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A Roadmap for Watershed Management in Bhutan

3 March 2011

Watershed Management Division

A Roadmap for Watershed Management in Bhutan

From Policy to Practice

4 March 2011

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Bhutan is a land of exquisite natural beauty inhabited by happy and peaceful people in harmonious coexistence with their environment, and endowed with ample ecological resources sensibly managed for manifold benefits. Beyond this semblance, we have barely ventured into unraveling the processes and forces that shape our country's landscape aesthetics, the quality and quantity of its resource endowment, and in turn our lives. No matter where we live or work, we are in a watershed teeming with unique components that manifest unique blends of climate, geology, hydrology, soils, and vegetation shaping the panorama. Understanding these aspects can instill better appreciation for healthy watersheds in sustaining life, and how human activities can be harmonized and tailored to complement nature's masterpiece rather than impact them. A watershed perspective is needed to integrate concepts and actions that will leverage focus on the community wellbeing and realize the national development goals. This Roadmap to watershed management is conceived to fulfill that role and guide us into an era of contextual and rigorous use of best practices based on sound, useful science.

Despite many well-intended efforts to secure watershed conditions and their functional integrity, we continue to encounter sporadic aftermaths and chronic spiraling of resource degradation. These changes are serious cause for concern as the country's future is vested in the quality of its ecosystems, and the wellbeing of its people premised on the renewable supply of watershed resources and services. Natural springs are drying up making rural settlements even more precarious due to drinking water shortage; townships face uncertain future as growth prospects are debilitated by dwindling supply for domestic, business and municipal utilities; agricultural productivity has plateaued or on decline for want of irrigation; increased sediment load and declining baseflow are extracting their toll on hydropower plants by shortening their design period of economic operation, and further depressing lean-season power generation; hydrological extremes ravage forest and riparian ecosystems, besides reversing food security gains and flood disaster risk reduction. All these real and urgent

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problems and issues clamor for tangible solutions that are environmentally sustainable, economically efficient, and socioculturally equitable and acceptable. The Roadmap offers a framework for integrated land, water and biomass improvement, and poverty reduction positioned at the center of watershed management as a new paradigm for participatory, bottom-up approach.

Amidst the technical details of the way-forward for watershed management, one dominant theme explicitly underscores a resounding caveat that effective linkage and integration of governance machinery must indeed precede integrated action at watershed level. Fragmented jurisdictions and single subject mandates of many government agencies in water are leading to policy externalities and conflicting management decisions. Other important issue is that the sub-national administrative boundaries do not always follow the biophysical boundaries of the watersheds. For positive impacts of integration, convergence and synergy we should seriously consider adopting ecologically coherent, political units of watershed dzongkhags and watershed geogs.

I am confident that all stakeholders will welcome the compelling rationale articulated in the Roadmap for coordinated and integrated watershed management in order to optimize social and economic welfare outcomes. Almost all dimensions of poverty are dependent on the multiple uses of water, thus necessitating a pro-poor development policy with clear understanding of the linkages between poverty, land degradation, integrated forest and water management within catchment areas.

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Executive Summary

Watersheds are natural waterscape resulting from the combination of the hydrology and topography of the landscape with a human perspective. While they project different contexts under natural, political or demographic framework, watersheds are, nonetheless, ubiquitous units that can be seen as the physical foundation of our nation state. They are logical divisions or regions of the natural landscape, and for some purposes they are ultimately the best framework to use for management. The human perspective, in an effort to factor in his interests, imposes an additional dimension to this definition to extend it beyond the boundaries of the physical watershed. As a result, we are inclined to perceive watershed space as a domain that transcends physical delineation.

Considering the historic transformation in the Bhutanese politics with power devolved to the people and authority decentralized to the local levels, the central government must stand up to the new roles and challenges posed in accommodating local-level, people-oriented imperatives while being resolute in safeguarding and representing the overall interests of the general public and the nation as a whole. Realization of the four pillars of Gross National Happiness (GNH) is squarely anchored in the collective resolve of all citizens, researchers and scientists, resource managers and decision-makers to focus on a vision of sustained peace and prosperity through integration of ecological, sociocultural, economic and to environmental objectives. Adopting a watershed perspective to the whole development strategy can provide a balanced framework for effective integration across management systems and administrative levels.

The watershed approach is one panacea with the real prospect of addressing coupled human, resource and environment related problems, in particular those related to water resources rapidly being exposed to competing demands. Most of the time, we get caught into the dichotomy of economic development and environment, and well-conceived participatory, integrated watershed management in the upper catchments may become an important tool. The watershed approach acknowledges linkages between upstream and downstream areas and between “Green” and “Blue” water, and reduces the risks of trading problems in space and time. Watershed management is an integrative way of thinking about various human activities that occur on a watershed that have effects on, or affected by, water. With this perspective, we can plan long-term, sustainable solutions to many natural resource problems, and find a better balance in fulfilling the current needs while leaving a sound resource legacy for generations to come.

Watershed approach cannot be impressed through regulations, changes in law, more money or any normal bureaucratic measure; but through integrative and participatory actions. Watersheds constitute a coherent and systematic basis for deliberation and action in natural resource management as those constituents relate to each other with minimal scientific ambiguity within their natural boundaries. A single nationalized solution is unlikely to succeed in an environment as complex as the human-associated diversity, and these local variations are the key to the growing demand for local actions and solutions. Unfortunately, watershed science in general has not yet developed an effective interface between what we know and how we use that knowledge. Good science is not enough; we need useful science. As a result, watershed management is perceived to be both institutionally and scientifically

complex, and thus inherently difficult to implement. Given the benefit of recent advances in watershed science in terms of new knowledge and experience, we are offered with unprecedented opportunity to embark upon a program of synergizing environmental and sociocultural safeguards with economic and consumptive imperatives while fostering the natural resource potential.

There are also challenges posed by the development pathway that the nation has cautiously chosen to tread. The proliferation of market-based economic activities have fueled accelerated demand for natural resources all too often leading to overexploitation and unsustainable practices. Problems associated with water scarcity, deforestation and land degradation are manifest. The urgency for achieving a watershed vision is related to both the need to protect an expanding network of major hydropower installations in the country and the relatively small but productive river valleys for improving food security situation of the largely agrarian-based rural communities. The approach envisioned is one of integrating watershed management practices with environmentally sound land-use management activities and effective community development efforts through comprehensive local institutional movement, emphasizing focus on best practices (Box 1).

Box 1: Paradigm of a watershed approach

- Broad-based approach with active and inclusive community participation
- Incremental approach to avoid failures that could discourage or distract people
- Right mix of top-down and bottom-up approaches of formal governmental and community-based organizations at all levels.
- Good cooperation between government, private sectors and NGOs assuming joint ownership and responsibilities, and establish effective linkages among stakeholders at the national, regional and local levels.
- Emphasize on short-term gains and early returns
- Appropriate technologies in terms of reducing uncertainty and ensuring good returns
- Adequate technical assistance and extension services for transfer of appropriate technologies
- Thorough logistical planning in addition to strategies and interventions
- Appropriate subsidies and support to reinvestment of gains in community improvement programs.

In 2009, the Watershed Management Division (WMD) was established under the Department of Forests and Park Services, and designated as national focal agency for operationalizing the watershed management program as a part of larger a initiative in developing integrated frameworks for major river basins in the country. In close consultation with managers, stakeholders and communities, WMD has developed three broad goals underpinning the common program objectives and practical measures contributing to the overall development vision of GNH by sustaining the flows of natural resources and better stewardship of watersheds. These goals and objectives are grounded in providing the country and its people with goods and services in ways that maintain the long-term productive capacity of natural resources without damaging the environment.

Watershed Roadmap Goals and Objectives
1. To restore, protect and improve watershed conditions through participatory, integrated and adaptive management strategy built into a coordinated management plan
Objective 1A: Advance knowledge and understanding of the watershed ecology and best management practices that provide economic benefits while securing natural area productivity.
Objective 1B: Rehabilitate watershed land, high-altitude rangelands, stream channels, wetlands and riparian systems that have become degraded; and conserve critical and sensitive ecosystems
Objective 1C: Find common ground and meet multiple needs through focused and coordinated efforts to generate ecologically-based, innovative, cost-effective solutions, and forge stronger working relationships among watershed partners, stakeholders and users.
Objective 1D: Establish partnership and collaborative watershed institutions at the national and local levels complementing and strengthening each other in supporting national development priorities and addressing unique local concerns
2. To support sustainable livelihood including options thereof, and enhance the quality of life of local watershed communities
Objective 2A: Develop, manage and sustain production systems well suited to the existing environment and natural resource base
Objective 2B: Reduce nutrient loads, contaminants in streams and rivers that contribute water for the desired uses
Objective 2C: Carry out activities that help regulate flows in streams and rivers to even off extremes of floods and droughts
Objective 2D: Harmonize the economic uses of natural resources between upstream and downstream areas to secure positive benefits along the watershed continuum and across multiple management objectives
Objective 2E: Explore options for innovative finance mechanism in managing watersheds under bilateral/multilateral funds, government grants, market-based arrangements and incentive/reward schemes.
3. To secure watershed services used to fuel the socioeconomic development of the country
Objective 3A: Sustain or increase supplies of high-quality water through improved quality and quantity of water in watercourses and water bodies
Objective 3B: Prevent excessive soil erosion to protect the productive potentials of land and reduce downstream sedimentation
Objective 3C: Take measures to increase groundwater storage to restore mountain springs and improve the volume of base flow in the natural watercourses.

Water resource of high quality and in sufficient amount is the central theme in the decision process of identifying and selecting land utilization types in meeting people's food, health or income priorities. Watershed management interventions involve rehabilitating degraded landscapes to restore the provisioning context of natural ecosystems, considering both on-site and off-site influences in terms of soil erosion and sediment movements, water flows and water quality characteristics (Figure 1). Soil and water conservation represents an

integral part of watershed management with holistic consideration of linkages among all the activities within a watershed. Achieving these objectives is contingent on planning for effective and efficient use of the land, water and other natural resources, coordinating management activities and benefits among many stakeholders and dealing with various land uses traversing political jurisdictions. Watersheds are biophysically and hydrologically consistent domain of a mosaic of land-use units each defined by specific ownership control and uses; but do not always coincide with administrative boundaries that partition political decisions and actions. As a management unit, watersheds reflect the linkages between components and processes, and the interactions initiated in response to natural forces and human activities. Understanding these connections provide a rational basis for effective, efficient and equitable management interventions within the boundaries of watersheds.

