

## **INTEGRATED WATERSHED MANAGEMENT: BASIC CONCEPTS AND ISSUES**

### **Gopal B. Thapa**

*Associate Professor, Integrated Watershed Development and Management Program, School of Environment, Resources and Development, Asian Institute of Technology, Bangkok, Thailand*

**Keywords:** watershed management, environmental considerations, development planning, conservation

### **Contents**

1. Watershed Approach to Conservation and Development
  2. Level of Watershed as Management Planning Unit
  3. The Dilemma
  4. Costs and Benefits of Watershed Management
  5. Major Issues in Watershed Management
  6. Determinants of Watershed Status
  7. Approach to Watershed Management
    - 7.1 Integrated Conservation and Development Activities
    - 7.2 Mobilization and Strengthening of Existing Development Agencies
    - 7.3 Participatory Management Planning and Implementation
- Glossary  
Bibliography  
Biographical Sketch

### **Summary**

Despite growing concern over the management of watersheds in view of environmental and economic implications of their degradation, there is confusion as to why watersheds should be considered conservation and development planning units. Likewise, watershed development and management projects receive low priority because of unattractive direct benefits reflected in traditional types of cost-benefit analysis. Inconsistency is found in the basic framework of programs, including activities, implemented in different watersheds of the same country.

Many watershed management projects have been implemented in South and Southeast Asian countries with ad hoc institutional arrangements, which disappear with the termination of the projects. Such confusion, inconsistencies and ad hoc arrangements are detrimental to sustainable watershed management. This paper is an attempt to address the above issues.

It starts with the rationale for a watershed approach to conservation and development, followed by a general assessment of benefits accruing from watershed management and associated beneficiaries. Major issues in watershed development are outlined and their causes are examined. Finally, the approach to watershed management is suggested against the backdrop of watershed management issues.

## 1. Watershed Approach to Conservation and Development

A repeatedly raised question by policymakers and planners is why should a watershed be considered a natural resource conservation and development planning unit. In order to explore this question, it is important to define the term “watershed”, which has traditionally been the subject of hydrologists and soil conservationists. According to the Soil Conservation Society of America, a watershed is a geo-hydrological unit comprising land and water within the confines of a drainage divide. Apparently, communities and their socio-economic activities, which have been the prime matter of concern for watershed management endeavors, have been overlooked by this definition. To reflect a more complete definition, a watershed can include the notions of both a bio-physical and socio-economic unit comprising all natural resources, people and their socio-economic activities within the confines of a drainage divide. Watersheds vary in size. They may be as small as watersheds of rivulets or as large as watersheds of major rivers.

A watershed is physically distinguished into lowland and upland or, in conventional terms, upstream and downstream. These two physical entities are integrated through a number of bio-physical and socio-economic linkages. Rivers originate in the uplands and provide water for drinking purposes as well as for the pursuit of economic activities in the entire watershed. Thus, any change in the volume of water caused by human activities leads to chain reactions in both upstream and downstream areas. Increased surface runoff caused by upland degradation raises the volume of water in rivers and streams, and accelerates the removal of soil that is deposited in reservoirs, riverbeds and canals. As a consequence, the upstream area major issues include dwindling land productivity and the downstream area major issues include flooding. Some agricultural lands, however, in lowlands benefit from flooding, as through this process nutrients are deposited in the rich silt. Siltation of particularly reservoirs constructed for hydroelectricity generation and irrigation impairs the amounts of energy and irrigation water provided by these structures and eventually curtails both agricultural and non-agricultural economic activities mainly in the downstream region. Agricultural activities in the upstream area may not be much affected by such change, as most of these activities take place on hill slopes with rainfed cultivation system. Reduced volumes of water in rivers caused by the development of irrigation schemes in the upstream area also generate a chain of negative effects particularly in the downstream.

Upland-lowland linkages in watersheds are not limited to the flow of water and silt. Apart from being in the same physical contiguous system, the upstream area of a watershed is socially and economically well linked with the downstream area. Even in remote watersheds, uplands and lowlands are inter-linked through foot-trails, which normally follow the river courses, and through these trails the two-way flow of goods, commodities and people takes place. The uplands are sources of several kinds of forest products, fruits and livestock products for people living in the lowlands. In an ideal situation, lowlands provide food crops and manufactured goods as well as offer job opportunities to upland people. In a small-scale watershed, strong social ties, facilitated by kinship, are found between lowland and upland settlers. Such attachment is reinforced by ownership of paddy lands, for example, in the valley floor by upland

settlers and the practice of grazing livestock in upland forests by lowland settlers especially during periods of fodder and forage shortages.

