Land-Water Linkages in Rural Watersheds Electronic Workshop
18 September – 27 October 2000

Synthesis Report

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Synthesis report of the FAO electronic workshop

Introduction

An electronic workshop on "Land–Water Linkages in Rural Watersheds" was held from 18 September to 27 October 2000. Its goals were to:

- examine relationships between land use and water resources in a watershed framework, and how these affect upstream and downstream stakeholders;
- identify focal areas and recommendations for further work with regard to land and water management, in particular with regard to the distribution of costs and benefits between upstream and downstream resource users;
- provide a forum for exchange of knowledge and information regarding mechanisms and instruments to link land and water management through the re-distribution of costs and benefits between upstream and downstream resource users.

Key questions addressed in the workshop were outlined in an introductory note. Supporting documents included two discussion papers, five background papers, and 31 case studies. There were 471 participants, 38 of whom made contributions, comments and suggestions for future activities. The interventions were summarized on four occasions as the workshop proceeded. A full documentation of the workshop materials is included in the CD-ROM, which accompanies the present document.

This report draws on relevant material from the interventions, case studies and background documents. Although the key questions from the introductory note provide the general outline for this report, some of them have been grouped together to reflect better areas of emphasis in the discussions. They are grouped into two main categories: the *Landscape Perspective*, which contains questions regarding biophysical impacts, and the *Lifescape Perspective*, which contains questions that pertain to the benefits and costs to upstream and downstream resource users, and economic and policy instruments that can be used to redistribute them more equitably as well as create incentives to reduce impacts.

Part I: Land–water linkages – the landscape perspective

Relationships between land and water are complex, as they consist of numerous and simultaneous processes that vary across spatial and temporal scales, are non-linear, and occur in watersheds

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with heterogeneous characteristics.[1] Moreover, impacts of land use practices depend heavily on interactions among site-specific biophysical characteristics, as well as on socio-economic factors. Assessment of these impacts, and development of appropriate response strategies, therefore requires a good understanding of this context. In addition to the identification of impacts themselves, development of appropriate response strategies requires an understanding of causes, ranging from management strategies to socio-economic incentives that influence them. The following two sub-sections review biophysical aspects of land use impacts on water resources and management strategies, with a focus on unresolved issues, following the typology proposed in Discussion Paper 1, as well as issues related to their assessment.

Session 1: Understanding and categorizing land–water linkages

Classification of impacts

Discussion Paper 1 proposes a typology of land use impacts on water resources that can be used to assess biophysical impacts of land use practices on water resources. Based on discussions and observations, a category has been added for soil moisture recharge, and also for impacts on ecosystems and aquatic resources:

1. Impacts of land use on the hydrological and sediment-related processes
   a. Mean surface runoff
   b. Peak flow/floods
   c. Base flow/dry season flow
   d. Groundwater recharge
   e. Soil moisture recharge
   f. Erosion and sediment load
2. Impacts of land use on water quality
   g. Nutrients and organic matter
   h. Pathogens
   i. Pesticides and other persistent organic pollutants
   j. Salinity
   k. Heavy metals
   l. Changes in thermal regime
3. Impacts on ecosystems and living aquatic resources.

In addition to distinguishing surface from groundwater supply, it is important to distinguish soil moisture, which is generally more important than surface water in semi-arid environments, though impacts on it have lower off-site consequences. In semi-arid countries such as in Africa, runoff coefficients are generally much lower than in the United States and European countries (10 percent compared to 40-50 percent), which also suggests the difficulty of making generalizations based on parameters found to be important in one or the other.[2]

Discussion paper 1 and background papers 2 and 3 provide a more thorough overview of impacts of land use and management practices on hydrology and on water quality. Examples of actual impacts and problems encountered in their assessment, can be found throughout the case

[1] Cudennec, Intervention 7
[2] Moriarty, Intervention 39

studies. Since what is considered an "impact" depends on the relative significance to various stakeholders, these are addressed more extensively in the sections on assessment and on valuation of land–water linkages.

Identification of land use impacts on water resources

The single most important parameter for determining impacts may be the ranges of variability of rainfall, runoff and water flows, particularly in arid areas.[3] This is because many hydrological impacts are dominated by extreme though infrequent events. Transport of sediment and other pollutants disproportionately occur during these events because they are linked to increases in water volume and velocity. Given their high variability, average yearly rates are irrelevant for predicting actual rates of sedimentation.[4]

Climate change is also an important consideration, as it may increase the frequency of extreme events including local droughts, intense rainfall with increased soil erosion and runoff, flooding, sea level rise and coastal inundation.[5]

In the identification of hydrological impacts, another important distinction is between hillslope elements and the hydrographic networks that drain hillslope flows. Hillslope processes play a more important role in smaller watersheds, and where structural management changes, such as dams, have altered their temporal scale. Because of their more diversified topography, they also interact with rainfall in more complex ways. Case study 2 presents a methodology for distinguishing these hillslope from lowland processes, and case study 3 provides an example of the relationship between hydrological impacts and geographical patterns in an upstream watershed.[6]

Participants provided examples of structural measures upstream that are constructed with a view to improving downstream hydrology, including:

- small hydro projects upstream to prolong life of dams downstream;[7]
- development of low-cost microdams to contain surface runoff damages, retain pollution, and favour recharge of water tables;[8]
- construction of reservoirs to enhance downstream flows;[9] and
- revival of traditional water harvesting systems such as the *Paals* in India[9a].
- There was also speculation that the siting of rice terraces could be optimized relative to watershed lag-time to reduce flooding.[10]

Variation of land use impacts under different agro-ecological conditions and management practices

The significance of land use impacts also depends on management practices, and on agro-ecological and socio-economic conditions that determine vulnerability and response capacity – the latter will be further discussed below in the section on valuing land–water linkages. With respect to management and agro-ecological conditions, background paper 1 provides an extensive discussion of the role of management practices and other parameters that need to be considered in determining whether or not forests control erosion, reduce flooding, regulate flows, increase

[3] Peters and Meybeck, Background Paper 2
[4] Faurès, Intervention 4
[5] Fairchild, Intervention 34
[6] Cudennec, Intervention 7
[7] Mechergui, Case Study 18
[8] Cordoval de Barros, Case Study 25
[9] Davidson, Intervention 16
[9a] van Etten, Intervention 18
[10] Cudennec, Intervention 7

runoff and improve water quality, all of which depend on interdependent or competing and site-specific processes.[11] An example is provided in Box 1.

Box 1: Forests and dry season flows in a semi-arid environment

Whether or not the presence of forest increases dry season flows will depend on infiltration properties of the soil and on climatic conditions. Planting of exotic tree species of pine and eucalyptus in a semi-arid climate such as South Africa not only reduced dry season flows but also dried streams completely and generated very deep soil moisture deficits that prevented their return and the recharge of aquifers for five years after the trees were felled.[12]

Whether or not forests increase or decrease overall annual runoff may depend also on the age of the forest, and hence the extent of the canopy and rooting systems, light and re-growth, and effect on soil organic matter and leaf litter: they generally reduce runoff volume compared with crops that have less biomass, with the exception of cloud forests. Older forests may also generate more runoff due to less re-growth. Some of the factors that affect whether planting of trees controls erosion include: existence of an understorey, grazing (which can lead to soil compaction and removal of understorey plants), road construction, logging techniques, pre-planting drainage activities, weight of trees and also the size of their leaves, because they modify drop size, which determines the extent of splash-induced erosion. Cultivation, drainage, road construction and soil compaction during logging are thought to have more influence on flood response than just the presence or absence of forest. Site-specific assessment is therefore necessary to develop appropriate responses to impacts.