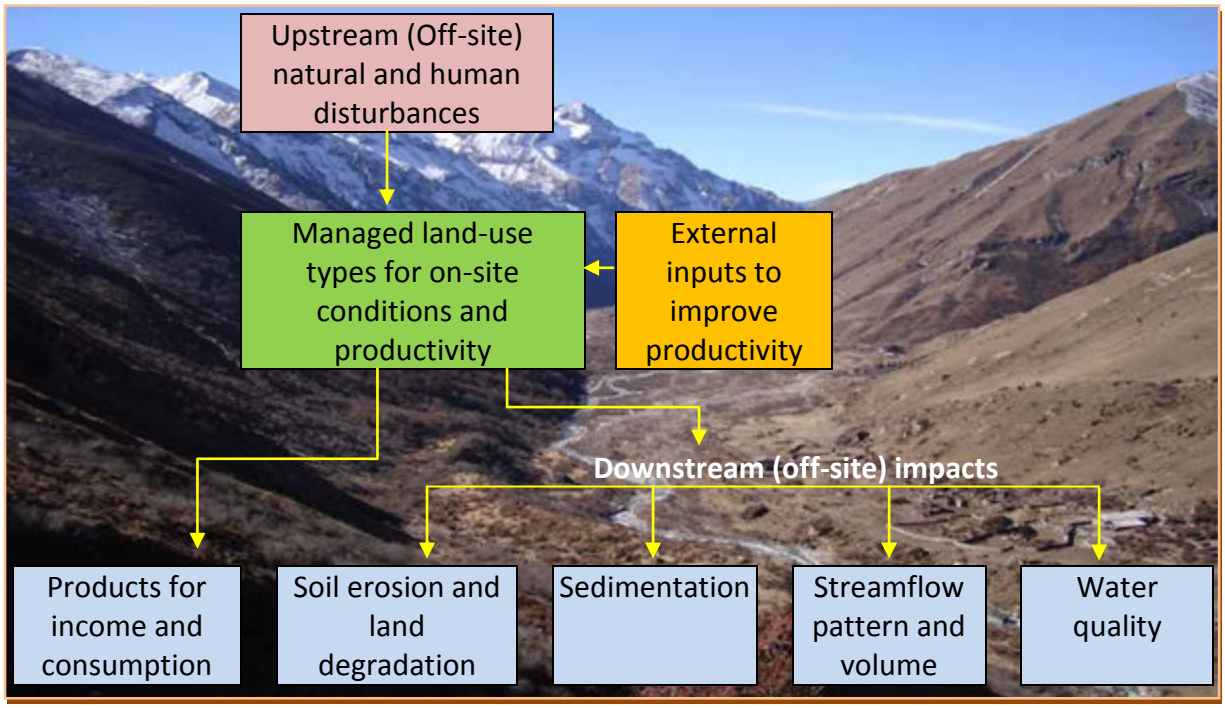

Figure 1. Upstream-Downstream linkage and outcome windows in a watershed

We hope that this watershed roadmap will resolve part of the puzzle posed by our national desire for developing water-related resources to sustain economic prosperity, while at that same time restoring and maintaining a quality environment. Despite extensive consultations and substantive versioning, we make no claim of being conclusive or definitive on the way forward outlined in this document. The roadmap represents a consensus among key actors, potential partners and stakeholders who have contributed thoughtfully to the process leading up to it. There is bound to be divergent position and compelling debate on the logic and substance depending on an individual's perspective of problems and solutions. Like everything else, it is meant to be adaptive with full expectation that at least watershed managers at the local and national levels, researchers and related agencies will grasp the principles of watershed approach and build on its strength to influence the people and policies in the right direction.

The Water Act articulates integrated thinking and enables bottom-up development of local watershed institutions with authority to respond to local problems by bringing the

watershed service providers and users under a benefit-sharing arrangement. This roadmap reinforces the basic guiding philosophy encapsulated in the Act, and offers feasible options and mechanisms to steer the nation toward improved strategies for watershed management. It is one serious attempt to put upstream-downstream interactions in proper perspective with a balanced view of both conflicts as well as complementarities. Considerable thought is put in the way of providing income-generation for poor and marginalized upstream dwellers for their resource-conserving practices that spawn multiple offsite environmental benefits downstream. The rest of the report describes the ultimate endpoint and number of important milestones to accomplish through actions that are seemingly unrelated but crucial for the success of the approach.

Acknowledgements

This Roadmap has benefited from the past experiences and lessons in watershed management under the Social Forestry Division, and more so from the wisdom of a leadership with professional quality to usher in positive changes. The Minister of Agriculture and Forests, Lyonpo Dr. Pema Gyamtsho, has been the inspiration behind the development of this Roadmap, who graciously committed his political credence and organizational energy in establishing the institutional environment to mainstream the watershed approach. Without his certitude and support, it would be difficult, if not impossible, to reach where we are right now. The watershed management pathway to natural resource governances shall forever remain the legacy of his insightful tenure. It is a pleasure to also acknowledge the continuing management support and policy directions from the Ministry with renewed interest and greater conviction that watersheds are practical, tangible units for integrating efforts in natural resources management.

For the most part, the approach described here retains the essence of watershed management culminating from a series of prior consultations with stakeholders which guided the preparation of original draft by Dr. Don Gilmour. We acknowledge his input in providing the basis and a way forward in adapting the Roadmap to the ever shifting context so that it remains relevant in time. It is truly the result of many cooperative efforts throughout the formulation and development period. Special thanks to Mr. Chado Tshering and his team in SFD that time for guiding the initial process and coming out with the first version of the Roadmap. Participants at a combined retreat and writeshop in Punakha in April 2010 uncovered fresh perspectives in key areas like interagency coordination, program integration, institutional arrangement and organizational development of WMD. It also offered an opportunity to review the early draft and recommended significant improvement to the document. Thanks to Ngawang Gyeltshen and Jigme Tenzin for succinctly distilling the salient ideas from that deliberations into a meaningful compilation. Lastly, we thank the Ministry for adopting the Roadmap as a strategic underpinning for natural resources policies and practices.

The Roadmap was made possible through funding support from SNV-Bhutan right from its inception to completion over a period of more than two years, covering a consultancy input, several consultations and briefings with stakeholders and partners. In particular, we are truly indebted to Ms. Marianne Meijboom, SNV specialist, who was not only instrumental in this rewarding partnership but also actively contributed in much-needed advice and guidance throughout the process. To all staff of Watershed Management Division (WMD) for holding together and trusting in a common purpose – thank you.

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4. Department of Energy, MEA

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Introduction

Bhutan occupies one rugged location in the Eastern Himalaya, and squarely placed in the path of South-West Monsoon system that dominates much of the weather, climate and water condition of the region. This physiographic position renders the whole country into a mosaic of watersheds that afford the very basis of people's well-being and national security. Without exception, all human activities take place in one or the other watershed, and thus the logical choice for considering watersheds as organizing units for decentralized, area-based planning framework. Sensible watershed management, therefore, holds the key to exploiting potentials and addressing problems associated with the conservation, rehabilitation and sustainable utilization of natural resources based in land, water and forest/vegetation.

Interest in and awareness of the multiple environmental, economic and social benefits provided by watershed management and development has greatly increased in recent decades, particularly in Bhutan where the economy depends predominately on hydropower generation, RNR sector and tourism. Degradation of natural resources is considered to be the greatest constraint to environmental conservation and sustainable development. Land degradation and deforestation create significant changes in the hydrologic function of watersheds. Downstream flooding occurred more frequently, with subsequent increases in loss of life and damage to properties and infrastructure. Accelerated erosion, produced by changes in the biotic and hydrologic components of natural watersheds, created unprecedented large-scale siltation of productive lowlands. As the importance of rangelands and cultivated lands in the hydrologic cycle and the erosion–sedimentation processes of catchments became known, forest hydrology gave way to the more comprehensive, present day watershed management. It is also one of the most important mechanisms to address global climate change and the high negative impact of desertification.

Sustainable use of watershed resources will only be achieved by adopting an integrated approach that recognizes the mutually dependent interaction of various basic elements of a watershed system, with the direct involvement and participation of the different actors and stakeholders. Watershed management attempts to integrate various aspects of forestry, agriculture, hydrology (precipitation and flow), biology (flora, fauna, ecosystems), geology (landforms, soils, sedimentation, topography), physical climatology and other sciences to provide guidelines for choosing acceptable management alternatives within a specific socioeconomic context. Each must be considered in context with the others, because a change in one spurs changes in the others, creating a different system outcome.

The scope of watershed management has thus broadened from the initial concept of technical management of the water resource to an integrated discipline that applies biogeophysical, technical, social and economic principles to maintain the productivity of headwater and lowland areas. Integrated watershed management through people's participation has become widely accepted as the approach that ensures sound and sustainable natural resources management, a better rural livelihood for upland inhabitants and greater economic prospects for people, services and industries in downstream areas. Of late, adaptive management framework is applied to watershed planning as the idea embodies a commonsense approach in adjusting to changing circumstances.

What is Watershed?

Watershed is an area of land that drains water, sediment and dissolved materials to a common receiving body or outlet. The term is not restricted to surface water runoff and includes interactions with subsurface and ground water. Watersheds vary from the largest river basins to just acres or less in size. It has structural and functional characteristics that can influence how human and natural communities coexist within them. Watershed structure exists in a four-dimensional framework describing its three-dimensional characteristics constantly changing with time at varying rates. An important element of watershed structure is the landscape pattern that explains the distribution and variations in vegetation and land use in terms of matrix, patch and mosaic types of native vegetation communities, non-vegetated areas, and land use patterns.

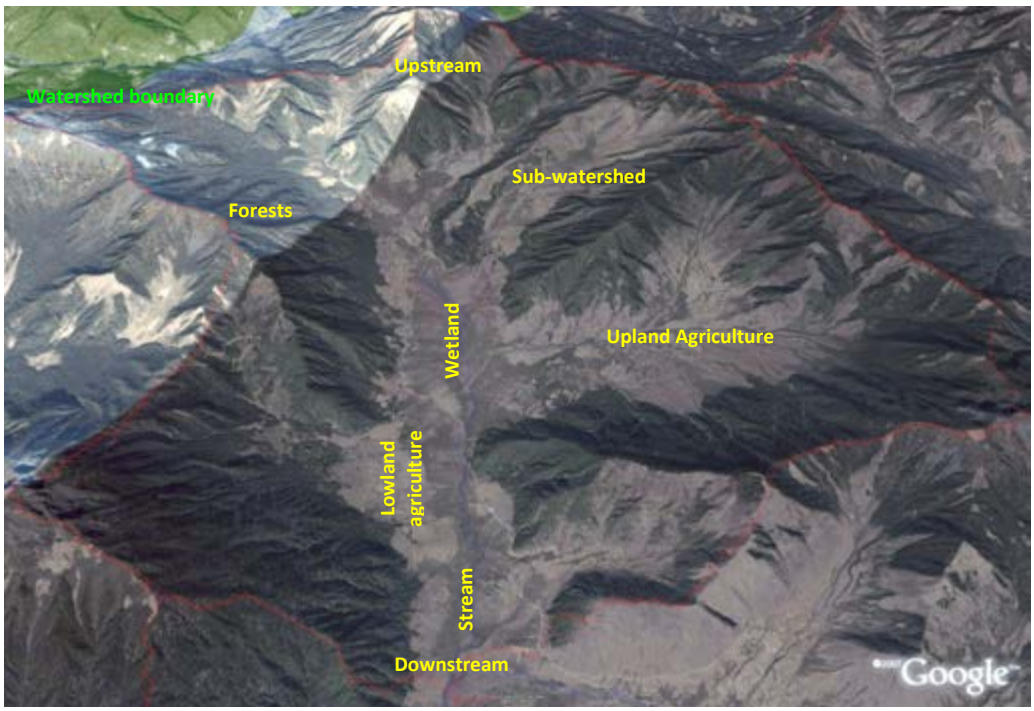


Figure 2. A typical depiction of a watershed area (main Phobjikha watershed).

Watersheds as natural systems are capable of performing many complex functions, from which essential ones are: transport and storage, cycling and transformation, and ecological succession. The processes taking place in the watersheds span all events that make up the hydrologic and biochemical cycles and their consequences on the biotic and abiotic components as well as in adjacent terrestrial and aquatic environments. Thus, watersheds are complex type of natural systems that may be characterized in terms of the physical template, the biological setting, the resulting traits and behavior, and systems' structure and function. From a human perspective, a watershed is a model for spatial planning, a unit of management providing a natural boundary for human-natural resources relationship. It is important for watershed managers to appreciate the natural processes at work, and how they are beneficial to human communities as well as the surrounding ecosystems. Even more, it is crucial to recognize how change affects watersheds and can jeopardize these benefits in very costly ways, when a normal change becomes great enough to be a change of concern.

What is Watershed Management?

Watershed management projects hitherto have been generally mechanistic following a problem-solving mode of operation with limited change in methods or perspectives used to manage natural resources. Emphasis has been on procedure rather than on the complex dynamics that impact and generates changes. Standalone operational setup and independent management have created personnel availability woes and breakdown in cooperative spirit and institutional linkage. Ambitious projects like Wang Watershed Management Project (WWMP) and many Area Development Projects (ADPs) did not contribute much in terms of science and technology in watershed management. They were mainly preoccupied with support to infrastructure, equipment and human capacity building of government institutions and dealing out inputs to the communities. Project managements largely discounted impact-level assessment with insufficient metrics to monitor service provision and evaluate impact of services.

