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Forests and Water: Towards Effective Watershed Management

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ABSTRACT

Interest in and awareness of the multiple environmental, economic and social benefits provided by watershed management and development has greatly increased in recent decades. This may be particularly true in developing countries where the economy is depending predominately on agriculture, but with fast growing urban populations depending on water and food supplies on an unprecedented scale.

Attention given to watershed management is even higher these days where water scarcity is an issue under discussion and debate all over the world. In fact, freshwater which supports at global level about 40% of all food crop production via irrigation and 12% of all fish consumed by humans and is used to generate 20% of all electrical power (Johnson et al. 2001), is now debated all over the world as water scarcity is threatening the multiple uses of freshwater and ability to achieve food security.

Recognizing that degradation of natural resources is considered to be the greatest constraint to sustainable agricultural development, it is generally accepted that sustainable use and management of land resources will only be achieved by adopting a system of improved land, water and vegetation management and use.

Watershed management which is the implementation of management systems intending to ensure the conservation and sustainable use of all land resources is considered by many to be the most appropriate approach for the sustainable use and conservation of land based water resources in the uplands and lowlands. That's why watershed management principles and approaches have been used since the 1960's by countries and development organizations in an attempt to reverse degradation of water and soil resources.

* The content of this paper is also based on the work which is being conducted with Brooks K., Tennyson L. and Sedell J. et al. on initiatives related to forests and water and watershed management issues.

As a consequence of the given attention and important investments secured for the development of watershed management, much progress has been achieved in the development of related approaches. However, several issues of major concern, which have been raised many years ago, are still requiring in-depth analysis and consultation among all concerned parties for better understanding and implementation of effective watershed management. The role of forests/forested watersheds in sustaining and protecting water supplies has been a debated issue for long time. In this context, the watershed perspective is seen as the best framework where such issues can be better understood and translated into effective programmes of sustainable management of water resources.

The important role of watershed management, especially with regard to water resources and food security, has received high attention in FAO programmes and priorities. During the Meeting of the Committee on Forests (COFO), 1999, the Committee requested FAO to assist in the formulation and implementation of policies for integrated watershed management. In this connection, a review and assessment of watershed management approaches and strategies was launched within the observance and follow up of the International Year of Mountains (2002). The FAO initiative called "Preparing the Next Generation of Watershed Management Programmes" is being carried out at global level in collaboration with key actors in watershed management. In addition, the newly developed technical entity "Forests and Water" will come under implementation during the Medium Term Plan 2004-2009. It will address the importance of mountain forests and upland areas with regard to the conservation of water resources through the development of effective watershed management.

1. Introduction

Degradation of natural resources is considered to be the greatest constraint to sustainable agricultural development in most of the developing countries. In particular, water scarcity is seen as a major threat to achieving food security and poverty reduction and therefore requiring effective management through the development of appropriate approaches and adequate policies.

It is widely accepted that sustainable use and management of land resources will only be achieved by adopting a system of improved land, water and vegetation management and use based on an integrated approach. Watershed management that includes participation of relevant stakeholders in land resources management has become widely accepted as the approach best suited to address the sustainable use and management of water resources. In fact, watershed management integrates various aspects of forestry, agriculture, hydrology, ecology, soils, physical climatology and other sciences to provide guidelines for choosing acceptable management alternatives within social and economic aspects.

In this respect, Kerr (2002) outlines that a watershed or catchment is an area from which all water drains to a common point, making it an attractive unit for technical efforts to harness scarce water resources and conserve soil for agricultural production and natural resources conservation.

To improve watershed conditions and to sustain water resources, sustainable forest management is considered a key factor to water resources management in particular and upland resources development in general. Forested catchments supply water for domestic, agricultural, industrial and other ecological needs in downstream areas. Well managed forests have direct impacts on the high quality of water yields from watersheds and on the lower storm flow peaks and volumes for a given input of rainfall. They also contribute to soil erosion control and consequently to reducing the levels of sediment downstream.

Sustainable forest management and watershed development are tightly linked. Upstream management of forests strongly affects downstream uses of water resources. These upstream-downstream linkages and related interactions are well recognized within a watershed management perspective. Effective watershed management that includes all interactions and implications related to the upstream-downstream relationship is well suited for forest and water sustainable management. In addition to the technical aspects, it takes into account the ecological, social and economical dimensions.

