries. The optimum would be to site programs within the framework of an overall long-term watershed plan, which includes integrated natural resource management and provides for appropriate M&E during implementation.[46] This might be done by means of approaches like Strategic Environmental Assessments (SEAs), which could help build in broader environmental concerns, such as biodiversity.

Environmental impacts both on-site and downstream could be understood, for example, through mechanisms such as (participatory) EIAs or through dynamic modeling.

If a full watershed management plan is not feasible, there should be, as a minimum, a sound understanding of linkages and likely impacts on the environment, within and beyond the project area. The project team should support efforts to study watershed properties and functions and list likely impacts. The analysis should be participatory, since including stakeholders in such an analysis is fundamental to understanding how the system works, and what could happen after the intervention. Involving stakeholders downstream is at least as important as involving stakeholders within the project area. A participatory Environmental Impact Assessment (EIA) could be carried out for a specific watershed management program or project. A dynamic model could be used also to understand phenomena and identify likely impacts (see the section, *Monitoring and Evaluation*, in Chapter 4).

Wherever possible, least-cost adjustments to project design should be made to achieve environmental objectives and to monitor them.

Achieving both local and global environmental objectives with a watershed management program could be done in many cases with minimum adjustments to the project design. Many interventions could be factored in at little or no cost (see Box 50). Neither does the inclusion of environmental objectives necessarily create complex M&E requirements (see the section, *Monitoring and Evaluation*, in Chapter 4). Certainly, M&E of biodiversity benefits has in the past been weak, but rapid, low-cost approaches exist. For example, some biodiversity indexes are based on the

46 For discussion of the need for an overall watershed plan and its relation to upstream watershed management programs, see the section, *The Combination of Natural Resource Conservation, Intensified Natural Resource Use, and Livelihoods Objectives*, in Chapter 2.

correlation between land cover and variety and biodiversity, and cost-effective rapid appraisal methods have been developed (see Box 49).[47] The analysis will need to propose indicators for monitoring of both on-site and downstream impacts.

Box 50: Watershed Management's Contribution to Biodiversity Preservation

Vegetation in watersheds can increase the biodiversity of flora and fauna and provide habitat for wildlife. Tree buffers planted or conserved under watershed management programs help regulate light and temperatures, allowing wildlife access to food and water and creating a wide variety of habitats—all contributing to ecological diversity. Buffers planted with a variety of species further increase the benefits to wildlife, and those containing woody vegetation are likely to exhibit greater species richness than grassy buffers. In addition to improving the ecological conditions for terrestrial species, riparian buffers, particularly those containing trees, can also contribute to the health of aquatic species by cooling stream waters, providing food and habitat, and increasing the dissolved oxygen in water. Conservation buffers can also provide corridors that connect wildlife habitats and allow safe movement between fragmented patches of natural areas.

Source: Lovell and Sullivan 2006.

Considering the Effects on the Water Cycle

The interactions of watershed management with the water cycle are of crucial importance. However, watershed management so far has focused more on land management than on the water cycle. Hydrology and water management have been neglected until recently, so that water outcomes may be unknown—or even negative in some cases. In addition, scientific findings and recommendations exploring the role of some watershed management measures in improving the hydrological cycle have been little applied. The impacts of watershed management on basin hydrology need to be integrated into planning, and monitored along with other externalities. Modern tools, such as modeling and remote sensing, can help understand and study these critical phenomena.

In large or complex hydrological systems, an integrated approach all along the watershed may be needed, with institutions for basinwide management, including integrated water resource management (IWRM). Hydrological objectives should be clearly stated and choice of technology adapted to those objectives. In addition, long-term scientific research is needed to establish the hydrological impacts of some practices and technologies, particularly larger-scale forestation under varying climatic, soils and geologic conditions.

As discussed in the section, *Watersheds and Their Degradation*, in Chapter 1, watersheds are the basic unit of water supply, and every action on water upstream will have consequences downstream—on the quantity, quality, and periodicity of water flows available to agriculture, domestic use, industry, transportation, and the environment, including ecosystems and the estuarine and marine environment and coral reefs. A principal rationale of watershed management approaches has been the protection and improvement of water flows to downstream areas (see the section, *Watershed Management: Drivers and Approaches*, in Chapter 1). The present section looks at how well watershed management has performed in setting and meeting hydrological objectives.

47 See the World Bank-GEF project on *Management of Ecosystems through Integrated Silvopastoral Systems.*

The interactions of watershed management with the water cycle are important, and the impact of watershed management measures can have both positive and negative effects on downstream water availability.

The impact of watershed management practices on water flows can be an important externality (see the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4), and in fact many watershed management programs have proposed objectives for improving downstream hydrology. However, few programs have set quantified targets or have been able to demonstrate impacts on the water cycle. Turton and others (1998) observed that approaches to watershed development in India had in fact concentrated on land-based activities and have paid little explicit attention to water development or the water cycle.

In some cases, this neglect of the water cycle and of the larger-scale hydrological dynamics has proved to be a problem. Broad assumptions about interactions within the watershed have turned out to be wrong and have resulted in negative consequences for some parts of the watershed. For example, in Himachal Pradesh and Madhya Pradesh in India, soil and water conservation efforts and intensified water use in upland agriculture reduced both surface runoff and groundwater infiltration.[48] Especially in semiarid areas, increased or less wasteful *in situ* upstream water use may reduce total surface or groundwater availability downstream (Calder 1998; Hayward 2005).

Improvement of water quality may also result from watershed management programs.

Watershed management can help improve water quality by reducing sedimentation and pollution. For example, tree planting programs can protect water supplies by removing fertilizers and pesticides from field runoff (see Box 51, and also Box 37 above).

Box 51: The Effect of Tree Buffers in Watershed Management on Pollution Downstream

Many studies have demonstrated the effectiveness of vegetative buffers in reducing the concentration of nitrates, phosphorous, and pesticides from water running off cultivated fields. Concentrations of nitrogen trapped and assimilated by buffers or wetlands can be reduced by up to 94 percent before entering a stream. Phosphorus runoff can be reduced by 25–95 percent. The ability of buffers to retain pesticides is variable because each pesticide has unique mobility and soil-binding properties, but they can be especially effective when pesticides are tightly bound to the soil.

Source: Lovell and Sullivan 2006.

Results of the Project Review

Projects paid most attention to land management—and virtually none to the water cycle—until recently.

Although watershed management refers in the first instance to water management, the watershed management projects reviewed were in fact primarily land management projects. Interventions in the projects reviewed were targeted to manage land, and were simply assumed to provide benefits to the water cycle. Until recently, little or no attention was paid to the water cycle per se, and the real impact on water flows or the dynamics of watershed hydrology remained unknown.

48 See also the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4 above for a similar result in Karnataka and Andhra Pradesh.

None of the completed projects reviewed measured whether the catchment water flow had actually changed as a result of project interventions.

Under the Turkey Eastern Anatolia Project, extensive afforestation was carried out in dry regions, yet no program was conducted to assess the impact on water flow. Given the water uptake and evapotranspiration rate of the newly growing vegetation, it could be that project interventions have had negative impacts on downstream water availability. Theoretically irrigation capacities or livelihoods could have been affected. However, there is nothing in the project documentation that reports the facts of the case one way or the other (see Box 52). Yet newer projects, such as the Karnataka Project in India or Turkey Anatolia Project, have begun tackling this challenge (see the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4).

Recommendations

Box 52: Lack of Knowledge on the Water Resource Outcomes of an Otherwise Successful Project

The area of the Turkey Eastern Anatolia Project receives only 350–600 mm rain per year. The project invested heavily in soil and moisture-conserving techniques, promoted small-scale irrigation investments to improve water availability and efficiency (such as concrete ponds and lined canals), and established nearly 100,000 ha of forests. The Project ICR reports impressive technical achievements in soil conservation efforts and afforestation of degraded hillsides and positive impacts in the short term on local flooding and (possibly) on local soil loss. However, the project did not consider possible impacts on water flows downstream of the project intervention area.

Source: Authors.

Impacts of watershed management on basin hydrology need to be integrated into planning and monitored along with other externalities. Modern tools, such as modeling and remote sensing, can help with understanding and study of these critical phenomena. As for other externalities (see the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4), the impact of watershed management on the water balance and quality needs to be understood up front, ideally as part of an integrated watershed plan, or as part of a project EIA or dynamic modeling component (see the section, *Dealing with the Environment through Watershed Management*, in Chapter 5 above). Positive and negative impacts on the water balance and quality need to be assessed, and local research may be needed to determine the contribution of watershed management measures to basin hydrology. For project design and implementation, a number of computer models are currently available to evaluate land use scenarios within a catchment and their impact on the hydrological cycle. Remote sensing data also increasingly provides measure of water parameters that was previously missing (see the section, *Monitoring and Evaluation*, in Chapter 4).

The hydrological objectives of watershed management projects should be clearly set at the design stage. Different objectives—more water overall, reduction in peak flows and localized flash floodings, improved dry-season or low flows, reduced sedimentation, and improved water quality—may need different kinds of interventions upstream. Even when the intervention involves a small area or a minor water course and local interactions are the main focus, the bigger picture needs to be borne in mind. Hydrological monitoring may in most cases be required, and the M&E system needs to be capable of picking up negative impacts promptly (see the section, *Monitoring and Evaluation*, in Chapter 4).

Particularly in large and complex watersheds, an integrated approach may be needed, which would be facilitated by basinwide institutions and IWRM, and informed by scientific research on watershed dynamics.

Especially when the intervention involves a big area and a complex hydrological system, a good understanding of the complexity of the system through research and modeling can help improve the contribution of watershed management programs. Otherwise, the integrated perspective is lost, and interventions may be less useful or even harmful. An integrated watershed—waterways—estuarine approach may be needed in some cases, taking into consideration all natural and anthropogenic impacts on the water resource. For example, such an approach may be needed to tackle problems of poor river and coastal water quality. Water pollution may be not only caused by upstream agricultural practices and other land uses in the watershed, but also by other sources of pollution, such as industrial waste or untreated urban discharges. Similarly, sedimentation may not depend on agricultural practices only. Other sources, such as urbanization in the uplands, might play a role. Ideally institutions should be in place for integrated water resources management (IWRM) and basin management.

Choice of technology has to be adapted to the hydrological objectives. Here further research and M&E are needed, since the performance of some commonly used interventions, particularly forestation, has been questioned.

Once hydrological objectives are determined, the question is, what is the most cost-effective combination of technologies to achieve those objectives? For example, it is very important to select the right afforestation or reforestation approach, depending on the program objectives (Box 53). Each species and management system is very different in its hydrological impacts (including the impact on runoff and drought tolerance) and in relation to soil and water conservation, biodiversity, microclimate, and socioeconomic implications (in case of sustainable harvesting).

Box 53: Hydrological and Soil Conservation Impacts of Tree Species Selection in Watershed Management

Different tree species and forestry management practices have different hydrological and soil conservation impacts. Hydrological effects can be summarized by the "sponge," the "filtration," and the "pump" theories. For example, many eucalyptus species used for afforestation may "pump" excessive groundwater, since they cannot adjust their water intake to the temperature by opening or closing their stomata. Increased transpiration from the leaf surface results in an uptake of water of sometimes more than 40 liters per tree per day.

Some species may also change soil structure and chemical composition, as well as the soil microflora and fauna. Negative effects are known from teak (*Tectona grandis*) trees and also some eucalyptus species. Positive effects arise from planting nitrogen-fixing trees (legumes), often used in agroforestry systems in order to regenerate depleted soils and to improve plant productivity.

Tree density and the development or maintenance of understory and groundcover affect soil conservation outcomes, which are greatest with intact tree canopies and well-developed understory vegetation. Agroforestry may entail land use practices with negative impacts on soil conservation, such as grazing or road construction for access to agricultural production areas. However, on balance, the presence of trees in agroforestry systems will generally provide better outcomes for soil conservation than pure agriculture.

