

WORKING PAPER 3

The Role of Watershed Management In Sustainable Development

by

The Working Group on Watershed Management and Development

December 1988

Forestry For Sustainable Development Program
Department of Forest Resources
College of Natural Resources
University of Minnesota
St. Paul, Minnesota 55108

**THE ROLE OF WATERSHED
MANAGEMENT IN
SUSTAINABLE DEVELOPMENT**

by

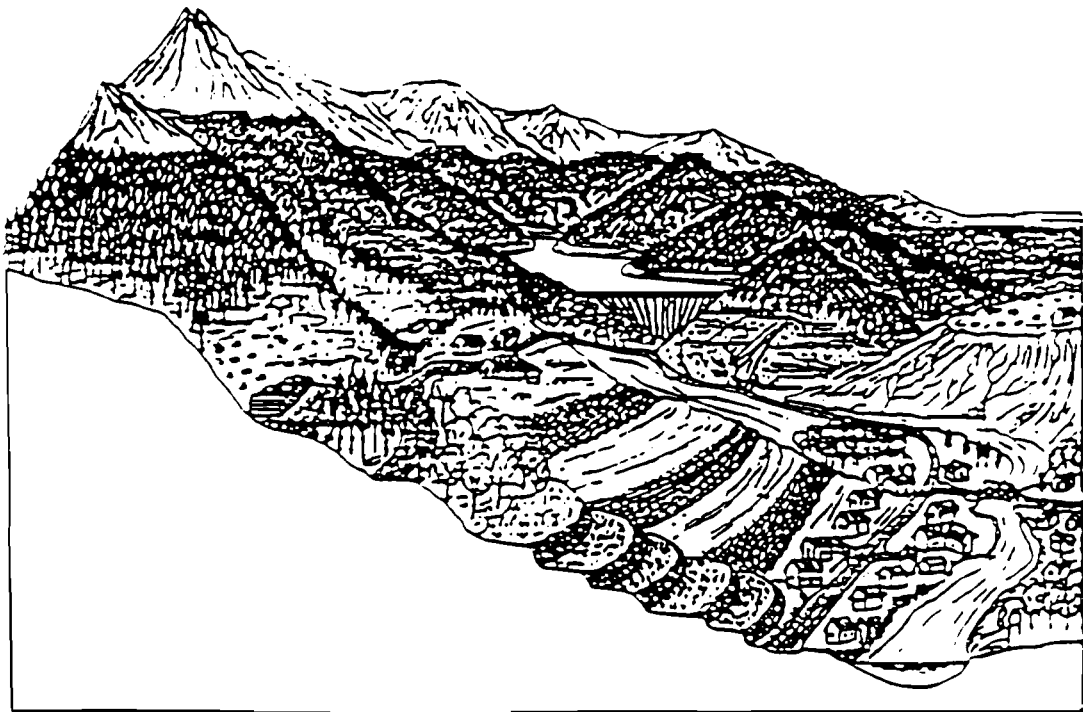
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FORESTRY FOR SUSTAINABLE DEVELOPMENT PROGRAM

**Department of Forest Resources
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Adapted from a 1983 FAO publication, "Protect and produce: Soil conservation for development."

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PREFACE

This is the third in a series of working papers produced for the Forestry For Sustainable Development (FFSD) Program at the University of Minnesota that represent work in progress. The purpose of these working papers is to stimulate discussion among individuals working in the field of interest.

The major objectives of the FFSD Program are to:

1. Improve the availability and usefulness of existing technical knowledge related to forestry for sustainable development - translate state-of-the-art scientific and technical information into practical and easily usable management guides and training materials that can be used effectively in planning and implementing development projects that will contribute to sustainable development; and
2. Improve the policy and organizational environment to encourage application of sustainability strategies - identify and develop effective institutional mechanisms, both at the policy and project levels, for introducing sustainability strategies into the development planning process at an early enough stage to influence project or program design.

The focus of the Program is on social forestry and related strategies within a watershed management framework as an integrating mechanism for moving toward sustainability in land use and in natural resource-based development projects. It involves an interdisciplinary group of faculty from the University of Minnesota, and associates at the University of Arizona, Yale University, Oxford University, the InterAmerican Development Bank, and other development groups. The FFSD Program is part of the University of Minnesota's Center for Natural Resource Policy and Management in the College of Natural Resources.

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This working paper was reprinted in December 1990 in order to produce a clearer copy for reproduction. It has slightly different paging than the original.

EXECUTIVE SUMMARY

This paper has two basic purposes: 1) to explain what a watershed management framework is and how its use can contribute to the sustainability of development efforts, and 2) to suggest what types of integrated training activities are needed to insure a wider appreciation of watershed management concepts, principles, and practices and their integration into the mainstream of development work.

The concepts of watershed management are built around the realization that the economic and political forces that shape development work within political boundaries, while the forces of nature that affect land and water resources respect natural or watershed boundaries. Often, the two sets of boundaries do not coincide. Since most rural development programs involve the use of land and water resources, lack of consideration of watershed boundaries in rural development programs can have disastrous effects in terms of the sustainability of such programs. Some means has to be found to reconcile the watershed boundaries respected by forces operating in the natural environment with the geographical boundaries set by the political and economic forces that drive development. That is the challenge presented in this paper.

An extensive body of principles and practices is being built up under the heading of watershed management and with the above recognition and challenge in mind. A first step in meeting the challenge is to make this body of knowledge more clearly and widely appreciated by policy makers, planners, managers, technicians and farmers in the field.

International development organizations will have to take the initiative in developing and supporting the innovative training programs needed to provide background for those who are in a position to integrate watershed management concepts and practices into development efforts, both at the policy and the project levels. Given availability of the types of materials discussed in this paper, the main priorities for the immediate future are to:

- develop case studies of programs and projects where watershed management practices have been successfully introduced and sustained. These case studies should emphasize the focus of watershed management on "production with protection" not just protection alone, i.e., productive and sustainable use of resources.
- expand training and information programs for high level policy makers and sector planners so that the concepts and principles of watershed management can become more widely incorporated into policies and programs affecting land and water uses; and, finally,
- support efforts of national and regional groups to make training programs more locally relevant and productive, by, for example, concentrating on developing and supporting effective programs for the "training of trainers" who in turn can improve and sustain local programs to train and support extension personnel, technicians and landusers.