In view of the upland-lowland linkages and watershed-wide reactions during changes accompanying development, the watershed is an ideal planning unit. The specific advantages of a watershed approach to conservation and development are the following:

- Conservation and development activities in upland and lowland can be planned and implemented in a well-coordinated way, so that the entire watershed benefits from the activities.
- The above facilitates cost-effective implementation of conservation and development activities.
- Both upland and lowland settlers are the primary beneficiaries of watershed resources. Thus, in principle, both groups should have an interest in watershed management, provided costs and benefits are well understood and the planning and management system is participatory.
- The cost of watershed degradation is internalized to a considerable extent, as both upstream and downstream environmental costs are taken into account. This contributes to justify the implementation of watershed management programs.

## **2. Level of Watershed as Management Planning Unit**

The above discussion justified the need for watershed approach to conservation and development. The immediate question that arises is which level of watershed should be considered as a management planning unit.

A macro watershed is a large area comprising watersheds of several tributaries of a main river. Consideration of this level of watershed as a management planning unit leads to the following problems:

- Watershed management plans cannot address effectively the location-specific problems and potentials.
- As a consequence of the above problem, active public participation in watershed management is constrained.

A micro-watershed comprising the catchment of a stream is the most appropriate management planning unit, as it addresses the macro-level planning-related problems effectively. However, the micro-level planning requires large investments in necessary institutional arrangements.

A meso-watershed approach represents the catchment of a tributary. Considering it as a management planning unit would address issues associated with both macro- and micro-level watershed management planning problems.

## **3. The Dilemma**

Technically a watershed is the best planning unit. Traditionally, however, development plans are prepared for administrative units since they are formally recognized planning areas whose boundaries do not follow watershed boundaries. All official information

required for planning is collected for administrative units. Preparing a management plan for a watershed would, therefore, require adjustments in political boundaries and in the information base. As this type of radical change cannot be expected in the foreseeable future, it would be sensible to suggest that an integrated watershed management plan be prepared at district or sub-district levels depending on the area and population of these administrative units.

The district or sub-district is the administrative unit closest to the meso-level watershed approach. In some instances, administrative boundaries may extend into other watersheds. This impairs formulation and implementation of comprehensive watershed management plans. Coordination in the planning of development and conservation activities to be undertaken by districts or sub-districts within the boundaries of a particular watershed can help to overcome this constraint to a considerable extent.

#### 4. Costs and Benefits of Watershed Management

The commonly held view, partly arising from difficult access, relatively high development cost and variation in bio-physical environment, has been that upstream areas have little or no development potential. In the popular eye, uplands are perceived as vast, rugged, and remote landscapes, which are difficult human environments. To a considerable extent, this view stems from the planners' and policymakers' inability to see the indispensable role of mountain watersheds in facilitating development activities in the plains and beyond. This is reflected by, for example, the exclusion of upland areas' downstream benefits in a typical cost-benefit analysis of watershed development and management projects and in the unexamined comparative advantages of mountains in terms of their production potentials. Preoccupied with lowland areas, policymakers and planners find the plains the most attractive area for investment, though a large proportion of population might be living in the mountains under very poor conditions.

There are multitudes of long- and short-term benefits that accrue from investments in entire watershed development and management plans. These benefits can be shared by the entire national and even sometimes by international communities (Table 1). Such benefits have to be taken into account when comparing costs and benefits of investment; otherwise watershed management projects will appear either unfeasible or less profitable. Concerned policy-makers and planners should be aware that the isolation and marginalization of mountain areas of watersheds, as a consequence of past policies, have already severely impinged upon environmental and socio-economic settings in lowland regions.

Benefits	Watershed Community		Regional Community	National Community	International Community
	Upstream	Downstream			
<i>Ecological/Environmental</i>					
Hydrological cycle	x	X	x	x	x
Carbon sequestration	x	X	x	x	x
Micro-climatic balance	x	X			
Soil conservation	x	X			
Groundwater recharge		X	x		

Bio-diversity	x	X	x	x	x
<i>Economic</i>					
Irrigation water	x	X	x		
Potable water	x	X	x		
Hydropower	x	X	x	x	x
Food crops	x	X	x	x	
Non-food crops	x	X	x	x	
Fuel-wood and fodder	x				
Timber and NTFP	x	X	x	x	x
Tourism industry	x	X	x	x	

Table 1. Selected benefits and major beneficiaries of watershed resources

## 5. Major Issues in Watershed Management

Watersheds bear significant importance from ecological, aesthetic and socio-economic perspectives. These watersheds are home to millions of people, a substantial proportion of whom are indigenous ethnic minorities eking out their livelihoods by utilizing natural resources available there. As much as 65% of the rural population of Asia, and a much larger percentage of its poor, live in upland regions. In Nepal and Laos, half of the population lives in the mountain areas and the overwhelming majority of them cannot meet subsistence levels. To what extent or how long the ecosystem-balancing and economic opportunity-generating roles of watersheds will continue depends on their status as reflected in the distribution, density and type of vegetation cover, and the pace of soil erosion and land productivity. Due to the lack of comprehensive macro-level studies, no conclusions can be drawn about the status of watersheds on a regional scale. However, findings of several micro-level studies indicate that watersheds are undergoing soil erosion, soil nutrient depletion and deforestation, though the extent of these problems varies from one area to another.