Source: Personal communication from Klas Sander.

Tradeoffs may be needed, since interventions may not be available that meet both upstream and downstream needs or that satisfy both conservation and livelihoods imperatives. One emerging challenge stems from recent scientific findings on hydrology, land cover changes, and land management that have cast some doubt on certain land uses typically adopted in watershed management projects. A particular case is afforestation, which is expected to increase water flows and to reduce flood incidence (see the section, *Watershed Management Externalities and Their Valuation*, in Chapter 4 and Box 54).[49]

The messages are evident. Enhanced research and M&E are essential to establish the performance of the various interventions; choices have to be adapted to objectives, with tradeoffs clearly evaluated; and scientific research needs to continue into the long term to establish an empirical basis for future watershed management interventions.

Box 54: Land Cover, Land Management, and Hydrology: Certainties and Uncertainties

The view that reforestation and afforestation programs are the best way to improve water resources is deeply ingrained in the collective thinking and has served worldwide as justification for many reforestation programs. In his book, Blue Revolution, Calder (2005) tests central “mother statements” in relation to forests, productivity, and hydrology, and assesses them according to the latest knowledge:

1. Forests increase rainfall.
2. Forests increase runoff.
3. Forests regulate flows.
4. Forests reduce erosion.
5. Forests reduce floods.
6. Forests “sterilize” water supplies and improve water quality.
7. Agroforestry systems increase productivity.

The questions “do forests increase runoff?” and “do forests regulate flows and reduce floods?” are of special interest to watershed management practitioners, since the assumptions are often made in project rationales that forests provide these services. Calder found that evaporation may be higher from trees than from grassland, but that comparative rates of infiltration and runoff depend more on land management practices than on the vegetation type per se. Nevertheless, the results from most catchment experiments indicate reduced runoff from forested areas compared with shorter vegetation, although these effects are often site-specific.

Regarding the relation between forests and floods, the interception of rainfall by forests and higher infiltration capacity under natural forests can reduce surface water runoff and localized flash floodings during low return period storms. These effects can expected to be significant for small storms, but there is little scientific evidence for larger storm events. Forest management on the other hand may contribute to floods, for example where drainage lines are created through road construction, or soil is compacted during logging (Calder 2005). As observed by Kaimowitz (2004), with large storms, land use management interventions may have little impact. Determining factors are more likely to be geology and topography.

Sources: Van Noordwijk, Richey, and Thomas 2003; Bonell and Bruijnzeel 2004; Bruijnzeel 2004; Calder 2005; Hayward 2005; FAO and CIFOR 2005.

49 Although some aspects are clearer (for example, consumptive use and interception of rainfall by different species, and total annual streamflows), other factors are still in doubt due to what will generally be site- and situation-specific factors (for example, dry-season or low-flow impacts, long-term effects on annual streamflow where revegetation efforts result in mature vegetative communities). What seems to be fairly certain is that the short-term effect of tree planting on total annual stream flows is likely to be negative, contrary to the conventional wisdom.

Watershed Management and the Challenge of Climate Change

Climate change is expected to bring both long-term structural changes to the water cycle and increased variability and unpredictability, and to have impacts on agricultural productivity. Greater frequency of high-intensity rainfall, floods, landslides, and wildfires is also likely to increase the vulnerability of communities in many watersheds.

Although structural changes and increased variability and unpredictability resulting from climate change will have economic and social costs, an integrated set of management responses, within a broad integrated basin planning framework and including watershed management, can mitigate those costs. Watershed management can also help implement a risk management approach for disaster preparedness.

Recently, watershed management projects have begun to factor in climate change, and some "dedicated climate change adaptation projects" have been designed to deal with high-risk watersheds. Climate change risk analysis and adaptation options should now be factored in to all watershed management projects.

Expected Impacts of Climate Change on Watersheds

In addition to the impacts on agricultural productivity, climate change is expected to bring both long-term structural changes to the water cycle and increased variability and unpredictability. It would also increase the vulnerability of communities in many watersheds through higher-intensity rainfall and greater frequency of floods, landslides, and wildfires.

The impact of climate change on agricultural productivity is likely to stem not only from changes in water availability and quality, but also from temperature increases, which will cause ecosystems to shift over space and will hence change the suitability of crops to the different latitudes. It is expected that mid- to high-latitude countries could well benefit from the warming, while countries in the subtropical and tropical regions (low latitude) may experience deleterious impacts, and some marginal areas may go out of production (Mendelsohn, Dinar, and Williams 2006). In the uplands, runoff will increase and will exacerbate soil losses and land slips and slides. Increased downstream sedimentation is likely to result. Moreover, climate variability in the form of typhoons, floods, and droughts is expected to cause production losses (IPCC 2001). The rural poor are the most vulnerable, since they bear the brunt of natural disasters and declining local agricultural productivity.

In addition, climate change is expected to bring an increase in stream flow in high latitudes and in Southeast Asia and a decrease in stream flow in central Asia, the area around the Mediterranean, and southern Africa. In other parts of the world, the direction of change is uncertain (IPCC 2001). Among scientists there is also "high confidence" that in many areas where snowfall is currently an important component of the water balance, peak stream flow will move from spring to winter and that water quality generally will be degraded by higher water temperatures. Flood magnitude and frequency are likely to increase in most regions, and low flows are likely to decrease in many regions.

Furthermore, as a consequence of changing rainfall patterns, floods, landslides, and wildfires are expected to increase. Drought years already bring an increase in fire outbreaks (McKenzie and others 2004) and increased forest fires are likely to result in a change in vegetation structure—in unmanaged forested areas—that in turn exacerbates the fire risk (IPCC 2001).

Results of the Project Review

Recently projects have begun to factor in climate change…

As the projects reviewed were largely designed in the early 1990s, there was only scant discussion of risks imposed by climate change in most of the project documentation. Nonetheless, some more recent projects, although not specifically addressing the problem, did factor in adaptation to possible impacts. For example, the Irrigation and Watershed Management Project in Madagascar, although not setting an objective related to climate change, adopted technical standards that will allow works to resist future cyclone damage. In addition, the watershed management approach in the project includes the revegetation of barren hillsides and promotion of farming practices to increase the soil organic matter content, which will provide a buffering capacity to resist shocks and fluctuations.

…and some "dedicated climate change adaptation projects" have been designed to deal with high-risk watersheds.

A few recent projects have specifically dealt with climate change in watersheds at particularly high risk (see Box 55). The focus of these "dedicated climate change projects" has been on vulnerability and adaptation to climate change only. They have lacked the broader characteristics of the watershed management approach.

Box 55: Climate Change Adaptation Measures in Highland Andean Watersheds

Highland Andean ecosystems are very vulnerable to impacts from the rapid glacial retreat in the Andes, which is already affecting water cycles and watersheds. Changes observed include loss of water regulation, increased incidence of flash fires, and changes in ecosystem composition and resilience. There is a considerable risk of recurring "glacial overflows" (floods caused by glaciers melting) threatening the large downstream populations and infrastructure.

Many of the valleys in the Central Andes have low rainfall and largely depend on the regulated flows from glaciers and snowcaps for water supply. Destruction of these water regulation systems will contribute to a gradual process of desertification with damaging implications to ecosystems and the services they provide.

Urgent actions are thus required to document, with a higher level of certainty, the range of potential future climate scenarios for the tropical Andes, the anticipated impacts of these climate scenarios on water resources (especially those derived from glacier and snow melt), and on hydropower and rural resource-based economies, and to formulate adaptation policies and measures, as well as development projects within which adaptation can be mainstreamed.

A pilot project is being considered to provide a sound scientific basis for assessing the effectiveness of different policy and management alternatives and then implement the best options. This will be achieved through (a) capacity building and improvements to the knowledge base (documenting trends and projecting impacts); (b) identifying and assessing measures and policy options to adapt to the effects of climate change, as well as development projects, within which adaptation can be mainstreamed; and (c) implementing regional and strategic adaptation pilots to address key climate impacts. Priority will be given to pilots in vulnerable highland and coastal watersheds, other mountainous ecosystems, cross-border watersheds, and regions where the impacts on global commons and associated local impacts are the highest.

Source: World Bank 2006a (Adaptation to the Impact of Rapid Glacier Retreat in the Tropical Andes Project, Project Information Document).

Recommendations

Although structural changes and increased variability and unpredictability will have economic and social costs, institutional responses can mitigate these costs.

The impact of climate change on watersheds depends not only on changes in the volume, timing, and quality of stream flow and recharge or on related rates of erosion and sedimentation, but also on management responses. Although all watersheds and their embedded hydrological systems may experience climate change impacts, institutional responses can mitigate these costs. It is unmanaged systems that are likely to be more vulnerable since, by definition, these systems have no management structures in place to buffer the effects of hydrological variability (IPCC 2001).

Watershed management approaches can also help implement a risk management approach for disaster preparedness.

With climate change, it is likely that the incidence of natural disasters will increase. Among the main policy lessons emerging from experience with disasters in recent years is the importance of integrating disaster prevention and natural disaster risk management into development plans.

Given the likely high incidence of these disasters in the fragile uplands and the causal connection between natural resource changes in the uplands and downstream disasters, such as flooding, preparing for natural hazards should be an important component of watershed management approaches. These preparations need not necessarily be highly elaborate. They may simply address current risks. For example, when landslides and floods have already been experienced in a watershed, plans and investments can be prepared that reduce the causes of the risk and set up institutional responses to future disasters of the same nature, such as flood emergency plans. Planning should ensure that key infrastructure, human settlements, and livestock are not placed along the most likely paths to be followed by floods or landslides.

An integrated set of management responses can help natural and human systems adapt to climate change, and watershed management can form an important component of these responses.

Watershed management can be per se a very effective set of adaptation measures, provided that these measures form part of an integrated approach throughout the watershed. The ideal is an integrated institutional response based on basinwide planning (see the sections, *Scales of Intervention* in Chapter 2, *Public Institutions* in Chapter 3, and *Considering the Effects on the Water Cycle* in Chapter 5 above) that incorporates both integrated land and water resource management approaches and other components of spatial planning, such as planning for infrastructure and urban development. Within this overall planning framework, watershed management approaches can help provide the institutional and investment responses needed for the upstream areas as part of a coherent response to climate change.

Climate change risk analysis and adaptation options should now be factored in to all watershed management projects.

Plainly, watershed management approaches have a major role to play in responding to climate change. In specific, very high-risk environments (such as the Andean situation, see Box 55), dedicated "climate change adaptation projects" may be needed, which would incorporate watershed management approaches. In less dramatic situations, climate change risks in watersheds need to be analyzed for all watershed management projects as a matter of routine. Project preparation should soon be able to use *rapid climate change risk appraisal tools* currently being designed to provide a risk assessment of projects. These tools are adapted for the sector and the geographic area where projects are located (World Bank 2006b). If necessary, suitable adaptation measures should be included in the project. These measures can generally be easily incorporated, and should not in most cases lead to higher complexity or extra financing needs. In fact, they are likely to be "no regret" investments, that is, measures that have positive benefits quite apart from their benefit of increasing resilience to climate change and variability (see Table 3).

Table 3: Possible Measures to Adapt to Climate Change in Watersheds

Adaptation Option	***Purpose (both general and climate resilient)***
Productive Systems	
Crop diversification	Promoting farm-level risk management, increasing productivity, defending against pest/disease, and reducing vulnerability to high temperatures and water shortages.
Land and water conservation practices	Conserving soil moisture, preventing erosion, increasing production per unit of evapotranspiration, reducing runoff, and assuring less variability in production during drought periods.
Improvement of agricultural water management	Increasing water efficiency and productivity, improving irrigation water distribution, and withstanding rainwater shortages.
Modernization of farm operations and development of extension services	Improving means, awareness, and knowledge of farmers to increase productivity, save water, and cope with extreme weather events.
Improving forecasting mechanisms	Assisting with farmers' ability to cope with droughts, floods, and so forth.
Water Resources	
Sound planning and investments in additional infrastructure	Investing in water regulation and conservation through single and multipurpose dams to regulate peak flows and provide water in drought periods. Investing in interbasin transfers to improve water use efficiency and to increase equity in water distribution.
Improved resource use	More efficient management of existing infrastructure facilities. Demand-side management and water-use efficiency.
Infrastructure	
Review of hydrological standards and design criteria for hydraulic structures	Updating technical construction standards for reservoirs, bridges, roads, and so forth—to account for higher climate variability and increase climate resiliency.
Extreme Weather Events	
Mainstream natural disaster risk management (including emergency plans)	Vegetative stabilization, for example, strategic location of tree buffers in landslide-prone areas. For nonextreme events (that is, lower return period events) the establishment and/or conservation of vegetative cover (especially in combination with appropriate in-channel infrastructure) can reduce peak flows and thus localized flash flooding.

