Sustainable Watershed Development: IWMI's Challenge in Asia and the Pacific

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Abstract

The Asia and Pacific region occupies about 23 percent of the world's land surface, about 72 percent of which (16 percent of the world's total) is occupied by 27 developing countries. Nearly 60 percent of the total land surface of the region is dominated by mountains and high plateaus where a large percentage of the population lives. A major portion of these areas is used for agriculture and has become seriously degraded and less productive. Thus, management strategies to improve the farmers' income and minimize or reverse the land degradation process are badly needed.

IWMI is very much concerned with programs that are related to watershed management. This is reflected in its mission of "improving water and land resources management for food, livelihoods and nature". In this regard, IWMI now implements three major programs that address land and water management at the level of catchments and river basins.

The Management of Soil Erosion Consortium (MSEC) makes use of the lessons learned from an earlier project on the management of sloping lands. It now intends to direct its focus from purely soil research to a broader theatre of integrated land and water management. The Comprehensive Assessment Program (CA) and the Global Challenge Program (CP) cover a much larger scope in terms of physical area and substantive coverage. All three programs aim not only to develop technological options for better land and water management, but also the mechanisms to best sustain the overall development progress. IWMI expects that through these programs, it will be able to contribute to improving food security and livelihoods, in harmony with nature.

Introduction

The Asia and Pacific region occupies about 23 percent of the world's land surface, about 72 percent of which (16 percent of the world's total) is occupied by 27 developing countries (Dent, 1990). Nearly 60 percent of the total land surface of the region is dominated by mountains and high plateaus (FAO, 1986). As of 1999, about 56 percent of the world's population lived in the region (World Bank, 2001). Population pressure has dramatically forced the proportion of this population to reside in uplands. The population of the tropical steep lands of Asia is estimated by the International Food Policy Research Institute (IFPRI) to be 263 million, many of whom live in poverty (Craswell and Maglinao, 2001).

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Agriculture is the economic mainstay for the majority of the people in the watersheds. However, the overall returns from agriculture are so low that they are not adequate to fulfill even subsistence requirements. Moreover, the farming practices employed are usually environmentally unsustainable resulting in deteriorating productivity of the watershed ecosystem. This degrading condition is causing adverse effects not only in the uplands but also in the adjoining lowlands that are home to another 25 percent of the world's population. Thus, there has been a strong need to reverse this downward process through the development and application of more sustainable watershed management innovations for upland development.

This paper presents a review of the present status of watershed development in Asia, the problems and constraints, and the suggested strategies to address these constraints. It likewise discusses the outputs of the Management of Soil Erosion Consortium (MSEC) project and other programs of the International Water Management Institute (IWMI) to support the global effort of reversing natural resource degradation.

Status of Watershed Management and Development in the Region

Watershed Management as an Approach

Watershed management has been defined as "the approach or process of establishing an enabling environment for the sustainable use of natural resources, especially land and water resources, to address the twin objectives of resource conservation and food security" (PCARRD, 1991; Koohafkan, 2001; Shivakoti and Neupane, 2001). With the ultimate goal of sustaining watershed development, the strategy has undergone changes through time.

In the past, watershed management was strongly identified with forest management and rehabilitation and was preoccupied primarily with securing water supplies and/or minimizing downstream damage by sedimentation and flooding emanating from "critical" watersheds (Koohafkan, 2001). Integrated watershed development and management has evolved as a development intervention framework facilitating sustainable utilization of natural resources and producing various services as required by the policies and priorities of the state and the local population (Jensen, 2001).

The Food and Agriculture Organization of the United Nations (FAO) has initiated a review and assessment of watershed management strategies and approaches to determine the present status of watershed management development, identify any major gaps, and formulate guidelines for future development projects/programs (Tennyson, 2002). Comparing the major issues and constraints in watershed management as described in 1986 with the current situation in 2002, the study showed significant progress in some aspects of the approach (Table 1).

Table 1. Major issues and constraints on watershed management and their status as of 2002