Research-level initiatives like Radhi and Lingmuteychhu were focused on specific issues like water-related conflict resolution and some isolated studies of aspects good enough for local development planning but not particularly relevant to mainstream watershed governance and management. While they have distantly contributed to the emergence of a coherent watershed-level knowledge system, the key outcomes have limited applications to local-level planning process in identifying areas for support. Past approaches have done little to comprehend watershed as a coupled human-environment system and explore management options that are most suited to the Bhutanese conditions. Research had achieved little to identify plausible causal connections between upstream land use changes and downstream water parameters in clarifying and qualifying the link between upstream conditions/actions and downstream services.

The natural systems concept is relevant to watershed management because it emphasizes that a watershed, as a natural system, is more than just a variety of natural resources coincidentally occurring in one place. Severely degraded watersheds may have lost several of their components and functions and provide fewer benefits to human and natural communities as a result. Thus it is clear that recognizing the natural system and working toward protecting the system's critical components and functions are key to sustainable watershed management.

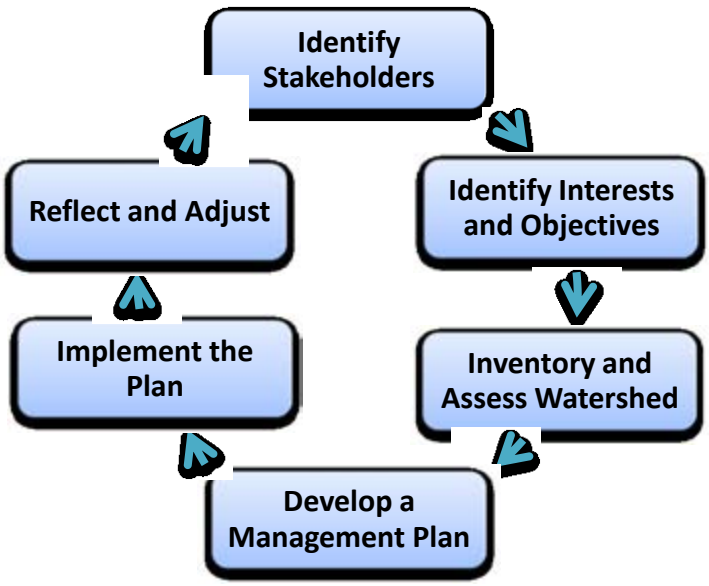


Figure 3. Watershed management process

Watershed management basically means management of land through careful consideration of geology, physiography, soil, vegetation, hydrology and human system in conservation and sustainable utilization of water provided by the watersheds. The process involved is illustrated in Figure 3. The watershed approach means redrawing the geographical boundaries to define a spatial focus of implementing a program of action to sustain and enhance watershed functions that provide the goods, services and values desired by the community affected by conditions within a watershed boundary. Without exception, the fundamental objective of watershed management is to increase and sustain a watershed's ability to provide for the diverse needs of the communities that depend on it, from geog-level all the way through to the national stakeholders. The watershed inventory is a systematic process for creating a pool of information about the current condition of watershed resources. The watershed assessment compares the current condition with the desired conditions, as defined by the stakeholder goals and objectives, to identify and quantify gaps.

Watershed management science principles

1. Watersheds are natural systems that we can work with. They are unique blends of climate, geology, hydrology, soils, and vegetation shaping the landscape, with waterways often cutting down steep slopes. Indeed each watershed zone has unique living and nonliving components that interact, with one element responding to the action or change of another that make up the ecological processes sustaining life through provisioning of goods, and performing regulating and supporting services.

2. Working with your watershed also means understanding how most human activities in the watershed can occur in harmony with natural processes. Communities located along streams and rivers can learn how the river functions and learn to draw benefits from it while staying out of harm's way.

3. Watershed management is continuous and needs a multidisciplinary approach. Many responsible agencies recognize the need for a more integrated approach to assessing conditions and developing management strategies. Although they have made progress through existing regulations and programs, they're now faced with solving more thorny environmental problems that cut across programs and jurisdictions. Effective watershed management is never ending, involves those affected by decisions, and reflects the integrated nature of nature itself.

4. A watershed management framework supports partnering, using sound science, taking well-planned actions and achieving results. There are three common elements of a successful watershed management framework: the geographic management unit that is the watershed selected by partners to provide a functional, practical basis for integrating efforts; the involvement of stakeholders meaning anyone who can impact or is impacted by a decision in that watershed; and finally the management cycle that partners agree to work on together following a fixed time schedule of sequenced activities.

5. A flexible approach is always needed. There is no cookbook recipe for watershed management. One part of the country have watersheds that function in very

different ways, and even neighboring watersheds can have major differences in geology, land use, or vegetation that imply the need for very different management strategies. Different communities vary in the benefits they want from their watersheds. Moreover, watersheds change through time, and changes can even occur on more immediate time scales due to the appearance of a serious forest pest or disease, a change in water use patterns, or the arrival of a new community, industry or enterprise for that matter. Watershed management is a dynamic and continually readjusting process that is built to accommodate these kinds of changes.

Watershed management application principle

1. Watersheds are optimal organizing units for dealing with the management of water and related resources, although their spatial extent rarely coincide with political jurisdictions and thus not very convenient for political, institutional, and funding purposes. However, they reflect the reality of the situations and provide a basis for sensible initiatives.

2. Watershed problems must be resolved at appropriate scale with right organizational setup, stakeholder involvement and matching action interventions.

3. Risk and uncertainty associated with the natural and institutional settings of watershed management have to be properly accounted for, and the public and decision-makers accurately informed.

4. Watershed management planning cycle should include formulation of a problem statement, identification of an agreed-upon set of goals, identification of the scope of activities appropriate to the issue in question, negotiated action steps, implementation, feedback, evaluation, and appropriate adjustments made as a result of lessons learned.

5. A scientific and technical review team needs to be constituted for monitoring progress and objective evaluation of impacts, recommend changes and offer alternative measures to reduce risks and uncertainties

6. Agencies need to come together within a program approach, and cease working in isolation to collectively examine the watershed-wide implications of their policies, programs, rules, and permitting processes to take into account the local and downstream ecological, social, and economic consequences of their actions, rather than using a limited project-by-project approach.

7. Watershed management is aimed at developing long-term solutions to problems and to provide sustainable access to resources. The Royal Government should consider establishing some stable funding mechanism for watershed management partnerships with local organizations for research, planning, implementation, and evaluation of watershed initiatives.

8. As a strategic resource, sustainable use of water is a national priority requiring management decisions and actions based on scientific data, knowledge and technology focused on integrating social, economic, and ecological elements.
9. Process-oriented research is required to enable all sciences afford a common perspective in unraveling linkages and cause-effect relationships of the processes operating within a watershed for effective implementation. Such research must focus in the following areas:
    a. Linkages among watershed components (rivers, wetlands, ground water, atmosphere, floodplains, upland areas);
    b. Integration across disciplines (especially biophysical and social sciences);
    c. Feedback among processes operating at different spatial and temporal scales;
    d. Inexpensive, useful indicators of watershed conditions and quantitative methods to evaluate land use and watershed management practices;
    e. Advanced watershed simulation models, especially models that link natural and social attributes, which are useful to and can be operated by managers who are not scientific experts;
    f. Understanding of risk and uncertainty in the decision-making process.

Good watershed management practices help to even out extremes of water availability. Careful planning can achieve flow moderation, maintain quality, prevent groundwater depletion and pollution, reduce flood and drought risks, and minimize soil erosion and land degradation. Poverty reduction depends on proper water resource management, equitable distribution and sharing of benefits.

Purpose – Why Create Watershed Management Plan?

In general, the focus has been on conservation with little attention to human activities, priorities and needs. Watershed management interventions were frequently limited in span and scope, lacked the long-term commitments needed to address underlying causes and issues in a satisfactory manner, and overlooked people's involvement and contribution to the planning and implementation stages. The importance of communication, education and awareness was not understood sufficiently to encourage broad participation, particularly of the poorer segment of the watershed communities. Decisions on watershed management were driven by political and major national development objectives and areas of treatment are chosen on these grounds rather than on the basis of studies and surveys. Through development of watershed management plans, problems and issues can be understood in their proper context, and effective response mechanisms can be formulated to take appropriate and timely action to deal with the situation or minimize the adverse impacts.

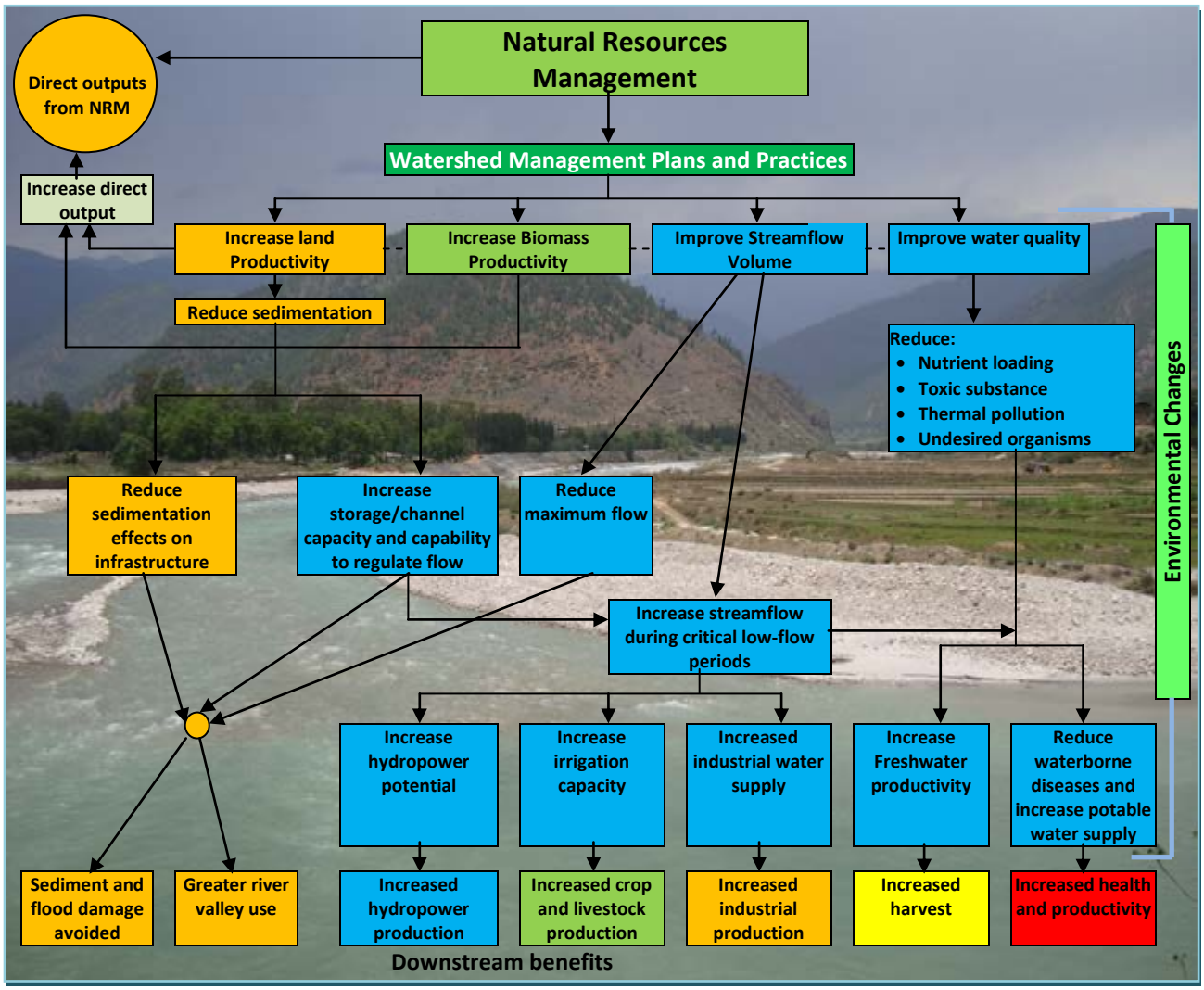


Figure 4. Relationship between the biophysical components and processes, management practices and socioeconomic benefits within a watershed ecosystem (adapted from Brooks, et al, 2003).