Source: Authors, and Kurukulasuriya and Rosenthal 2003.

CHAPTER 6:
CONCLUSIONS AND RECOMMENDATIONS

Many of the findings of this report represent a corpus of best-practice lessons.

The watershed management approaches implemented during the last 15 years have been generally successful in achieving goals of upland soil and water conservation and of intensification of natural resource use to increase the incomes of the upland population in a sustainable way. Although there are significant variations in practice and performance, and although adaptation and flexibility are hallmarks of all good projects, some of the principal factors of success can be listed. Characteristics of best-practice approaches have been the following:

Starting from the building block of the micro-watershed: Watershed management programs undertaken at the micro-watershed level clearly allow the needs and concerns of all stakeholders to be taken into account and an integrated package of land, water, and infrastructure to be developed that is responsive to needs.

Targeting actions to both livelihoods and natural resource conservation objectives: The new generation of projects has demonstrated that, although difficult, it is nonetheless often feasible to target both improved livelihoods and conservation objectives, and a considerable body of best-practice has demonstrated ways to identify both stakeholder needs and appropriate technology.

Adopting participatory and decentralized approaches: Although effective participation imposes demanding requirements, participatory approaches and the use of community watershed management plans have often been effective in empowering communities and in gaining ownership of watershed management programs.

Demand-driven research and dissemination: Although many applied research programs have been lackluster, successful programs have been characterized by relative simplicity and demand drive, by participatory research and learning, and by careful up-front organization and incentives to ensure institutional cooperation.

Mainstreaming integrated watershed management within public institutions: Institutional arrangements for successful watershed management have been characterized by multidisciplinary and multiagency collaboration across ministries, by decentralization, and by institutional development at all levels. For sustainability, it has proved effective when watershed management programs and staff are located within permanent institutions.

In a number of areas, however, the findings of the report have been less straightforward or have been negative.

Other findings in the report suggest areas where changes may improve future watershed management approaches or where further analytic and empirical study is needed to develop good approaches. These areas, discussed in the paragraphs below, are as follows:

1. *Poverty reduction:* Watershed management programs have not always been demonstrably propoor, and there has been little systematic approach to poverty reduction in watershed management.
2. *Upstream and downstream interrelations:* Watershed management programs have focused on microlevel activities and institutions upstream and have produced little or no evidence of impacts on downstream areas.
3. *Incentives for sustainability*: Incentive structures for resource conservation often have not provided for sustainable watershed management after the end of a project, and land tenure and common pool resource issues have been largely neglected.
4. *Watershed management versus other approaches*: Criteria are needed on when a watershed management approach is to be applied.

Poverty Reduction and Watershed Management

Watershed management programs and participatory processes in general may not always be propoor.

Many of the programs assessed did mention poverty reduction among their objectives, but there was little or no accountability against that objective. In fact, the reasoning for mentioning poverty reduction objectives and achievements seems to have been little more than that the upland areas where watershed management programs operate are by their nature characteristically poor. Few projects quantified the overall improvement in livelihoods in the project area, none was targeted specifically at poor segments within the project area, and none was able to demonstrate any "progressive" distribution of project benefits in favor of poorer segments. As with all participatory approaches, there is little evidence that communal decision-making mechanisms employed were inherently propoor, and the opposite may have been true.

These apparent weaknesses are not uncommon in rural development projects. However, they are of concern in the case of asset-based interventions, such as watershed management programs, where much of the project effort is directed to enhancing the value and productivity of land and water where the better-off segments have more access or ownership. In addition, there is some evidence (for example, from India) that the poor may actually be losers under watershed management programs if they depend on common resources for their livelihoods, where free access may be restricted for conservation purposes. Few projects have analyzed this tradeoff between resource conservation and poverty reduction.

An important lesson from these and similar experiences is that special efforts beyond the common application of participatory methods are needed. There is a case for developing better propoor methodologies for watershed management concerning knowledge (who are the poor and how are they affected by the programs?), institutions (what institutional mechanism can ensure that all parties benefit?), and project actions (what type of interventions are more propoor and what are the means of encouraging communities to adopt them?). Social analysis during preparation can identify poor target groups and propose mechanisms to include them in project benefits and governance. However, poverty reduction is not the sole objective of watershed management projects. The challenge is to develop mechanisms that can reach three potentially conflicting objectives: to target the needs of the poor; to adopt a participatory approach inclusive of all stakeholders; and to reach watershed management objectives.

Recommendation

Further attention to the poverty and watershed management interventions nexus is indicated, and a dialogue should be opened with other areas of practice that may be able to help develop better approaches, for example, rural and community-driven development, social fund programs, and decentralized land and water management programs, which have similar aims and target populations and which may have developed solutions that can be adapted to watershed management.

Strengthening the Focus on Upstream and Downstream Interrelations in Watershed Management

The report has identified a significant disconnect between objectives and what actually was produced in relation to downstream impacts. Downstream externalities played an important role in the justification for the projects to apply a watershed management approach, yet virtually no evidence has been produced of beneficial impacts, and there is some evidence of negative impacts.

Little evidence exists that microlevel activities and institutions upstream actually contribute to improved conditions in the wider watershed.

Watershed management programs have typically focused on on-site interventions, such as land improvement for the benefit of the local upland population. Similarly, stakeholder involvement and participation typically covered on-site needs of local farmers, and the spatial dimension was addressed through community-based planning of their territory. The institutional approach focused on the micro-watershed, with little or no cooperation across the watershed, or between upstream and downstream populations. Project success was also measured on-site, and the individual results (income increase, land area treated, yield increase) were typically summed up across the watershed area. There is little evidence from projects that the sum of all these demand-driven micro-level activities has had much impact on conditions downstream in the watershed, or even that the activities were optimal or cost-effective ways to improve conditions in the watershed.

At the level of overall programs, too, there has been little or no proof that upstream actions have had a beneficial downstream effect.

The targeting of downstream impacts at the level of project objectives was often based on assumptions that the overall improved upland management will have a beneficial outcome for the downstream location as well. In practice, M&E systems were weak and did little to measure outcomes at the larger scale. A few projects measured sedimentation, but the impact of projects on downstream parameters received little attention in reporting.

The impact of watershed management on water flow in particular received virtually no attention.

Little direct attention has been paid to the water cycle in watershed management programs, even though one of the justifications of watershed management has been improvements in basin hydrology. Watershed management interventions globally have been targeted to manage land, and the subsequent impacts were assumed to provide benefits to the water cycle. However, little or no evidence exists that this is the case. In fact, watershed management programs appear in some cases to have actually produced negative impacts on downstream hydrology.

Watershed management also has significant untapped potential to contribute to broader environmental objectives and to help in adaptation to climate change.
Hitherto, watershed management programs have focused on direct soil and water impacts, but watershed management may address broader local, regional, and global environmental benefits. Programs may also contribute to adaptation to climate change.

Recommendation

Harnessing upstream activities to management objectives at the broader watershed level is evidently a major challenge. If watershed management is to be justified by its beneficial impact on the downstream environment, institutional mechanisms are needed to integrate micro-watershed programs into higher-level objectives at the overall watershed level, and to measure and monitor outcomes and impacts. The next phase of watershed management programs will need to work toward an integrated institutional process with three complementary components:

- A *comprehensive process of watershed planning* to set out the natural resource dynamics within the whole watershed and to identify critical environmental services to be protected. The level and complexity of this planning process will vary, but new institutional arrangements and a broader range of planning tools may be required that will be adapted to the particular context. These tools may range from environmental assessments to take account of broader environmental considerations and responses to climate change, through basinwide hydrological modeling and Integrated Water Resources Management approaches, to a comprehensive basin planning framework incorporating land and water resources together with other aspects of spatial planning. Stakeholder consultations and mechanisms for participatory diagnosis need to be integrated into the process.
- A *bottom-up institutional and investment process* to negotiate between stakeholders, and to develop and measure the impact of a set of interventions that can fulfill both upstream objectives (at the local community level and also between upstream communities) and broader downstream objectives.
- A *much improved M&E methodology*, incorporating research, measurement, and monitoring to provide the scientific and economic knowledge for managing and evaluating watershed management programs and for assessing and pricing costs and benefits. New modeling and satellite imagery tools can be of great value in this.

Incentives for Sustainable Watershed Management Interventions

Incentive structures for resource conservation need to be further developed to ensure that they are sustainable.
Sustainable watershed management requires an incentive structure that continues beyond the project period and that is supported by economic instruments that assign costs and benefits according to public and private good. The design of the incentive structure requires analysis of both local level incentives (what technologies, for example, could both achieve resource conservation objectives and justify stakeholder investment and effort) and the public good characteristic of conservation activities. The cases reviewed in the report show that much work remains to be done on this aspect, which deserves increased attention in the next round of watershed management programs.

Recommendation

In conjunction with the further work recommended on identifying and valuing costs and benefits (see above), research and analysis is needed to develop a methodology for designing equitable and sustainable incentive structures. In addition, further work is suggested on innovative instruments, such as payment for environmental services (PES). Here, research is needed to understand the relationship between land use and the generation of environmental services, to develop simple technical and economic tools for measuring costs and benefits and their distribution, and to define options for low-cost and practical institutional frameworks for PES.

A framework is needed in watershed management initiatives for assessing and dealing with the policy, institutional, and program aspects of land tenure and common pool resources.
Although land tenure and common pool resources have long been identified as critical in developing a sustainable incentive and institutional framework for watershed management, remarkably little systematic attention has been paid to handling the issues.

Recommendation

Further research would help identify common issues and useful practices. The next round of watershed management projects should assess land tenure and common pool resource issues systematically in the initial diagnostic phase and develop a framework for dealing with them at the policy, institutional, and program levels.

Charting the Future of Watershed Management

Watershed management approaches are complex and costly. They should be applied where there is a clear upstream resource conservation objective and where downstream externalities related to water and soil conservation are clearly identified problems.
The recent generation of watershed management projects has been largely successful in its integrated and participatory approach to sustainable conservation and development in upstream areas, which has given some impetus to scaling up. However, the impact on larger natural resources management objectives has been disappointing. Watershed management approaches have also proved complex, both in natural resource management (dealing with the myriad interactions of land, water, and people within a complex system), and in implementation (requiring elaborate decentralized and participatory approaches, complex financial and subsidy arrangements, and organizational setups involving many different agencies). These approaches have proved viable in many situations in developing countries, but at a high cost in financial and human resources. A strong rationale is therefore needed to convince governments and financing agencies to continue support.

In some ways watershed management is at a decisive phase of its development, since the flush of interest that sprang up during the last two decades appears to have died down: World Bank lending for watershed management, for example, is well below levels of 10 years ago (Annex 4). On the positive side, projects in some countries have evolved into broader regional and national programs, watershed management has been incorporated into national policy in several countries, and local-level initiatives for natural resources management are increasing.

Discipline is required in identifying the need for a watershed management project, and alternatives should be considered. In the first instance, it is essential to understand what the main problems are to be solved in a watershed (preferably by involving all stakeholders), and then to specify the objectives to be achieved, including both on-site objectives and off-site, downstream objectives. Second, the interventions needed to achieve those objectives need to be spelled out, considering different options. In these two steps, the use of integrated planning tools discussed above would be invaluable. In a third step, alternatives have to be reviewed and the question asked, is watershed management the appropriate approach to reach the project objectives?