Relative importance of anthropogenic and natural causes

Understanding the consequences of land use decisions, and the development of appropriate responses implies the ability to distinguish these impacts from natural processes and their variability. This is particularly evident for issues associated with erosion and sedimentation rates, for which several case studies were discussed that also illustrate management implications. For example, if the amount of erosion generated by farming practices in a dam catchment is insignificant compared to natural erosion, changing those practices will not change the impact of sedimentation on the dam. The design and siting of the dam itself may simply be inappropriate in an arid and semi-arid area where high erosion is an inherent element of landscape processes – as is suggested in a case from Zimbabwe (see Box 6).[13] Other factors that make it difficult to distinguish anthropogenic from natural causes include: climatic variation and rainfall patterns; the long time lag between cause and effect, particularly at larger scales; and the reluctance to invest on already degraded lands. These are also illustrated in experiences from Morocco (see Box 2), and the Russian Federation (see Box 3).

Change in the relative importance of impacts with the size of the watershed: considerations of scale

As can be seen in the examples of Morocco and Zimbabwe, scale is a key parameter in the problem of detecting impacts of land use. Many myths about land use impacts are based on the extrapolation of effects observed at smaller scales to large ones, for which the most well-known case is the attribution of severe floods in Eastern India and Bangladesh to deforestation in the Himalayas (see Box 4).

[11] Calder, Background Paper 1
[12] Calder, Background Paper 1
[13] Moriarty, Intervention 26

Box 2: Morocco – Natural versus man-made causes of sedimentation[14]

In the preparation phase for a large-scale watershed management project in Morocco, hydrologists were requested to assess the possible impact of the project for reducing sedimentation of reservoirs. Sedimentation is a critical problem for Morocco's large dams, as they are the main source of water for the country's large irrigation systems and cities. In 1994, 8 percent of their total capacity had already been lost. The watershed areas range from 1 000 to 50 000 km^2, with a variation in sediment yield between 300 and 3 000 $t/km^2/yr$, depending on the geology of the watershed.

There was an expectation that hydrologists could quantify the extent to which proposed land conservation practices would reduce sedimentation of reservoirs, and that these impacts could then be valued and accounted for in the overall financial analysis of the project. It became clear to the hydrologists, however, that the impact on sedimentation of reservoirs would be negligible, regardless of the extent of land included in the programme. The main reasons were:

- The areal extent of land that could benefit economically from erosion control measures represents only a small percentage of the total area of each watershed and could therefore contribute only marginally to the reduction of sedimentation.
- Using the participatory approach, efforts concentrate on the improvement and reduction of erosion of farmer's land, whereas the badlands, which are the areas contributing the most to sedimentation would not be treated by the project, as they were not of interest for farmers in the uplands. The high rate of natural erosion compared to human-induced erosion was regarded as a serious constraint.
- The alarming rate at which dams are filling implies the need for an action that can have immediate effects. Any significant action in upland areas would only be expected to show benefit after several decades due to the size of the watersheds. This was not an option that could be considered by the Water Resources Department, which then had to find other remedial actions.
- The extremely high variability of the erosion and sediment transport processes made any assessment of the average yearly rate irrelevant: most of the erosion and sediment transport occur on the occasion of extreme events, (such as storms that lead to landslides) on which soil and water conservation actions would show little impact.

In conclusion, it was not possible for the hydrologists to significantly quantify the impact of watershed management activities on sedimentation in reservoirs. Different results might apply to other areas, with smaller watersheds and different geological conditions, but, in this specific case, each of the reasons given above was sufficient to discard any clear linkage between land management and water resources.

Box 3: Russian Federation, Degradation of small rivers in agricultural zones[15]

A team at Moscow State University studied the problem of degradation of small rivers within different landscape zones of Russia, where the area under tillage has increased by up to 50 percent or more of the total area over the last 300 years. The existence of high quality old maps enabled them to compare changes in river lengths at different times during the period of intensive agriculture. It was found that the total length of the small river net decreased by 30-50 percent during this period because of changed surface water runoff and increased sediment input from cultivated slopes to the river valleys. Natural fluctuations in precipitation were probably the main cause of river-net degradation, as these fluctuations correlated with the level of the Caspian Sea. However, increased volume of sediment from cultivated slopes, which filled up the small river channels, also contributed significantly.

In this example, a combination of anthropogenic and natural causes influenced the degradation of water resources. A quantitative assessment of the influence of natural and anthropogenic factors requires a detailed spatial and temporal analysis. A recommendation for research arising from this experience is to define sediment delivery coefficients for small watersheds, considering the different pathways from agricultural land to river channels.

[14] Faurès, Intervention 4
[15] Golosov, Intervention 19

BOX 4: DOES FOREST REMOVAL IN THE UPLANDS CAUSE FLOODING IN THE LOWLANDS? THE CASE OF THE GANGES-BRAHMAPUTRA BASIN[16]

An example of media headlines for this region states that: "the severe floods in Eastern India and Bangladesh are not the result of a natural disaster, but of a ruthless exploitation of wood which has been practised over centuries in the forests of the Himalayas". Headlines such as these are based on assumptions that the forest cover in the Himalaya is rapidly decreasing, which only holds true for certain areas, e.g., the Western Himalayas of Pakistan. Also, that there is a direct link between forest removal in the Himalayas and flooding in the lowlands of the Ganga and Brahmaputra river systems, and that the mountain people with their forest management practices are responsible for the inundations in the plains – a highly sensitive statement.

The newspaper statement reflects the still widespread wrong assumption that land–water linkages observed in small and medium sized watersheds can be extrapolated to large watersheds. In many studies, it can be documented that in small watersheds the human impact on land–water influences is dominant. In medium sized watersheds it is already difficult to distinguish between man made and natural impacts on the land–water linkages. In large watersheds, natural factors (e.g., heavy rainfall events and deep landslides) clearly are the dominant links between land and water.

There is, of course, a significant contribution of "base flow" from the highland catchments of the Brahmaputra and the Ganga to the floods, but this input is just one element of many others and is not a flood triggering one. The natural rates of weathering and erosion in this tectonically active steep land zone are high, and sediment transport is a dominant process irrespective of vegetation cover. Inappropriate land use practices may still have disastrous consequences within a highland watershed, but conservation practices should not be undertaken with the expectation that they will prevent floods in the lowlands.

The consequences of such myths are further discussed in the following section on assessment and dealing with uncertainty.

As a general rule, as suggested by Table 1, impacts of land use on hydrological and landscape processes can only be verified within small basins, and most of the case studies in fact pertain to small-scale watersheds. At larger scales, natural processes are dominant, which make it difficult to detect any change as a result of conservation practices, particularly on a short time scale. Impacts on water quality can be observed at much larger scales and, in some cases, have been well documented and quantified even in larger basins. However, when dealing with multiple sources of multiple pollutants, one-to-one linkage of causes and effects may remain elusive.

TABLE 1
Measurability of land use effects by basin size

Impact Type	Basin size [km²]						
	0.1	1	10	10^2	10^3	10^4	10^5
Average flow	x	x	x	x	–	–	–
Peak flow	x	x	x	x	–	–	–
Base flow	x	x	x	x	–	–	–
Groundwater recharge	x	x	x	x	–	–	–
Sediment load	x	x	x	x	–	–	–
Nutrients	x	x	x	x	x	–	–
Organic matter	x	x	x	x	–	–	–
Pathogens	x	x	x	–	–	–	–
Salinity	x	x	x	x	x	x	x
Pesticides	x	x	x	x	x	x	x
Heavy metals	x	x	x	x	x	x	x
Thermal regime	x	x	–	–	–	–	–

Legend: x = Measurable impact; – = No measurable impact
Source: Discussion Paper 1

Information on the scale at which land use practices have a verifiable impact on water resources availability and quality is crucial for discussing the feasibility of benefit-sharing

[16] Hofer, Intervention 5

instruments between upstream and downstream resource users. Obviously, when land use impacts do not extend beyond the plot level, it does not make sense to talk about benefit-sharing arrangements on a watershed scale. When they do extend beyond the plot level, the extent to which upstream causes can be linked with downstream effects, and the degree of uncertainty, will determine the agreements that can be made between stakeholders toward a more equitable sharing of costs and benefits.