The role of forests in the conservation and sustainable use of water resources is still an issue of discussion and debate. Effective watershed management provides a framework where the role of forests and forested watersheds in the protection of uplands and in the sustainable use and conservation of lowlands resources are better understood. This perspective which recognizes the opportunities and limitations of forest management on freshwater, translates this recognition into more effective planning, implementation and monitoring of forest, water resources and agricultural development programmes.

Effective watershed management considers forests and their management as an integral component for watershed conditions improvement and consequently water supplies improvement. To better identify the elements which constitute effective watershed management, an FAO initiative on the review and assessment of watershed management approaches and strategies was launched early 2002 to identify guidelines for the implementation of future watershed management programmes. FAO is also launching a new entity project within the Forestry Department Programme called "Forests and Water". This entity aims to promote the role of forests in the conservation and sustainable use of water resources.

2. Why a Focus on Effective Watershed Management?

Chapter 13 of UNCED Agenda 21, for which FAO is the UN Task Manager, stresses that "Promoting integrated watershed development programmes through effective participation of local people is a key to preventing further ecological imbalance. An integrated approach is needed for conserving, upgrading and using the natural resource base of land, water, plant, animal and human resources".

Given that watershed management is the implementation of management systems which ensure the conservation and sustainable use of all land resources, the development of watershed management is being recognized as a pre-requisite for the sustainable management of land resources and improvement of the living conditions of upland inhabitants. In this context, watershed management is considered by many to be the most appropriate approach to ensure the conservation and sustainability of land based water resources in the uplands and lowlands.

Technically, watershed management offers the possibility to consider the interrelationships between the productivity and conservation in the use of natural resources as well as the recognition of upstream-downstream linkages related to the protection and use of land resources, especially with regards to water supplies. Effective watershed management is also considered by many as an appropriate approach to address food security and poverty alleviation which explains the popularity of watershed development among planners.

All the above mentioned reasons were behind the increased interest and investments secured for the development of watershed management in recent decades. As an example, the recent review of watershed management projects (World Bank projects) shows that a total envelope of \$ 2.37 billion was spent on watershed/watershed management related projects between 1990 and 1999.

With water scarcity issue increasingly recognized, watershed management development has become widely accepted as the approach best suited for sustainable management of water resources in uplands areas and downstreams. To better consider the opportunities offered by watershed management and the challenges and constraints it faces, efforts are needed to develop innovative approaches to cope with emerging issues and controversies such as water scarcity threat and forest hydrology application in sustainable use of water resources.

3. Forest Hydrological Processes

Lee, 1980 considered forest cover as necessary to sustain river flow and Tsukamoto et al 1982; Sidle, RC, 2000 outlined that hydrological processes in forested hill slopes and in small watersheds control stream flow. According to the “sponge theory”, which came under criticism as early as 1920, the forested areas absorb a large amount of water during wet periods or snow melt and slowly release water into streams and rivers during dry periods when water is most needed. Such perception has led to the establishment over 100 years ago of the National forests of the United States. The system was in place to protect and enhance water supplies, reduce flooding and secure favourable conditions of water flows.

Although there is no general consensus on forest hydrology impacts, particularly on water resources management at downstream areas, watershed management is considered as the best framework not only for a better understanding of the forest hydrology processes but also for a better concerted management of forests and water resources.

Forest hydrology emerged as a discipline to reverse degradation of watersheds and subsequently to respond to changes happening in the hydrological functions of watersheds. During the 19th and early 20th centuries, the removal of forests at large scale was seen, at that time, as directly influencing accelerated soil erosion, large scale siltation and frequent damaging floods. Tennyson (2002) mentioned that during the 2nd quarter of the 20th century, the discipline of forest hydrology evolved from the need for scientific management of the water and soil resources of headwater catchments to minimize flooding and siltation of productive lands and infrastructures in the valleys and plains inhabited by man.

Forest hydrology has developed to a more comprehensive concept known as watershed management. Watershed management implies land resources management within social and economic contexts. With time, the scope of watershed management evolved from the initial concept concentrating on water resources management to a participatory integrated approach aiming to maintain productivity and improve uplands people conditions.