Issues and constraints	Current status
Policy, legislation and regulations	• Watershed management becomes an integral part of upland development • Existing legislative and regulatory measures now emphasize more on empowerment than enforcement • Coherent policies to coordinate and promote watershed management still inadequate
Institutions and organizations	• Implementation of watershed management activities has shifted from a single department to a multi-agency responsibility • Well trained watershed management staff at all levels still inadequate
Problem identification, program planning andproject implementation	• Rapid rural appraisal method has been developed and used globally • Social and cultural issues are now an integral part of planning • Scope of watershed management activities still needs to be clearly defined especially when it is integrated with rural development • Economic analysis models remain inadequate • Absence of operational guidelines for development of programs that will resolve conflicts between project objectives and administrative organizations
Monitoring and evaluation	• Performance monitoring and evaluation has improved with the identification of verifiable indicators in project design • Social and cultural factors are also included in monitoring and evaluation
Training and education	• Professionals and technicians now have a broad perspective in watershed management • Learning institutions have modified curricula to fit local conditions • Training has emphasized building the capacities of field workers • Conservation of natural resources is taught, to varying degrees, in elementary and secondary schools throughout the world • Human resources training for local people still inadequate
Research and demonstration	• Relationships between technical and social benefits of watershed management still poorly understood • Understanding of causes and effects of watershed degradation in highly populated watersheds is still inadequate • Demonstration watersheds have fallen out of favor for various reasons • Effective linkages between appropriate research, demonstration, extension, and education organizations still lacking
Awareness	• Public awareness campaigns are now an integral part of conservation education • NGOs are more involved in all aspects of watershed management
Extension	• Training of extension workers is commonplace in many countries • Extension networks still remain one of the weakest links in watershed management activities • Weak linkages between extension, research, and training
People's participation	• Considerable progress has been made in the participatory process • Legal, institutional, and organizational approaches for involving local residents in project planning and implementation still not satisfactory • User rights, land tenure, crop rights are changing to benefit rural people
Investments	• Donors and governments are aware that to achieve success, long-term commitment is required • The advent of payment to upland dwellers for environmental services provided to lowlanders is a forward step.

With time, the scope of watershed management has broadened from the initial concept of technical management for water resources to an integrated discipline, which includes the application of biological, technical, social, and economic principles to maintain the productivity of the headwater and lowland areas by scientific management of the soil, plant, and water resources. Watershed management, which includes the participation of all the relevant key actors, has become widely accepted as the approach best suited for the sustainable management of water resources in the upland areas.

Development of Watersheds

While there have been some positive signs resulting from the paradigm shift, the sustainable development of watersheds has not progressed very much. The problem of land degradation, most especially that caused by soil erosion by water, continues to be a major constraint in sustaining upland development in the region. The seriousness of the problem is illustrated by the increasingly perilous condition of upland farming, the enormous discharge of suspended sediments in rivers, and the worsening poverty situations. Obviously, the extensive soil erosion that occurs when steep land areas are continuously cultivated has significant impacts, both on- and off-site.

A major on-site impact is the selective loss of the surface soil layer that contains much of the reserves of plant nutrients, which accelerates nutrient mining (Hashim *et al.*, 1998). Data from experiments in the region have shown nutrient losses via erosion (from farmers' practice plots) to be as high as 194 kg ha^{-1} $year^{-1}$ for N, 32 kg ha^{-1} $year^{-1}$ for P, and 36 kg ha^{-1} $year^{-1}$ for K. A recent report from erosion studies conducted in Asia by IWMI showed that soil losses as high as 54 t ha^{-1} $year^{-1}$ have been observed. This is way above the tolerable soil loss of 2 t ha^{-1} $year^{-1}$ (Maglinao and Penning de Vries, 2002). Replacing the amount of nutrients lost by soil erosion with external fertilizer inputs would cost as much as US$68 ha^{-1} $year^{-1}$ (Agus and Sukristiyonubowo, 2002). Such rates of soil and nutrient losses would make farming unsustainable particularly in areas where the common subsistence crops provide little cash income for purchased external inputs.

The total annual sediment outflow from Asian countries to the oceans is more than seven billion tonnes. This represents an enormous net loss of fertile topsoil and nutrients, and is higher than outflows from other regions of the world. Based on nutrient content alone, valued at US$3.00 t^{-1}, this amounts to an annual economic loss of US$22 billion. This represents a major loss of nutrients and a drain on the economies of the countries of the region.

Off-site impacts are complex and difficult to assess quantitatively (Enters, 1998). However, observations show that cultivation of sloping lands significantly increases runoff (Craswell *et al.*, 1998) and hence may affect the regularity and seasonality of stream flows. In terms of sedimentation downstream, Carpina *et al.* (2001) showed significant amounts of soil being deposited in irrigation canals generating increased cost in desilting them.

The average land per capita in Asia is less than 0.15 ha, lower than any other region in the world. The Asian Development Bank (ADB, 1997) has estimated that during the last 30 years, one-third of the agricultural land has been degraded. It further indicated that degradation and loss of natural resources is progressing at a high rate, and that this is already affecting the opportunities of countries to produce food or the capacity of people in poor areas to generate income. Soil erosion is considered Asia's most widespread natural resource problem.