THE ROLE OF WATERSHED MANAGEMENT IN SUSTAINABLE DEVELOPMENT

by

The Working Group on Watershed Management and Development

I share the optimism of the recently released report of the World Commission on Environment and Development. With its members, I, too, "see ...the possibility for a new era of economic growth ... based on policies that sustain and expand the environmental resource base."

Barber Conable, President
The World Bank, May 5, 1987

The developing world is now finding that the costs of watershed protection are small, relative to the costs of increased flooding and reduced irrigation and hydroelectric capacity that result from unprotected watersheds.

Robert Repetto,
in World Enough and Time. 1986.
Yale University Press.

INTRODUCTION

This paper has two purposes. One is to clarify why and how the concepts and practices of watershed management help to improve the design and implementation of programs for sustainable development.¹ Watershed management focuses on using resources in a productive, sustainable manner. Since this also is a major objective of most development organizations and countries, it seems logical that watershed management concepts and practices should become more widely known among people involved in development. Thus, our second purpose is to suggest ways of educating people at all levels so that watershed management becomes more widely integrated into national and international development programs.

RELATING DEVELOPMENT TO ENVIRONMENT: WHAT NEEDS TO BE DONE

It is becoming evident that certain types of economic development efforts are having increasingly negative impacts on the environment. Partly, it is because our awareness of the problems is increasing. However, partly it also is a matter of new technology becoming available can produce more and more harm with less and less human effort. Finally, there is an increasing population and, thus, an increasing number of people undertaking activities which may not be consistent with sustainable development.

¹ A watershed is the total area of land above some point on a stream or river that drains to that point; it can be as small as a few hectares for a small stream drainage, or as large as the entire Amazon River basin. Watershed management is the process of guiding and organizing land and other resource use on a watershed to provide needed goods and services without adversely affecting soil, water and other natural resources. Watershed management concepts recognize explicitly the interrelationships among land use, soil and water and the linkages between upstream and downstream areas.

In the past, such environmental problems were largely ignored in the quest to increase rates of economic growth and development. Political boundaries were the logical ones to work with in development efforts. However, the forces of nature do not recognize nor respect political boundaries. Many natural processes, such as water flow, erosion, fish migration, and pollution, take place within, and are affected by watersheds. Similarly, many development activities including hydropower, irrigation, and transportation systems, are strongly influenced by, and in turn influence, watersheds. In fact, most activities undertaken in upland areas of a watershed eventually have some impact downstream.

Thus, watersheds are logical planning and management units from an environmental point of view, while political boundaries are logical from a political point of view. Somehow, if development and environmental protection are to be harmonized, some means has to be found to integrate the two points of view in an operational context, which means adapting a watershed management framework to the political and economic realities of the world. Watershed boundaries are not the only ones which should be considered in development programs, but because soil and water are basic ingredients in sustainable development, and because the watershed is the natural unit for considering the management of these resources, it makes sense to use the watershed as a unit in planning and management.

Professionals working with the major international development organizations increasingly recognize this need for a new perspective. Yet, they also realize that in practice the world is far from achieving an integration of environmental concerns in economic development efforts. The grave consequences of this gap can be seen in the Sahel, the Amazon, the Andes, the Indus basin and in many industrialized regions.

In the Asia and Pacific region, the activities of populations in mountainous or high plateau areas have led to almost one-third of the land area becoming seriously degraded. This degradation not only reduces the livelihood of upland inhabitants, but adversely impacts one-fourth of the world's population living downstream.² Although the population in Africa is not as great, the land degradation problems may be even more severe. For example, deforestation and intensive grazing and cultivation of uplands in northern Morocco have resulted in a situation whereby 6 percent of the land area of the country contributes about 60 percent of all sediment leaving Morocco. Yet watershed management can reverse such degradation in an economically feasible way. For example, a watershed management project above a major irrigation reservoir in northern Morocco showed an economic rate of return of 15.9 percent.³ Economic rates of return on investment in watershed management and soil conservation projects financed by the World Bank are in the 15 to 21 percent range.⁴ With rates of return such as these, why is watershed management not given higher priority

² Taken from "Watershed management in Asia and the Pacific: Needs and opportunities for action. 1986. Technical Report FO:RAS/85/017, FAO, Rome. 166 pp.

³ Brooks, K. N., H. M. Gregersen, E. R. Berglund, and M. Tayaa. 1982. Economic evaluation of watershed projects—an overview methodology and application. *Water Resources Bulletin* 18(2):245-250.

⁴ Cf. World Bank. 1984. Annual report on FY84 Bank and IDA lending for agriculture and rural development. Washington, D.C.: The World Bank. 41 pp.

in the planning and management of resource development projects? We think the reason is largely a lack of awareness and a lack of appreciation by high-level administrators, field staff and farmers themselves that watershed management makes good sense not only from an environmental point of view, but also in terms of sustainable economic development.

Still, many people believe that little can be done to reduce the conflicts between development and environment. This belief leads to polarization of attitudes and a lack of willingness to adopt an integrating framework that helps in the reconciliation of conflicting objectives. Clearly, these attitudes have to be changed. In fact, they are changing in organizations such as the World Bank, which recently underwent a major reorganization, including an increased focus on environmental management in relation to development.

What has been recognized by many development professionals--and what a watershed management framework emphasizes--is that economic growth, poverty alleviation and environmental protection can be made to complement each other, or at least a workable integration of economic, social and environmental concerns can be developed, if the appropriate approach and integrating mechanisms are used. A practical, operational framework has to be developed and then implemented by countries and development organizations. Such frameworks have been developed and tested, and could be used more widely by planners and decision makers if they were aware of them and trained in their use.

A WATERSHED MANAGEMENT FRAMEWORK

During the past several decades an extensive body of knowledge and general principles has been developed under the heading of "watershed management." Watershed management provides the basis for dealing more effectively in an integrative fashion with the biophysical and socioeconomic aspects of natural resource and environmental problems. It provides a logical framework for organizing development activities involving land and water resources.