Operationalizing the principles outlined earlier could provide both theoretical and practical underpinning for the evolving interest and investment in watershed management in the country. There are substantial gains to be achieved through advocating this approach and most relevant in the present circumstance when the country is fully committed to pursuing the development philosophy of Gross National Happiness – a win-win proposition for the environment, economy and human-wellbeing. A planning framework that embraces watershed approach would provide a systems perspective in managing natural resources by focusing on activities aimed at delivering multiple benefits as illustrated in Figure 4. Rather than concentrating on specific interventions, a good watershed plan is carefully formulated to take advantage of the positive interaction among system's components, institutions and stakeholders. It provides a context for integration using practical, tangible management units that people can relate to in focusing and coordinating efforts and finding common ground and meeting multiple needs. It provides a better understanding and appreciation of nature's interrelated processes, and identifying entry points for management interventions. Better management practices in turn beget ecologically-based, innovative, cost-effective solutions through closer working relationships among the government agencies and stakeholders.

A watershed management plan charts a path for closing the gap between actual and desired watershed conditions, integrating biophysical elements with socioeconomic objectives (maximizing outputs) and ecosystem maintenance (restoring degraded ecosystems and prevent further degradation). It is a detailed plan for natural resource management with watersheds as the basic organizing unit for planning, coordinating, monitoring and evaluating research, development and conservation initiatives and their human-induced impacts. Typically, the plan states the mission, goals, and objectives of the management initiative. The plan also describes the action steps the responsible agencies will take to attain its objectives, and how success will be measured. The plan should not be confused with the actions required to implement it. Within an effective process, plan implementation includes the responsibility of stakeholders to work within a network of partnership groups. No single entity or group can effectively manage a watershed. Continuous monitoring of all aspects of plan implementation and results of actions is an essential and integral component of effective watershed management. By reflecting on and discussing feedback information from the monitoring program, the watershed community can identify appropriate adjustments to all aspects of the plan and its implementation.

Thus the purpose of this Roadmap is to clearly state the goals for preserving and restoring watersheds to their natural conditions with structure and functions characterizing such ecosystems. The fundamental objective is to sustain the provision of basic raw material and beneficial services for environmental integrity and socioeconomic development. The Roadmap also outlines the specific actions that are necessary in order to achieve these goals and objectives. In other words, it defines what our watershed community wants to achieve and how this will be accomplished.

Policy, Legislation and Regulation

Watershed governance is about effectively implementing socially acceptable allocation and regulation involving mediating behavior through values, norms and through laws and regulations. National sovereignty, social values and political ideology can have strong impact on governance arrangements related to land and water rights or corruption in natural resource use. Watershed governance is inwardly focused on all the nuances of politics, legislative backgrounds, social and economic conditions, as well as organizational landscapes that define a local community, region or country. It is also outwardly focused on the interrelationships between the different political units that share common watersheds affecting each other in terms of land and water use. Mechanisms (formal and informal) like peoples' organizations, policies, laws, regulations and behaviors associated with social, economic and political circumstances provide an institutional context to guide activities that affect watershed conditions, flow timing, water uses and settlement of associated disputes.

Watersheds include resources that have different types of rights and rules associated with diverse individuals and groups, and diverse resources, resource users, and the institutions that govern their access, use and management. Major problems associated with watersheds in Bhutan are the small and fragmented land holdings, and the dominance of leased-in land holders and sharecroppers with short periods of land tenure-ship. Apparently, policy measures must enable and facilitate collective actions and appropriate technologies suited to small and tenant farmers through watershed-specific integrated farming systems. Many policy documents stress the need for watershed management for poverty alleviation, environmental sustainability and nation building. Watershed management is covered in several pieces of legislation: Article 5 of the Constitution of Bhutan; Bhutan 2020; National Forest policy, 1974, 1990, 2008 (draft); Forest and Nature Conservation Act, 1995; Articles 235, 236, 240, 241, 247 of the Land Act, 2007; Bhutan Water Vision 2025 and Bhutan Water Policy, 2008; and Bhutan Water Act 2010. However, these legislative frameworks suffer from overlapping responsibilities, unclear jurisdiction for implementation, lack clear-cut resource allocation for watershed management and lack of emphasis on ground-level coordination.

The policy support to the watershed program is incontestable since it is explicitly as well as implicitly enshrined in the Constitution, while specific policy statements and legal provisions are standard entries in their respective instruments. Effective policy actions can require changing institutions, formulating and developing new policy instruments. We have also managed to strengthen the watershed awareness in the new policies and legislations under formulation for natural resources management e.g. draft Water Act and draft National Forest Policy. Mediation of trade-offs and conflict resolutions are conducted through customary practices, legal and regulatory interventions, pricing and market mechanisms, and incentives. The next step is to navigate the Roadmap, along a series of waypoints punctuated with milestones, to the ultimate program destination.

Bhutan has an intricate system of customary and statutory natural resources rights that needs to be harmonized across sectors, administrative divisions and local communities. Customary rights are good enough under situation of water abundance, but with increasing water demand and dwindling supply, the requirement of more formal laws is inevitable.

However, failure to recognize the existence and resilience of customary practices in "modern" natural resources legislation is a recipe for social tension. Fortunately, customary rights are recognized in the constitution of the kingdom and enshrined in several legislations governing land use and ownership rights. The existing policies are largely supportive of the watershed management approach described in the previous section. There is little contradiction in what this approach sets out to accomplish and what many policy strategies have recognized as watertight pathway to realizing the vision of sustainability, prosperity, peace and happiness. The only policy lapse evident is the ominous silence on the anticipatory and proactive policy measures that are central to any risk management provisions. The policies are also mute when it comes to coping with the impacts of climate change (or that such tacit line has their own purposes), which anyway is incomprehensible when the global political and economic debates and decisions are dominated by climate change.

Snow and ice cap wasting off the southern massif of Jomolhari. Dislodged ice blocks form kettle lakes in pitted outwash or in irregular ground moraine.

Much of the policy background provide for effective and integrated watershed management to maintain and improve water and watershed conditions and so contribute to sustainable livelihoods through provision of watershed services. An important principle guiding policy formulation and implementation has always been people's participation and empowerment in managing forests sustainably to ensure continued provision of watershed services. Such people-centric forest management practices and decision-making have found favor in the broader issues of environmental protection, socio-economic development and sustainable utilization of natural resources. While the policies are anchored in the overarching aspiration of a nation and its people enshrined in the Constitution and keystone visions, the objectives found expression through several legal and strategic instruments regulating the course of action in a responsible, equitable and acceptable manner.

There has been a significant shift in perception from the conventional policies guiding forest management with the change in focus from protection and conservation to balanced conservation and sustainable utilization that are strategically anchored in the decentralized decision-making, devolution of authority to people and participatory approaches in implementation. In the medium term, poverty reduction is the primary goal of the 10FYP emphasizing the importance of mainstreaming environmental issues into the development planning process. Watershed management program is one of the major programs of the RNR sector under the plan period, and one that has the deepest linkage to its overarching theme of poverty reduction through knowledge-intensive interventions fully grounded in science and technology. The draft National Forest Policy (expected to be endorsed soon) envisions an ecosystem approach to interventions in watersheds linking biophysical

processes with socioeconomic wellbeing of the local communities. It identifies watershed management as one of the key policy areas for the future, and proposes an objective to: **"Manage all watersheds effectively for sustainable livelihoods and reliable supply of high quality water"**.

Community-led analysis of Tsamdro issues under the Land Act 2007 (Ura Geog)

The Land Act 2007 provides the legal basis for scientific management of grazing and pastureland, and agroforestry-type natural woodlots as long-term leaseholds under joint management framework with shared responsibilities. The vision statements (Bhutan 2020, Bhutan Water Vision 2025, etc.) and the policy principles behind the draft Water Act enjoin all relevant sectors and institutions, at local and national levels, to pursue land use planning within the framework of river basin management plans. Water is acknowledged as the most important but increasingly scarce watershed resource, which must be secured by adopting an integrated water resource management (IWRM) strategy within the area-based planning framework. Notwithstanding their enabling and supportive role, the following policy interventions remain to be harmonized in creating a common environment for implementing the following strategies in managing watersheds sustainably, equitably and productively:

- Mainstream watershed management objectives into regular national and local development plans as well as land-use specific planning frameworks like forest management units, protected areas, community forests, industrial areas, urban development, human settlement, etc.
- Adopt river basins as organizing units for strategic level planning to assess watershed conditions across the country and to identify critical sub-watersheds for priority attention and bring them under appropriate management regimes.
- Adopt an integrated approach to development through area-based planning frameworks for operational level planning to enhance watershed conditions, water quality and improve livelihood of the people.
- Pursue options for the payment for watershed services to cover the costs of maintaining and improving watershed conditions and sustain watershed services.
- Notify and declare critical sub-catchment areas where ecosystems resilience and human dependence on the watershed services have reached a critical threshold.
- Manage catchment areas in an integrated and holistic manner involving both upstream and downstream stakeholders for continued supply of quality water and ecosystem services from the watershed to fulfil the human development needs and maintain environmental integrity.
- The upstream-downstream linkage in relation to conjunctive management and demand for natural resources, and sharing costs and benefits thereof entail formal

mechanisms and agreements to serve the interests of all stakeholders while ensuring proper care of the watersheds.

- Tenure-ship and rights associated with natural resources must be clearly articulated in policies and established on a legal basis in terms of ownership status, trade and transaction.
- Establish strong monitoring and evaluation mechanism for positive impacts of the management interventions.

We still rely primarily on direct regulation in dealing with watershed management and institutional issues, although options and opportunities exist to use economic instruments given the right design of policy and institutional framework. Policy changes may be necessary to forge stronger link between users, managers and providers through attractive incentive structures based on performance and service output. People need incentives to improve water provision, use and allocation.

Conceptual and Development Process

The initial process for formulating a Roadmap was supported by SNV-Bhutan through a consultant who had enormous experience working in developing countries on similar assignment. On the basis of a series of meetings with relevant agencies, and through numerous consultative workshops, the first version of the Roadmap captured the key features of all focal domains that are integral to a watershed approach, and secured the stakeholders consensus necessary for governmental endorsement and mandate for implementation. However, an appropriate institutional base was not established at that time to coordinate the activities and ensure accountability in keeping the dates with a series of milestones en route. While WMD had been instituted since then, its structure and functions needed to be rationalized and aligned with the program mission and action, which itself is tenuous. Since the program mandate stipulates the functions of the division and that division structure is premised on functions (form follows functions), we recognized the need to deliberate exhaustively on this multifaceted organizational issue.

A second round of exercise was undertaken to revisit the strategies and actions, taking into account subsequent developments, to reposition the Roadmap between a responsive and effective institutional arrangement and a manageable program agenda. SNV once again contributed to the effort in fine-tuning the Roadmap to reconcile few intractable issues and provide a fresh perspective on the relevance of the logic stipulated under it in view of the recent changes and evolving wisdom, while once again stimulating and reconfirming solidarity with programs and projects in fulfilling the shared watershed objectives. The Roadmap was finalized and presented to the Ministry, which endorsed it with few helpful comments and suggested improvements. This document is the outcome from almost two years of hard work and dedication from all those involved at some points or throughout the process (Annex I & II).

A recurrent theme in all consultations and deliberations throughout the conceptual and development phase is that “one size does not fit all.” Watersheds of Bhutan reflect tremendous diversity of climatic conditions, geology, soils, and other human and institutional factors that influence water flow, flora, and fauna. No single model of watershed management arrangement could account for all the variations. Other commonly expressed concern is the fragmentation of responsibility and lack of clarity about how to resolve disputes caused by conflicting missions among government agencies, which inhibits the success of the watershed approach. There are several agencies, programs and projects that deal with various aspects of watersheds management, but often with dramatically different perspectives. To the public, these confusing and sometimes conflicting approaches to watershed management are baffling with little or no consistent voice. The value of watershed management as a means for truly integrated efforts to achieve a balance of ecological, economic, and social goals remains a hypothesis that has not yet been completely proven. But flexible application of watershed principles can improve the joint efforts of researchers, managers, policy and decision-makers, and citizens in their search for a sustainable economy and a quality environment.