As a result, there are differing opinions as to whether further work on land–water interaction should be limited to small and medium scale watersheds of up to a few hundred square kilometres. Land–water interactions are only easily measurable at the small scale. While working on minimizing sedimentation in the catchment of a micro-dam in a catchment of five square kilometres may be worthwhile, trying to improve land management at a larger scale, for instance, in Ethiopia in the hopes of seeing a result at the Aswan dam, is not.[17] Similarly, improving tank maintenance in India will lead to measurable improvements in local groundwater, but will not affect flooding in Bangladesh. Rehabilitation also takes less time in smaller watersheds.[18] However, it also is important to consider that natural resource managers often have to make decisions about complex cases at larger scales. The relevant scale will clearly depend on the type of impact addressed.

Adequacy of existing knowledge and understanding of biophysical processes

Much is known about environmental processes involved in land–water linkages. According to one contributor, this knowledge is sufficient to take care of probably 90 percent of land use problems in the world's watersheds, and the remaining ten percent is simply a matter of refining techniques.[19] Methods to inventory soils, geology, vegetation, climate, demographics are well known. Geographic Information Systems and computer programs help to develop model variations for different contexts. The real issue is getting people to understand that after years, and probably centuries, of manipulating a watershed without either understanding "the big picture," not caring, or being a victim of historic, difficult-to-break practices, it may take years of efforts and improved practices to prevent or mitigate degradation.

Others contend that the existing knowledge base is based more on perceived wisdom or myth than on science, which can lead to considerable misallocation of resources. This often occurs when inappropriate generalizations are made, for example by extrapolating from small to large scales, or by making assumptions about processes in arid and semi-arid regions based on observations originating in wet temperate ones.[20] In addition to the need for more basic research in arid and semi-arid regions, this underscores the need for more site-specific information, which may require more emphasis on participatory research and monitoring. This is an approach emphasized in many of the case studies.

Knowledge is not always sufficient to determine which management actions will affect downstream water availability. This makes negotiation difficult. An example is seen in the case study regarding the Rio Paute catchment in the southern Andes of Ecuador,[21] analyzing effects of land use on water retention capacity (see Box 5). Other areas singled out as needing more research include groundwater processes, and changing land–water linkages at spatial and temporal scales.

[17] Moriarty, Intervention 26
[18] Stevens, Intervention 32
[19] Stevens, Intervention 32
[20] Calder, Background Paper 1
[21] Buytaert *et al.*, Case Study 29

Scientists are not immune from the vested interests of their institutions. One contributor suggested that obfuscation benefits these interests, as well as those of consultants and scientists whose existence and livelihoods are dependent on the fostering of crisis scenarios and the design and implementation of what may be economically indefensible amelioration schemes.[22] For example, the wisdom and economic benefits of soil conservation programmes, which have been widely promoted in Africa and Asia, are now under question.

Box 5: Impacts of land use on soil water retention capacity in the southern Andes

In the catchment of the Rio Paute in the southern Andes of Ecuador, soils have a high water retention and regulation capacity because of the presence of allophane clay, in which hollow spheres are formed that store water. Although cultivation is known to affect hydrophysical properties, it is not clear which phenomena control the retention and release of water (i.e., whether it is retained in soil, in vegetation, in organic matter layers, in swamps, in lakes, or in forests, etc.). Traditional analytical methods do not seem to apply as they are based on concepts of equilibrium between gravitational, capillary and hygroscopic forces – other forces are active in the andosols. Therefore, it is not clear which actions of stakeholders will affect downstream water availability.

Given the inherent complexity and uncertainty of land and water relationships, it will not always be possible to have complete information, or to wait for further information before making critical decisions. Inadequacy of knowledge may only become apparent when things go wrong and new problems arise that go beyond the realm of past experience. This reinforces the need for an adaptive approach to management, which is more flexible than a narrow technical framework that assumes complete information can be obtained, at least in principle. Much progress can be made through a process of assessment that identifies existing information of relevance for decision-making and makes it accessible to stakeholders. Greater emphasis is also needed on long-term monitoring because not is known enough to make reliable predictions over long periods of time.[23]

Session 2: Assessing and perceiving land–water linkages

Assessment refers to the process by which links knowledge to decision-making. It involves selecting relevant information as well as conducting relevant research. What is regarded as relevant depends on policy objectives. It may focus on narrow technical questions from the perspective of a single discipline or, through a more integrated and participatory approach, synthesize information from both biophysical and socio-economic disciplines and engage stakeholders in defining the problems, providing information about the local context and identifying the range of management options.

Tools and methods for assessment of the relation between land use and water resources

Many assessment tools have been found to be inadequate for understanding the complex interactions between land and water, although triangulation between results of measurements taken at different times, scales and places, and using different methodologies, can reveal inconsistencies and shortcomings. For example, many estimates of erosion are based on plot experiments that only measure the amount of soil moved. However, much of this soil remains within a watershed. One study in eastern Zimbabwe found that the amount of sediment leaving

[22] Calder, Intervention 11
[23] de Graaff, Intervention 44

a small headwater catchment never exceeded 5 t/ha, though plot based experiments reported 70-100 t/ha.[24] The Andean case study (Box 5) raised questions about the ability to make generalizations based on the use of standard methodologies for identifying key factors that control the retention and release of water in soils, because of differences between the actual hydrophysical properties of the Andean soils examined in the study, and assumptions. The authors speculate that the problem may be pertinent to other soils as well.[25]

The complexity of processes involved in land and water interactions suggests the need for detailed, site-specific models. Better understanding of land use effects on dry season flows, for example, could be achieved through models that consider vegetation, soil physical properties including hydraulic conductivity and water content properties of the soil, and their spatial distribution. A better process for understanding erosion could be achieved by considering the effect of vegetation type, such as size of leaves, which influences drop size, and by relating vegetation type, soils and slope characteristics to specific soil conservation techniques.[26]

Methods of assessment provided in case studies range from describing the application of particular methods to understanding specific watershed processes, to more integrated and participatory approaches. These include:

- comparisons between measurements and model results, and use of models to compare outcomes under different management scenarios;[27]
- surface flow measurements taken in locations selected to be able to isolate hillslope from lowland processes;[28]
- use of caesium isotope deposits as a tracer to examine sediment distribution throughout a catchment;[29]
- chemical analysis of water upstream and downstream from contamination sources and engagement of the community in monitoring, by providing monitoring tools that can be easily understood;[30]
- statistical analysis of correlations between fish catch data in reservoirs and land use maps of the reservoir catchments;[31]
- comparison of basin sediment yield with yield from individual sources, to identify those that contribute to it disproportionately, e.g., unpaved roads;[32]
- comparisons of the results of household surveys regarding perceptions of nitrate pollution, with well samples and nitrogen budgets;[33]
- a participatory process of land use classification and mapping to reveal traditional and existing land use practices, and engage local people to take their own resource management initiatives;[34]
- an Integrated Catchment Management framework to integrate technical knowledge with social learning, to develop knowledge and tools that can provide common ground for decision-making;[35]

[24] Moriarty, Intervention 26
[25] Buytaert, Intervention 29
[26] Calder, Background Paper 1
[27] Cepuder *et al.*, Case Study 1; and Armour, Case Study 6
[28] Cudennec *et al.*, Case Study 2
[29] Golosov and Belyaev, Case Study 9
[30] McGregor *et al.*, Case Study 16
[31] de Silva, Case Study 21
[32] Ziegler *et al.*, Case Study 28
[33] Cortez Lara, Case Study 27
[34] Puginier, Case Study 4
[35] Bowden, Case Study 8

- a Water Resource Audit to consolidate existing data from a wide range of sources, and to highlight discrepancies between scientific knowledge and local perceptions of problems;[36]
- a Participatory Landscape/Lifescape Appraisal (PLLA) to understand community perceptions and water quality concerns, and to foster community involvement in the development of relevant indicators and monitoring.[37]