The integrated concepts of watershed management provide a framework for sustainable development, while watershed management practices provide the tools for making the framework operational. Various institutional mechanisms--regulations, market and nonmarket incentives, public investment--provide the means for implementing the practices.

The Concepts

A watershed management approach incorporates "soil and water conservation" and "land use planning" into a broader, logical framework by focusing on the following concepts:

- 1) People are impacted positively and negatively by the interaction of water with other resources; and in turn, people affect the nature and severity of such interactions by the ways in which they use resources and the quantities they use.
- 2) The impacts of these interactions do not follow political boundaries: water flows downhill regardless of how people define their political boundaries. Thus, what is done in the highlands of one country can have significant effects in another country; and the use of land by farmers in one village will affect villages downstream.

3) Since such interactions cut across political boundaries, what may be sound resource use from the point of view of one political unit (country, community, or landowner) may not be sound resource use from a broader, societal point of view, because of undesirable downstream effects, i.e., what economists call "externalities."

4) Given the existence of externalities, ecologically sound management becomes good economics for all concerned only if costs and benefits are appropriately distributed among the political units, communities and individuals that carry out the watershed management activities and those who benefit from them.

A common misconception is that watershed management is based only on physical interrelationships. The above concepts indicate that sound watershed management involves economic and institutional interrelationships as well. These concepts also illustrate the focus of a watershed management approach, and they guide the design of the practices and institutional mechanisms needed to implement the approach on the ground.

Watershed Management Practices and Their Socioeconomic Impacts

In a watershed management framework, various structural and nonstructural practices are undertaken to:

- 1) protect a watershed or prevent damage to it;
- 2) mitigate the effects of land use to an acceptable level;
- 3) restore degraded environments.

More specifically, as indicated in Figure 1, activities or practices such as vegetation management, controlled grazing, erosion control structures, terracing, and selected agroforestry practices are carried out to:

- 1) stabilize soil and steep slopes;
- 2) stabilize/modify water yield and streamflow; and
- 3) maintain or improve water quality.

The effects of these various actions translate into direct and indirect economic benefits to society, as shown in Figure 1. These are the benefits that link the on-the-ground practice of watershed management to economic development and justify the integration of a watershed management framework into economic development programs. Furthermore, indirect benefits of environmental quality also are realized in biological diversity, wildlife habitat, fishery habitat and in water quality.

In looking at Figure 1, it should be noted that the changes suggested in the boxes represent the economist's traditional view of the difference "with and without" a project or set of actions. Thus, for example, in the boxes where we say "increase reservoir/channel capacity", or "increase hydropower potential," we mean increases over what would have existed without watershed management intervention; it might still be that a reservoir is filling with silt and losing storage capacity, but the loss in capacity would have been greater without the

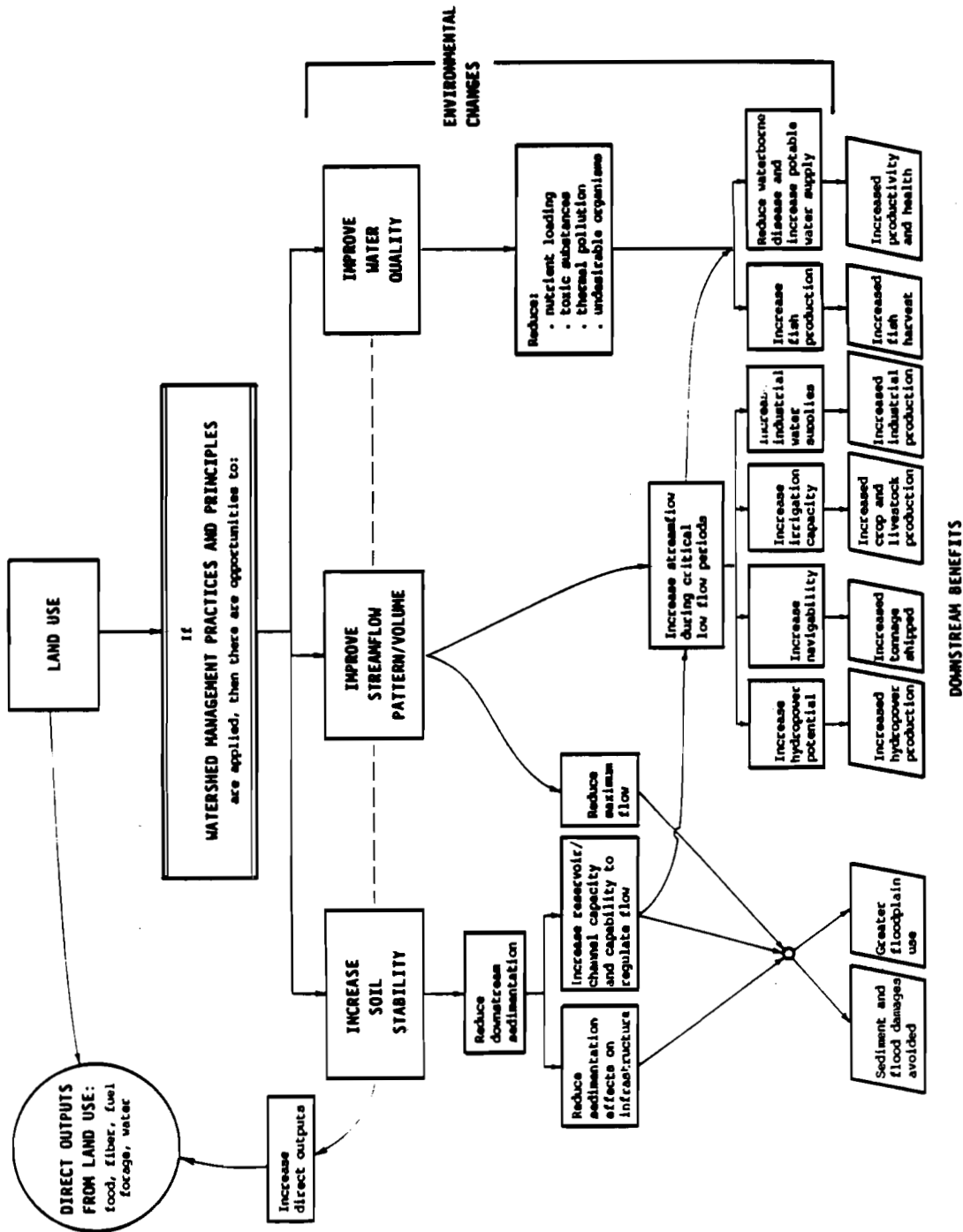


Figure 1. Environmental changes and downstream benefits from watershed management (modified from Gregersen, Brooks, Dixon, and Hamilton 1987)

watershed management activity than with it; thus there is a net increase in remaining capacity with the activity vs. without it at any moment in time.