The worldwide attention on effective water resources management highlighted the need for a better understanding and application of forest hydrology in water resources relevant development programmes. To achieve such objective different initiatives are being carried out to improve the knowledge on hydrological processes and the effects of forests and mountainous watersheds, mainly on water resources and to identify/justify forest hydrology as an important element of effective watershed management.

4. The Role of Forests and Forested Watersheds

Forests and forested watersheds provide multitude of services. Although, we still don't know enough about the effects of forest management on climate and water flows, it is generally accepted that forest ecosystems play important roles in providing valuable hydrological services.

Forests and effects on rainfall: Research on how afforestation/deforestation affects rainfall remains inconclusive. Simulation models predict that massive deforestation will decrease rainfall in some areas and increase it in others (Kaimowitz, 2002). On this subject, Calder (1999) outlined that deforestation has little effect on regional precipitation and Lee (1980) noted that the removal of all forest cover would only reduce global precipitation by at most 1 to 2%.

Forests and floods: Although, it is widely accepted that forests contribute in regulating river flows through produced lower peaks and volumes, the role of forests in controlling floods is far from certain. Due to their high infiltration capacity, forests can store higher rainfall quantities, reduce runoff rates and therefore minimize, to some extent, floods. The question is to what extent the forest cover can contribute to the protection from floods. At larger scale, it is believed that forests have no substantial impact on reducing flood damages. Studies have shown that beyond certain spatial scales, forests/land use don't have effects on river flows:

The spatial dimension of land-use effects

Impact	Basin size [km ²]						
	0.1	1	10	100	1 000	10 000	100 000
Average flow	x	x	x	x	-	-	-
Peak flow	x	x	x	x	-	-	-
Base flow	x	x	x	x	-	-	-
Groundwater recharge	x	x	x	x	-	-	-
Sediment load	x	x	x	x	-	-	-
Nutrients	x	x	x	x	x	-	-
Organic matter	x	x	x	x	-	-	-
Pathogens	x	x	x	-	-	-	-
Salinity	x	x	x	x	x	x	x
Pesticides	x	x	x	x	x	x	x
Heavy metals	x	x	x	x	x	x	x
Thermal regime	x	x	-	-	-	-	-
Legend: x = Observable impact; - = no observable impact							

Source : FAO electronic workshop on Land and Water linkages in Rural Watersheds, 2000.

Forests and sedimentation: Everyone agrees that well managed forested watersheds produce less sediment. Sediment that can affect storage capacity of reservoirs, water quality, irrigation systems and hydroelectric dams. However, the

frequently asked question is the extent to which forest cover can reduce sediment when extreme events are taking place.

Forests and water quality: Well managed forested watersheds play an important role in reducing sediment and in discharging high quality of water and consequently in reducing the costs related to water treatment at downstreams.

Example: Land Management II-Santa Catarina Project, Brazil (World Bank)

A case study was conducted on the Lajeada Sao Jose micro-watershed (7,744 ha) (Bassi, 2002), one of 520 micro-catchments included in the project. Due to the downstream environmental monitoring of streamflow the project was able to determine some of the off-site benefits from the land management interventions. One important benefit was the reduction in suspended sediment levels by 69 percent. This reduction represented a savings in water treatment costs for domestic supply of about U.S. \$2,445 per month. This study illustrates that investment in upland watershed management related interventions can produce downstream economic return. (Source: Tennyson, 2002)

The New York City watershed management programme is a model where considerable amount of investment on water treatment US\$ 7-8 billion can be avoided by investing about US\$ 1.5 billion in effective watershed management interventions (Claudia, 2002).

5. FAO's Initiatives on Forests and Water and Related Issues

5.1. Review and assessment of watershed management approaches and Strategies

Although there is a general agreement on the important role that integrated watershed management can play in natural resources conservation and improvement of the conditions of upland people, conflicting views on the approaches and methods of watershed management continue to be the subject of concern and controversy.

The development of concepts and approaches and watershed management experiences carried out in many places of the world now calls for further investigation, analysis and consultation among watershed management stakeholders for greater consensus on what has been achieved and how things could be done better. Stakeholders are stressing the need to have a clearer picture on several key issues of major concern to watershed management development.