Watershed management approaches are likely to be the best in steeper terrain, particularly where there are problems both with upstream land and water management and with downstream impacts. In other cases, alternative rural development approaches may be more cost effective.

Watershed management approaches are optimal when demonstrated linkages exist between upland activities and basin-level environmental conditions, and where conservation measures upstream are likely to have significant impacts downstream. This may be the case, for example, in steeper terrain where soil and water interactions can be more important. On the other hand, where these interactions are not a burning issue and upstream-downstream impacts from an investment—either positive or negative—are likely to be slight, a broader rural development approach may be a more cost effective way to tackle upland problems.

Box 56 outlines a ten-step approach to developing a successful Watershed Management approach.

Box 56: Ten Steps to Watershed Management

Although every situation is different, some of the lessons recorded in this report have been used to set out a simple checklist for designing and implementing watershed management programs. The intention of the list is to illustrate possibilities rather than to provide a blueprint.

At the national level, establish a supportive policy and institutional framework.

1. Mainstream watershed management concerns and practices within relevant institutions, especially those concerned by or affecting watershed hydrology (for example, power and transport sectors, agriculture, forestry, agribusiness, and local governments).
2. Set up or strengthen institutions specifically in charge of watershed management and provide capacity building (for example, to a river basin agency, or forestry department).

At the watershed level, develop and implement watershed management plans in partnership with government agencies and local stakeholders.

3. Identify linkages between upstream land uses and practices and downstream environmental conditions, and identify key socioeconomic and environmental characteristics of upland areas.
4. Define broad criteria to target critical watersheds and subwatersheds, and interventions within these areas.
5. Adopt a sequencing and up-scaling strategy, whereby a few subwatersheds would be targeted for interventions first, and others in following years to test and refine the approach.
6. Engage communities in targeted subwatersheds and develop community watershed management plans that would include both livelihood development and conservation measures.
7. Carry out a detailed financial and economic analysis to assess the financial feasibility of the plan and the economic interest to society.
8. Implement the management plans.
9. Monitor the project to ensure that it is on track to the achieve desired livelihood and environmental objectives, and adapt plans as needed.
10. Quantify downstream positive externalities and, if necessary and feasible, value the costs that upland stakeholders should be compensated for, and develop an incentive stricture for sustainable land and water management.

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ANNEX 1.
THE PROJECTS REVIEWED

This annex contains a summary description of the watershed management projects covered by the project review, including 24 dedicated watershed management projects, 29 watershed management components of broader projects, 7 land and water management projects, and 9 “outlier” projects.

1. The Watershed Management Projects

From the Africa Region

Burkina Faso, Environmental Management Project, 1991, (US$25.5 million total project cost, US$16.5 million IDA). The project objective was to stop and reverse natural resource degradation, secure agricultural growth, restore biodiversity and manage forests and wildlife sustainably. More specifically, the activities were to implement the “*terroir*” approach, design and implement 120 community management plans, provide technical support to existing organizations, and establish national environmental and project impact monitoring systems. Watershed management was part of the “*terroir*” approach, but was not explicitly elaborated on.

Mali, Natural Resource Management Project, 1992 (US$32.2 million total, US$20.4 million IDA). The aim was to introduce a rational land use system, which would stop and reverse natural resource degradation, the greatest threat to agricultural growth. Further, local community capacity building and developing an environmental monitoring system were the more specific objectives. Watershed management was part of village-level investments in natural resources, more specifically land and water conservation that includes the improvement of water harvesting techniques, watershed correction techniques, erosion control, and revegetation of watershed areas.

Niger, Natural Resources Management Project, 1995 (US$42.7 million total, US$26.7 million IDA). The project aimed to slow down, stop, and reverse natural resource degradation to secure sustainable agricultural production and growth, alleviate poverty, and improve the living conditions of Niger’s rural communities. Specifically, the objectives were to (a) assist selected rural communities in different agro-ecological zones in designing and implementing land management plans, and strengthen their capacity; and (b) to assist the government in building up a national capacity to promote, assist, and coordinate the diverse natural resource management initiatives under way in Niger.

From the Middle East and Northern Africa Region

Tunisia, Northwest Mountainous Areas Development Project, 1993 (US$50.7 million total, US$27.5 million IBRD). The project addresses problems of rural poverty and natural resource degradation. The project would reverse soil degradation, erosion, and sedimentation of reservoirs, and increase productivity and incomes in impoverished region. By using a participatory approach, the project would strengthen farmers’ planning and implementation capacity, and improve the responsiveness of rural service agencies to farmers’ needs.

Morocco, Lakhdar Watershed Management Pilot Project, 1998 (US$5.8 million total, US$4 million IBRD). The project tests on a pilot basis participatory approaches to improve land use and natural resource management in mountainous areas, through providing technical packages to improve living conditions and incomes for the local population. This would be accomplished through the lessons learned of past watershed management experiences to develop a new, more sustainable approach to land use and natural resource management in mountainous areas. The project would invest in natural resource management, infrastructure, and institution building. From the Europe and Central Asia Region

Turkey, Eastern Anatolia Watershed Rehabilitation Project, 1993 (US$115.5 million total, US$77 million IBRD). The project aimed to restore sustainable range, forest, and farming activities in three provinces in the upper Euphrates watershed by reducing soil degradation, erosion, and sedimentation in reservoirs and increasing productivity and incomes in impoverished areas. Project components were capacity strengthening, watershed rehabilitation, income supporting activities, and applied research. Watershed management was mainstreamed within all the components.

Turkey, Anatolia Watershed Rehabilitation Project, 2004 (US$45 million total, US$20 million IBRD, US$7 million GEF). The project supports sustainable natural resource management practices in 28 micro-catchments in Anatolia and Turkey's Black Sea Region and thereby raises incomes in communities affected by resource degradation through the following: (a) encouraging local communities to plan and implement an integrated approach to sustainable natural resources management in selected micro-catchments; (b) introducing communities to more environmentally friendly farming and forestry production practices to raise land productivity, reduce pressures on marginal lands, and improve household income; (c) helping reduce nutrient discharge from agricultural sources into the Black Sea; (d) strengthening the policy formulation and regulatory capacity toward meeting European Union standards for agricultural nutrient pollution control.

'Tajikistan, Community Agriculture and Watershed Management Project, 2004 (US$15 million total, US$10.8 million IDA, US$4.5 million GEF grant). The project objective was to build the productive assets of rural communities in selected mountain watersheds in ways that sustainably increase productivity and curtail degradation of fragile lands and ecosystems. GEF Objective was to: entail protection of globally significant mountain ecosystems by mainstreaming sustainable land use and biodiversity conservation considerations within agricultural and associated rural investment decisions.

From the South Asia Region

India, Integrated Watershed Development (Plains) Project, 1990 (US$91.8 million total, US$55 million IDA, US$7 million IBRD). The project aimed to stabilize selected watersheds through land treatment, sustainable land management, and soil and moisture conservation, including a solution seeking public nonarable land. Investment in land management, technical support, and training were among the components. Watershed management was mainstreamed within all the project activities.

India, Integrated Watershed Development (Hills) Project, 1990 (US$125.6 million total, US$75 million IDA, US$13 million IBRD). The project addressed watershed degradation through soil and moisture conservation on arable and nonarable land. Introduction of horticulture and livestock improvement programs, training of staff in implementing agencies, and interactive planning with beneficiaries were among the more specific objectives. Watershed management was mainstreamed.

India, Integrated Watershed Development (Hills-II) Project, 1999 (US$193 million total, US$60 million IDA, US$75 million IBRD). The project aims to improve the productive potential of the project area in five states, using evolving watershed treatment technologies and community participatory approaches. It would significantly decrease soil erosion, increase water availability, and alleviate poverty in the contiguous areas of the Shivalik Hills in the five project states. Sustainability of project interventions would be ensured through participatory involvement of project stakeholders/beneficiaries. An associated objective is to assist the states with institutional development and consolidate progress already made in harmonizing approaches to watershed development management among various programs operating in the Shivalik Hills.

India, Karnataka Watershed Development Project, 2001 (US$128 million total, US$100 million IDA). The objective is to improve the productive potential of selected watersheds and their associated natural resource base, and strengthen community and institutional arrangements for natural resource management. The poverty focus has been ensured by selecting districts or *taluks* with a relatively high incidence of poverty, low water availability, and a preponderance of small and marginal farmers. An associated objective is to strengthen the capacity of communities in the project districts for participatory involvement in planning, implementation, social and environmental management, and maintenance of assets emanating from local level development programs, and to have the implementing department operate in a more socially inclusive manner within the framework of a convergent watershed development plan.

India, Uttaranchal Decentralized Watershed Development Project (UDWDP), 2004 (US$89 million total, US$70 million IDA). The project would improve the productive potential of natural resources and increase incomes of rural inhabitants in selected watersheds through socially inclusive, institutionally, and environmentally sustainable approaches. This should be achieved through participatory watershed management and development, the enhancement of livelihood opportunities, and institutional strengthening.

From the East Asia and Pacific Region

Indonesia, Yogyakarta Upland Area Development Project (Bangung Desa II), 1991, (US$25.2 million total, US$15.5 million IBRD). The project aimed to stabilize soils and improve agricultural development as a basis for improving incomes and living standards in upland villages. The subprograms were soil and moisture conservation, upland agricultural productivity, social and physical infrastructure (credit, markets, roads, and bridges), and improvement of managerial skills of government extension and support services. Watershed management activities were mainstreamed within the project components.

Indonesia, National Watershed Management and Conservation Project, 1993 (US$488 million total, US$56.5 million IBRD). The project objective was to improve the living standards of poor upland farmers by improving and restoring the productive potential of their resource base and to improve the environmental quality of watersheds and protect downstream watershed resources. The project was a support to the National Watershed Management program (Regreening and Reforestation), and it provided institutional strengthening and investment support. Development of the Upper Cimanuk watershed was the other specific objective.

China, Second Red Soils Area Development Project, 1994 (US$296 million total, US$150 million IDA). The project aimed to increase production and productivity on degraded red soils; benefit the environment by improving soil and water conservation, thereby reducing erosion and promoting sustainable land management in paddy, upland, and forest areas. The main features were (a) land development, including vegetative and structural soil/water conservation treatments and on-farm irrigation, rural electrification, roads, and biogas units; (b) crop establishment and forestry, including fruit tree orchards, tea, paddy rehabilitation, and fodder crops; (c) livestock and aquaculture; (d) agro-processing and marketing, including feed mills, fruit and vegetable processing and packing lines, cold storage, and tea processing; and (e) support for research, extension, and training.

China, Loess Plateau Watershed Rehabilitation Project, 1994 (US$249 million total, US$150 IDA). The first objective was to increase agricultural production and incomes on 15,600 km^2 of land in the Loess Plateau in nine tributary watersheds of the Yellow River. A secondary objective was to reduce sediment inflows to the Yellow River. Specific objectives were to (a) create sustainable crop production on high-yielding, level farmland; (b) plant the slopelands with a range of trees, shrubs, and grasses for land stabilization and the production of much-needed fuel, timber, and fodder; and (c) substantially reduce sediment runoff from slopelands and gullies in the nine watersheds.

China, Second Loess Plateau Watershed Rehabilitation Project, 1999 (US$252 million, US$50 million IDA, US$100 million IBRD). The project will support the government's development strategy for the Loess Plateau by financing integrated planning and treatment of small watersheds. The challenge here is to further develop and refine an integrated model of small watershed management to turn the existing unsustainable practices into a sustainable approach. The project will (a) create high-yielding, level farmland for sustainable production of field crops and orchards and thereby replace the areas devoted to crops on erodible slopelands; and (b) plant the slopelands with a range of trees, shrubs, and grasses for the production of fuel, timber, and fodder. This is a follow-up project to Loess I, with planned intervention on 2 million ha of land versus previously 700,000 ha.