According to recent estimates by Penning de Vries (1998), East and South Asia will not be self-sufficient in food by the 2040 if land degradation continues at a high rate. In contrast to other regions of the world, the Asian region is a danger zone in relation to food security.

Issues on the Sustainable Development of Watersheds

The Concept of Sustainability

Serageldin (1996) conducted a comprehensive discussion on the definition of sustainability. He considered a two-step approach in developing an operational definition of sustainable development. The first step is to set in place a systematic way of testing the economic, environmental, and social sustainability of a specific proposal, in our case, watershed development. It uses a triangular framework, which considers the interaction of these three factors (Figure 1). In terms of economic and financial sustainability, one should consider growth, capital maintenance, and efficient use of resources and investments.

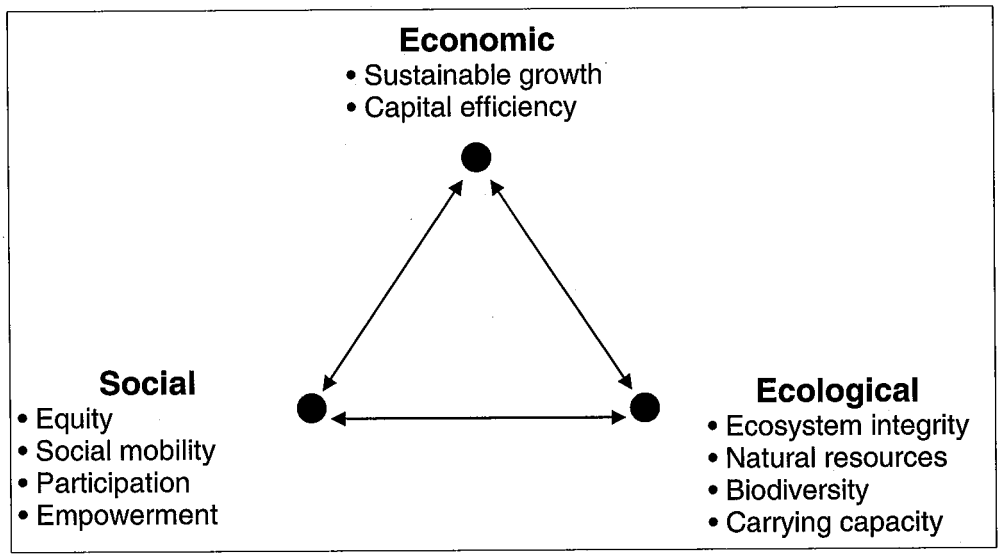

Figure 1. Triangular framework for environmentally sustainable development (Serageldin, 1996).

Ecosystem integrity, carrying capacity, and conservation of natural resources, including biodiversity are the aspects related to ecological sustainability. This is the domain of biologists and the physical scientists. On the social side, equity, social mobility, social cohesion, participation, empowerment, cultural identity, and institutional development are considered.

The next step is to consider sustainability as an "opportunity". From this concept, sustainability is *to leave future generations as many opportunities as we ourselves have had, if not more*. This further considers four kinds of capital stocks (opportunities) that are needed to carry on the activities of development. The four stocks are: 1) human-induced capital (houses, roads, factories, ships, equipment, technology); 2) natural capital (soil, atmosphere, forests, water, land, etc.); 3) human capital (people, their education, health and

capacity levels); and 4) social capital (institutions, cultural cohesion, collective information, knowledge). These capital stocks are expected to partially complement and partially substitute. We expect that the composition of the capital stocks we leave the next generation will be different from the stocks we have today (Figure 2). Yet, we must recognize the limits of substitution, because it is impossible to conceive of any type of activity if any of the four kinds of capital is driven to zero.

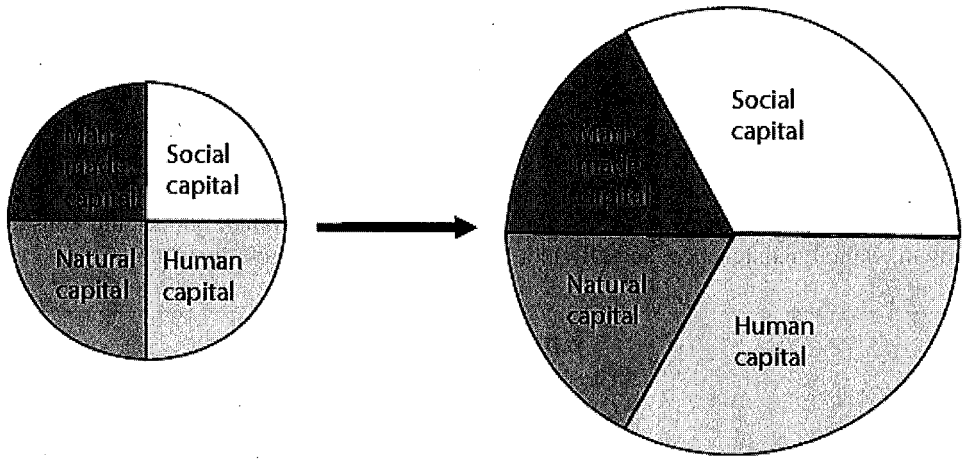

Figure 2. Possible change of capital stocks from the present status to some future time (Serageldin, 1996)