This point about the "with and without" principle is important to keep in mind. Some watershed management practices (e.g., soil erosion control) do not stop or reverse a physical process, but they do slow the rate of environmental damage and thus create benefits. A dollar of losses prevented is fully as valuable to society as a dollar of new production. Although the short-term effects of such practices may not be readily observed by people, their cumulative long term effect can contribute directly to the success and sustainability of a development project.

A more detailed view of the most common problem situations encountered on a watershed and the alternative preventative or restorative practices for dealing with them is presented in Annex 1. Note that agricultural, forestry and other land use, and engineering practices commonly are combined to accomplish watershed management objectives.

Institutional Mechanisms

The preventative, mitigative and restorative practices of watershed management have to be accepted and implemented by people--project managers, farmers and other land users, power companies, community and other governmental organizations. In terms of project design, there are three types of institutional mechanisms which can be used to insure that the needed practices are carried out:

- 1) there is direct public investment to implement the practices. Examples include tree planting on public lands, building dams and investment in streambank stabilization.
- 2) there are regulations and laws which guide the actions of individuals and groups. Examples include the regulation of grazing, forest cutting, road construction, mining on public land, and, of course, tenure laws which govern private and communal ownership and land use.
- 3) there are incentive mechanisms. These can involve subsidies linked to certain practices, or market prices, or direct payment for services, e.g., when upland land users are paid to carry out certain conservation activities that mainly benefit downstream residents.

BARRIERS TO ADOPTION OF A WATERSHED MANAGEMENT FRAMEWORK

Ironically, the basic concepts underlying a watershed management framework also explain part of the reason why more widespread adoption of this approach has not taken place. Since local political and tenure rights boundaries rarely coincide with natural watershed boundaries, the local political institutions that drive development seldom recognize the watershed as a workable unit for planning and action purposes.

Since the main effects of the water and land use practices of one political unit often are felt by people outside that unit, or by future generations who can't vote now, there has been little incentive to consider the concepts of watershed management that account for these interactions. A common question from upstream land users is: "why should we carry out watershed management activities when the main benefits occur downstream?" Indeed, why should we expect them to, if they are not compensated for the costs of such activities?

Lack of awareness or understanding of watershed management concepts and practices by development professionals and the public also has limited the application of watershed management concepts. There has been a lack of interaction of technical experts in this field with development practitioners and administrators. Only recently have technical experts made a concerted effort to explain, in language understood by the pragmatic development professional, how watershed management concepts and practices can aid in development programs aimed at increasing food security, employment opportunities, economic growth and poverty alleviation, all within a sustainable development framework.

THE CHALLENGE: OVERCOMING THE BARRIERS

The barriers to wider adoption of a watershed management framework are being broken down slowly but surely. Many decision makers now recognize the imperative of environmentally sound and sustainable development. Ignoring the boundaries and interrelations set by the forces of nature will inevitably lead to serious, if not disastrous problems.

Increasing Public Awareness and Concern

The public is becoming increasingly aware of environmental matters and rightfully concerned about the condition of the world for future generations. This concern is translated into increased political awareness and action. It also has led to the creation of more effective and politically acceptable resource transfer mechanisms to distribute the costs and benefits associated with watershed management activities. Incentives are being created to encourage more environmentally sound land use on watersheds. In fact, such mechanisms have been used successfully in countries such as Japan for more than a century.⁵ Developing countries, such as Colombia, also are beginning to establish such transfer mechanisms. A percentage of revenues from hydropower production is allocated for upland watershed management.

In developed countries, the concern over water issues has led to establishment of organizational and administrative mechanisms that cut across traditional political boundaries to encompass critical watershed boundaries. Examples in the United States include the Tennessee Valley Authority and the Delaware River Compact. The latter is an example of application of a watershed management plan based on natural rather than political boundaries. An interstate commission ensures the equitable allocation of water resources

⁵ Kumazaki, M. 1982. Sharing financial responsibility with water users for improvement of forested watersheds: A historical review of the Japanese experience. In: The current state of Japanese forestry. Vol. II. R. Handa (ed.).

among its members. This agreement has helped to prevent disputes during severe drought periods in the 1960s and 1970s.⁶

Increasing Use of Watershed Management Approaches in Development Projects

The challenge in introducing a watershed management approach is not to change the world by replacing current practices with some cure-all "watershed management" formula. Development within a watershed management framework does not mean populating the world with professional "watershed managers" who direct projects and the activities of people living in a given watershed; nor does it mean establishing a great number of isolated watershed management projects. Rather, watershed management principles and practices should be, and have been, introduced mainly as integral components in rural, agricultural, forestry development, hydropower and irrigation projects.

These components have to be implemented and sustained by people other than "watershed managers"--by general project administrators, foresters, agriculturists, sociologists, hydrologists, and, most importantly, by farmers and other land users. The implication is that these types of people need to understand why and how watershed management should be incorporated into everyday activities.

Watershed management must be integrated into the mainstream of development activity. It may be that watershed management practices only need to account for a small part of the budget to be effective. The watershed management expert may play only a small role in the total project; however, it can be an important one if sustainable economic growth and poverty alleviation are goals.

What all of this implies is that, while general development professionals and project personnel should understand watershed management and what it can do, they do not all need to become experts in the field. Technical details and advice on alternative technical packages can be developed by watershed management professionals. General project personnel--planners, managers and technicians--can choose and implement the most appropriate alternative, given the project situation and a broad general understanding of watershed management.

WATERSHED MANAGEMENT TRAINING NEEDS

With the above discussion as background, we now can turn to a consideration of the second purpose of this paper: to suggest comprehensive training activities that can introduce watershed management concepts and practices more widely into the programs of both national and international development organizations.