Philippines, Laguna de Bay Institutional Strengthening and Community Participation/ LISCOP, 2003 (US$12.5 million total, US$5 million IBRD). The project assists the Laguna Lake Development Authority, Local Government Units, and other stakeholders in improving the environmental quality of the Laguna De Bay watershed. This will be achieved through (a) behavioral changes and activities undertaken by watershed users to improve the environmental quality of the lake and its watershed; and (b) improved planning, regulatory instruments and incentives, and participation in the environmental management of the Laguna de Bay watershed.

From the Latin America and the Caribbean Region

Brazil, Land Management I Project, Parana, 1989 (US$138 million total, US$63 million IBRD). The project aims to increase agricultural production and farm incomes by promoting the adoption of sustainable land management and soil and water conservation by Parana's farmers. This would improve farm profitability, halt soil loss and the silting of riverbeds and dams, reduce floods and the destruction of rural roads, and reduce pollution of water sources and depletion of natural resources. The project would also assist the Secretariat of Agriculture and Supply in improving its efficiency in the implementation and expansion of soil conservation program activities.

Brazil, Land Management II Project, Santa Catarina, 1990 (US$71.6 million total, US$33 million IBRD). The project objective is to increase agricultural production and farm incomes by promoting the adoption of sustainable land management and soil and water conservation by

Santa Catarina's farmers. This would (a) improve farm profitability through cost-effective and sustainable productivity gains and better land use; and (b) halt soil loss, the silting of river beds and dams, floods, the destruction of rural roads, pollution of water sources, and depletion of natural resources. The components were (a) adaptive research; (b) land use mapping, planning, and monitoring; (c) rural extension; (d) incentive program for land management, soil conservation, and pollution control; (e) erosion control along rural roads; (f) forestry development and natural resource protection; (g) project administration, M&E; and (h) training.

Brazil, Land Management III Project, 1997 (US$125 million total, US$55 million IBRD). The projects aims to increase and sustain agricultural production, productivity, and farm incomes and assist in the conservation of natural resources by (a) promoting the adoption of sustainable land management and soil, water, and forest conservation planned and implemented at the watershed management level and with full involvement of the farming community; (b) developing community environmental awareness and participation in environmental protection efforts; (c) increasing the extent and duration of vegetative soil cover; and (d) improving internal soil structure and drainage, thus increasing water infiltration and safely disposing of any remaining runoff. The project builds on the models of Land Management I and II.

Brazil, Natural Resources Management and Rural Poverty Alleviation Project, 1997 (US$208 million total, US$100 million IBRD). The objective is to improve the management and conservation of Rio Grande do Sul's natural resources by promoting an integrated strategy involving the adoption of sustainable land management and soil and water conservation practices, and improving the income and living conditions of rural poor communities. It would be achieved through (a) implementation of integrated natural resource management plans in watershed management; (b) support of poverty alleviation initiatives aimed at increasing incomes and access to basic services of rural poor communities; and (c) strengthening of the overall capacity of public and private institutions responsible for natural resource management and delivery. The project builds on Land Management I and II.

Peru, Sierra—Natural Resources Management and Poverty Alleviation Project, 1996 (US$93 million total, US$51 million IBRD). The project aims to help alleviate the poverty of rural Sierra people. Specific objectives are to assist the poor to (a) improve sustainable natural resource management through soil conservation measures and reforestation at the micro-catchment level; (b) increase rural production and productivity through the introduction of irrigation and improved agricultural practices; and (c) strengthen their rural organizations so that they can become autonomous and sustainable entities.

2. The Watershed Management Components of Broader Projects

2.1. Upland Development Projects

2.1.1. Natural Resource Management Projects

Pilots

- **Brazil, Santa Catarina, Natural Resource Management and Rural Poverty Reduction Project, 2002, 2 percent of project cost,** a project with three components: institutional development, rural investment, and environmental management. A pilot is supporting the environmental component by establishing Watershed Management Plans that would provide support to the river basin management policies and laws, and Subwatershed Plans based on Watershed Management plans.

- **Pakistan, Balochistan Natural Resources Management Project, 1994, 3 percent of project cost.** The pilot tests recharge the upland aquifer through check dams, contour trenches, restoration of plant coverage to increase infiltration rate with a highly productive food shrub. If successful results can be achieved, the interventions will be considered for scaling up.
- **Uruguay, Natural Resources Management and Irrigation Development Project, 1994, US$3.1 million or 4 percent of project cost.** The project focused on irrigation development, soil and water management strategies and sustainable natural resource management. Small pilot component in four micro-watersheds aimed to gain experience in ecologically fragile zones to improve land use planning and to encourage farmers to invest in on-farm investments for soil degradation and erosion control and improved agricultural production.

Watershed Management as Project Component

- **Pakistan, Environmental Protection and Resource Conservation Project, US$24.3 million or 43 percent of project cost.** Within a larger environmental and natural resource rehabilitation component, in a long-term natural resource management project, pilots, operational work, and studies on natural resource management and watershed management will be carried out in order to develop a multidisciplinary and integrated approach for forestry, livestock, and crop production within the watershed.
- **Ghana, Natural Resource Management Project, US$3.4 million, or 12.5 percent of project costs.** The long-term natural resource management project that focuses in the first phase on policy reform and institutional strengthening. Watershed management is part of a system's approach to natural resource management planning and implementation. It also includes pilots in six watersheds, conducting surveys and establishing land use plans.
- **Colombia, Natural Resource Management Project, 1993, US$25.7 million or 39 percent of project costs.** The natural resource management project aims to develop policies and mechanisms to arrest degradation of natural resource over the longer term. Next to national parks, policy development and capacity building, watershed management rehabilitation is a project component promoting improved land use practices, reforestation, and soil and water conservation in an integrated approach within a micro-watershed.
- **Armenia, Natural Resources Management and Poverty Reduction Project, 2002, US$5.8 million or 36 percent of project costs.** The natural resource management project takes place in a mountainous area of Armenia. Watershed management is a project component next to forest management and protected areas management. The watershed component promotes sustainable land management for crop production, community pastures, and hay meadows, and includes biodiversity and forestry aspects.
- **Paraguay, Natural Resources Management Project, 1994, US$42.8 million or 54 percent for agricultural development component, allocation for watershed management not mentioned.** The watershed approach is a spatial approach for agricultural development within a natural resource management project, where catchment area plans and individual farm plans are established and a more detailed watershed analysis and protection master plan for the region will be undertaken. Since watershed management is still a novel approach in the country, this project should establish a good basis for further work.

2.1.2. Land and Water Conservation, Agriculture, and Irrigation

Pilots

- **Dominican Republic, Irrigated Land and Water Management Project, 5.5 percent of project cost.** A watershed management pilot would be carried out in five watersheds to develop methodologies and approaches for watershed protection and sustainable agricultural development.
- **Yemen, Land and Water Conservation Project, 1992, US$2.3 million or 4.8 percent of project costs.** This was a small pilot in an integrated land and water conservation project that worked on irrigation, agricultural production, and forestry. The watershed management pilot established rehabilitation plans, implemented terrace construction, and emphasized self-help operations by farmers and development of an integrated approach for future scaling up.
- **Sri Lanka, National Irrigation Rehabilitation Project, 1991, US$0.7 million or 1.4 percent or project costs.** The national irrigation project put aside a small amount for studies on environmental protection with the aim to minimize harmful activities, alleviating existing problems, and studying environmental problems at the watershed level.

Watershed Management as Project Component

Watershed management as a project component takes an integrated approach at the landscape level to benefit agriculture, forestry, and biodiversity in the following projects:

- **India, Agricultural Development Project—Tamil Nadu, 1999, US$17.6 million or 13.2 percent of total project costs.** Watershed development was included in an agricultural sector project that focused on capacity and institutional strengthening and investment support. The watershed management component promoted sustainable and replicable production systems, and supported land treatments on private, public, and common lands, with emphasis on vegetative soil and moisture conservation technologies. Watershed management work should also be beneficial to other sectors, such as forestry.

Watershed management components were mainstreamed into the soil and water conservation component of the following projects:

- **Madagascar, Second Environment Program, 1996, US$16.2million or 10 percent of project costs.** The national environment program includes a component of soil and water management. Watershed management is integrated in the component and includes anti-erosion measures, such as terracing, reforestation, gully stabilization, and fruit tree planting.
- **China, Shanxi Poverty Alleviation Project, 1996, US$15.9million or 9 percent of project costs.** In a poverty alleviation project with 11 components that address infrastructure issues (roads, irrigations, and water supply schemes) and agricultural development (livestock and fruit tree expansion), the soil and water conservation component applies a watershed management approach with the watershed as a physical unit and by focusing on soil and water conservation, more specifically on terracing, sediment control dams, afforestation, and comprehensive and integrated planning of individual watersheds.

2.1.3. Forestry

Watershed Management as Project Component

- **Forest Resource Development and Protection Project, China, 1994, US$37.4 million or 10 percent of total project cost for the Protection Forest component.** In a forestry project with components (among others) of high-production plantation forests and nature reserve management, one component was the establishment of a watershed protection forest for the middle and upper reaches of the Yangtze River basin, which suffers from severe soil erosion and river sedimentation. The watershed management approach encompassed multiple use of forest, species diversification, and comprehensive land use planning, including agriculture, forestry, and conservation zones. This differed from previous approaches where protection forests were stand-alone interventions, on monocultures, and not oriented toward local people use of products.

- **Algeria, Pilot Forestry and Watershed Management Project, US$9 million or 24 percent of project costs.** The project integrated watershed management is a new approach for the country to address water and natural resource management problems. A master plan for the country's major watersheds was established, and pilot watershed development in two watersheds was carried out by introducing new low-cost technologies to reduce erosion and increase farmers' income.

2.1.4. Water Resource Management

Pilot

- **Brazil, Ceara Integrated Water Resources Management Project PROGERIRH, 2000, US$5 million or 2 percent of project cost.** The small pilot in an integrated water resource management project aims to develop and test approaches for involving local communities and implementing simple techniques for implementation.

Watershed Management as Project Component

- **Philippines, Water Resources Development Project, 1996, US$13.4 million or 16 percent of project cost.** Improving water resource planning, development, and management is a primary goal of the project through policy and institutional frameworks, and improvement of irrigation systems' efficiency, thus increasing agricultural production and alleviating poverty. Another project objective is to initiate an integrated and comprehensive approach to watershed management to sustain water resources. The watershed management component includes the formulation of a national watershed management strategy and investment and institutional strengthening program; investments for the improved management of a few high-priority watersheds, and a training or study tour for watershed management staff to other countries.
- **India, Karnataka Rural Water Supply and Environmental Sanitation Project, US$9.2 million or 8 percent of project costs.** The watershed management approach is used in the rural water supply component with the aim to recharge ground water to produce a better water supply in the drought-prone region.
- **Ghana, Village Infrastructure Project, Rural Water Infrastructure Component of US$13.8 million or 23 percent of project cost.** The project includes (a) a pilot study on integrated watershed management, which studies practices that protect soils, water, vegetation, and wildlife and identifies best practices (amount not specified); (b) mainstreaming the watershed management approach into the rural water infrastructure component by considering the catchment management and other water conservation practices within the watershed and investment for a rational use of water in agriculture, livestock, and human consumption.

2.2 Downstream Protection

2.2.1. Flood and Landslide Protection

- **Romania, Hazard Risk Mitigation and Emergency Preparedness Project, 2004. Infrastructure investment was 50 percent of project costs, whereas pilot area study on**

watershed management was 0.3 percent. Within a natural disaster mitigation projects, within the component of flood and landslide risk reduction, watershed management focuses on protection infrastructure and not on land use.