In response to raised key issues of major concern to the development of watershed management, FAO launched early 2002, in the framework of the International Year of Mountains (IYM) 2002, the initiative "Preparing the Next Generation of Watershed Management Programmes" to review and assess watershed management activities. The review aims to:

- provide an adequate opportunity/platform to all concerned parties to share information and contribute to a better understanding of the current status of watershed management;
- provide required advocacy and support for the implementation of effective watershed management at local, national and regional levels.

To achieve the review objectives, five steps were identified: first, to identify key actors involved in watershed management, second, to conduct stocktaking of FAO experience in watershed management, third, to analyse selected case studies on watershed management projects or programmes and fourth, to convene a series of regional workshops for stakeholders input. The fifth step is an international conference where the sum-up of the steps one to four are shared/discussed among all key actors in watershed management. The final step is the formulation of guidelines/strategies for effective watershed management programmes and results distribution on global scale.

5.2. New Entity "Forests and Water"

The new entity "Forests and Water" which is being included in the FAO Medium Term Plan 2004-2009 reflects the special attention paid by FAO/Forestry Department to the conservation of water resources (Medium Term Plan 2004-2009, FAO). This new entity will focus on improved national awareness and policy environment in support of the sustainable management of mountain forests and upland areas with regard to water resources.

In addition to raising awareness on the role and application of forest hydrology and the promotion/identification of elements which constitute effective watershed management, the entity aims at the development, demonstration and promotion of appropriate technologies and practical methodologies. This work will be undertaken with the participation and direct inputs of all stakeholders as a follow up to the implementation and promotion of the findings and recommendations of the International Year of Mountains and the International Year of Freshwater.

The expected outputs of the new entity were identified as the following:

- Advice on defining and implementing effective watershed management approaches and strategies and forest hydrology application and other appropriate forest related practices for the sustainable use of water resources

- Innovative approaches for the conservation and sustainable development of critical mountain watersheds and upland resources relevant to water conservation and use
- Development of best forestry practices for the enhancement and conservation of water resources in lowland landscapes
- Institutional capacity building at all levels for the implementation of effective strategies and programmes for the sustainable management of mountain watersheds/upland resources
- Appropriate policies and action programmes to effective watershed management, including field-level approaches to the management of water resources as a follow up to the International Year of Mountains and the International Year of Fresh Water

5.3 Sustainable Mountain Development: International Partnerships

The International Year of Mountains has already achieved significant results. To consolidate and capitalize on these achievements, there is a need for a concerted/long-term action and work in partnership among all concerned parties in order to achieve the expected objectives of sustainable mountain development. In this respect, a comprehensive mountain facility will be established to provide required support to countries on issues related to the implementation of Chapter 13 of UNCED Agenda 21. Water and watershed management are important components of Chapter 13.

6. Some Elements of Effective watershed management

The expert meeting on strategies, approaches and systems in integrated watershed management held in Kathmandu, Nepal in 1985, highlighted the threats that watershed degradation represent for the livelihood of millions of people and identified and recommended relevant action for urgent implementation. The main recommended actions were as follows:

- Need to develop significant policy and programme responses
- Need to develop national conservation strategies and frameworks to achieve appropriate and comprehensive management of mountain watersheds
- Need to develop relevant training, efficient applied research and demonstration projects required to achieve effective watershed management.

In spite of the progress achieved in developing watershed management approaches and application, most of the actions identified above are still considered to be urgent/relevant for implementation. In addition, conflicting views on the approaches and methods of watershed management and controversies over issues of major concern, such as people's participation, upstream-

downstream linkages and required institutional arrangements are calling for further analysis and identification of the appropriate elements which constitute effective watershed management. In this respect, the following elements are considered by many as needed to achieve effective watershed management:

Scale effects: Although, it is easier to monitor watershed management effects at smaller scale, watershed management activities should be considered at the local, national and regional levels. Successful cases are not limited to small size watersheds. Watershed management benefits on freshwater are better recognized when the upstream-downstream linkages and interactions are linked to scale effects.

Stakeholders involvement/participation: In addition to uplands people participation which is recognized as key to the success of watershed management programmes, all stakeholders, downstream users of watershed resources, government concerned institutions, NGOs and other concerned parties should be involved from the very beginning in watershed management programmes. Such involvement/participation should be integrated as a major component in the design/development of relevant programmes/policies.