An increased understanding of watershed management and, therefore, increased training activity, is needed by a broad range of people playing different roles in the design and implementation of sustainable development projects. Further, it is evident that different

⁶ Black, P. 1982. Conservation of water and related land resources. Praeger: New York.

groups need different kinds of information. A summary of these different needs is presented in Table 1.⁷

The bilateral and multilateral agencies could concentrate on support and development of international training activities and programs for the policy makers and high level administrators, and the sector planners. These groups need general understanding of how watershed management fits into the broader development process, how a watershed management framework will help them, how they can introduce it into their programs, and where their staffs can get more detailed information on technical, economic and institutional details. Knowledge at this level has to be presented and packaged in such a way that these groups can translate it into productive policy decisions and transfer it effectively to their staffs. International support also is needed for regional programs for "teachers of teachers."

Country level programs, perhaps supported by bilateral or multilateral funds and technical personnel, might concentrate on more technical watershed management training for extension personnel, field managers and skilled technicians. The focus should be on how watershed management concepts and practices fit within the broader context of development projects and everyday income producing activities. Extension services, supported by various kinds of development NGO's could concentrate on field level training and demonstration of the benefits to be derived from good watershed management.

To implement expanded, comprehensive training programs, effective training materials and training formats are needed. Considerable past experience in this area has accumulated and can be drawn upon in designing new training packages (see Annex 2). Additional materials will have to be developed.

With all the training courses and educational programs illustrated in Annex 2, one might ask why more training activities? First, the listed activities represent somewhat of a shotgun approach that has been supported by a variety of agencies for a variety of purposes. Second, with few exceptions the activities were oriented towards specific technical aspects of watershed management practices. A base is present, however, from which more effective integrated training and education programs can be developed.

Future training activities are needed that can: (1) provide information for high-level administrators, policy makers, and sector planners--the very people that have the political clout to get watershed management programs and projects implemented at the national level; (2) build upon the increasing experience base of watershed projects--using case studies of actual projects that allow us to better understand the social, economic, and political factors and how they mesh with technical solutions in the planning and implementation of watershed management projects; (3) build upon local experience and adaptations for a particular country or region--what works for one group of farmers and herdsmen may not

⁷ Although not shown in Table 1, which concentrates on training needs of operational and administrative personnel, watershed management scientists and professionals also, of course, will need training. These professionals currently are being trained at universities. For example, there are many professional programs in the United States. Other countries, such as Costa Rica, India, Morocco, the Philippines, and Australia also have programs.

Table 1. Who Needs to Know What About Watershed Management

<u>Information and Knowledge Types</u>	<u>Background Information on</u>				<u>Technology and Resource Requirements</u>	<u>Techniques of Watershed Management Planning</u>	<u>Design, Evaluation, and Appraisal Methods</u>	<u>Technical Options</u>	<u>Management and Organization</u>	<u>Field Techniques</u>
	<u>Benefits and Linkages</u>	<u>Needs</u>	<u>Constraints</u>							
<u>Actors or Users</u>										
Policy makers and sector planners	A	A	A	A	A	--	--	--	--	--
Project-level planners and managers	LS	LS	LS	LS	S	LS	S	LS	LS	LS
Field-level staff	LS	LS	LS	LS	--	--	LS	LA	LS	LS
Local leaders and NGOs	LA	LA	LA	LA	--	LS	LS	LS	LS	LS
Farmers and other land users	LS	LS	LS	LS	--	LS	LS	--	--	LS
"Teachers of teachers"	S	S	S	S	S	S	S	S	S	S

* A = general appreciation, S = specific knowledge; LS = local specific knowledge; LA = local general appreciation.

Adapted from: Gregersen, H., S. Draper and D. Elz (eds.). Forthcoming. People and Trees: The Role of Social Forestry in Sustainable Development. The World Bank: Washington, D.C. 369 pp.

be feasible elsewhere; (4) involve national agencies in the development of cadres of teachers that can continue educational programs for a particular target group, country or region; and (5) provide teachers of teachers with an educational process rather than an assemblage of facts, i.e., our knowledge of what works and what is effective in implementing watershed management practices is expanding and we need to build upon this knowledge. With concrete and directed case studies coupled with ongoing research we can learn what techniques work, and how project elements are integrated to achieve sustainability. This knowledge, in turn, can be used to update our educational materials and methods. It is an iterative process that allows teachers to convey the current and the most workable solutions to the respective target groups. This process should be part of every development program.

The basic strategy emphasizes local or regional involvement which accomplishes two major purposes: (1) training materials and methods are developed that are locally relevant; and (2) local capability to continue training activities is enhanced.

There is a particular need for regional case studies that illustrate the various biophysical, social and economic practices that have and have not worked. These case studies would be designed to provide relevant information for all levels, from policy makers to field technicians. They also would be designed so that they could be brought together in a comparative fashion to highlight general principles where such emerge. To facilitate their use in teaching and to improve their effectiveness, they should be well illustrated, for example, with video, slide-tape presentations, and so forth. Such media should be formatted efficiently and effectively for presenting information to people with limited time and to people who may not be familiar with a particular project environment. The framework for a program of activities to develop such materials is attached as Annex 3.

CONCLUSIONS

Sustainable development can occur only when the needs of people and the capacity of the natural resource base to meet those needs are balanced over time. Watershed management provides a convenient framework to use in moving toward this balance.

Watershed management provides a logical, systematic set of concepts, practices and mechanisms which can be used in solving inherently complex development problems involving use of natural resources. It does not provide a universal solution to the conflicts that arise between economic growth and environmental protection. The on-the-ground implementation of watershed management relies on many biophysical practices (e.g. soil erosion control, reforestation) and institutional mechanisms (e.g. market and nonmarket incentives, regulations) within a framework that attempts to balance demands on resources with the supplies of goods and services they can produce on a sustainable basis.

State-of-the-art training is the key to improving the effectiveness with which watershed management concepts are introduced into development programs by policy makers, managers, technicians in the field, and farmers and other land users.