Sustainable Development of Watersheds

The concept of sustainability discussed above can also be easily applied in defining sustainable watershed development. An almost similar framework was put forward by Gottret and White (2002) in defining a methodology for impact assessment for integrated natural resource management (INRM). They based this on the framework of sustainable rural livelihoods, where sustainable rural livelihoods refer to *the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets, while not undermining the natural resource base* (Scoones, 1998).

This definition can be divided into two sub-components that reflect sustainable watershed development. The first focuses on well-being or livelihoods and includes aspects of employment and income, poverty reduction, enhancement of human capacity, and improvement of the social well-being. The second is the sustainability dimension, which includes the adaptation and resilience of livelihoods and the natural resource base on which they depend (Figure 3).

The framework considers five livelihood resources or capitals from which different production processes are derived. These are:

1. Economic/financial capital: Economic/financial capital is the capital assets (such as credit, credit/debt, savings) that are essential for the pursuit of any livelihood strategy.
2. Physical capital: Physical capital includes the household assets and farm infrastructure, including production equipment, technologies, and plantations.
3. Natural capital: Natural capital is the stock of natural resources (soil, forests, water, sequestration, etc.) from which both resource flows and useful services for livelihoods are derived.
4. Human capital: Human capital is the capacities, skills, knowledge, ability to work, good health, and physical capability important for the successful pursuit of different livelihood strategies. Human capital can be developed consciously through formal education and training and subconsciously through experience.
5. Social capital: Social capital is the social resources (networks, social relations, affiliations, associations, norms, trust, and disposition to work for the common good) upon which people draw when pursuing different livelihood strategies requiring coordinated and collective action.

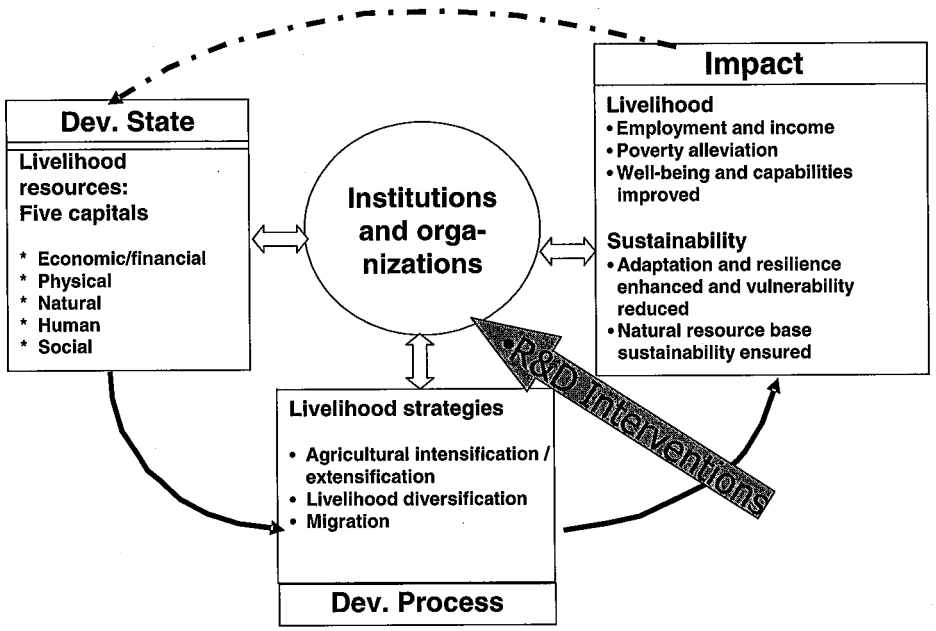

Figure 3. Analytical framework for INRM impact assessment on sustainable rural livelihoods (Scoones, 1998).

Similar to the four capital stocks that were described earlier, these five capitals identified for the production process need to be adequately balanced to attain sustainable rural livelihoods. Using the baseline information on these capitals will help identify the livelihood strategies that need to be introduced. Institutions and organizations are central to identifying restrictions/barriers and opportunities with regard to sustainable rural livelihoods.