Food security and environmental sustainability are two of the main challenges. Protecting and strengthening watershed ecosystems is one of the main strategies to address these two

issues. Although watershed planning and management offers great potential and can draw on a technical foundation that has evolved tremendously in recent years, implementation has proven extremely difficult for various reasons, some of which are:

- Ignorance and misplaced preconception that watershed planning is a static process that can be addressed through formulation and adoption of a master-plan approach; when in reality, diverse interest groups will seldom accept or agree to a rigid, overbearing master plan.
- Watershed boundaries typically do not coincide with political boundaries, creating problems in establishing a watershed authority, committee or management group.
- Planning models are largely based on weak databases, and thus the results were not realistic and had little credibility.
- Watershed planning involves great complexity, especially when environmental impacts are included.
- The planning process is slow, and people grow impatient waiting for answers, agreement, and especially action.
- Watershed related authority or mandate is seriously fragmented as agencies often disagree with one another on the correct approach to managing water resources as they compete for the limited government budget to carry out their missions. Each has its sphere of influence over land and water resources. These result in actions and outputs that rarely satisfy all stakeholders.

Given these challenges, and in view of advancing scientific foundation, both in depth and breadth of information, tools and techniques available now, it makes sense to visit the watershed approach. Perhaps more importantly, public awareness of watershed issues and public's desire to participate in decision-making, changes in government funding mechanisms and new methods for conflict resolution might have spurred renewed interest in a watershed approach. This means that a watershed approach can offer real help to decision-makers working in ever more complex settings.

As much as GNH is a development philosophy that transcends economic and material considerations, the ecosystem perspective of watershed management is in itself a management philosophy which focuses on the desired conditions, rather than system outputs, and which recognizes the need to progress along the four pillars of human and environmental virtues that current metrics and yardsticks have miserably failed to capture. It focuses on socially defined goals and management objectives; use of integrated, holistic science, covers a broad range of spatial and temporal scales, reliance on collaborative decision-making; and a call for more flexible, adaptable institutions in which decisions are continuously reviewed and revised, and thus where planning and decision-making can go forward even in the face of uncertainty.

Through this conceptual and development process of the Roadmap, unrestrained focus and emphasis are given to solving water-related problems as well as conservation and restoration of watershed ecosystems. It would have been most appropriate if political boundaries have followed the watershed delineation, which then would have provided a perfect overlap between resource supply and resource use, besides simplifying governance and management.

Institutions, Stakeholders and Key Players

Institutions act as an interface between government and the user base including private groups and corporate entities typically involving a mix of public and private initiatives. The variability in natural systems occasions for consequent variability of the institutional landscape created to manage watershed resources. It is unlikely that a single, standard solution imposed nationwide will be workable in all localities. Rather, it appears that partnerships involving a range of governmental levels, community-based institutions, private sector, and non-governmental and civil society organizations are necessary to accommodate the variability. A systematic procedure should be followed to create watershed groups for balanced representation and collective decision-making from a range of stakeholders and partners. The idea of inter-agency and inter-disciplinary committees is not new in Bhutan although their relevance and effectiveness are often called to questions. There are proposals to establish and empower river basin committees, dzongkhag and even geog-level committees to oversee watershed management at their respective levels. Policy directives and political support is required to authorize these mechanisms for watershed and river basin coordination and planning purposes. The government must also be prepared to sustain these entities through technical and financial contributions.

Stakeholders are anyone who can impact or is impacted by a decision in the watershed because they live and work in it, to consult with and provide input periodically. They must be involved throughout the process, with clearly defined roles and responsibilities. Players or partners are people or institutions who work together on a daily or weekly basis, and agree on watersheds as common set of geographic management units to provide a functional, practical basis for integrating efforts. They agree on a management cycle, including activities they will work on together and a fixed time schedule for sequencing these activities.

There are many national-level agencies dealing with water and watershed related problems and issues. In fact, almost all the sectoral ministries are involved one way or the other in the management of watershed resources or associated components. Table 1 is a matrix of agencies and their associated watershed-related responsibilities, often shared for numerous important functions. These roles and responsibilities cascade to the local level in dzongkhags and geogs, while some spill over to the community-led initiatives. This often gives rise to conflicts among agencies because of differences in mission and mandate for each one of them, and especially when their roles and responsibilities are not well-defined vis-à-vis taxing, spending and investment and regulatory authority. Normally, decisions are made through a bargaining process among the same levels of government through technical and scientific elucidation, exchange of support, promises as well as threats.

Such conflicting situations may be inevitable in a governmental structure that has to represent varied groups of stakeholders. Nevertheless, the varying levels of government are generally in pursuit of common development goals, and must make proper decisions to choose between legitimate but competing public purposes. As the agenda for watershed management broadens to encompass intangible benefits and novel value systems, the need to incorporate multiple-use concept in the planning process is gaining momentum. The urgency for management is no longer driven by the interest of a single group or

stakeholders or one economic concern. The planned activities under each managed watershed are anticipated for incorporation into the relevant workplans of cooperating programs with implementation responsibilities in area-specific or landuse-specific natural resource management. These implementers must engage community groups in a fair and transparent manner, while WMD will facilitate communication, capacity building, and monitoring and evaluation of progress and achievements.

Table 1. Agencies with interests and responsibilities in watershed management

Wetlands	Research & Technology	Infrastructure & Industry	Hydropower	Recreation	Wildlife Protection	Fisheries	Flow regimes	Biodiversity Conservation	Erosion/Sediment Control	Water quality	Flood risk management	Food Security	Water Supply	Weather & Climate	
	■								■	■		■			DOA-MOAF
■	■				■		■	■	■	■		■		■	DOFPS-MOAF
	■					■						■			DOL-MOAF
	■													■	CORRB-MOAF
■	■	■									■				DGM-MEA
	■	■	■				■		■		■			■	DOE/HMSD-MEA
	■	■											■		DOI-MEA
				■	■			■						■	TCB
										■			■		DPH/PHED-MOH
											■			■	DDM/DMD-MOHCA
	■	■					■		■						DOR-MOWHS
		■		■						■	■		■		Township Municipalities
	■	■	■				■		■		■			■	Hydropower Corporations
					■			■							NRDCL
■	■				■			■							WWF-Bhutan
■					■			■							RSPN

The local communities living in the watersheds are the key stakeholders as they impact on and are being impacted by changes taking place in the watersheds. It is necessary to bring all the communities within a watershed to work together and show the benefit through entry point activities. Without their participation and cooperation, any effort or investment in watershed management will not be able to achieve the desired outcome. While they like to be consulted with and kept informed of the inputs and results, they can also help prioritize the issues facing the watershed and share their vision of what watershed condition should look like for future generations. Their livelihood strategies are inextricably linked to the surrounding watershed resources, and recognizing their rights to access and use can confer some sense of ownership and empowerment as equal partners in the process. Technical, science-centric approach to watershed management needs to be sensitive to the

traditional knowledge system and sociocultural values of the inhabitants as they hold the best prospect for sustained and responsible stewardship. A sure recipe for success, therefore, is to engage locals and implement activities through local institutions whether be formal or informal.

The Watershed Management Division (WMD) is designated under the authority of a cabinet executive order with the responsibility to prepare watershed management plans in close consultation with stakeholders and partners. Area-based programs and projects at the central and local levels with involvement in the watersheds, whether be in resource utilization and protection, are to be assigned with the implementation responsibilities. Watershed-specific institutional bodies of multidisciplinary nature will be created to advise and inform the planning and implementation stages. The bodies will later be mainstreamed under the purview of basin-level management committees once the provisions of Water Act are being enforced. Considering the present setup of the government machinery wherein mandates and responsibilities in the water domain are shared across sectors, a workable institutional arrangement is proposed (Annex I) to inform and oversee the realization of a shared vision.

Participation of stakeholders and key players must be fostered on trust and cooperation, and not through contractual mode for enduring partnership. A holistic system's approach must be adopted that positions livelihood outcome at the center of watershed protection and rehabilitation efforts. Indigenous methods rooted in community practices are sustainable natural management tools, and need to be explored to promote equitable contribution and distribution of benefits to sustain watershed management. A wide spectrum of institutional consortia can serve not only as the nucleus for technical-backstopping but also as instruments for integrating multidisciplinary treatments and harmonizing comparative advantages of various stakeholders.

Management Process and Timeline

Watersheds are complex ecosystems and envisioning a perceptive management system is a challenge that requires not only proper understanding of the biophysical structures and functions, but also of the evolving socioeconomic imperatives and expectations of the diverse watershed communities. The rallying point in the process of developing this Roadmap has been the constant focus on the positive outcomes to satisfy the interests of all stakeholders through fair and acceptable resolution of tradeoffs involved. Various options are discussed from enforceable regulations to positive incentives in generating consensus between upstream and downstream, and between different political units within a watershed or river basin. The Roadmap does not start in a vacuum but from reasoned appreciation of the current situation as a basis for leading arguments while emphasizing its dynamic nature to adapt with emerging new knowledge and changing values and interests. It provides a consensus vision of how watershed management should evolve in the future and the strategic elements needed to move towards that vision. More specifically, it also lays out a multi-stage program of action in the next five years with achievable milestones to monitor and measure progress. All major stakeholders and key partners have participated and contributed in preliminary phase to influence the context of this strategic watershed management framework.

There is an emerging trend towards decentralized but coordinated responsibilities for the environment, and participatory planning and management of watersheds. The way to the future will likely involve further development of innovative institutional mechanisms involving local participation and adaptive management with recognition that planning is a continuous process of evolution and successive approximations rather than a distinct, time-bound process involving definable starting and ending points. The effectiveness of river basin and watershed committees and associations is greatest where there is strong motivation for cooperation and social equity. Institution building and formalizing the associated processes would require establishing a forum for dialogue; a focal point for watershed management; decentralized funding, planning and operations with sensible controls; contribution of beneficiaries; participatory design with local consultation and empowerment; focus on water and good philosophy of watershed management at its core; regional networking and education; and conservation of environments.

The devil is in the details, and surely there are specific actions and activities that need to be carried out to achieve useful results. Watershed approach to planning is a conscious attempt to be holistic, recognizing that most activities on a watershed affect or depend on other activities. It is multi-sectoral, cross-disciplinary and an integrative and a dynamic process. Technical considerations are mostly specific to hydrology and watershed management issues, options and activities, while many of the social, economic, institutional and political issues and concerns are largely common across many fields and sectors of interest because of linkages between the sectors and fields. Institutional mechanisms and organizational arrangements are meant to envision a strategic context for watershed management, and should be established before management activities are planned.