Some observations from the latter study were that community involvement increases problem awareness and, subsequently, the probability that the research will have a policy impact. Although slow and expensive to initiate, it has the potential for longer lasting benefits. In this case, the indicators were incorporated into the local government's Natural Resource Management Plan and became part of an ongoing citizen water quality monitoring programme. The lack of precision and possible bias inherent in community monitoring needs to be weighed against the advantages of simplicity, mobility, cost-effectiveness and local relevance through comparisons with results of researchers. Other practicalities are that it may also be useful for identifying hotspots for restoration activities, and is faster than waiting for complete scientific understanding.[38]

Parameters and indicators that are easy to monitor

Development of meaningful indicators of water quality that could be easily monitored by community volunteers and by a local government was the explicit objective of the study reported in Background Paper 3. The criteria used to select the indicators were that they were based on scientifically valid methods, relevant to the community, and practical and relatively inexpensive. The parameters selected were:

- Community perceptions, memories and experience – obtained through PLLA;
- Eroded soils and sediment concentration in streams – obtained from measurement of total suspended solids (TSS) during base flow conditions and just before and during selected rainfall events;
- Altered stream flows and soil export – low-tech approaches were developed for estimating stream depth, area and current velocity to indicate alteration of stream flows; this stream flow data was then combined with TSS data to estimate soil export;
- Bacterial sontamination of water – a new and relatively low cost method was used to take measurements in four major tributaries and at community drinking water faucets throughout the municipality; and
- Demographics and land use – this was derived from government census and remote sensing data, and used for comparison with other data collected and to identify patterns; for example, a correlation was found between the decrease in forest cover and water quality degradation.

Other indicators of biophysical changes mentioned that could be easily measured were:[39]

- soil accumulation in a flood plain, which is visually indicated by the burial of root crowns of small trees and shrubs;
- visual evidence for decreasing runoff and flood peaks are smaller channels, more stable tributary channels (with smaller deposits and more vegetation) and less frequent and less severe flooding;

[36] Batchelor *et al.*, Case Study 12
[37] Deutsch *et al.*, Background Paper 3
[38] Deutsch *et al.*, Background Paper 3
[39] Bunning, Intervention 40

- change in habitat and populations of fish and aquatic organisms, to indicate change in water quality, increased sediment load, stream channel instability, and more frequent and violent floods;
- estimate of sediment yield from small hill slope catchments by measuring the volumes of sediment accumulated in excavated farm dams of known ages.[40]

Two case studies examined land use impacts on fisheries, focusing on effects with livelihood importance to local populations, and impacts that can be integrated in benefit-cost analysis. Because of the complexity of ecosystems, they may represent a greater challenge, even in long-standing and well-funded programmes.

Technical and financial constraints to assessment

By definition, a watershed approach implies dealing with large areas and complex issues that are intractable in a narrow and strictly technical framework, for financial as well as technical reasons. A watershed programme in the Fouta Djallon highlands in Guinea was mentioned which first included reference watersheds for purposes of evaluating initiatives in pilot watersheds. The reference watersheds were soon dropped, and impact monitoring was found difficult for lack of baseline data. In many cases, measurable downstream impacts cannot realistically be expected given the small area covered by project interventions relative to the total watershed area. Nevertheless, such downstream impacts are often mentioned as a justification for upstream rural development.[41]

Such limitations are, at least in part, a problem of governance and institutional arrangements, related to the distribution of benefits and costs among stakeholders. Increasing emphasis on participatory approaches in monitoring, assessment, and decision-making reflects not only financial constraints, but also the limits of technical knowledge for solving complex problems, and the need to make value judgements. It demonstrates the value of local knowledge that stakeholders bring to the process. An important role of researchers and organizations is in working in partnership with and providing technical and financial support for community-based efforts. As pointed out in background paper 3, this approach can have high up-front costs but is likely to have longer lasting benefits and may be more cost-effective.

Variability, uncertainty and myths about land–water linkages

Due to the complexity of landscape processes and the long time lag between cause and effect, uncertainty is inherent in any scientific findings and assumptions about land–water interactions. This uncertainty has given rise to a number of overgeneralizations, or myths, regarding land–water interactions (see discussion paper 1 and background paper 1). Such overgeneralizations may lead to negative impacts, when they are used to justify policies and actions and to allocate funds. This can be illustrated in a number of the case studies. For example, the general statement that "all sediment is a pollutant" that underlies attempts to reduce sediment in Colorado, USA, has resulted instead in the incision of stream banks.[42] Another common generalization is that upstream deforestation causes downstream flooding and sedimentation in large-scale basins (see Box 4 regarding assumed links between deforestation in the Himalayas and flooding, in the lower part of the Ganges-Brahmaputra basin).

[40] Conacher, Intervention 43
[41] Facon, Intervention 14
[42] Kimsey, Intervention 9

The singling out of a particular factor, from complex ranges of multiple causes, may be used to support institutional interests and to blame or scapegoat poor and minority populations often found in marginal upland areas. In the Chittagong Hill Tracts in Bangladesh, for example, shifting cultivators have been regarded as the main initiators of erosion. However, shifting cultivation, which is only practised on four to six percent of the area, is in decline because it is no longer regarded as sustainable as a result of diminished productivity. Other factors contributing to erosion include the monsoon climate, steep slopes, extensive deforestation, and increasing land pressure from in-migration.[43] This kind of biased selection of key impacts may also be used to justify more popular structural projects that do not work, and to avoid less popular measures, such as licensing and user fees. Examples of ineffective structural projects include the construction of siltation dams for addressing problems of groundwater depletion, and improving the efficiency of water use in irrigation, which often simply leads to the increase of irrigated areas and accelerates water depletion.[44]

In addition to generalizations about biophysical causes, there are those held about stakeholders, for instance whether millions of small farmers should be regarded as "bottlenecks" in watershed management which "need to be educated in management".[45] Though seemingly harmless, such

Box 6: Zimbabwe: The causes of sedimentation[46]

An experience from south-eastern Zimbabwe was described regarding the myth that 'poor agricultural practices in the headwaters are leading to increased siltation in reservoirs.' The large sugar estates of the lowlands are major agribusiness users of water in Zimbabwe, and rely on an extensive series of mid-catchment storage dams that all face problems of sedimentation. Often, the increased sediment is blamed on poor local farming practices, including deforestation and overgrazing by the 'indigenous,' 'subsistence' farmers of land in the headwaters.

Following the devastating drought of the early 1990s, some of the sugar estates started outreach programmes to work with the farmers in the headwaters to 'improve' their land management. By the late 1990s, those involved in the outreach programme were reporting positive results: the suspended solids entering their dams were decreasing dramatically. Yet, to a disinterested observer it seemed highly unlikely that changes in how the headwaters were managed could have been responsible for these dramatic falls in sediment load. The outreach programme was tiny, and the catchment area large. Research also revealed a 10-year cyclical pattern of above and below 'average' rainfall, possibly related to the El Niño Southern Oscillation (ENSO). The 1980s, which were capped by a drought, had been the driest on record.

The combination of research and local farmers' perspectives allows development of an alternative narrative to that of the sugar cane farmers. This suggests that during the long dry years, water levels drop, shrubs and grass die, and livestock (before dying) exacerbates the situation by eating everything available, turning the area into a desert. During this period, sediment levels generally increase and can erode easily, as what rain does come is unmitigated by vegetation. In particular, large storm events at the end of the dry period can move huge quantities of 'stored' soil. However, once a wetter period is entered, browse and crop cover quickly returns, aided by low livestock numbers, and erosion more or less ceases – until the next dry cycle.

Just as the account of sugar cane farmers, the above is a narrative rather than a scientifically proven account. Proof, in this case, would require monitoring sediment loads and other key parameters for a full 20-year cycle. However, it corresponds with what is known of erosion from other arid and semi-arid regions. Photographs of the study site in the 1990s show a bare expanse of red earth, in no way comparable to the lush 'humid' vegetation seen since 1994. Sediment measured leaving a small headwater catchment, where there had been no outreach programme and where subsistence agriculture was being practised, never exceeded 5 t/ha – far below the 70-100 t/ha reported from so many plot-based experiments.