The Core Issue: Development while Maintaining Environmental Integrity

The above discussions lead us to the core issue that has to be addressed to attain the sustainable development of watersheds, that is, enhancing social and economic development for people in the watersheds while maintaining environmental integrity. A better understanding of the connections between economic changes and the environment will create more favorable environmental outcomes and permit rational assessment of the remaining trade-offs between growth and environmentally sound objectives. However, the links between economic growth and the environment are complex.

In relating development and the environment, Serageldin (1996) indicated that rising incomes increase willingness and ability to invest in environmental protection. The same argument was put forward by Craswell and Maglinao (2001) who described the relationship between income and environmental degradation as shown in Figure 4. At very low incomes (e.g. with shifting cultivators at low population pressures) the degree of degradation is low. However, as population increases and/or demand for higher incomes increase, the need to exploit the resource base increases degradation. This reaches a point where income is high enough that the conservation ethic and the political will grow, leading to reduced rates of environmental degradation. They also indicated that the focal point for intervention is the steep part of the curves where exploitation to increase incomes rapidly degrades the resource base.

Also referring to Figure 4, Penning de Vries *et al.* (2002) argued that if a lack of "green" concerns is prevalent in a society, people are less willing to invest in environmental concerns. And if equity within society is not achieved, many people remain at a low income level even though the national average rises. If land and water resources are exploited beyond their threshold resilience, due to high population density or ecological fragility, the system fails rather suddenly. When this happens, in a short period, land is lost for agriculture, water is no longer productive, national food security is reduced, and the option for income generation through agriculture disappears. It is now recognized that food security implies security of the natural resource base as well as the food and agriculture sector, including forestry and fisheries (Koohafkhan, 2001).

Some of the more specific issues that need to be addressed to sustain the development of watersheds are presented by Tennyson (2002). These can be grouped into issues related to technical, social, and institutional aspects. They can also be related to the capital stocks described above.

Technical Issues

- Inadequate understanding of the pathways of water, sediment, and nutrient movement in response to land management.
- Lack of process-based concepts and models across many spatial scales.
- Integrating biophysical and socio-economic issues across scales.
- Appropriate sustainable natural resource management options.
- Dynamics of natural resource use intensification.
- Inability to replicate successes (lack of real understanding why some major catchment development programs are working well, while others do not).
- Defining more effectively ecosystem services of catchments and damage to on- and off-site environment from the viewpoints of farmers and of society.

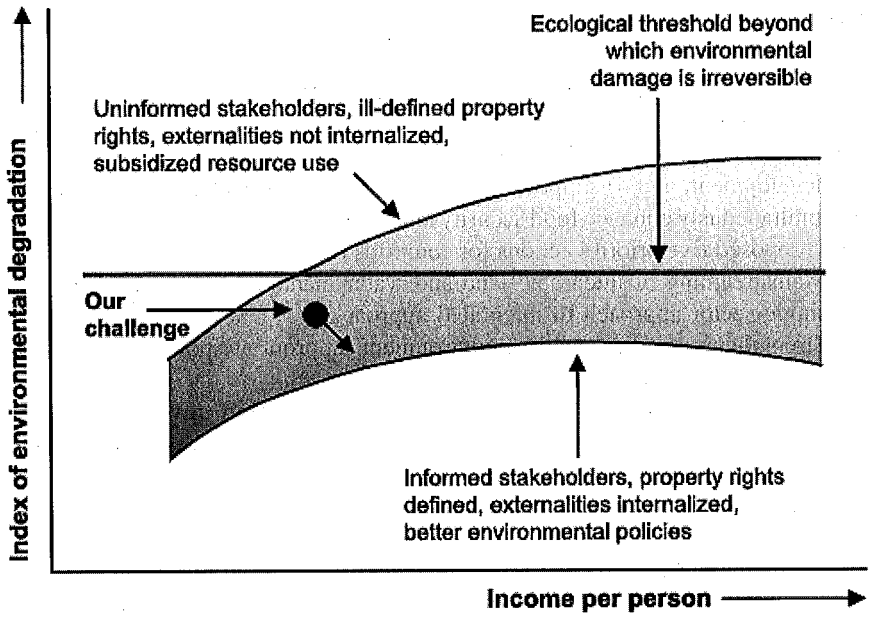

Figure 4. Relationship between income and environmental degradation (IBSRAM, 1999).

Socio-economic Concerns

- Creating options for development in catchments in which all stakeholders gain (including downstream-upstream transfers).
- Dealing with tradeoffs and conflict analysis.
- Reconciling the needs of resource-based planning with "people first" objectives.
- Training and capacity building at all levels.
- The role of youth in watershed management.