Special emphasis on water: To deal appropriately with water resources management, effective watershed management requires innovative approaches and adequate technologies. Taking into account events such as the International Year of Mountains 2002 and the International Year of Freshwater 2003, forest hydrology should be considered as one of the important elements constituting effective watershed management.

Economic returns: To ensure sustainability and replication of watershed management interventions, there is need to make sure that economic returns are guaranteed. Economic returns which benefit upland beneficiaries as well as downstream inhabitants/resource users. In this respect, the initiatives launched on the payment for environmental/hydrological services need to be enhanced.

Adequate institutional/organizational arrangements: institution building for watershed management has been raised as one of the most neglected part of watershed projects. In this respect, it is being recognised that there is a need for improved understanding and identification of institutional and organizational arrangements required for an effective watershed management. An appropriate legislative framework to support watershed management policies has been also raised as an important tool which needs particular attention.

Long-term vision/commitment: Watershed management is increasingly seen as an appropriate vehicle not only for environmental conservation but also for the improvement of living conditions of rural communities. In this regard, there is a need for long-term commitment, including financial, from all stakeholders.

The preliminary results of the FAO's review and assessment of watershed management approaches and strategies show that a paradigm shift is needed in order to achieve an effective watershed management. The important components of this shift were defined as follows:

Present Scenario	Future Scenario
<p>1. Treating the symptoms of watershed degradation [deforestation, soil erosion, siltation, decreasing production, etc.], (WRDP-WMIC 1998)</p>	<p>Identifying and treating the underlying causes of watershed degradation [lack of knowledge, poverty, population increase, demand for resources, improper land use, etc.] More focus on prevention rather than the cure.</p>
<p>2. Priority focus on off-site/downstream costs and benefits of watershed management; e.g. downstream infrastructure risk, decrease in floods and sedimentation, increase in water quantity and improved water quality for downstream users.</p>	<p>At minimum, equal priority to on-site costs and benefits of watershed management; e.g. improving and maintaining upland agric., forest, and rangeland productivity, water quantity and quality.</p>
<p>3. Inadequate project designs that often overestimate government capacity and assume policy changes will occur.</p>	<p>Project design that provides for adequate government capacity and assurance of policy changes.</p>
<p>4. Top down research and development and transfer of technology to local stakeholders that is driven by donors and education and research institutions.</p>	<p>Emphasis on stakeholder participatory learning and technology development process, that builds on indigenous technologies and addresses local research needs.</p>
<p>5. Diffuse focus of watershed management that often maximizes production of resources/commodities other than water and soil.</p>	<p>Sustainable multiple-use management of watersheds that combines water resources development with compatible economic land based production systems e.g. trees, crops, livestock, fish, recreation.</p>
<p>6. Encroachment of integrated rural development approach with multi-sectoral steering committees and line agencies [which for the most part has been a failure] into the integrated watershed management concept.</p>	<p>Multiple use management of natural resources (renewable and non-renewable) with emphasis on water and soil resources in upland watersheds with development responsibility given to the relevant line agency.</p>

Source: Tennyson, 2002.

7. Opportunities for the Future and Follow up Actions

The FAO review on watershed management is expected to provide, through the conducted stocktaking, regional meetings/workshops, recommendations for follow-up to the activities of the International Year of the Mountains (2002) and contribute to the activities of the International Year of Fresh Water, 2003. It is also expected that future discussions will emphasize on forests and their management as important elements of effective watershed management.

Among other events, the present meeting on forests and water will contribute in clarifying the role of forests/forest hydrology in the conservation and sustainable use of water resources. It will also contribute in raising awareness about the role of forests and application of forest hydrology through the presentation of its findings/results in the coming meetings such as COFO, World Water Forum, etc.

At this stage, there is still a need for a better understanding of forest hydrological processes and forest management impacts on land resources management. The international Year of Freshwater 2003 is an opportunity where such issues can be further discussed/developed among practitioners, researchers and other concerned parties.

Another initiative which can provide opportunities for further development of effective watershed management is "White Water to Blue Water". Forest and watershed management are expected to be major components of the initiative which will involve a wide variety of partners. The United States has agreed to take the leading governmental role in the first phase of this initiative which will begin by a conference scheduled during 2003.

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