- **St. Lucia, Watershed and Environmental Management Project, US$1.2 million, or 17 percent of project costs.** The project assists the government in short-term rehabilitation of St. Lucia's hydraulic infrastructure damaged by tropical storm Debbie, by preparing an integrated watershed management strategy and program, and by strengthening institutional capacities in environmental management and flood preparedness. The watershed management component will establish a plan, identify structural measures, and consider nonstructural aspects, such as land use regulations, with the goal of reducing the probability of future flood damage and addressing long-term natural resource management problems. Other donors will finance the implementation of proposed plan.

2.2.2. Watershed Management to Provide Downstream Water Supply for Population, Agriculture, and Other Uses

- **Vietnam, Vietnam Water Resources Assistance Project, US$2.6 million or 1.5 percent of project costs.** Water resources assistance project with focus on irrigation and water supply, mostly through infrastructure investments (river flow control structures, irrigation schemes, and dam safety work). Watershed management is a very small component oriented toward downstream water supply for cities that provides feasibility studies and initiates a river basin management program.
- **Malawi, National Water Development Project, 1995, US$1.6 million or 1.7 percent or project cost).** The water development project aims to provide safe (unpolluted) water for downstream users, with three project components of institutional reform and studies, physical works and goods, and equipment. Watershed management is within the physical works component, and interventions are geared toward protection of catchment areas, stabilization of watercourses through soil conservation and slope stabilization, restriction of river bank cultivations, and revegetation and farmer education to alleviate soil degradation and to preserve water quality.
- **China, Shanghai Urban Environment Project, 2003, US$45.7 million or 9 percent of project costs.** The urban environment project addresses waste water management, urban solid waste management, urban planning, and institutional strengthening. In addition, it includes an upper catchment management component where water pollution issues are addressed in the upper watershed through policy and physical investments. It also comprises the establishment of a watershed management plan to establish pollution sources and develop strategies for their control.

2.2.3. Watershed Management Approach to Reduce Water Pollution for Downstream Water Bodies

- **Kenya, Tanzania, Uganda, Lake Victoria Environmental Management Project, 1996, US$37.5 million or 48 percent of project costs).** This is an integrated project with an ecosystem and watershed approach, focusing on the rehabilitation of the lake ecosystem. It addresses issues of groundwater, wetlands, sediments and nutrient flow, municipal and industrial inflow and contamination, exotic invasive species (such as Nile perch and water hyacinths), improvement of fishing production, harmonization of regulation and legislation; monitoring of recovery and impact; and building of institutional capacity. Watershed management is mainstreamed in four components: (a) water quality and ecosystem management, (b) industrial and municipal waste management, (c) land use and wetland management, and (d) institutional framework, which totals US$37.5 million.

- **Estonia, Haapsalu and Matsau Bays Environmental Project, 1995, US$0.48 million or 5.7 percent of project cost).** The project focuses on protection of water quality of the Baltic Sea, reduction of waste water problems, and promotion of the management of point and non–point source pollution from the catchment area. The project takes a catchment approach to reduce pollution (for instance, from cattle farms) to downstream water resources. The approach is less oriented toward creating on-site benefits for local upland communities, and more concentrated toward reducing pollution.
- **Lithuania, Siauliai Environment Project, 1995 US$0.7 million or 3 percent for project cost).** Project objectives are to reduce the pollution load from the Siauliai area into the Upper Lielupe River Basin, improve the quality of the water supply, establish a financially sustainable provision of municipal services, and improve regional and local environmental quality monitoring and enforcement systems. Complementary to the Haapsalu project, it also considers the watershed management approach to reduce point source and non–point source pollution.
- **Poland, Rural Environmental Protection Project, 1999.** The Project for the Protection of Baltic Sea aims to comply with European Union targets of water quality. It addresses public awareness building and provides extension services to farmers to adopt environmentally friendlier farming practices. Although the project adopts watersheds as physical units, there is no direct design of watershed management interventions. The link to watershed management is made through the monitoring of long-term environmental benefits from reduced discharges of pollutants to surface and groundwater.

3. Land and Water Management Projects

These projects although identified through the water resources database are not considered watershed management projects, since they do not explicitly apply a spatial and systems approach to watershed management. Some of the projects may well be borderline projects, especially those that apply an integrated natural resource management approach.

Mauritania, Rainfed Natural Resources Management project, 1997. The objective is to rehabilitate land, water, and vegetation for increased agricultural production and livelihood improvement. There is no watershed management component. Watersheds are mentioned in the context of land and water conservation, but the project does not specifically apply a spatial approach.

Peru, National Rural Water Supply and Sanitation Project PRONASAR, 2002. There is no watershed component or a defined approach. The only link was some training for communities that related to the cumulative effects of individual interventions on a larger scale, which does not seem to justify including it as a watershed management project.

Tunisia, Natural Resources Management Project, 1997. This is a natural resource management project that focuses on rehabilitating degraded zones and improving agricultural productivity. It does not consider the watershed as a geographic unit, although it seems it would be in similar line with the Tunisia Northwest Mountainous Areas Development project. This is an integrated natural resource management project with many aspects of a potential watershed management project, such as hillside improvement, soil erosion control, and irrigation improvement, but it does not exhibit a holistic systems or watershed management approach.

Lebanese Republic, Agriculture Infrastructure Development Project, 1996. Land and water development, agricultural roads, and institutional support are the three components. The project does not mention the term *watershed*. Project may have been included in the internal management information system for investments in terracing and orchard establishment in hilly, remote, and less developed areas (physical watershed protection investments).

Chad, Agricultural Services and Producer Organization Project, 2003. The project is aimed at increasing agricultural productivity and rural incomes while preserving the natural resource base. Soil fertility and water management at the farm level (conservation tillage, cover cropping, and anti-erosion facilities) are assumed to add up positively at the larger scale for natural resource,, but no planning at the landscape level or watershed analysis accompanies the project interventions.

Argentina, Forestry Development Project, 1995. Project components are institutional strengthening for the forestry sector, research and information generation and dissemination, and the support of small farmers to improve their farming practices. The project concentrates on forest plantation and timber industries for institutional development and not on a watershed management approach. Support to small farmers in sustainable land management has no watershed management linkage.

India, Bihar Plateau Development Project, 1992. Agricultural development, rural roads, drinking water, and minor irrigation are the project components. The project does not pursue a spatial watershed management approach, but it does refer to soil and water conservation investments on hillsides as watershed treatments.

4. Outliers

Tunisia, Agricultural Sector Investment Loan (ASIL), 1993. It includes an investment, policy, and institutional strengthening component. Although watershed management is mentioned in the investment component in relation to infrastructure establishment for water management, it is not a watershed management project.

Brazil, Espirito Santo Water and Coastal Pollution Management project, 1994. The water supply project does not mention watershed management or catchment approaches. The only link is improved environmental quality of rivers, estuarine ecosystems, and tourist beaches, mostly through pollution control.

Iran, Irrigation Improvement project, 1993. This is an irrigation project that relates to irrigated surfaces and does not mention watersheds at all.

Angola, Third Social Action Fund, 2003. In this post-conflict project, physical rehabilitation includes water infrastructure, but there is no mention of watersheds.

Comores, Services Support project, 2004. This is a post-conflict project where infrastructure and capacity are rebuilt in the health and water sectors. Watershed is not mentioned at all.

Yemen, Social Fund for Development III Project, 2004. There are components of community development, micro-enterprise development, and capacity building and institutional support. There is no mention of watersheds. Water and environment as a topic is included in training plans for communities.

Pakistan, NWFP On-Farm Water Management Project, 2001. Improved on-farm water management will contribute to increased agricultural production, leading to increased farm incomes. The project focuses on irrigation water management, on-farm water use efficiency, and maintaining of water infrastructure. It does not refer to watershed management at all.

Egypt, Matruh Resources Management project, 1993. Project documentation is not available.

Mexico, Mexico Programmatic Environmental project, 2003. Project documentation is not available.

Table 1.1: World Bank Watershed Management Projects, 1990–2004

Country	FY	Project Name	Total Cost US$ million	WS cost US$ million	% WS of Total %	Total Bank US$ million	% WB of Total %	Total WB in WSM US$ million	IBRD US$ million	IDA Loan US$ million	GEF US$ million	Project Documents SAP/PAD	ICR	PPAR
Africa														
Burkina Faso	1991	Environmental management project	25.5	25.5	100	16.5	65	17		16.5		1991	1999	2002
Mali	1992	Natural resources management project	32.1	32.1	100	20.4	64	20		20.4		1992	2001	2003
Niger	1996	Natural resources management project	42.7	42.7	100	26.7	63	27		26.7		1995	2003	
East Asia and Pacific														
Indonesia	1991	Yogyakarta Upland Area Development Project (Bangun Desa II)	25.1	25.1	100	15.5	62	16	15.5			1991	1998	2000
China	1994	Second Red Soils Area Development Project	296.4	296.4	100	150.0	51	150		150.0		1994	2002	
Indonesia	1994	National Watershed Management and Conservation Project	487.8	487.8	100	56.5	12	57		56.5		1993	2000	
China	1994	Loess Plateau Watershed Rehabilitation Project	248.7	248.7	100	150.0	60	150		150.0		1994	2003	
China	1999	Second Loess Plateau Watershed Rehabilitation Project	252.0	252.0	100	150.0	60	150	100.0	50.0		1999		
Philippines	2004	Laguna de Bay Institutional Strenthening and Community Part.	12.45	12.45	100	5.0	40	5	5.0			2003		

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Table 1.1: World Bank Watershed Management Projects, 1990–2004 *(continued)*

Country	FY	Project Name	Total Cost US$ million	WS cost US$ million	% WS of Total %	Total Bank US$ million	% WB of Total %	Total WB in WSM US$ million	IBRD US$ million	IDA Loan US$ million	GEF US$ million	Project Documents SAP/PAD	ICR	PPAR
Europe and Central Asia														
Turkey	1993	Eastern Anatolia Watershed Rehabilitation Project	115.50	115.50	100	82.1	71	82	77.0		5.1	1993	2002	2004
Turkey	2004	Anatolia Watershed Rehabilitation Project	45.11	45.11	100	27.0	60	27	20.0		7.0	2004		
Tajikistan	2004	Community Agriculture and Watershed Management Project	15.29	15.29	100	15.3	100	15		10.8 (5.8grant)	4.5	2004		
Latin America and the Carribean														
Brazil	1990	Land Management II Project - Santa Catarina	71.60	71.60	100	33.0	46	33	33.0			1989	2000	
Peru	1997	Sierra - Natural Resources Management and Poverty Alleviation Pr	93.20	93.20	100	51.0	55	51	51.0			1996		
Brazil	1997	Natural Resources Management and Rural Poverty Alleviation Pr.	208.00	208.00	100	100.0	48	100	100.0			1997		
Brazil	1998	Land Management III Project	124.70	124.70	100	55.0	44	55	55.0	1997				
Middle East and North Africa														
Tunisia	1994	Northwest Mountainous Areas Development Project	50.70	50.70	100	27.5	54	28	27.5			1993	2001	2003
Morocco	1999	Lakhdar Watershed management Pilot Project	5.80	5.80	100	4.0	69	4	4.0			1998		

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Table 1.1: World Bank Watershed Management Projects, 1990–2004 *(continued)*

Country	FY	Project Name	Total Cost US$ million	WS cost US$ million	% WS of Total %	Total Bank US$ million	% WB of Total %	Total WB in WSM US$ million	IBRD US$ million	IDA Loan US$ million	GEF US$ million	Project Documents SAP/PAD	ICR	PPAR
South Asia														
India	1990	Integrated Watershed Development (Plains) Project	91.80	91.80	100	62.00	68	62	7	55.00		1990	1999	2000
India	1990	Integrated Watershed Development (Hills) Project	125.60	125.60	100	88.00	70	88	13	75.00		1990	1999	2000
India	1999	Integrated Watershed Development (Hills-II) Project	193.00	193.00	100	135.00	70	135	75	60.00		1999		
India	2001	Karnataka Watershed Development Project	127.60	127.60	100	100.00	78	100		100.00		2001		
India	2004	Uttaranchal Decentralized Watershed Development project	89.35	89.35	100	69.62	78	70		69.62		2004		
			2780.00	**2780.00**	**100**	**1440.12**	**60**	**1503**	**583**	**829.72**	**16.6**			
Brazil	1989	Land Management I Project - Parana	138.30	138.30	100	63.00	46	63	63			1988.00	1998	