Institutional Aspects

- Multi-institutional approaches to acting together in watershed management projects.
- Linkage among central and local governments and civil organizations, together with a more coordinated and effective international aid effort.
- Political will to allocate appropriate staff.
- Lack of appropriate governance (local vs. central, upstream users vs. downstream users, community organization, mechanisms for water allocation and property rights).
- Lack of a sustainable financial and institutional mechanism.
- Lack of central and/or local government/community commitment.
- Weakness of the national research systems in developing countries.
- Finding the right way to address the policy framework and the sets of incentives that affect natural resources in watersheds.

Strategies to Address the Issues and Problems

The aforesaid issues can be addressed through efficient, effective, and relevant research and development (R&D) programs (see Figure 3). R&D here is defined as any activity that addresses the following: 1) improvement of the knowledge base, 2) finding solutions to constraints, 3) capacity development, and 4) supporting policies and institutional arrangements.

To simultaneously enhance food security and environmental quality, Penning de Vries *et al.* (2002) proposed five priority actions for countries to consider. These are:

- Mainstreaming of integrated land and water management approaches (shift from single-sector approach to integrated approaches).
- Strengthening of the enabling environment (appropriate policies, regulations, and institutional arrangements).
- Wider adoption of good management practices and environmentally sound technologies (development, dissemination, and adoption of good management practices and technologies).
- Expansion and acceleration of capacity development activities (skilled human resources to plan and implement programs).
- Strengthening of partnerships to implement priority programs (at the local, national, and international levels to provide a mechanism for a coordinated response to the issue of food and environmental security).

While most of the issues on watershed management are becoming clearer with time, most research and development efforts are now considering the most effective mechanism of how to do it more effectively and efficiently, with the ultimate goal of sustainable watershed development. The literature mentions participation and coordination, integrated and holistic approaches, etc. One should take note, however, that this is easier said than done. One has to also have a good grasp of the situation where the research is conducted. While the principles of participation are generic, applying it is another matter.

IWMI Programs Related to Watershed Management

The International Water Management Institute (IWMI) is now very much concerned with programs that are related to watershed management. This is reflected in its mission of *improving water and land resources management for food, livelihoods and nature*. The following section briefly describes three such programs.

The Management of Soil Erosion Consortium (MSEC)

MSEC is one of the four consortia established through the soil, water, and nutrient management initiative of the Consultative Group on International Agricultural Research (CGIAR). IBSRAM and PCARRD facilitated its establishment through consultations with the NARES, IARCs, ARIs, NGOs in and outside Asia. MSEC uses an integrated, interdisciplinary, participatory, and community-based approach to research that involves all land users and stakeholders on a catchment scale. It focuses on the on- and off-site impacts of soil erosion, emphasizes community involvement, and provides scientific data for rational decision-making at all levels. MSEC draws on the comparative advantages offered by the NARES, IARCs, and ARIs which

conduct research at different levels, ranging from the individual plot and farm to the catchment, regional, and national scales, to develop principles of global relevance (Figure 5). It is linked to the ecoregional program for humid and sub-humid tropical Asia, led by the International Rice Research Institute (IRRI) based in the Philippines.

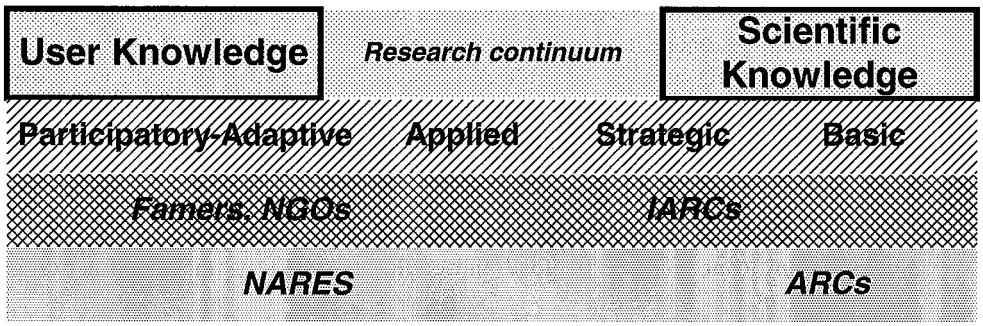

Figure 5. The primary stakeholder domains across the research continuum of an SWNM consortium (Craswell and Maglinao, 1999).