The specific issues being confronted in regard to watershed management are as follows:

- How to control or even reverse the process of forest and rangeland degradation?
- How to reduce the rate of soil erosion in agricultural land to a minimum possible limit?
- What should be done to improve the soil fertility, so as to increase crop yield on a sustainable basis?
- How to enable watershed settlers to improve their quality of life without inflicting damage on natural resources?

-  
-  
-

TO ACCESS ALL THE 11 PAGES OF THIS CHAPTER,  
Visit: <http://www.eolss.net/Eolss-sampleAllChapter.aspx>

## Bibliography

Geertz, C. (1968) *Agricultural Involution: The Processes of Ecological Change in Indonesia*. University of California Press, Berkeley, [This is one of the earlier works presenting a concise overview of Indonesian agricultural systems. It looks at the historical development of Indonesian agriculture, and in particular the process of "agricultural involution". It is necessary reading for those interested in Southeast Asian agriculture].

Heathcote, Isobel W. (1998) *Integrated Watershed Management: Principles and Practice*, John Wiley & Sons, New York [Presents a flexible, integrated framework for watershed management that addresses the biophysical, social, and economic issues affecting water resources & their use].

Karki, M., J.B.S. Karki and N. Karki. (1994). *Sustainable management of common forest resources: an evaluation of selected forest user groups in western Nepal*. International Centre for Integrated Mountain Development, Kathmandu [This publication discusses interaction among issues related to community-based management of forest resources and sustainable development].

Messerli, B. and Ives, J. D. (eds.), (1997) *Mountains of the World: A Global Priority*. The Parthenon Publishing Group, New York [A scientific textbook and reference on the human dimension of mountain development. Describes the science of mountain ecosystems, resources, and development. This book also provides agendas for scientific research and sustainable development in the world's mountains today].

Reimold, Robert J. (eds.) (1998) *Watershed Management: Practice, Policies, and Coordination*, McGraw-Hill, New York [Watershed Management builds on the premise that many ecosystem issues are best addressed environmentally, financially, socially, and administratively at the watershed level rather than at the individual waterbody or specific discharger level. Important within the watershed approach is the cumulative impact of a wide variety of human activities and the prioritization of critical issues within a given watershed].

Sharma P.N. and Wagley, M.P. (eds.) (1997) *The status of watershed management in Asia*. PWMTA-FARM, Kathmandu, [The publication reviews the watershed management policy related to: people's participation, farmers' organization building and gender equity, extension methodology, human resource development, conservation incentives and refinements in land use titling/tenure policies to make them implementable. It also elaborates on the status of watershed management in China, India, Nepal, the Philippines, Sri Lanka, Thailand and Vietnam and evaluates the status of methods for planning and implementation of watershed/natural resources management programs].

Shivakoti, G. Varughese, G. Ostrom, E. Shukla A. and Thapa, G. (eds.), *People and participation in sustainable development: understanding the dynamics of natural resource systems*. Institute of Agriculture and Animal science, Rampur, Chitwan. [Elaborates on organizational structure, performance, and participation in the forest user groups in the Nepal hills, among other things].

Tiffen, M., Mortimore, M. and Gichuki, F. (1995). *More people, less erosion: environmental recovery in Kenya*. John Wiley, Chichester, [Uses conventional data, oral history and photographic records to examine the interactions between people and their environment over a period of 60 years. Challenges the view that population growth inevitably leads to environmental deterioration. Features valuable lessons on how resource management technologies, the right social and economic milieu and supportive policies can lead to sustainable development].

## Biographical Sketch

**Dr. Gopal B. Thapa.** Currently working as Associate Professor with the Integrated Watershed Development and Management (IWDM) Program of the Asian Institute of Technology (AIT), Thailand, Dr. Gopal B. Thapa obtained a M.A. degree in geography from Tribhuvan University, Nepal, M.Sc. in Rural and Regional Planning and Ph.D. in Watershed Management from AIT. He also serves as Faculty Coordinator of the IWDM Program jointly implemented by Agricultural Systems, Natural Resources Management and Rural and Regional Development Planning fields of study of the School of Environment, Resources and Development, and Integrated Water Resources Management field of study of the School of Civil Engineering. Dr. Thapa's main areas of specialization are integrated watershed development and management, and natural resources management. He has more than 50 publications,

including internationally referred journal articles, book chapters, monographs, research papers and reference materials, to his credit. He is editorial board member of the *Environmental Management* journal published by Springer Verlag, New York, and is a member of the International Mountain Forum and associate member of the International Mountain Society.

UNESCO – EOLSS  
SAMPLE CHAPTERS