International development organizations will have to take the initiative in developing and supporting innovative training programs that provide background for those who will

integrate watershed management concepts and practices into the mainstream of development work. The initial objective should be to:

- increase efforts to develop effective case studies of programs and projects where watershed management practices are being successfully introduced and sustained; these case studies should illustrate how social, economic and political factors are integrated with technical solutions to improve the sustainability of land and water use;
- expand training and information programs for policy decision makers and sector planners so that the concepts and principles of watershed management can become more widely incorporated into policies and programs affecting land and water uses; and, finally,
- support efforts of national groups to make training programs more locally relevant and productive, by, for example, concentrating on developing effective regional programs for the "training of trainers" who in turn can improve and sustain local programs to train and support extension personnel, technicians and landusers.

ANNEX 1

**ALTERNATIVE PREVENTATIVE OR RESTORATIVE PRACTICES FOR DEALING
WITH PROBLEM SITUATIONS ENCOUNTERED ON A WATERSHED**

<u>Problem</u>	<u>Alternative Solutions</u>	<u>Associated Watershed Management Objectives</u>
1. Deficient water supplies	a. Reservoir storage and transport	a. Minimize sediment delivery to reservoir site—maintain watershed vegetative cover
	b. Water harvesting	b. Develop localized collection and storage facilities
	c. Vegetation manipulation—ET reduction	c. Convert from deep rooted to shallow rooted species or from conifers to deciduous trees
	d. Cloud seeding	d. Maintain vegetative cover to minimize erosion
2. Flooding	a. Reservoir storage	a. Same as (a) above
	b. Construct levees, channel improvement, etc.	b. Minimize sedimentation of downstream channels
	c. Flood plain management	c. Zoning of lands to restrict human activities in flood prone areas. Minimize sedimentation of channels.
	d. Revegetate disturbed areas	d. Afforestation or reforestation of denuded watersheds; encourage natural revegetation.
3. Energy Shortages	a. Utilize wood for fuel	a. Plant perpetual fast growing tree species that maintain productivity of sites by minimizing erosion.
	b. Develop hydro-electric power project	b. Minimize sediment delivery to reservoir pools and river channels.

<u>Problem</u>	<u>Alternative Solutions</u>	<u>Associated Watershed Management Objectives</u>
4. Food Shortages	a. Develop agroforestry	a. Maintain site productivity-minimize erosion (nutrient losses); develop crops compatible with soils climate of area.
	b. Increase cultivation	b. Restructure steep hill slopes and other areas susceptible to erosion; utilize contour plowing, terraces, etc.
	c. Increase livestock production	c. Develop herding-grazing systems for sustained yield and productivity
	d. Import food from outside watershed	d. Develop forest resources for pulp, wood products, etc. to provide economic base.
5. Erosion-sedimentation from devegetated landscapes	a. Erosion control structures	a. Maintain life of structures by revegetation and management.
	b. Contour terracing	b. Revegetate, stabilize slopes, terraces, and institute land use guidelines.
	c. Revegetate	c. Protect vegetative cover until site recovers; use reseeding, fertilization, etc.
6. Poor quality drinking water	a. Develop alternative supplies from wells, springs	a. Protect groundwater from contamination.
	b. Treat water supplies	b. Protect catchments from contamination.

ANNEX 2

EXAMPLES OF WATERSHED MANAGEMENT TRAINING PROGRAMS AND TRAINING MATERIALS

The growing interest in watershed management is indicated by the number of training activities conducted and materials that have been developed for many parts of the world just within the last 10 years. Numerous agencies and organizations have been involved--and much of the activity has concentrated on specific needs and objectives of the respective organizations. Selected examples of such programs and materials, in which the authors have participated, are listed below. These could provide the basis for the development of comprehensive training packages targeted for specific audiences and purposes.

Training Programs

The following are examples of training programs, seminars and workshops that have been conducted by the authors and others since 1980:

Workshop on Research in Forest Hydrology in China - An Analytical Assessment, Harbin City, The People's Republic of China, August 18-23, 1987. Sponsored by UNESCO-MAB--45 participants.

ASEAN Roving Seminar on Watershed Management - held in the Philippines, Thailand, Indonesia, and Malaysia--1987 and 1986 sponsored by USAID--over 200 participants.

Future of Watershed Research in the Asia Pacific Region. A workshop held in March 1987 sponsored by the East-West Center and Forest Research Institute of Taiwan--57 participants from 16 countries.

Sub-regional Workshop on Forestry and Watershed Management in Arid and Semiarid Zones of the SADCC Countries, Maseru, Lesotho, April 7-18, 1986. Sponsored by Finland and FAO--23 participants from 9 African countries.

Workshop on Training Material Needs for Watershed Management, Ft. Collins, Colorado. July 1986. Sponsored by Colorado State University and CATIE.

FAO/Finland Training Course in Forestry and Watershed Management for Asia and the Pacific Region, Kathmandu, Nepal, May 19-31, 1985--22 participants from 11 countries.

Expert Meeting on Strategies, Approaches and Systems for Integrated Watershed Management, Kathmandu, Nepal--sponsored by FAO, East-West Center, and ICIMOD, 1985.

First Bilateral Research Oriental Workshop on Experimental Watersheds. Montivedeo, Uruguay, November 7-11, 1984. Sponsored by U.S.-National Science Foundation and CONACYT of Uruguay. 50 participants.

Regional Training Courses "Watershed Resources Management and Environmental Monitoring in Humid and Tropical Ecosystems" taught in the Philippines (1979 and 1982), in Thailand (1981), and Zimbabwe (1985)--sponsored by UNESCO-MAB--over 150 participants.

Training Course (6 weeks) "Resource Development of Watershed Lands," held each year at the University of Arizona since 1979. Sponsored by USDA Office of International Cooperation and Development (OICD)--over 200 participants from over 35 countries.

Training Materials

In support of the training activities above, materials have been developed in the form of syllabuses, technical papers, reports, slide-tape presentations, etc. Such materials have not become widespread and have had limited distribution to participants who attended a particular course. Examples of these materials are listed below:

Resource Development of Watershed Lands, syllabus used as a primary informational source for training course of same title since 1979.

Watershed Resources Management and Environmental Monitoring, syllabus used in regional training courses of the same title, in the Philippines, Thailand, Malaysia, and Zimbabwe.