The objectives of the program are:

- to develop sustainable and acceptable community-based land management systems that are suitable for the entire catchment;
- to quantify and evaluate the biophysical, environmental, and socio-economic effects of soil erosion, both on- and off-site;
- to generate reliable information and prepare scientifically-based guidelines for improvement of catchment management policies; and
- to enhance NARES capacity in research on integrated catchment management and soil erosion control
- The program focuses on three major components to address the stated objectives. These are:
- catchment research to evaluate the effects of different land management practices on water and nutrient flows in selected representative catchments;
- capacity building of participating NARES in research on integrated catchment management and soil erosion; and
- dissemination of research results for the enhanced adoption of land management technologies and for more accessible information as the concrete basis for decision-making.

Progress and Accomplishments

Research

- Established an active network of institutions and projects working together to address the problem of soil erosion. The network has facilitated exchange of information and expertise on catchment research.
- Adequately instrumented the benchmark catchments in six countries for long-term monitoring and scientific studies. This network of catchments provides a valuable

tool to evaluate the impact of land use practices and changes on runoff production and sediment yield in a variety of biophysical and socio-economic conditions.

- Data analysis has shown that soil losses as high as 54 t ha^{-1} annually have been recorded at the Philippine study site. This rate of erosion is way above the tolerable soil loss of 2 t ha^{-1} $year^{-1}$. Replacing the amount of nutrients lost by soil erosion with external fertilizer inputs would cost as much as US$68 ha^{-1} $year^{-1}$. With the very low income of the farmers in the study sites (only US$296 per annum in Laos), purchase of external inputs could be difficult. As erosion continues and no inputs are added, the yield will surely decline. Consequently, the decline in income will follow.
- Land management practices greatly influence hydrological behavior and soil erosion, with the proportion of the area cultivated to annual crops presenting the best predictor of sediment yield. Soil loss decreases with increasing catchment size but this can often be overridden by the effect of land use. Suspended sediments appear to be more significant than the bedload and could significantly impact on activities downstream.
- The model developed to simulate and predict soil erosion showed a four-fold increase in soil erosion with an increase of the proportion of the cultivated area from 9 to 60 percent. The model also supports the observation that land use greatly affects soil erosion, more than the effect of climate. The use of this model will greatly help planners in deciding development options for better catchment management.
- Through dialogue with the farmers, the best bet land management options were identified and introduced for evaluation. These are essentially variants of the hedgerow cropping technology combined with other options considered to more quickly generate additional income. These options have already been proven to reduce soil erosion and with the farmers' participation in the process of selection, it is expected that they will continue practicing the system which in the long run will provide better income and reduce resource degradation. Further validation of the introduced land management options is still needed to evaluate their acceptability and sustainability, and define the strategies for wider promotion and uptake at the community level to produce greater impact.
- Tools, guidelines, and methodologies for carrying out the project have been developed. These include guidelines for the site selection of benchmark catchments, biophysical and socio-economic site characterization, procedures for rainfall simulation studies, methodology for financial and economic assessment of soil erosion, a framework for impact assessment, and a soil erosion and hydrology model. These guidelines, procedures, and tools have helped the researchers in data collection and analysis. Moreover, the model is expected to provide support to planners and decision-makers in evaluating development options under different scenarios. For example, the MSEC-1 dynamic soil erosion and hydrology model is able to simulate and predict soil erosion under different land uses. It provides the planners with information on various options as a basis for decision-making.

Capacity building

- A network of 34 catchments and sub-catchments for hydrology and soil erosion management research has been established. With the adequate instrumentation put in place, the network provides a valuable asset for evaluating the impact of land use

and land use changes on soil erosion over a range of biophysical and socio-economic environments. It provides benchmark information for evaluating the acceptability and sustainability of technology options for catchment development. It can also provide the basis for scaling up and promoting the uptake of such options to at least the level of the communities.

- Fourteen training events on various topics have been conducted benefiting more than 80 NARES scientists from 18 institutions. Thirteen graduate students have also been provided assistance in the conduct and analysis of their research. This has enhanced the capacity of the national institutions in the planning and implementation of soil erosion management research at the catchment scale.

Information dissemination

- The project has published four proceedings and six articles in other journals/ proceedings. Sixteen technical papers have been prepared and presented at scientific conferences. The project also participated in international conferences and meetings to share information. The MSEC web page has been incorporated in the IWMI web site and can be viewed at www.iwmi.org/msec. The preparation of the technical papers and the participation of IWMI and its partners have provided a good opportunity for more interaction with other scientists and have broadened project and institutional linkages and collaboration.
- The project has been submitted to the ISC of the CGIAR as a case study for INRM.

Others

- Submitted a follow-up proposal for funding by ADB, latest revision submitted in August 2002.
- Submitted a proposal to the CA program of IWMI, shortlisted but not accommodated in the first four.
- Submitted a proposal for the RE-source award in Switzerland; decision to be known early in 2003.
- Linking with CP for possible funding support.