Table 1.2: Watershed Management Component Projects, 1990–2004

Country	FY	Project Name	Total Cost US$ million	WS cost US$ million	% WS of Total %	Total Bank US$ million	% WB of Total %	Total WB in WSM US$ million	IBRD US$ million	IDA Loan US$ million	GEF US$ million	Project Documents SAP/PAD	ICR	PPAR
Africa														
Ghana	1998	Natural resources management project	25.7	6.0	23	11	44	3		9.3	2.1	1998	2004	
Madagascar	1997	Second Environment Program	155.0	43.5	28	51	33	14		30.0	20.8	1996	2003	
Uga/Tanz/ Ken	1997	Lake Victoria Environmental management Project	77.6	37.5	48	70	90	34		35.0	35.0	1996		
Ghana	1997	Ghana Village Infrastructure Project	60.0	13.8	23	30	50	7		30.0		1997		
Malawi	1995	National Water Development Project	94.1	1.6	2	79	84	1		79.2		1995	2004	
East Asia and Pacific														
China	1994	Forest Resource Development and Protection Project	356.0	37.4	11	200	56	21		200.0		1994	2002	
China	1996	Shanxi Poverty Alleviation Project	182.8	15.9	9	100	55	9		100.0		1996	2004	
Philippines	1997	Water resources Development Project	85.2	13.4	16	58	68	9	58			1996		
Vietnam	2004	Vietnam Water Resources Assistance Project	176.2	2.6	1	158	90	2		157.8		2004		
China	2003	Shanghai Urban Environment Project	512.2	45.7	9	200	39	18	200			2003		

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Table 1.2: Watershed Management Component Projects, 1990–2004 *(continued)*

Country	FY	Project Name	Total Cost US$ million	WS cost US$ million	% WS of Total %	Total Bank US$ million	% WB of Total %	Total WB in WSM US$ million	IBRD US$ million	IDA Loan US$ million	GEF US$ million	Project Documents SAP/PAD	ICR	PPAR
Europe and Central Asia														
Estonia	1995	Haapsalu and Matsalu Bays Environmental Project	8.37	0.5	6	2	24	0	2			1995	2001	2003
Lithuania	1996	Siauliai Environment Project	22.85	0.7	3	6	27	0	6.2	1995	2001	2003		
Poland	2000	Rural Environmental Protection Project	15.8	0.0	0	6	35	0	2.5		3	1999		
Armenia	2002	Natural Resources Management and Poverty Reduction Project	16	5.8	36	14	85	5		8.31	5.21	2002		
Romania	2004	Hazard Risk Mitigation and Emergency Prepardness Project	203.65	0.7	0	150	74	1	150			2004		
Latin America and the Carribean														
Uruguay	1994	Natural resources management and Irrigation Development Project	74	3.1	4	41	55	2	41			1993	2003	
St. Lucia	1996	Watershed and Environ-mental Management Project	7.1	1.2	17	5	75	1	2.65	2.65		1995	1998	
Brazil	2000	Ceara Integrated Water Resources Management Project	247.2	5.0	2	136	55	3	136			1999		
Colombia	1994	Natural Resource Management Project	65.3	25.7	39	39	60	15	39.0			1993	2001	

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Table 1.2: Watershed Management Component Projects, 1990–2004 *(continued)*

Country	FY	Project Name	Total Cost US$ million	WS cost US$ million	% WS of Total %	Total Bank US$ million	% WB of Total %	Total WB in WSM US$ million	IBRD US$ million	IDA Loan US$ million	GEF US$ million	Project Documents SAP/PAD	ICR	PPAR
Dominican Rep	1995	Irrigated Land and Water Management Project	43.2	2.4	5	28	65	2	28.0			1994		
Paraguay	1994	Natural Resources Management Project	79.1	42.8	54	50	63	27	50.0			1994		
Brazil	2002	Natural Resource Management and Rural Poverty Reduction Pr	107.5	2.3	2	63	58	1	62.8			2002		
Middle East and North Africa														
Algeria	1992	Pilot Forestry and Watershed Management Project	37.4	9.0	24	25	67	6	25.0			1992	1999	
Yemen	1992	Land and Water Conservation Project	47.6	9.2	19	33	69	6		32.8		1992	2001	
South Asia														
Pakistan	1992	Environmental protection and Resource Conservation Project	57.2	24.3	42	29	51	12		29.2		1992	2000	
Pakistan	1994	Balochistan Natural Resources Management Project	17.8	0.5	3	15	83	0		14.7		1994		
India	1991	Agricultural Development Project -Tamil Nadu	133.3	17.6	13	113	85	15	20.0	92.8		1991	1999	
Sri Lanka	1991	National Irrigation	49.8	0.7	1	30	59	0		29.6		1991	1999	2004
India	1993	Karnataka Rural Water Supply and Enviornmental Sanitation Pr.	117.8	9.2	8	92	78	7		92.0		1993	2001	
			3075.8	**378.0**	**16**	**1833**	**61**	**222**	**823.15**	**943.36**	**66.11**			

ANNEX 2: PROJECT REVIEW

Criteria and Methodology of the Project Review

The review of World Bank projects in watershed management was based on internal World Bank project documentation: SARs (Staff Appraisal Reports), PADs (Project Appraisal Documents), ICRs (Implementation Completion and Results Reports), and PPARs (Project Performance Assessment Reports executed by the Operations and Evaluation Department). Sixty-nine projects were identified through the World Bank internal management information system, 1993–2004, and through the watershed management portfolio review, 1990–99, by Boerma (2000). For these projects, 67 SARs or PADs, 32 ICRs, and 11 PPARs were available and considered in this analysis.

According to an initial screening of the project appraisal documents, the projects were divided into four categories:

1. Watershed management projects (24 projects)
2. Projects with watershed management components (29 projects)
3. Land and water management projects (7 projects)
4. Outliers (9 projects)

The characteristics of each group are described below. According to project titles, the main sectoral attribution of the projects is presented in Table 2.1.

Table 2.1. Project Categories According to Project Titles

	Dedicated watershed management	Projects with watershed management components	Land and water	Outliers
Watershed management projects	12	1		
Area Development	3		1	
Natural Resources Management	4	7	2	1
Environmental Management, protection	1	7		1
Land &Water management, Agricultural Development, Irrigation	3	4		2
Water resources		5	1	2
Forestry		2	1	
Institution, Participation, Agricultural services	1		1	1
Poverty reduction		1		
Infrastructure		2	1	
Social fund				2
Total	24	29	7	9

Source: World Bank Internal Management Information System, 2006.

Watershed Management Projects (24 projects)

The watershed management projects were committed to an integrated watershed management approach and to the watershed as the spatial unit of intervention. Half of the 24 projects were called watershed management projects. The other three main domains were integrated area development, natural resources management, and land and water management. No water resource management project was found in this category, indicating that water management was undertaken in an integrated land and water management approach.

Projects with Watershed Management Components (29 projects)

In 29 projects, watershed management was a project component or subcomponent, or was mainstreamed within a project component. Most projects were natural resource management projects and environmental management and protection projects (seven projects for each), followed by five water resources management projects and four agricultural development, as well as land and water conservation projects. Additionally, two forestry and two infrastructure projects, one poverty reduction project, and one watershed management project were part of this category. A short description for each of the projects and how they relate to watershed management is given in Annex 1.

Land and Water Management Projects (7 projects)

In seven projects, watershed was used as a general geographic term and project work focused on land and water management without relating it spatially to the watershed. The underlying assumption in these projects was that localized interventions would eventually add up and create positive environmental benefits at a larger scale. A short description for each of the projects and the reference to watershed management is given in Annex 1.

Outliers (9 projects)

Nine projects were identified as outliers. Project documentation was missing for two projects; the other seven projects were an agricultural investment loan project, a social fund project, two post-conflict projects investing in physical rehabilitation of upland infrastructure, two water resources projects, and one irrigation project. None of them referred to watershed management in their project documentation, nor did they apply a spatial watershed management approach in project implementation. A short description of the projects is given in Annex 1.

ANNEX 3: APPROACHES IN PROJECTS

Watershed Management Approaches in the Projects Reviewed

This annex describes the varying approaches adopted in the watershed management projects that were reviewed.

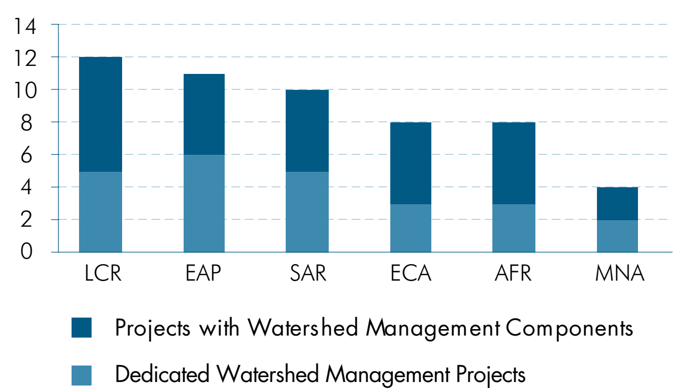
Watershed Management Approach in Watershed Management Projects

Objectives and project orientations were similar for most projects. The project rationale and objectives for more than 80 percent of the projects were based on sustainable management of natural resources as a basis for agricultural production increase, which would lead to income increase and poverty reduction. Simultaneously, institutional development and capacity strengthening was addressed by more than 90 percent of the projects.

The watershed management approach as a means to address and reverse environmental degradation in the upper catchment areas was explicitly chosen and stated in more than 50 percent of the project objectives. Similarly, in more than 50 percent of the objectives, projects committed to a participatory approach to work with stakeholders and put emphasis on land use planning as part of the project implementation strategy. Forty percent of the projects included a research component. In less than a quarter of the projects, infrastructure development and engagement in policy and legal work and biodiversity issues were among the project objectives. Congruent to the observations under the project title categories, water management per se was not part of the project objectives or strategies, but was integrated in natural resources management or sustainable land management.

The reason for this could lie in the integrated watershed management approach where the interdependency of land and water is recognized. The number of watershed management projects in each of the regions is shown in Figure 3.1.

Figure 3.1: Number of World Bank Watershed Management Projects and Projects with a Watershed Management Component in Six Regions, 1990–2004



Source: World Bank Internal Management Information System, 2006.

Most watershed management projects were in East Asia and the Pacific Region. Of the six projects, three were in China, two were in Indonesia, and one was in the Philippines. In China, the Loess project from 1994 received a follow-up project Loess II in 1999. The China, Second Red Soils project was a successor to the First Red Soils Project from the 1980s. In the Latin America and Caribbean Region, four out of five watershed management projects were implemented in Brazil, of which three followed a similar approach (Land Management I, II and III). In South Asia, the five projects were all in India. The sister projects Plains and Hills were succeeded by Hills II. In Eastern and Central Asia, the Anatolia project from 2004 was a follow-up to the Eastern Anatolia project. For the central Asian region, the watershed management project in Tajikistan is the first of its kind, although Armenia has a natural resource management project with a strong watershed management component. In Africa no watershed management projects per se could be identified. Nonetheless, three natural resources management projects with a holistic and spatial approach, the *terroir* approach, were included. These projects have all the ingredients of a watershed management project, but they do not refer to the watershed as their explicit spatial unit. They may consider the boundaries of forests or pastoral zones more suitable to delineate their intervention zone, which in the case of nonhilly or flat areas can make more sense. In the Middle East and North Africa Region, only two watershed management projects were implemented: in Tunisia, a country already experienced in watershed management and in Morocco, executing a first-time watershed management project.