Watershed Resources Management and Environmental Monitoring, problem manual used in above regional training courses.

Manejo de Cuencas y Monitoreo Ambiental, syllabus used in regional training courses of the same title, in Panama, Honduras, and Mexico.

Watershed Instrumentation, Design, Data Monitoring, and Analysis, syllabus used as a primary informational source for an ASEAN Watershed Management Study Tour of the same title.

Forestry Development and Watershed Management in the Upland Regions, lecture notes used (by the UNDP) as a primary informational source for a training course in Jamaica.

Forestry and Watershed Management for Asia and the Pacific Region, a summary report of an FAO/Finland training course held in Nepal.

Workshop on Watershed Management in Arid and Semiarid Zones of SADCC Countries, a summary report of an FAO/Finland workshop presented in Maseru, Lesotho.

In addition to the above materials that have been developed for specific training sessions, several general publications and manuals are available for use in Watershed Management courses. Examples of these types of materials include:

FAO Materials

1. Technical Papers and Bulletins

(a) "FAO Conservation Guides"

Examples:

. Guide no. 8: Management of Upland Watersheds: Participation of the Mountain Communities, 1983.

. Guide no. 16: Guidelines for Economic Appraisal of Watershed Management Projects, 1987 by Gregersen, Brooks, Dixon and Hamilton.

(b) "FAO Soil Bulletins"

Example: no. 53: Improved Production Systems as an Alternative to Shifting Cultivation, 1984.

(c) "FAO Forestry Papers"

Example: no. 48: Land Evaluation for Forestry, 1984.

2. Technical Reports and Project Documents:

Examples:

(a) FAO/UNEP: Guidelines for the control of soil degradation, 1983.

(b) FAO/SIDA/CIDIAT: Study Tour on Incentives for Community Involvement in Forestry and Conservation Programmes, 1980.

(c) FAO Technical Report FO:DP/RAS/81/053: Watershed Management in Asia and the Pacific, 1983.

(d) Ministerio de Agricultura y Ganaderia, El Salvador and FAO: Manual de conservacion de suelos en Tierras Inclinadas, 1977.

3. Training Notes and Reports:

Examples:

(a) FAO Training course on Watershed Management for Africa, 1984.

(b) FAO/UNDP Project (Jamaica) Lecture Notes, Watershed Management, and Soil Conservation Training Course, 1975.

(c) FAO Sixth FAO/UNDRO/WMO/ESA - Training course in Remote Sensing--Satellite Application to Flood Control and Forecasting, 1984.

(d) FAO/Thailand Government Conservation Farming Extension Symposium (mimeo), 1978.

4. Films and Filmstrips:

Samples:

FAO Filmstrips on Community Forestry and Conservation.

Watershed Management Textbooks and Related Reference Materials

Hydrology and the Management of Watersheds (forthcoming) by K. N. Brooks, P. F. Ffolliott, H. M. Gregersen and J. L. Thames. Iowa State University Press.

Sheng, T. C. 1986. Watershed conservation--a collection of papers for developing countries. The Chinese Soil and Water Conservation Society and Colorado State University. 92pp.

Watershed Management and A Wetlands Conservation Strategy. 1985. Quesada and Jimenez. CATIE, Turrialba, Costa Rica.

Forestry and Water Quality. 1980. George W. Brown, Oregon State University Press.

Virginia Erosion and Sediment Control Handbook. 1980. Division of Soil and Water Conservation, 203 Governor St., Suite 206, Richmond, Virginia 23219.

Forest Hydrology. 1978. Richard Lee. Columbia University Press.

Publications of the World Bank

Forestry Terms - Terminologie Forestiere - Presents terminology related to forestry development and erosion control in arid and semiarid lands. ISBN: 0-8213-0175-6 Stock no. BK 0175.

Training and Visit Extension - Useful to extension staff and training institutions involved in agricultural and rural development and public administration. ISBN: 0-8213-0121-7 Stock no. BK 0121.

People and Trees: The role of social forestry in sustainable development. Forthcoming. H. Gregersen, S. Draper, and D. Elz (editors). Economic Development Institute.

UNIPUB - Publications (examples)

Experimental Facilities in Water Resources Education - UNESCO Technical Papers in Hydrology no. 24. ISBN: 92-3-102107-9.

Curricula and Syllabi in Hydrology - UNESCO Technical Papers in Hydrology no. 22. ISBN: 92-3-102106-0.

Soil Erosion by Wind and Measures for its Control on Agricultural Land - FAO Land and Water Development Paper no. 6. ISBN: 92-5-100473.

Soil Erosion by Water: Some measures for its control on cultivated land - FAO Land and Water Development Paper no. 7. ISBN: 92-5-100474.

Guidelines for Watershed Management - FAO Conservation Guide no. 1. ISBN: 92-5-100242-8.

Hydrological Techniques for Upstream Conservation - FAO Conservation Guide no. 2. ISBN: 92-5-100115-4.

Conservation in Arid and Semiarid Zones - FAO Conservation Guide no. 3. ISBN: 92-5-100130-8.

Special Readings in Conservation - FAO Conservation Guide no. 4. ISBN: 92-5-100615-6.