Constraints

- The nature of the work needs longer term investigation and therefore continued support is needed. At present, the financial support is provided primarily by IWMI and ADB. The support from ADB lasts until the end of December 2002.
- Although most of the members have shown keen interest in the project, some members cannot sustain their commitment.

Challenges/opportunities

- Long-term monitoring will refine the models for prediction and assist in policy-making.
- Farmers' involvement in the project will provide a feeling of ownership in the project and empower them to make more knowledgeable decisions.

- Further evaluating the best options to better manage soil erosion in catchments will provide support to sustainable upland development.
- Country initiatives could further be enhanced with more reliable information becoming available.
- There are new projects that MSEC could very well link, collaborate, and complement with.

The Comprehensive Assessment Program

The Comprehensive Assessment of Water in Agriculture (CA) is an international program supporting research, capacity building, and knowledge sharing; it is focused on providing solutions that will reduce poverty in developing countries. Through its five-year program (2002-2006), the Assessment will generate a wealth of useful data, practical knowledge, and a synthesis of experiences, and a number of water management and planning tools. These products are designed to help water users, development organizations, governments and research organizations make the best possible investments in water for rural agricultural development. The overall goal is to help countries manage water better to improve the livelihoods of the rural poor while sustaining the environment.

The priority research areas that need to be addressed are:

- Benefits, costs, and impacts of irrigated agricultural development and what conditions these impacts.
- Extent and significance of use of low quality water in agriculture (saline and wastewater), and what the options are for its use.
- Options for better management of rainwater to support rural livelihoods and land rehabilitation in water-scarce areas.
- Options and their consequences for improving water productivity in agriculture.
- Management to sustain and enhance fisheries and aquaculture systems.
- Options for integrated water resource management in basins and catchments.
- Consequences of land and water degradation on multiple users of water in catchments.

The last two areas are the most relevant to watershed management. Each usage of water in a basin potentially affects other users and uses within, calling for more integrated water resource management. Key to this is good governance, including policies and institutions. Improving water productivity is constrained by land management practices, and sustaining levels of productivity is threatened by severe levels of land and water degradation. Research should therefore focus on water productivity and food security, and search for promising practices to reverse the trends of degradation. For more information about the program, visit www.iwmi.org/assessment

The Global Challenge Program

The Global Challenge Program is a new initiative of the CG system. At present, IWMI leads the development of the Challenge Program on Water and Food. The objective of the program is to catalyze effective and efficient improvements of water productivity in food production in a way that favors the poor and is gender-equitable and environmentally sustainable. At the basin level, water productivity needs to be understood in the widest possible sense – including crop, livestock, and fishery yields, wider ecosystem services and social impacts such as

health, together with the systems of resource governance that ensure equitable distribution of these benefits.

In view of the scale of issues to be addressed, the program is structured according to a number of interacting modules. At present five themes are envisaged:

- Improving the efficiency of water use in agriculture, via increased crop water productivity.
- Management of upland watersheds for multiple functions.
- Management of aquatic ecosystems and wetlands.
- Policy and institutional aspects.
- Interaction among the four themes.

The second theme bears greatest relevance to watershed management. Upper catchments present a diffuse spectrum of challenges to improving the management and use of water. The complexity of the challenge can be summarized in three phrases that represent different facets of the problem, namely, water and livelihoods, catchment hydrology, and social organization. The major focus of the research will be on: 1) water and poverty in upland watersheds, 2) identifying the hydrologic basis for improvement, 3) realizing the increased hydrologic potential in upland watersheds, and 4) extrapolation and generalization. For more detailed information, visit www.cgiar.org/iwmi/challenge-program

Summary and Conclusion

1. The Asia and Pacific region occupies a large portion of the world's land surface, nearly 60 percent of which is dominated by mountains and high plateaus. It has the most serious problem of land degradation and achieving food security.
2. Watershed management has broadened its scope from the initial concept of technical management for water resources to an integrated discipline, which includes the participation of all the relevant key actors in planning and implementation.
3. This change in thinking has not yet resulted in a corresponding progress in sustainable development of watersheds in Asia and the Pacific. The problem of land degradation, most especially that caused by soil erosion by water, continues to be a major constraint in sustaining upland development in the region.
6. The core issue of enhancing social and economic development for the people in the watersheds while maintaining environmental integrity should be addressed to sustain upland development.
7. IWMI is now completing the first four years of the implementation of the MSEC project, which looks forward to strengthening the integration of land and water management.
8. Two other programs that address land and water management at the level of catchments and river basins have started recently and are expected to contribute to improving food security and livelihoods, in harmony with nature.

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