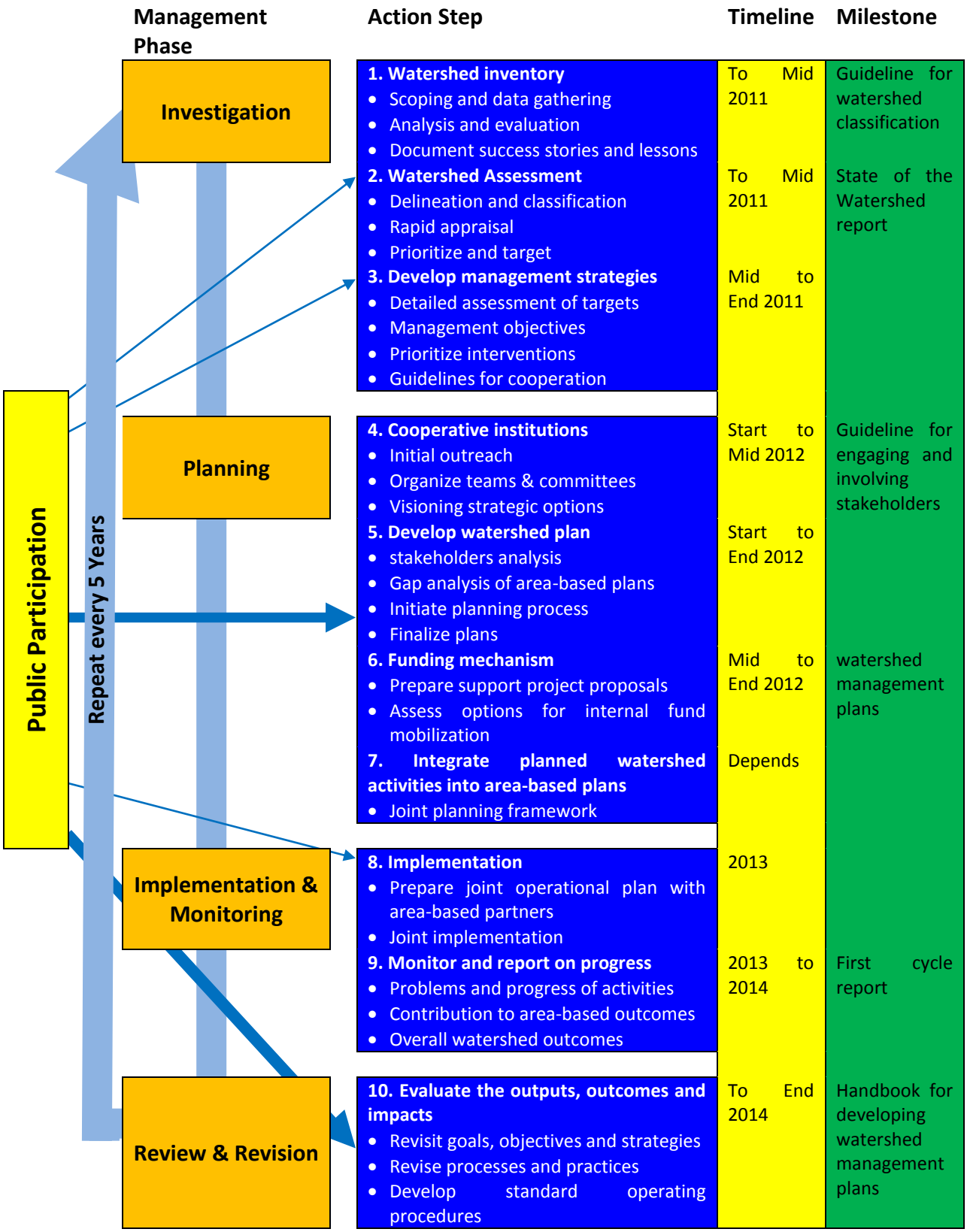
At the outset, a situation analysis must be carried out to create a realistic basis for operationalizing the watershed program to assess who is doing what in water, agriculture,

livestock and forestry for nature conservation, sustainable use and community development. This must be followed up with data and information compilation and collation exercise, including among others, a chronology of public sector development and conservation interventions and a time series of water-flow information. Once such a baseline is established, the desired future watershed conditions would become more perceptible considering what is being proposed in the 10th FYP and what are the likely consequences on water quantity and quality based on empirical association and experiences from countries similar to Bhutan in biophysical and socioeconomic conditions.

In the 10FYP, WMD will focus on watersheds of Wang and Punatsangchu river-basins. This Roadmap adopts a 10-stage adaptive management process to guide protection and restoration of watershed conditions in securing and sustaining continued provision of raw materials and ecological services for economic and environmental benefits. Based on the experiences from these two river-basins, the roadmap will be revised for enhancing the guidance for deployment in remaining basins. Subsequent adjustments are envisaged to be conducted at regular intervals, perceptively every five years following the development FYP cycles. The inputs and actions needed to accomplish the procedure charted out in the Roadmap are explained in detail under the section on implementation actions. Once implemented successfully, increased appreciation for watershed approach could stimulate broader policy reform in institutionalizing a new system of natural resource management. Watersheds are natural management units that provide a context for integration, help us to understand and appreciate nature, and generate better management solutions.

Watersheds are practical for integrating efforts and partnering among interest groups to develop coordinated management plans. The conceptual foundation that sets this Roadmap in a league of its own is the novel perspective challenging the programmatic and organizational insularity and advocate common but differentiated responsibilities in achieving the shared goals. It is a paradigm shift from the mundane procedures in watershed management for one important aspect that it does not subscribe to “one size fit all” tenet, but to work at different geographic scales, weigh multiple management objectives, and address unique concerns of all partners and stakeholders by linking all initiatives at the national and local levels complementing and strengthening each other. It recognizes that each watershed is a unique ecosystem that changes over time, managed in a dynamic and adaptive process to secure varied benefits and foster compelling relevance for natural resource governance. The steps describing the cyclic process are intended for broad interpretation in transforming watershed principles into practices. Central to the framework roadmap is the pervasive rationale that underscores the use of sound science, the need to facilitate communication and partnerships, foster well-planned, cost-effective actions and achieve verifiable results. There is no definite timeline to a predictable completion of watershed management undertaking as the cyclic process is perpetuated through a feedback loop forced by the evolving biophysical and socioeconomic contexts. The timeline illustrated here (Figure 5) spans just one management cycle that will take up the remaining period of 10FYP, and anticipated to spill over into the 11FYP. The cycle shall repeat for each target watersheds at five-year intervals, building on stakeholders participation at every stage to integrate efforts, acknowledge changes, and revisit and redistribute milestones by carrying out strategic monitoring of actions and evaluating results.

Figure 5. Basic steps and corresponding timeline in the watershed management cycle.



Watershed Background – Perceptions and Actual State of Watersheds

Two distinct stages have passed in the history of institutionalized watershed management approaches in Bhutan. The initial stage concentrated on forestry and forestry-related hydrology as the business of forest department with no people's participation, and limited to symptomatic responses. The second stage has been a transient episode of integrated watershed management with greater focus on land resource management in bringing economic benefits to the people. The emerging stage brings in more holistic approach through participatory, integrated watershed management including community involvement and contribution, and looks at treating symptoms as well as causes. It looks more closely at the upstream-downstream biophysical interactions and socio-economic linkages ensuring not only economic benefits but also preserving the watershed potentials for environmental services. The importance of upstream watersheds in water production and sustaining the livelihoods of upland farmers and grazers is incontestable.

Mass wasting due to natural processes

Land slips caused by roads across steep hillslopes

Well managed upstream catchments with effective vegetation cover are critical to smooth out variations in water flows and to minimize erosion. Failure to do this can have serious downstream consequences in terms of reduced life of reservoirs, interruptions to electricity supply due to blockages of intakes with resulting higher maintenance costs to turbines and channels. In short, downstream water users depend on good stewardship of the natural resource base by upstream residents and land managers, which make up close to 70% of the population dependent on land-based activities. Water has traditionally been considered a "free" good. However, there are costs involved in good stewardship, and this notion of "free water" needs to be questioned in the contemporary environment. Equity considerations suggest that the upstream stewards should receive some recompense for the costs involved in their good stewardship.

Bhutan's relatively low population, combined with past policies with a strong conservation emphasis, have resulted in its watersheds being in overall good condition, and the country's forest cover remains at about 72% of the land area. The final report of the Wang Watershed Management project (Anon. 2007) noted that land degradation (as an anthropogenic

process) is not a major issue in Bhutan, but it went on to note that the potential for problems is high. There are some notable exceptions to this generally positive situation, particularly in the east. The challenge of a watershed management program is to minimize the adverse effects of human activities. Observations in the intensely managed landscapes in eastern Bhutan suggest that most of the mass wastage is associated with those parts of the landscape that have been subject to deforestation, such as heavily utilized pasture and arable land. An additional contributory factor to mass wastage is clearly associated with road building where road construction cuts into unstable hillsides triggering slippage. While some mass wastage is observed in tree covered land, the incidence is much less than in the deforested parts of the landscape. This suggests that mass wastage has been accelerated by anthropogenic influences.

There is a high background level of sediments (both bed load and suspended) in streams in Bhutan. Natural erosion is extremely high due to the steep rugged mountains, the regular monsoon rains and the active mountain building processes that are on-going. Damaging floods during the monsoon season cause considerable downstream damage to land and infrastructure and there is an increasing risk of damage from glacial lake outburst floods in the future. A considerable amount of water originates in alpine areas that are snow and ice covered during winter. Uncertainties exist about the impact of climate change on the hydrology of these areas, although it is already clear that most glaciers are retreating, some at a rapid rate. As a consequence, policy should be framed in a conservative manner, but in a way that is also anticipatory and proactive. However, distinguishing between natural and anthropogenic causes of erosion is difficult if not impossible. Human activity has the potential to increase sediments loads significantly and impact adversely on the delivery of a clean well regulated water supply to hydro power producers.

There has been no systematic assessment of the condition of Bhutan's watersheds as a whole. Upadhyay (1991) prepared guidelines for the rapid appraisal and identification of critical watersheds, but these have not been applied in any systematic manner. However, studies have been carried out in several specific areas, particularly the Wang watershed in the west and parts of the Radhi watershed in the east. There is also considerable local knowledge of the location of critical sites within watersheds where degradation processes are visually evident. Most of the issues relating to watershed management in Bhutan are well known and fairly well documented (Wangchuk, 2006; and Anon., 2008). Unfortunately, no single agency has the mandate for protection of the country's watersheds. The responsibilities are spread across many agencies, including agriculture, livestock and forestry as well as municipalities, corporations, private farmers and other land users. This has created a situation where there are uncertainties and overlaps in responsibilities and roles.

While the notion of a "watershed" is a useful organising unit to conceptualise the necessity of integrated and holistic planning in order to achieve a defined goal, it does pose practical difficulties when it comes to operationalizing the plan. Watershed boundaries rarely coincide with administrative/political boundaries (Dzongkhags and Geogs) that form the basis of most development planning, or of the land-use specific boundaries (for uses such as FMUs, protected areas, community forests, etc.) that are the basis of many area based management plans that cover much of the landscape. Achievement of the goals set for

watershed management means that integrated and holistic planning (as seen through the prism of watershed management goals) needs to be interposed with the development plans of the administrative/political units and the other land-use specific area based plans.

There are regular planning frameworks that contain explicit requirements aimed at maintaining or improving watershed values. For example, management plans for FMUs generally contain requirements aimed at excluding logging from riparian zones as well as from steep and erosion prone areas in logging coupes. Watershed management objectives are also implicit in other area based planning frameworks, including for protected areas and community forests, and these contribute greatly to the generally good condition of most of Bhutan's watersheds. There is potential for these implicit objectives to become explicit and to receive focused attention, particularly in critical areas.

A large part of the landscape of Bhutan is managed under the purview of formal management plans. Before going on to consider how watershed management planning could take place it is useful to review the existing planning frameworks and consider how watershed management can interface with government reserve forests, agriculture, livestock, dzongkhag and geog plans.

- Government Reserved Forest land covers about 72 % of the country and includes both tree covered and non tree covered terrain, including the alpine regions. It is managed under a variety of categories, and formal management plans are required for most of them.
- FMU plans for commercial logging have stringent guidelines to protect areas of environmental, cultural and community/customary use significance. Such plans serve the watershed objectives of maintaining good forest cover, prevent erosion and land degradation and improve water quality. Assessed potential for FMUs is 16.8% of GRF (currently 4.4% under FMU).
- National parks and protected areas cover about 15,238 sq.km (40%); biological corridors are 9.5% bringing the total area under protection to 49.5%. Management plans of P&PAS are framed around the central theme of biodiversity conservation. The strategies for implementing P&PA system management plans include actions that contribute to realizing the watershed management objectives of watershed restoration, rehabilitation and reducing pressure of community extractive demand for forest commodities like replacing shingle-roofing with CGI sheets and fuelwood with solar-power systems, etc.
- Community forest management plans transfer the management responsibility to communities under a leasehold arrangement that secures the right to access and utilization by the communities. Community involvement through their representative community forest management groups (CFMGs) will provide better protection and practice equitable and sustainable extraction of resources. About 8-10% of the GRF (i.e. about 238,000 ha) has the potential to become community forests with planning taking place at the local level facilitated by Dzongkhag Forest Offices and Divisional Forest Offices, and supported by the Social Forestry Division.
- Forests outside the various management regimes need to be the focus for watershed management under the WMD, specifically giving greater attention to this category of forest falling under the priority river basins and critical areas within the watersheds. Intensive resource harvesting from such areas might therefore have negative

implications on the watershed, and need to be progressively brought under explicit watershed management plans.