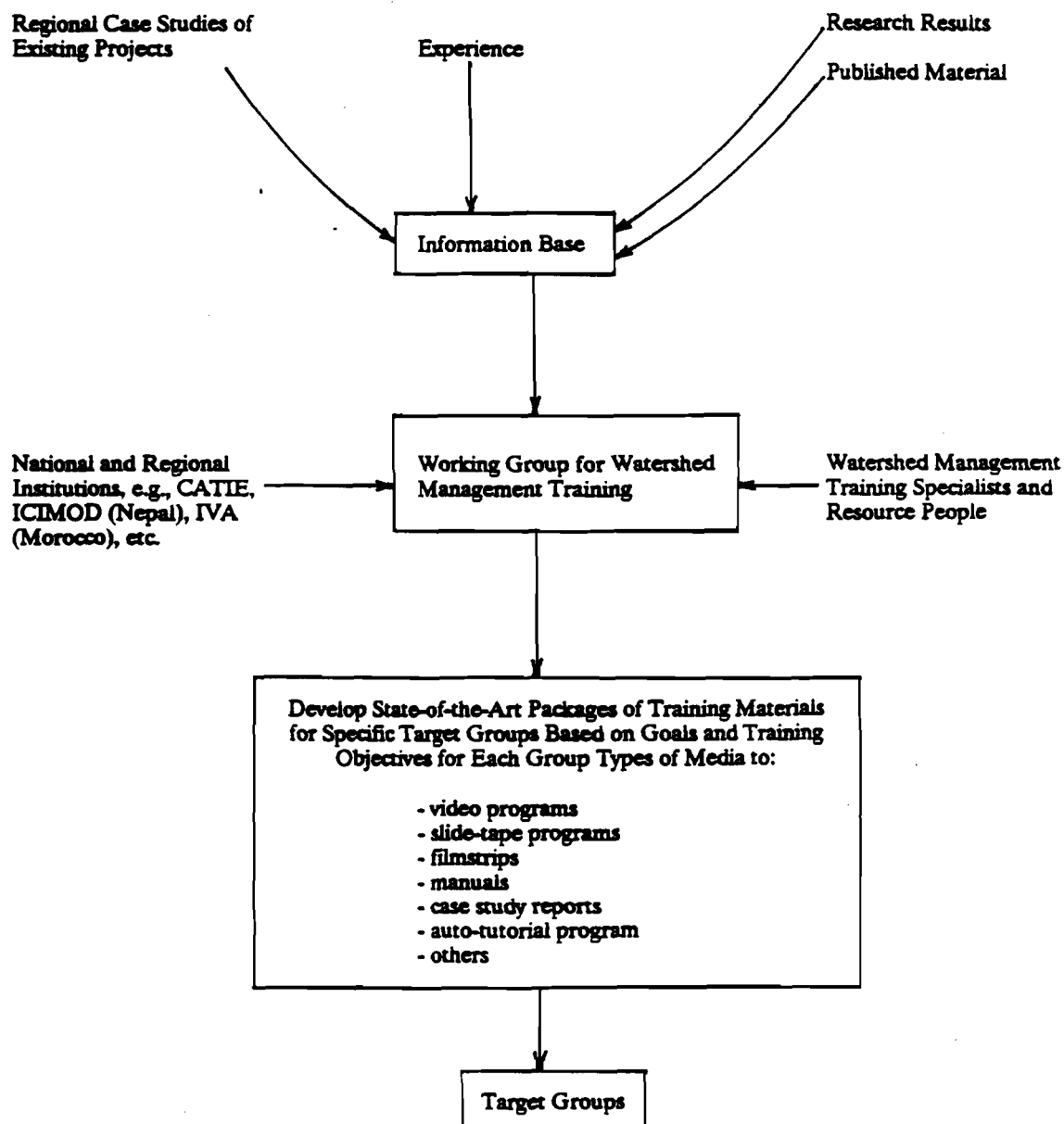
Environmental Impact of Forestry: Guidelines for its assessment in developing countries - FAO Conservation Guide no. 7. ISBN: 92-5-101296-2.

Management of Upland Watersheds: Participation of the Mountain Communities - FAO Conservation Guide no. 8. ISBN: 92-5-101337-0.

ANNEX 3

FRAMEWORK FOR DEVELOPING TRAINING PROGRAMS IN WATERSHED MANAGEMENT

The following flowchart indicates a framework that could be used to achieve training objectives for the various clientele groups that need to be reached.



- continued on next page -

<u>Target Groups</u>	<u>Goals</u>	<u>Training Objectives</u>	<u>Format for Training</u>
Policy makers and sector planners	Achieve environmental objectives and economic development	<ul style="list-style-type: none"> · Understand role of watershed management programs and projects to achieve goals · Convince target group of need for political/governmental support for watershed management program · Illustrate upstream-downstream dependency 	<ul style="list-style-type: none"> · Conferences · Seminars
Project-level planners and managers	Develop natural resource programs that are sustainable (environmentally sound) and that produce needed goods and services	<ul style="list-style-type: none"> · Illustrate how watershed management practices are used to achieve productivity and environmental objectives · Project planning guidelines and methods · Economic appraisal methods · Methods of planning and mitigatory effects of land use—protect soil and water resources. 	<ul style="list-style-type: none"> · Seminars · Training courses · Workshops with case study examples
Field-level staff and technicians	<ul style="list-style-type: none"> · Stabilize soil · Protect water resources · Improve resource production 	<ul style="list-style-type: none"> · Methods of implementing soil conservation measures · Construction of: <ul style="list-style-type: none"> —contour terraces —gully plugs —other erosion control measures · Methods of revegetation and watershed restoration · Multipurpose tree species to use · Land use planning techniques 	<ul style="list-style-type: none"> · Field-oriented training courses · Workshops · Field trips

<u>Target Groups</u>	<u>Goals</u>	<u>Training Objectives</u>	<u>Format for Training</u>
Local leaders and local NGO's	<ul style="list-style-type: none"> · Develop local support for watershed management projects/programs 	<ul style="list-style-type: none"> · Role of watershed management in local community economic development · Environmental benefits of watershed management · Provide background for public hearings/meetings to illustrate watershed management benefits 	<ul style="list-style-type: none"> · Seminars · Conferences · Workshops
Farmers and other land users	<ul style="list-style-type: none"> · Improve productivity on-site · Reduce adverse impacts on downstream communities 	<ul style="list-style-type: none"> · Field methods of soil conservation/watershed practices that increase food/resource productivity without environmental degradation; techniques such as: <ul style="list-style-type: none"> —contour furrows —bench terraces · New species of trees and combined production systems to achieve production goals · Water supply development · Water quality and health relationships: <ul style="list-style-type: none"> —wells —springs —surface supply 	<ul style="list-style-type: none"> · Demonstrations in field · Public meetings · Extension programs
Teachers of teachers	<ul style="list-style-type: none"> · Achieve widespread education about watershed management at all levels of society 	<ul style="list-style-type: none"> · Develop training capabilities among local and regional people · Provide state-of-the-art techniques · Develop local examples from case studies for furthering education of local audiences 	<ul style="list-style-type: none"> · Training courses · Workshops