Watershed Management Approach in Various Sector Projects with Watershed Management Components

The importance of watershed management differed among the projects and ranged from large components to small pilots to watershed management mainstreamed within the respective project sectors, sometimes not even explicitly mentioned. Two primary watershed management approaches can be distinguished: (a) watershed management for upland development and (b) watershed management for downstream protection. All the 24 watershed management projects and 20 of the watershed management component projects adhere to the upland management approach, which is discussed in detail in this report. On the other hand, 9 projects explicitly focused on the protection of downstream areas. The watershed was the zone of intervention of water management, but the projects did not always explicitly refer to applying a watershed management approach.

A. Upland Development

Natural Resource Management Projects

Three pilots that cost only between 2 percent and 4 percent of the total project expenditure had different goals. In the Brazil Santa Catarina natural resources management project, watershed management plans were established that supported the environmental management component, as well as the river basin management policies. In Pakistan, Balochistan natural resources management project, techniques were tested to recharge the upland aquifer and, if found successful, were planned to be considered for scaling up. In Uruguay, gaining experience in land use planning and farmer engagement in a few ecologically fragile micro-watersheds was the goal of the pilot.

The natural resources management projects with a larger watershed management component (12–54 percent of total project costs) were the Pakistan environmental protection and resource conservation project and the natural resources management projects of Armenia, Colombia, Ghana, and Paraguay. The projects addressed environmental degradation at the landscape level, affecting various sectors, such as agriculture, forestry, water resources, and biodiversity. The aim of watershed management components was the development of an integrated watershed management approach to manage natural resources for agriculture, forestry, protected areas, and the water sector. In Ghana and Paraguay, establishing land use and watershed management plans was an important activity.

Land and Water Conservation, Agriculture, and Irrigation

Three pilot projects applied an integrated water and land management approach for watershed protection and sustainable agricultural development, including irrigated land. Terrace construction and upland rehabilitation plans were emphasized in the Yemen project, developing watershed management methodologies and approaches at local level were the focus in the Dominican Republic project, and the undertaking of studies to evaluate the harmful upland activities onto irrigated areas was financed in the Sri Lanka national irrigation rehabilitation project.

Watershed management was mainstreamed into the agricultural components of three projects (India Agricultural Development project, China Shanxi Poverty Alleviation project and Madagascar, Second Environment Program). It focused on soil conservation activities, such as terracing, sediment control structures, and afforestation, that should favor agricultural production. In India, watershed management activities were implemented across private, public, and common lands.

Forestry

Two forestry projects emphasized the shift in forest management from previously stand-alone forest interventions with monocultures and without including the local population toward a watershed management approach. In China, the protection forest for the middle and upper reaches of the Yangtze River was planted with the strategy to diversify the forest ecosystem, to undertake a comprehensive land use planning, and to integrate people's needs. In the Algeria Pilot Forestry and watershed management project, watershed management was recognized as a new approach to be developed to address water and natural resources management problems. The establishment of a master plan for the country's most important watersheds was an important objective of the project.

Water Resources Management

In four projects, water resources management was part of a larger natural resource management approach with the spatial consideration of the watershed. The Brazil Ceara project had a small pilot on watershed management to develop and test simple water management techniques with the local population. In India Karnataka, the watershed management approach was aimed at recharging groundwater to provide a better water supply in drought prone areas. In the Ghana Village Infrastructure project, the watershed management approach was mainstreamed into the rural water infrastructure component with the aim of investing in a rational use of water in agriculture, livestock, and human consumption. In the Philippines, the watershed management component included the formulation of a national watershed management strategy and investment and institutional strengthening program within a larger water resource development project.

B. Downstream Protection

Flood and Landslide Prevention

Two projects focus on flood and landslide protection. The Romania Hazard Risk Mitigation and Emergency Preparedness project focuses on infrastructure establishment and very little on land use change, and the St. Lucia tropical storm rehabilitation project integrates strengthening of institutional capacity to establish plans and identify needed structural measures and nonstructural aspects at the watershed level to be taken into account to reduce the gravity of future storm events.

Protection for Downstream Water Supply

In three projects, watershed management was an approach adopted to provide water to population, agriculture, and other users downstream. The Vietnam Water Resources Assistance project focuses on water supply for irrigation and for cities through infrastructure investments. Providing safe and unpolluted water for the population is the objective of the Malawi National Water Development project. Watershed management as an approach is within the physical works component and interventions, which are oriented toward catchment protection through slope stabilization, revegetation, and farmer education to reduce degradation and preserve water quality. The Shanghai Urban Environment project in China includes a small watershed management component addressing water pollution in upper catchment areas through policy work and physical investments in order to reduce contamination of the water supply to the city.

Protection for Downstream Ecosystems

The reduction of water pollution for large downstream water bodies is the objective of four projects. The Lake Victoria Environmental project is a multicountry project (Kenya, Tanzania, and Uganda) and covers a wide range of activities to restore and maintain the ecosystem of the lake. Watershed management is mainstreamed into four components that deal with land and water management and institutional frameworks. The projects in Estonia, Lithuania, and Poland are all focused on pollution reduction in the upper catchment areas of the Baltic Sea by addressing point and non–point source pollution through promoting cleaner practices and awareness building, and by supporting the local and regional environmental quality monitoring and enforcement systems.

Conclusions

The review on watershed component projects shows that projects focused either on upstream or downstream development objectives. Few projects integrated upstream and downstream in a more balanced way with the exception of the Lake Victoria project. The upland projects concentrated their efforts on natural resource management at the landscape level, integrating forestry and agriculture, and aiming at poverty reduction and livelihood improvement. The downstream protection projects, by contrast, focused on water resource management with the specific objective of providing a quantitatively and qualitatively adequate water supply for downstream areas. These projects designed targeted interventions in the upland areas with a rather technical and top-down approach. The approach included identification of the ideal location for installing infrastructure, enforcement of regulations, and monitoring of environmental indicators, among others. For both types of project, the externality question was not well considered, which would be for upstream or downstream projects: What is the impact of project interventions on the downstream and upstream livelihoods, environment, and production systems, respectively?

ANNEX 4:
WORLD BANK INVESTMENTS

World Bank Investments in Watershed Management from 1990 to 2004

This analysis is based on 53 projects with 24 projects being watershed management projects (dedicated watershed management projects) and 29 projects having a watershed management component (projects with a watershed management component). The list of projects, including amount and type of investments, are reported in Annex 1. For 29 projects, ICRs were available, including 10 PPARs. For 24 projects, only the appraisal documents existed.

World Bank Lending

Total project costs, World Bank lending, and the amount of lending attributed to watershed management is presented for each of the projects in Annex 2. A summary of World Bank lending for watershed management projects is presented in Table 4.1. The table shows a decline in investments from the 1990s to the early 2000s. This is congruent with the overall decline in agricultural lending. In 2000, agricultural lending at the World Bank was about one quarter of what was loaned in 1990, in nominal terms (Cleaver and Ganguly 2005). However, since 2003 investments in agriculture and rural development have been increasing anew.

Table 4.1: World Bank Investments in Watershed Management, 1990–2004

	Dedicated watershed management projects (US$ million)	Projects with watershed management components (US$ million)	Total watershed management lending (US$ million)
1990–94	765	111	876
1995–99	522	80	602
2000–04	217	30	247
Total	**1,504**	**221**	**1,725**

Note: For total project costs, see Annex 2.
Source: World Bank Internal Management Information System, 2006.

World Bank Investments per Region

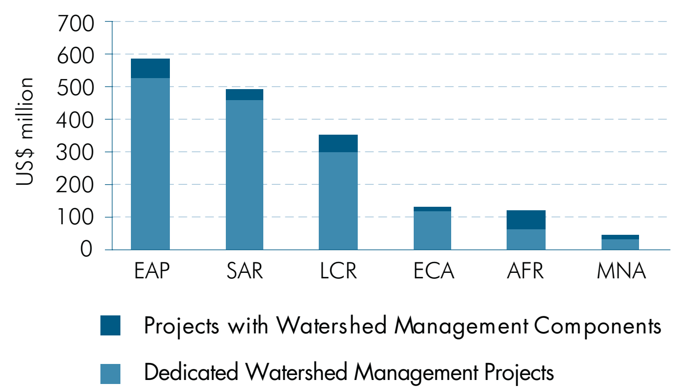
In more detail, investments for the three periods and for the six regions are shown in Table 4.2. In Figure 4.1, the total investments over 15 years for each region are shown, and in Figure 4.2 the average amount of investments per project for the 6 regions is presented. These numbers show clearly that most investment in watershed management was to the regions of East and South Asia and Latin America. The amount of investments per project was also significantly higher than what was spent in the three other regions. Whereas the average lending per project was US$21 million in Africa, it reached US$91 million in South Asia. Investments in watershed management components were small compared to the full-size watershed management projects. Relatively many of the components were small pilots or small components.

Table 4.2: Investments for Watershed Management for Different Regions, 1994–2004

	Dedicated Watershed Management Projects				Projects with Watershed Management Components				All investments in Watershed Management	Regional Distribution (%)
	1990–94	1995–99	2000–04	total	1990–94	1995–99	2000–04	total		
AFR	37	27	0	64	0	59	0	59	123	7
EAP	372	150	5	527	21	18	20	59	586	34
ECA	82	0	42	124	0	0	6	6	130	8
LCR	96	206	0	302	44	3	4	51	353	20
MNA	28	4	0	32	12	0	0	12	44	3
SAR	150	135	170	455	34	0	0	34	489	28
Total	**765**	**522**	**217**	**1504**	**111**	**80**	**30**	**221**	**1725**	**100**

Note: AFR = Africa Region; EAP = East Asia and Pacific Region; ECA = Europe and Central Asia Region; LCR = Latin America and the Caribbean Region; MNA = Middle East and Northern Africa Region; and SAR = South Asia Region.
Source: World Bank Internal Management Information System, 2006.

Figure 4.1: Total World Bank Watershed Management Investments by Region, 1994–2004,

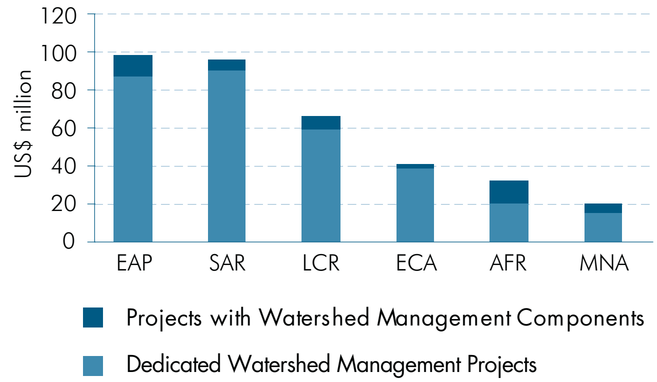


Source: World Bank Internal Management Information System, 2006.

Performance Ratings

Project performance ratings at the completion of the projects (in ICRs) are reported in Table 4.3. This overview of ICR ratings shows that overall about 76 percent of the projects were rated satisfactory, about 12 percent were highly satisfactory, and about 12 percent unsatisfactory. The ratings in the PPAR were in most cases congruent with the ICR ratings or slightly lower.

Figure 4.2: Average Investment in Watershed Management per Project in the Bank (US$ million)



Source: World Bank Internal Management Information System, 2006.

Table 4.3: Performance Ratings for 29 Watershed Management Projects

Project ratings in ICR	Number of projects per rating category		
Outcome	Highly satisfactory 3	Satisfactory 23	Unsatisfactory 3
Sustainability	Highly likely 4	Likely 20	Unlikely 5
Institutional Development Impact	High 4	Substantial 19	Modest 6
Bank performance	Highly satisfactory 4	Satisfactory 24	Unsatisfactory 1
Borrower performance	Highly satisfactory 2	Satisfactory 24	Unsatisfactory 3

Source: World Bank Internal Management Information System, 2006.

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