- Grazing lands are landscape mosaic of open forests under the matrix of temperate and subtropical tree-cover. They are extensive rangeland in the high-altitude scrubland and brushes. Under the Land Act 2007, grazing land and GRF can be leased out to people engaged in animal husbandry for grazing and pasture development within a planned management regime. Most of the graziers have an agricultural base and graze animals in nearby forests as part of their overall farming system. There is scope for including watershed management concerns while preparing such management plans. Similarly, agroforestry and biomass mining leaseholds should be effected under appropriate management plan
- Arable lands are under various combinations of farming systems adopted by the farmers, who live under decentralized jurisdictions and geog-based planning framework. Geogs are physically based in watersheds, or may span watersheds. Geog development activities should give sufficient attention to the maintenance and improvement of watersheds through coordinated and integrated efforts in agriculture, livestock and forest. Primary areas will be water sources, sensitive landscapes, disturbed forests and arable lands.
- Usually subsistence farming systems dominate the upstream watersheds. Agricultural cropping systems used by a farmer are dictated by the local climatological conditions, inherent soil capabilities, as well as the farmer's needs, abilities and perceptions of agricultural practices. Diverse forms of agricultural production methods and strategies are adopted by farmers ranging from sedentary to shifting cultivation, to fodder and pasture development for livestock farming, agroforestry and private forestry for a variety of wood and non-wood products.
- Livestock are maintained for the production of milk, meat, wool, draft power and transportation. They are also kept for social prestige, religious sentiments and as an insurance against the shortfalls in household food security. Some of these practices lead to bearing the burden of unproductive animals that aggravate the conditions of overstocking and overgrazing resulting in resource degradation and environmental damages.
- Extractive demand for forest resources continues to grow to the extent of impairing their renewal potential. Forests are continually being converted to agriculture and pasture lands, and large tracks are lost to infrastructure development and urban encroachment. Significant areas are also consumed annually by wildfires, and human-induced forest fire outbreaks, while the loss to pests and invasive species, diseases and other disturbances is equally detrimental to be overlooked.
- Watershed areas occupied by urban settlements and infrastructure development disrupt the hydrologic functioning of watersheds on steep slopes, on erodible soils and those prone to landslips, in narrow riparian corridors, or at stream crossings. Roads that facilitate increased accessibility can foster more rapid and often ill-planned human settlements and the accompanying increased exploitation of natural resources. Roads at stream crossings are known to be the biggest source of sediment from a particular watershed.

The on-going Sustainable Land Management Project (SLMP: 2006-2012) executed by the National Soil Services Centre, is also relevant to this discussion as it aims to test approaches

to reduce land degradation, improve productivity and integrate these into Geog level five year and annual plans. The project currently operates in three Geogs, in the west (Chukha Dzongkhag), centre (Zhemgang Dzongkhag) and east (Tashigang Dzongkhag). Plans are in hand to expand from one to three Geogs in each of the Dzongkhags. The approach taken by the project is to apply participatory methods to identify and discuss issues and to incorporate ideas related to area based sustainable land management. The SLMP's Operational Manual indicates that sites for SLM interventions will be prioritized "according to the severity and extent of the (risk of) land degradation". In effect, the intended outcomes of many of the SLM interventions will contribute directly to watershed management objectives. It is important that the modalities for watershed management interventions are harmonized with the approaches being tested by the SLMP and that there is one planning framework for Geog level planning that can accommodate many issues, of which watershed management will be one.

Watershed Management Goals and Objectives

The vision, goals, and objectives describe increasingly detailed levels of organizing watershed management plans. The vision acts as the singular, long term guiding statement, calling for an integrated effort in sustaining ecosystem and economy of watershed communities. The goals which although broad and general serve as guiding statements for issues that were identified. The objectives are specific, measurable, and achievable outcomes that are considered desirable, as they relate to a specific watershed as geographic target area. The actions are concrete steps necessary to achieve the goals, objectives, and ultimately the vision for healthy and productive watersheds. Since the activities are even more specific to a target watershed and explicit in their desired outputs, it is difficult to generalize them under this framework document. These actions shall only be prepared to detail at individual target watershed level in the course of developing its implementation plan.

Vision

The vision of the national watershed management program is preserved as the vision of this Roadmap; which is, ***"To ensure effective and integrated watershed management to maintain and improve water & watershed conditions and contribute to sustainable livelihoods through provision of watershed services."***

Goals

To plan and work toward an environmentally and economically healthy watershed ecosystem benefitting all end users through effective management of all watersheds for sustainable livelihoods and reliable supply of high quality water. More specifically:

1. To restore, protect and improve watershed conditions through participatory, integrated and adaptive management strategy
2. To support sustainable livelihood including options thereof, and enhance the quality of life of local watershed communities
3. To secure watershed services to fuel the socioeconomic development of the country

Objectives

The core objective is natural resource conservation, maintaining quality of water in sufficient amount, increased agricultural productivity and socioeconomic upliftment of people by harmonizing the use of natural resources between upstream and downstream areas within a watershed. In the process, the Roadmap will aim to fulfill and influence efforts in the following areas of watershed management:

- Advance knowledge and understanding of the watershed ecology and best management practices that provide economic benefits while securing natural area productivity.
- Promote management interventions to reduce sediment and nutrient loads in streams and rivers of problem watersheds that contribute water for the desired uses.
- Carry out activities that help regulate flows in streams and rivers to even off extremes of floods and droughts

- Promote appropriate area-based land use types and sustainable natural resource management that preserve ecological resilience and environmental integrity without degrading the natural resource base.
- Take measures to increase groundwater storage to restore mountain springs and improve the volume of base flow in the natural watercourses.
- Harmonize the economic uses of natural resources between upstream and downstream areas to secure positive benefits along the watershed continuum and across multiple management objectives
- Find common ground and meet multiple needs through focused and coordinated efforts to generate ecologically-based, innovative, cost-effective solutions, and forge stronger working relationships among watershed partners, stakeholders and users.
- Establish partnership and collaborative watershed institutions at the national and local levels complementing and strengthening each other in supporting national development priorities and addressing unique local concerns
- Conserve wetlands, high-altitude rangelands and riparian zones in the watersheds
- Explore options for innovative finance mechanism in managing watersheds under bilateral/multilateral funds, government grants, market-based arrangements and incentive/reward schemes.
- Coordinate efforts to develop integrated management plans for target watersheds.

Implementation Actions

The activities identified for implementation will vary across vulnerable and threatened watersheds that are candidates for concerted management. Generally, decisions for protection, restoration or improvement are influenced by local concerns and issues that impinge on the resource security, livelihood options and ecosystem safeguards at the local level, with little or no attention to consequences beyond its boundary or downstream impacts. Any specific watershed management plan should, therefore, account for any negative externalities that could leak into adjacent areas and communities. As actions must be specific to problem contexts, it is neither feasible nor meaningful to anticipate desired measures of positive outcomes as a way forward in this Roadmap. A doable action plan will only emerge from public consultations with communities and other stakeholders within the watershed, which will provide direction and focus during the implementation process. However, the following questions in Box 2 could assist in framing the issues, express concerns and stimulate ideas to formulate solutions.

Box 2. Tactical questions for the Roadmap

1. Why certain aspects of natural and human-related conditions and processes raise issues and concerns?
2. What are the causes, associated risks and threats?
3. What are we trying to accomplish?
4. How will we get there?
5. Where should we focus our efforts?

These plans are in fact roadmaps in every sense for watershed communities, government agencies and other stakeholders by outlining where we want to go through objectives, and how we are going to get there, through actions. The actions may be grouped according to lead implementers and explicitly linking them to the goals to be achieved. Each action may also include a measure of success, partner agencies to assist implementation, a target timeframe to complete the action, specific target areas for the action, and a reference to the objectives.

Issues, Concerns and Problems

There is no single solution to addressing all issues and concerns associated with watershed conditions. Our focus must be on improving the productivity of all types of watershed resources in a participatory, integrated and cross-sectoral manner under shared responsibility. It is important to appreciate the fact that we must find local solutions to local problems while learning from the experiences of others. It is equally important not to be overly ambitious to begin with, but being mindful of the sensitivity and the inevitable tradeoffs, which can bring the affected people on board to make it a truly collective undertaking on equal footing.

Integrated watershed management goals and objectives do not fit well into conventional project model, as projects are often stand-alone entities with separate budgets, generally supported both technically and financially through external support. The integration and multi-disciplinary modality is usually achieved by seconding people from various departments: forestry, agriculture, livestock, etc. or by providing technical and financial support to the work of the line agencies. Often departmental interests and priorities influence project operation to lose focus on the primary watershed objectives, and turn them into area-based rural development projects. Joint planning and implementation has been carried out under the project umbrella, and in many cases, reasonable results have been achieved. However, it has been found difficult, if not impossible, to institutionalize this approach once the projects have concluded. A project-based stratagem is still relevant in addressing specific issues and problems and therefore appropriate for in-depth resolution component-wise, particularly when capacity is limited and resource is scarce.

While considering the underlying parameters for watershed management, the following questions need to be posed: To what extent should program activities be limited to the primary watershed management outcomes of water quality and quantity? What activities should be left to other planning and implementation platforms? How can the enhancement of livelihoods be linked to watershed management activities? It is suggested that, in Bhutan's context, watershed management activities fostered by a roadmap should be those activities that contribute directly to the key watershed outcomes of maintaining and improving water quality and quantity, linked where possible to sustainable livelihood enhancement. That is, there should be a clear and unambiguous link between the roadmap and the watershed management objectives. Other rural development activities should be left to regular planning frameworks of relevant agencies.

Another problem often encountered when deciding on which activities contribute directly to watershed management objectives is that the cause-effect relationship between activities and outcomes, which is often tenuous and difficult to quantify. This is particularly relevant when trying to monitor the impact of watershed management activities. Perhaps the best that can be done is to look for "plausible causal connections" between upstream watershed conditions and downstream water manifestations. The concept of "plausible causal connections" relates land uses and disturbances (human-induced or natural) to the watershed conditions, biogeochemical yields and socioeconomic consequences; and concludes a plausible causal connection without having to measure an adverse impact directly. In most cases indirect, surrogate or proxy measures will be needed to identify

activities and to monitor outcomes and impacts rather than direct measures of water quality and quantity. This requires making decisions in prioritizing activities and in monitoring outcomes and impacts based on the results of studies from Bhutan and other countries. In general, there is good understanding from the science of watershed hydrology under what conditions the flow regime, sediment and nutrient loadings would be affected. More data and information are readily available to the interested citizen, manager, researcher, and decision-maker than ever before, often free over the Internet. But despite significant progress over the past decade, there are still gaps in scientific understanding of watershed processes, gaps in basic data related to water quality and flows, and gaps in the capabilities of simulation modeling and decision support systems (Box 3)

Box 3. Knowledge and data gaps

- areas of exposed surface soil on hill slopes;
- stability of geomorphic features;
- fragility topographic characteristics;
- extreme weather and climate, and climate change;
- vegetation structure, composition and functions;
- land use and land cover change;
- surface hardening on hill slopes;
- agricultural production practices and farming systems management;
- design, construction and maintenance of irrigation canal, dams and reservoirs, roads and tracks, power and communication infrastructure; and
- mechanical disturbance of riparian areas and river/stream beds and banks.