[43] Hopkins, Intervention 45
[44] Facon, Intervention 49
[45] Stevens, Intervention 53
[46] Moriarty, Intervention 26

metaphors play powerful roles in shaping policy and programmes. It may also be convenient for experts to base their advice on unverifiable assumptions.

The uncertainty inherent in findings and assumptions about land–water interactions needs to be made very explicit to avoid the emergence of new myths. For example, in the Zimbabwe case (Box 6), the explanation that links sediment reduction to 20-year climatic cycles cannot be proven without conducting a long-term study and therefore includes a degree of uncertainty, but it is consistent with available information.

One conclusion that can be drawn from the Zimbabwe case study is that both climatic fluctuation and land–use changes influence erosion rate and sediment delivery, though little is known about relationships between the natural and anthropogenic factors responsible for sediment redistribution within river basins.

Another conclusion that can be drawn from it is that assumptions about land–water interactions need be continuously questioned and revised in light of new information. Given that watershed problems are often tied to cycles much longer than 20 years and to less frequent extreme events, myths help to form perception of long-term relationships that are otherwise difficult to perceive. Myths can be an impediment to the formulation of sound policies with regard to land–water relationships when decisions and institutional commitments are based on them, as this reduces flexibility and the capacity for adaptive responses.

One participant expressed concern about the danger that the concept of "forest myths" could be interpreted to imply that conservation and reforestation are not significant to the stabilization of watersheds.[47] Decisionmakers expect to be given explicit advice as to policy options and actions that can be taken. The message that "it depends" may instead lead to confusion and open the door to greater arbitrariness.

It was suggested that it is the role of scientists to seek out and expose pseudo-science myths upon which much of current land and water management policy is based, and which continue to lead to misallocation of development funds on projects with unachievable objectives.[48] They also have a responsibility not to oversell explanations when informing policymakers, though their message may be used in unintended ways.[49]

Part II: The Lifescape Perspective

A defining characteristic of watershed management is that resulting costs and benefits are divided between upstream and downstream people, and in time, between the present and the future. This makes it difficult to assess the benefits and costs, which is necessary to achieve an equitable sharing among upstream and downstream stakeholders, creating incentives to expand beneficial land uses and discourage negative ones at a watershed scale. It implies the need to explore and develop new economic and regulatory instruments as well as social and institutional arrangements for watershed management.

With respect to typology, there was some discussion of the term "watershed management" itself, and whether or not it is useful to distinguish it from "watershed development". However, following clarification, there was no disagreement that the term watershed management pertains

[47] Echavarría, Intervention 50
[48] Calder, Intervention 68
[49] Hafner, Intervention 56

to socio-economic as well as biophysical concerns and is therefore inclusive of livelihood concerns,[50] at least in theory if not always in practice.

Session 3: Valuing land–water linkages: assessment of benefits and costs

Direct and indirect water use values affected by land use

The most significant use values of water that may be affected by upstream land uses are those associated with agriculture, production of hydroelectricity, and domestic uses in urban areas. Other use values may include forestry, aquaculture and recreation. In addition, indirect uses include flood control, sediment retention, water quality, transport, flow regulation, fishing, and climate stabilization. Consumptive uses, which are primarily associated with agricultural, domestic and some industrial uses, are those that affect water quantity and quality because they make it unavailable to others.[51] For example, irrigation, which consumes water, may be of greater concern to downstream stakeholders than hydroelectric production, which uses the flow of water without consuming it. Consumption does not always have negative economic impacts. In one case, use of water for rice paddies in Japan was found to have significant downstream benefits of flood control as well as groundwater recharge, soil erosion control, and preservation of the landscape and biodiversity (see Box 7). Aquatic resources and riparian areas may also have significant non-use values, as reservoirs of biodiversity.

BOX 7: THE BENEFITS OF RICE PRODUCTION IN JAPAN[52]

Economic benefits of rice production in Japan include:

- Flood prevention: total water storage capacity of paddy fields in Japan is estimated at around 4.4 billion m^3, which is much higher than the total storage capacity of dams constructed for flood control. Peak runoff from paddy field areas is 3 times less than peak runoff from 75 percent urbanized areas. Several municipalities therefore subsidize paddy production. This subsidy amounts to between 20 and 80 percent of the gross income from rice production. Total benefit from paddy fields for flood prevention is equivalent to constructing flood control dams worth 1.95 trillion yen per year.
- Groundwater recharge: Groundwater recharge is estimated at 160 million m^3 per day in whole Japan. This supports pumping for domestic and industrial use. The benefit of groundwater recharge based on the construction of the equivalent reservoirs is estimated at 800 billion yen per year.
- Soil erosion control: 40 percent of paddy fields are terraced sloped land. Total benefit assessed by the construction cost of soil sedimentation dams is estimated to be about 40 billion yen per year.
- Preservation of landscape and biodiversity: willingness to pay in Nara Prefecture for the preservation of paddy fields is estimated at about twice the value of gross production of paddy rice (at Japanese prices). Willingness to pay of the paddy fields in mountainous areas was 74 percent and 91 percent higher than those in flat areas and suburbs, respectively.

[50] de Graaff, Intervention 33; Stevens, Intervention 53
[51] Echavarría, Background Paper 4
[52] Facon, Intervention 14

Valuation of benefits and costs for downstream users

Assessment of costs and benefits of a particular land use is more straightforward when links between causes and effects are well understood, which, in a watershed context, is often not the case. Given this uncertainty, it is important to recognize that results represent best judgement, based on what information is obtainable, and that they only represent a limited period of time. Also, that they only represent factors considered as costs and benefits in the analysis. Although non-monetary costs and benefits, as well at those that only become evident over long periods of time are usually not considered in this type of analysis because of methodological difficulties, it is not always necessary to include these to justify watershed protection. In the Loukkos project (see Box 8) for example, streambank erosion and landslides that may be influenced by land use were not considered, which suggests that the estimated high rate of return is a conservative one. Policy and social ethics may make it necessary to include less tangible and less certain costs and benefits.[53]

The assessment requires estimation and comparison of net downstream benefits, with and without a particular intervention, for which two examples are provided in background paper 5 (see Boxes 8 and 9).[54] The key factors considered will depend on the particular costs and benefits of concern, and the environmental changes they are associated with. For example, if the concern is water supply, the key factor will be changes in dry-season flow. Estimation of this change can then be used to estimate changes in yield of irrigated crops or potential reduction of reservoir levels and hydroelectric generating capacity. If the concern is flood control, the key factor will be changes in peak flow. Changes in the flow regime then need to be linked to changes in land use. For example, disturbances from fires, cyclones, and selective logging will affect flow regimes differently from conversion to agriculture.[55]

Changes in sedimentation rates can have positive or negative economic impacts, depending on where the sediment is deposited. For example, sediment deposited in agricultural areas may be beneficial. When it is deposited behind dams, it may decrease the life of the dam, which may be irreplaceable because of limited availability of new sites, and reduced hydroelectric generating capacity.[56]

A methodology suggested for estimating land use related changes in biomass production, stream flow and downstream sedimentation, and also as a way to make monitoring more manageable, is to subdivide the watershed hydrological subunits, based on agro-climatic conditions. It can then be further divided into upper, lower and middle parts based on altitude and physical characteristics. This information can then be combined with land use and technology data to calculate water balances for different scenarios and time periods, and assess erosion, sedimentation and production changes.[57] Another methodology suggested, now being tested on the Zambezi river, was to develop a process model emphasizing rates of reproduction of renewable resources, that describes changes in the system. Economic analysis can then be applied to a given state in the system.[58]

One case study described an economic valuation of impacts of irrigation on aquatic resources was based on a household survey regarding use of aquatic resources, the value of the catches, and how these values were affected.[59]

[53] Appelgren, Intervention 54
[54] de Graaff, Background Paper 5
[55] de Graaff, Background Paper 5
[56] de Graaff, Background Paper 5
[57] de Graaff, Background Paper 5
[58] van Wesenbeeck and Albersen, Intervention 46
[59] Lorenzen, Intervention 20

Box 8: Economic evaluation of the Loukkos Watershed Project in northern Morocco[60]

The Loukkos river basin (1 820 km^2) provides stream flow for the Oued El Makhazine reservoir, which provides irrigation water for 25 200 ha, hydroelectric power, water supply and flood control. About half of the watershed area shows signs of severe erosion. Conservation measures implemented by the Loukkos Watershed Project included: reforestation, pasture management, olive and fruit tree plantations, channel stabilization, gully control and road construction. Based on the level of sedimentation in the reservoir, and estimated annual soil loss, the sediment delivery ratio was estimated to be 39 percent. Assumptions were made about the extent to which vegetation would reduce sedimentation, which provided a basis for estimating the extent to which irrigated crop losses would be reduced. Also included in the analysis were benefits from olive and fruit production. Based on these benefits, it was found that the project would have an internal rate of return of 15.9 percent and would have a net present value of US$ 18.8 million. Not included were the benefits of reduced soil nutrient losses, and increased productivity of animals and wood.

Box 9: Economic evaluation of Konto River watershed development activities in east Java, Indonesia[61]

The Upper Konto River watershed area (232 km^2) drains into the Selorejo reservoir, which provides hydroelectricity and irrigation water benefits for 5 700 ha downstream. Conservation measures implemented by a watershed development project to counteract land degradation included: reforestation, coffee rejuvenation, terracing, gully control, and grass planting. An evaluation of the costs and benefits of project activities was based on an assessment of the effects of increased vegetation cover and higher water infiltration which could potentially increase minimum dry season flows as well as reduce wet season flows. A method similar to the above (see Box 8) was used to estimate soil conservation related benefits. To estimate benefits of stream flow changes, it was necessary to also estimate evapotranspiration, infiltration, and direct runoff for each type of land use, which included: natural forest, open forest, shrub, coffee, poorly and well terraced rainfed land, irrigated land and built-up areas. This runoff was apportioned to dry and wet season, and estimates were made of how this would be affected by land use changes. Estimates suggested that dry season flows would have a minimal increase but that the decrease in wet season flows, though small, would reduce annual flood damage by 5-10 percent. This last estimate was based on levels of damage associated with past flood patterns. Together, the flood control and sedimentation related benefits were comparable to on-site benefits of wood and coffee production.

Session 4: Sharing benefits and costs from land–water linkages

The results of economic valuation can be used to identify existing financial incentives that various stakeholders have for implementing conservation measures. This information can improve the learning and negotiation among stakeholders with a view to developing more effective and equitable ways of reducing the costs and sharing the benefits of land use impacts on water resources. Development of new incentives requires consideration of institutional, regulatory and economic issues. Watersheds provide a frame of reference for considering all of these issues in a broader context, and for building awareness of upstream-downstream relationships among stakeholders. The following sub-sections identify various types of mechanisms and instruments, ways that they have been applied, and associated constraints, that need to be considered when selecting an approach that is appropriate for a particular context.

[60] de Graaff, Background Paper 5
[61] de Graaff, Background Paper 5

Benefit-sharing mechanisms for linking upstream and downstream users

Mechanisms and instruments for linking upstream and downstream users to share the benefits and reduce the costs of watershed management include a broad range of approaches: regulatory instruments, economic instruments, mechanisms to increase market access, educational and awareness-building measures, the development of organizational arrangements, and participatory approaches. Also mentioned were approaches rooted in local knowledge and customs. These measures rely on the existence of effective and appropriate biophysical and structural responses for mitigating problems of watershed degradation. Most often, different instruments are used in combination.

Economic instruments generally involve various forms of transfer of payments between downstream and upstream stakeholders, but may also include transfers between land users and society at large, such as government subsidies that influence the magnitude of land use or that are aimed at economic development of marginal upper basin areas.[62] Examples of specific economic instruments presented and discussed in the workshop include: water pricing and allocation reform through the establishment of user fees and tradable water entitlements or pollution permits; removal or correction of subsidies; cost sharing arrangements to cover costs of works activities and ongoing operations and maintenance, in which the contributions of downstream beneficiaries are made through state and federal governments;[63] and improvement of market access for upstream farmers. One way to do this is through negotiating agreements with businesses to purchase from farmers who participate in development and implementation of management plans, another way is through labelling of products from these farms.

Many initiatives have not been in place long enough to evaluate their effectiveness for actual conservation but a number of initiatives appear promising at least from the standpoint of engaging stakeholders and gaining support and cooperation. Some examples that have had promising results are:

- A water tax-scheme in Baden Württemberg Germany, in which proceeds of a water use tax finance compensation payments for restrictions on fertilizer use in water protection zones;[64]
- A property tax rebate of up to 80 percent for preparation and implementation of a forest management plan in the New York City watershed;
- Purchase of development rights or conservation easements on particular tracts of land, also in the New York City watershed;
- Sale of downstream fish products to upstream farmers at a discount (see Box 10);
- Establishment of a fund for upstream conservation activities financed through downstream user fees, as is seen in the Cauca Valley in Colombia[65] and in Quito, Ecuador (Box 11);[66]

Use of environmental criteria for the allocation of a portion of sales tax revenue – in the state of Paraná, Brazil, part of revenue from a sales tax is allocated to municipalities in watersheds upstream of water sources for public drinking water systems, to increase the resources available for environmental protection and improve water quality.[67]

Other instruments that could be categorized as economic, even if non-monetary, are traditional incentive systems within communities. For example, in Konso, a semi-arid area in southwestern

[62] Kiersch, Discussion Paper 2
[63] Feehan, Case Study 22
[64] Kiersch, Discussion Paper 2
[65] Echavarría, Background Paper 4
[66] Echavarría, Case Study 30
[67] Echavarría, Background Paper 4

Ethiopia, a man has to build a terrace before he is allowed to marry, which seems to provide the required incentive. This area has a high population density and intense land pressure but less visible erosion than a nearby area to the north.[70]

Box 10: Environmental transfer payments in Zamboanga Province, Mindanao, Philippines[68]

In a region where upstream farmers had been applying Sloping Agricultural Land Technology (SALT) and other soil and water conservation methods for approximately 8 years, the quality and quantity of fish stocks downstream, which had been nearly depleted, rose significantly. The fishermen observed increased growth of plants in the water and lower siltation levels. A forester from the upstream site brought the farmers' association and the fishermen's association together and they worked out an agreement: in recognition of the beneficial impact of upstream land management regimes which had reduced erosion, fishermen sell their fish to members of the upstream organization at a discount (75-80 percent of market price approximately). This agreement has been in operation since 1997 and the two associations have held quarterly meetings since, always supported by the project staff.

Box 11: Watershed protection fund to preserve drinking water in Quito, Ecuador[69]

A case study on the Water and Watershed Protection Fund (FONAG) as a mechanism for the conservation of the Cayambe-Coca and Antisana nature reserves in Ecuador describes a proposed financing mechanism for water and watershed protection activities in the upper watersheds of the city of Quito, Ecuador. Local (e.g. the water supply company) and international sources will be contributing to the fund. A board that consists of representatives of the local water and electricity companies, water users, regional and local government, communities, and non-governmental organizations will govern the fund. It will finance conservation activities with the aim of ensuring a clean, dependable water supply.

Regulatory instruments consist of a wide range of restrictions that may be applied to the use of land and water resources, from limitations on pesticide and fertilizer use to the establishment of zones in which some land use practices are allowed and others forbidden. Regulations are often difficult to implement because of the potential economic losses to resource users, who may have to be compensated, depending on the individual circumstances. However, economic incentives are not necessarily a substitute for regulations but are sometimes a complement. For example, for tradable permits to work, a regulatory cap on pollutant emissions or resource extraction is required. Participation in market measures may also be motivated by the threat of regulation, and capacity to enforcement agreements is also necessary for them to work effectively.

Implementation of economic and regulatory measures tends to be more effective when they are part of broader approaches that include education and awareness building activities. Strong community interest and participation makes it feasible for measures to be implemented over large upper-watershed areas, which may not be possible under a centralized command and control approach. This in turn depends on the existence of appropriate organizational arrangements that provide opportunities to participate.

An example of education and awareness building approaches is found in case of the New York City watershed where farm audits are conducted and pollution sources are identified with farmer participation, in conjunction with offering economic incentives to reduce pollution.[71] A

[68] Agostini, Intervention 52
[69] Echavarría, Case Study 30
[70] Hopkins, Intervention 45
[71] Kiersch, Discussion Paper 2

participatory approach, involving farmers in central western Brazil, made it possible to extend the development of micro-dams, built to contain polluted runoff and promote recharge of water tables, to cover an entire micro-basin.[72]

Participation often takes place through watershed associations, developed to reduce transaction costs in stakeholder negotiations. An important consideration is that there are different interests at different scales – reflecting these differences in organizational arrangements can provide greater opportunities for public participation. At larger scales, participation is a challenge because it is more difficult to engage all concerned people in all of the affected communities. At these scales, there is a greater role of regional and national governments. Development of self-help groups below the village level can provide a foundation for watershed associations that encompass multiple villages[73] and also ensure that these local interests are represented in negotiations over large-scale problems.

Further important elements of organizational arrangements are the decision-making autonomy of watershed associations and transparency in how money is managed and spent. This is seen in the example of the Cauca Valley of Colombia, where large-scale downstream agricultural users pay a user fee to water user associations that work as private foundations in implementing watershed conservation projects. The local authority oversees the technical aspects, works with these organizations and even helps in the payment process, but the resources are managed independently by each organization.[74]

Ultimately, the different types of instruments are best seen as elements of integrated approaches, including crop management, agricultural and crop pricing policy, macro-policy measures, and structural change,[75] with the objectives of poverty alleviation and improvement of upstream living conditions in ways that are consistent with watershed protection.

Integrated regional and basin-wide approaches often evolve from a narrow to a broad focus, as is seen in the examples of Laguna Lake and the Agno Basin (see Box 12), which illustrate the evolution of a mandate from management of a water body to its whole catchment area with the involvement of upstream and downstream users. These examples also demonstrate that stakeholders can be brought together around a shared vision and strategic plan, that basin-wide planning can foster development that is more equitable between upstream and downstream users, and that coordination among government agencies is important.

An example from India (see Box 13) illustrates the process of scaling up, from local ad hoc to national and intersectoral initiatives with broad-based collaboration, and suggests that NGOs can play an important role in this process.

At the largest scales, in international river basins, it becomes necessary for agreements to be reached among all riparian states. Because of the difficulties of linking causes and effects at these scales, conflicts and concerns are generally over water allocation issues. For example, in the Niger basin, there is concern with water diversion for irrigation as development proceeds in the upstream riparian states. Basin-wide planning may include joint responses to drought and climate change. Lacking a centralized authority, river basin negotiations tend to become the basis for general economic cooperation that transcends water resources development. Basin-

[72] Cordoval de Barros, Case Study 25
[73] Lorenzen, Intervention 20
[74] Echavarría, Intervention 50
[75] Appelgren, Intervention 6

BOX 12: THE EVOLUTION OF INTEGRATED BASIN-WIDE APPROACHES IN THE PHILIPPINES - LAGUNA LAKE AND THE AGNO BASIN[76]

After several initiatives to create regional and basin-wide planning agencies had failed, the Philippine government took a renewed interest in building the capacity of the Laguna Lake Development Authority (LLDA), and the Agno Basin Development Commission (ARBDC).

Laguna Lake is the major water source for Metro Manila. LLDA was given regulatory powers related to use of the lake and regional development activities, developed a master plan containing a vision and strategies for achieving it, and adopted a multi-use policy, shifting from a focus on fisheries promotion to environmental protection and pollution control at the watershed level. It also implemented a user fee system, encourages multi-sector involvement to stop degradation of 21 river systems draining into Laguna lake, and commissions relevant studies and projects.

The ARBDC is not an authority but relies instead on the commitment and participation of related agencies, and provides leadership for a programme of basin-wide strategic planning and management. In the course of its activities, it developed a comprehensive master plan that was integrated into local and regional plans and investment programmes. Related activities include coordination of the implementation of a development programme and projects, review and recommendation of project proposals, identifying and proposing policy improvements, coordination of monitoring, soil erosion prevention and siltation mitigation activities, flood control, and establishment of an information system.

wide hydrologic monitoring and forecasting systems could provide better support for integrated management of resources.[77]

BOX 13: INDIA: THE ROLE OF NGOS IN THE PROCESS OF SCALING-UP

Watershed management efforts in India began as ad hoc soil and water conservation measures over two decades ago but have evolved into a national level integrated inter-sectoral participatory approach with substantial budgetary provisions for the rehabilitation and development of micro-watersheds. A key factor that influenced the change was the success of a few local initiatives taken by NGOs. Scaling up has taken place formally as a result of government funding to communities through NGOs for programme implementation, and informally, through cross-learning between NGOs and village communities. NGOs have therefore played a significant role in the process through programme implementation and institutional capacity building.

Constraints to the implementation of benefit-sharing mechanisms

A number of constraints to the mechanisms discussed above are often encountered in the implementation phase. These range from the need to find a compromise among conflicting interests over the distribution of their costs and benefits, to the institutional challenges and up-front costs of engaging stakeholders in the initial planning phases; weak or non-existent property rights that can provide some assurance to people that they will reap future benefits; poverty; and lack of perception that there is a problem to begin with.

Conflicting interests are often found between objectives, which may also be related to jurisdictional boundaries. At the most general level, there is often a conflict between the objectives of sustaining livelihoods in the short term, and protection of resources. The Working for Water programme in South Africa, which provides training and employment as part of efforts to eradicate the introduction of exotic vegetation that consumes large amounts of water, represents one attempt to reconcile these objectives.[78] An ideal mechanism is one that harmonizes conflicting

[76] Facon, Intervention 57
[77] El-Khodari, Intervention 10
[78] Calder, Intervention 42

objectives and provides ample clean water to all users, in which the role of the government is to provide regulatory frameworks in which private enterprise profits from improving delivery and quality of water, to protect human and environmental health, and to harmonize interests. In the real world, governments often fail to fulfil these basic obligations, even in disaster situations, and mechanisms are often manipulated to the advantage of the more powerful interests.[79]

Inherent in various mechanisms, are different ways of distributing costs and benefits, not only between upstream and downstream users, but also within communities, where burdens may fall disproportionately on parts of the population, such as women or minority groups. For example, closing of common forest and grazing areas to allow for regeneration may disproportionately affect landless and pastoralist households, or may reduce women's access to firewood and fodder.[80] Acceptance of a particular arrangement of costs and benefits depends on whether they are regarded as fair. Equally important is the designation of an acceptable body to implement and to oversee implementation.[81] It is therefore important to make clear who will benefit by and who will pay for potential interventions.

A particular equity concern related to the use of economic instruments is that transfer payments to upstream land users to implement conservation practices may reverse the "polluter pays" principle. This may make upstream farming more attractive rather than encourage alternative livelihood strategies.[82] In principle, upstream users should accept cost sharing for pollution they are responsible for, and it was recommended that subsidies for adopting infrastructure and management practices be accompanied by a tax on pollutants in the future.[83] However, it was also recognized that incomes are lower in rural areas, which may be related to other kinds of equity problems. French agricultural policies illustrate one way this problem has been addressed (see Box 14).

Box 14: Multiple functions in French agriculture[84]

In France, agriculture is considered to have multiple functions and is supported and regulated by policies and regulations found across several political and administrative levels. In return for providing food security and for maintaining landscapes and environmental quality, farmers expect a decent income. Consumers are increasingly willing to pay for this directly or as taxpayers. A recently created instrument in France provides financial incentives for adoption of best practices and for producing the public good of maintaining the landscape, and is also supplemented by water fees and eco-taxes. Direct benefit sharing takes place through quality or provenance labelling, tourism, and use of water fees to assist upstream users in implementing environmental regulations. In contrast, previous policies to reduce nitrate pollution by the livestock industry were found to be ineffective because incentives had not been accompanied by a sanction on pollution.

Additional constraints to the implementation of benefit-sharing mechanisms are weak or non-existent property rights, and lack of institutional capacity for collective action, which are both necessary for watershed management because management practices are above the individual farm level, and benefits tend to be only in the long-term. Thus they can help to address issues of spatial and temporal scale. However, the relationships are not always simple because land–titling programmes may decrease the security of those who lack the education and connections needed to gain a formal title. There is also evidence that customary tenure arrangements can provide enough security for people to invest, although they are often not recognized by government. In Southern Mindanao, land tenure was found to be a key factor in

[79] Kehrig, Intervention 55
[80] Meinzen-Dick, Intervention 37
[81] Davidson, Intervention 16
[82] Agostini, Intervention 52
[83] Facon, Intervention 49
[84] Facon, Intervention 49

the adoption of soil conservation technologies (see Box 15). Collective action has been found to emerge for various reasons. For example, people may participate as a way to establish good relations or because it is "the right thing to do."[85]

Box 15: Philippines: The role of tenure in the adoption of soil conservation practices[86]

In Southern Mindanao in the Philippines, farmer adoption of soil conservation technologies (Sloping Agricultural Land Technology – SALT) was low, but there was a higher rate of adoption among landowners than among tenants. Constraints to the adoption of SALT were that farmers were required to give a significant amount of land to tree crops or hedgerows, which also required an increase in labour. Even when grants were provided, agroforestry farmers failed to maintain the hedgerows. It is also unlikely that loss in area cultivated would be compensated by higher yields though there might be financial benefit after 3-5 years. Subsidies are therefore needed if this is to be used as a strategy for reversing land degradation.

The process of engaging stakeholders is ultimately a problem of governance. Ensuring that local interests are represented and considered at the larger scales is a way to build capacity for collective action. Constraints to the scaling-up process, revealed in evaluations and consultations between government agencies, NGOs and donors, include: inadequate and ineffective participation of the watershed community; insufficient integration of gender and equity concerns; lack of inter-departmental coordination; inadequate emphasis on building the capacity of staff and community members; and lack of monitoring mechanisms. Also, needs of women and resource-poor groups are easily overlooked in implementation unless they are involved in the planning process. A phased implementation was recommended, with more emphasis on community organization in the first phase, and implementation of physical works in the second.[87]

The most obvious constraint is funding, which in some cases is restricted to particular uses that fail to address the most urgent problems. For example, if sedimentation problems due to unstable slopes in danger of landslides and riverbank erosion call for structural measures, restriction of funding for small-scale participatory approaches will leave the most urgent problems unaddressed.[88] At the household level, poverty often constrains the adoption of options that require investment for long-term benefits. This implies the need to focus on measures which have quick and direct benefit to the local population.

Criteria for success in implementation of benefit-sharing mechanisms

A number of comments addressed the set of criteria for success in implementation proposed in discussion paper 2.

1. "The impact of upstream land use on downstream water use is well understood."

   This is not necessarily so at the beginning of a programme, because groups tend to organize around priority issues and opportunities. However, to reach agreement, there needs to be a way to determine costs and benefits as they are initially perceived by stakeholders, which may change as understanding is increased. Costs and benefits may also change depending on the portfolio of activities chosen and on external conditions,[89] as was seen in the example from Zamboanga Province in Mindanao, Philippines, where fish stocks rose approximately eight years after upstream farmers began to adopt soil conservation methods. The upstream farmers association and the fishermen's association were then able to work out an agreement

[85] Meinzen-Dick, Intervention 76
[86] Hopkins, Intervention 45
[87] Pangare, Intervention 66
[88] Facon, Intervention 14
[89] Dixon, Intervention 48

in which fish were sold at a discount to members of the upstream farmers organization (Box 10).[90] This criterion might be modified then to state that "There is some common understanding and agreement among stakeholders regarding the impacts of upstream land use on downstream water use, as well as awareness of uncertainty."

2. "The impact of land use on water resources clearly dominate over natural impacts or other anthropogenic impacts"

   This criteria could be considered a part of criterion 1.[91]

3. "The groups of upstream and downstream stakeholders are few and well-organized."

   This criterion was considered important. Based on overall discussions regarding the formation of watershed associations that can be composed of numerous stakeholders, it should be modified to state "The groups of upstream and downstream stakeholders are generally few and/or well-organized."

4. "The economic impact of land use on downstream stakeholders can be quantified."

   Margins of error do not necessarily impede a satisfactory outcome, because payments just need to cover the extra effort not otherwise compensated for through on-site benefits, and those downstream will only be willing to pay for additional benefits received. Therefore it is not always necessary to know exact impacts.[92] The criterion should be modified to say that impacts can be "approximately" quantified.

5. "The incentives to upstream and downstream resource users offered by the benefit-sharing instruments are high enough so that the users give preference to the instruments over alternative solutions to their problems."

   This appears superfluous because it is a standard criterion for any choice and does not seem to add to criteria for benefit-sharing.[93]

6. "There is political commitment to establish upstream-downstream linkages."

   This may be necessary at larger scales. At smaller scales, at which there is a realistic chance of determining impacts, stakeholders can act and negotiate independently of policy frameworks. Outside assistance may still be important for providing information and training regarding physiographic and hydrological linkages, and support for negotiations. Even at this scale, changes in the legal and institutional environment may be necessary if there are obstacles to the implementation of transfer payments. This criterion might be modified to say "There is a commitment to establish upstream-downstream linkages, whether it is through contractual agreements or through policy frameworks, and some underlying technical basis for it."

7. "There is a strong institutional and legal framework, including land tenure structure, which may allow for or hinder the implementation of benefit-sharing instruments."

   This is ambiguous. It was pointed out that, in Zamboanga, Philippines, (see Box 10) farmers had been granted tenure in exchange for land use conditions, and that it is therefore not clear why the fishermen compensated them. One possible explanation is problems in enforcement of tenure regulations, which would suggest that such benefits may compensate for lack of a strong institutional and legal framework. Further examples are needed to clarify this issue.

[90] Agostini, Intervention 52
[91] Agostini, Intervention 52
[92] Agostini, Intervention 52
[93] Agostini, Intervention 52

Suggestions for additional criteria included:

"There should be decision-making autonomy for those who pay and who benefit, and a transparent mechanism for deciding how the money is spent."

This criterion was suggested based on experience in the Cauca Valley in Colombia, where large-scale downstream agricultural users pay a fee to water user associations that then implement watershed conservation projects. Resources are managed independently by each organization, although a local authority may oversee technical aspects.[94]

"Management interventions and also watershed associations should be appropriate to the scale of the river basin".

The scale of the river basin is critical to the effectiveness and the penetration of management interventions. Meso-basins of 100-500 km^2 within well-defined jurisdictions at the state or national level seem to be optimal.[95]

"Basin treaties should be acceptable to all riparians, for equitable use, protection and management of water resources in basins."[96]

This criterion appears to be fundamental to translate conservation and development programmes into negotiated, voluntary and self-enforcing agreements as well as for cooperation in inter-jurisdictional and transboundary watersheds.[97]

"Information about impacts, and their potential costs and benefits, needs to be communicated using common methods of expression."

For example, the concept of agro-climatological zones is easily and widely understood, and would also allow for assessment and extrapolation of actual and potential land use and production in relation to land use, management capacity and environmental hazards.[98]

[94] Echavarría, Intervention 50
[95] Appelgren, Intervention 54
[96] El-Khodari, Intervention 10
[97] Appelgren, Intervention 27
[98] Appelgren, Intervention 54