In the process of implementing the program, several problems, issues and constraints are expected to emerge that could frustrate planned activities in generating the desired outputs. There are also challenges that the implementing agency must be prepared to deal with decisively and effectively. A strong policy support and a high-level functional mandate must endorse its institutional position and organizational capability to deal with such complications:

- The watershed approach is expected to be multi-pronged, participatory, integrated and holistic while it still remains a difficult concept to understand and apply
- There are practical difficulties in the application due to institutional issues, many stakeholders, dispersed and piecemeal mandate, overlap in responsibilities on jurisdiction, accountability and liability. Watershed management responsibilities are spread across many agencies and none charged with the overall mandate of planning and coordination, and monitoring and evaluation of watershed management interventions.
- The coordination problem within the Ministry of Agriculture as well as with other relevant agencies stem largely from the conflict over access and use of watershed resources, while no systematic assessment of watershed conditions has been carried out to date to properly evaluate the resource endowment and degree of fragility.
- Impacts are not readily visible or directly attributable to watershed management interventions. Monitoring and evaluation practices are not straightforward.
- Watershed management is still observed through a sectoral lens, carrying distinct perspectives on the process and outcome of what constitutes a watershed management for agriculture, livestock, forestry, land care and use systems, water resource use.
- Identifying the plausible causal connection in the upstream-downstream linkages under watersheds in terms of the flow of goods and services, as well as the incidences of erosions, flooding, siltation, etc.

What Are We Trying to Accomplish?

The production of hydro power for export, mainly to neighboring India, contributes about 24% to the country's GDP and this is expected to rise further with the construction of more hydro plants, making electricity generation the single biggest contributor to the economy. Consequently, a reliable supply of quality water is the most valuable commercial product derived from Bhutan's forest and agricultural lands (both tree covered and non tree covered). It is evident that the maintenance and improvement of the country's watersheds is a high management priority, not only for hydro power, but also for domestic use and irrigation. Anecdotal reports suggest that dry season river flows have declined (possibly connected with retreating glaciers) and this is causing concern among those involved with hydro power production.

Poverty reduction is a priority and well reflected as overarching goal of the Tenth Five Year Plan of the Royal Government. For an agrarian country, RNR Sector therefore plays a significant role in enhancing the rural livelihoods and contributes to poverty reduction. The rural population depends predominantly on the economic activities that are supported by the sustainable use of natural resources. The RNR Sector has therefore the vision of ***'sustainable natural resources for equitable, social and economic well being of the Bhutanese people and the nation state'*** for the Tenth Five year Plan. Recognizing the importance of watershed program which has implications for the sustainability of many other development programs to ensure ecosystem services, one of the important objectives therefore is to conserve and promote sustainable utilization of forest and water resources. Watershed management will therefore play a vital role in supporting other key agriculture, forestry and livestock development programs geared towards improving rural livelihoods and reducing poverty.

Climate change is one impending threat that is increasingly being recognized as observed reality than fiction. Several studies have confirmed the fact that warming rate is disproportionately higher at higher elevations (Tsering et al., 2010). The implication for glaciers and snowfields that feed the headwaters is disconcerting, as accelerated melting and thawing means increased flow volume in the drainage basins that could exceed the confining and routing capacity of the channels. Erosion of skeletal surface soil mantle and more frequent flashy nature of the flow might reduce the natural resource productivity of high-altitude rangelands, adversely affecting stream morphology and hydrology, and result in flash floods downstream exposing lives and properties to unprecedented risk of death and destruction. Excess water in the early phase of hydrologic changes may be followed by irreversible periods of extreme water shortage, drought and desertification, as the glaciers retreat and snowfields contract. Higher temperature also means that vegetation structure and composition could change, and the entire forest and agricultural belts may shift upwards along the altitudinal gradient. Such events could create phenological anarchy and cause extinction of some endemic and niche species. While the tropical and subtropical species range expands, the temperate and alpine range would shrink and get compressed between the advancing lowland invaders and the rocky, and nutrient-poverished landscapes of the high-Himalayan crests.

A recent study of hazards associated with climate change in the Nepal and Bhutan Himalayas (Bajracharya et al., 2007) noted that the changes in global climate are impacting on the Himalayas in several ways. Glaciers are retreating at rates ranging from 10 to 60 m per year and many small glaciers (<0.2 sq.km) have already disappeared. As glaciers retreat glacial lakes grow. In the Pho Chu basin in Bhutan the increase in area of some glacial lakes has been as high as 800 % over the past 40 years. These lakes pose a threat because of their proximity to other glacial lakes in the Pho Chu basin. There is a risk of a glacial lake outburst flood (GLOF) if glacial lakes merged together with potentially disastrous downstream consequences to life and property. When GLOFs occur (as happened in Bhutan in 1994), the downstream consequences in terms of flooding and sediment transport are disastrous. However, there is little that can be done to prevent them and the capacity for prediction is limited.

It is clear that the future climate scenarios are poorly characterized, and the practical implications of any changes are highly speculative apart from what we know from people's perspectives and the past observations and experiences. This combination of circumstances means that watershed management policy should recognize the existence of potential hazards such as GLOFs and be framed in a conservative manner. In particular, infrastructure development on flood plains of risk prone rivers should be avoided as much as possible.

Of late, decision-making in watershed management is becoming more decentralized with new institutions emerging, while the capacity of community-based groups is also improving. The approach is becoming more bottom-up, with more interest in participatory research and indigenous knowledge to develop appropriate technologies. Even better proposition for a devolved watershed management approach is to use a set of basic guidelines that inform development, implementation and integration among various programs, processes and other interventions that may have an impact on watershed conditions. Best practices and technologies need to emphasize the watershed dynamics that generate change; promotes creativity, consensus and collaboration; allows generation of new creative prototypes for natural resource management in achieving the goals of the watershed community; and emphasizes good rapport and information exchange that informs the public dialogue. In implementing watershed management activities, this model approach underscores the continued relevance of well-designed, appropriate technology packages, community-led demonstrations, improved networking and linkages, advocacy and awareness, and comprehensive educational programs.

Box 4. Core targets

- **Maintaining good watershed condition**
- **Sustaining and improving on-site productivity**
- **Increasing water yield to improve water supply**
- **Improving water quality**
- **Mitigating effects of landslides, debris flows and flooding**
- **Reducing sediment loads**
- **Conserving biodiversity and wildlife habitats**

Consistent with the goals and objectives, the major targets to accomplish are outlined in Box 4. All these targets are interrelated and can be considered in the context of a watershed health in dynamic equilibrium, the upstream-downstream connections explaining beneficial or detrimental impacts in term of flow volume and sedimentation, and cumulative watershed effects of multiple landuse activities.

How Will We Get There?

Despite the enormous environmental significance and definite socioeconomic importance, watershed management could not be operationalized in a scientific, systematic and coordinated manner. Apart from isolated undertakings in few localized sites, a national perspective backed by concrete and enduring strategy has not been realized in addressing the emerging issues. Past efforts were limited to watershed delineation in setting an areal context for rural development activities rather than tackling real watershed problems. There were practical difficulties in the application due to institutional issues with no single agency charged with the overall mandate. Operational ambiance was confounded with multiplicity in stakeholder interests and involvement, uncoordinated mandates spread within and across sectors, and ambiguity in tenure, ownership and rights of communities. For the most part, project related one-off "fire and forget" attitude and approach have confined the efforts to cosmetic corrections rather than strategic consolidation, and at the same time diluting investment in core capacity building.

Success stories and good practices from these discrete efforts are not replicable or transferable to other watersheds; while scaling-up in spatial coverage to higher order aggregation of watersheds becomes almost nonsensical. An initiative that came closest to being a component of watershed management is the so-called "Wang river basin management framework", which again is essentially a watershed inventory describing the current conditions of its resources. Rest of the energy and resources were expended on land management and soil conservation activities that were not anchored in the outcomes of a comprehensive watershed assessment study, or incorporated in the implementation process of an integrated watershed management plan as depicted in Figure 6.

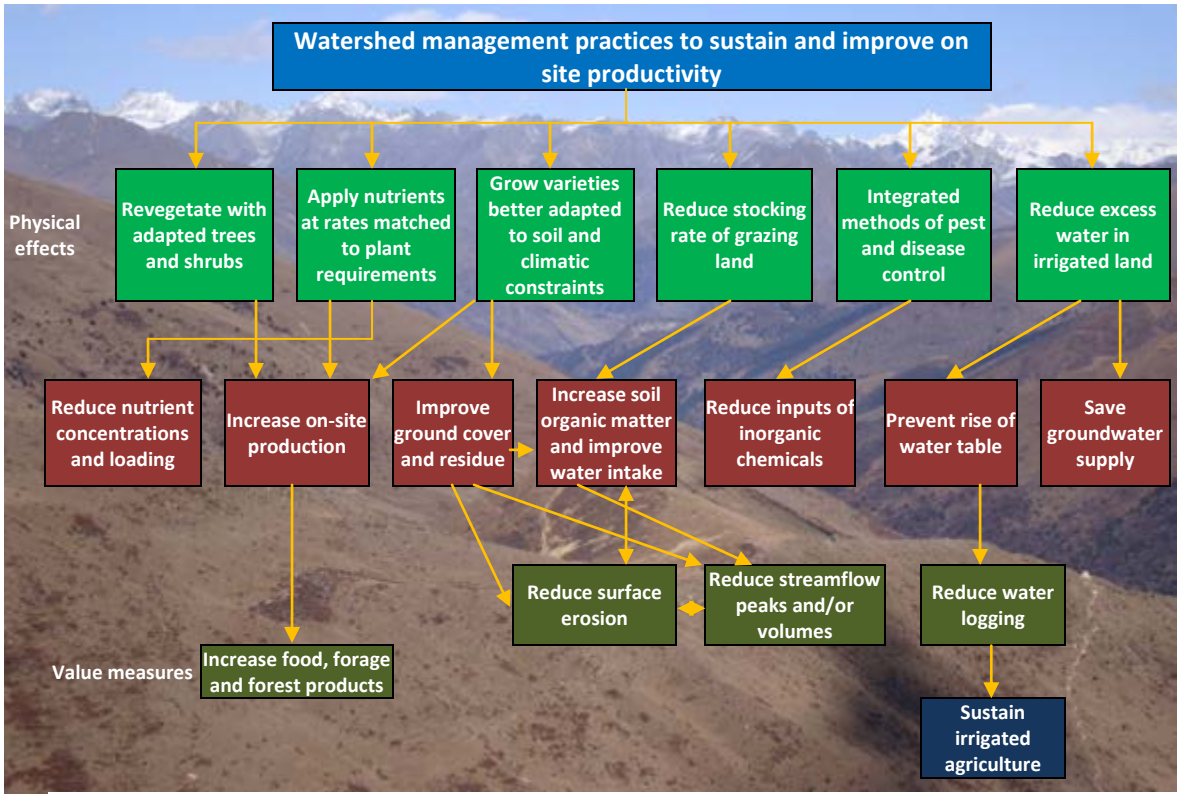


Figure 6. Land and water management practices to sustain and improve on-site productivity.

An important strategy to integrate watershed approach in natural resource management is to mainstream its principles and processes into the policies, plans and programs aimed at addressing problems and build on the opportunities associated with human-environment interrelationships. The Watershed Management Division as the main implementing agency has adopted a process-approach to developing management plans for delineated and prioritized watersheds based on comprehensive resource inventory and assessment taking into account both biophysical and socioeconomic attributes, while recognizing the ecosystem dynamics. These watershed plans will then be integrated into the area-based development and conservation plans of the sectoral programs and the decentralized dzongkhag and geog plans through a coordinated and participatory planning mechanism of appropriate time-scale. While actual action in situ will be executed by the field-based agencies in accordance with the prescribed practices and guidance manuals, the monitoring and evaluation of the outputs, outcome and impacts will be the done by the Division. Feedbacks in terms of reflection and readjustment shall inform successive planning cycles and guide future elaboration for success replication and scaling up in time and space.

Watershed management is recognized as full-fledged program in the 10FYP to strengthen capacity and channel resources in the preparation of at least two river-basin level management frameworks, which will in turn inform the formulation of watershed management plans to guide implementation of management activities, setting up institutional mechanisms and settle on the expected outputs that will serve the program goals and objectives. The core implementation strategy was to create the Watershed Management Division and charge it with the mandate to fulfill the program objectives. The Division expected to coordinate, plan, monitor and evaluate watershed research, development and conservation activities aimed at reducing poverty, enhancing food security and protecting the natural environment and ecosystem integrity. The actual program implementation shall be carried out by the field operatives of the three foremost departments (DOFPS, DOA and DOL), the dzongkhag and geog RNR sector outfits in accordance with the operational guidelines consistent with the management plans. Organizational instruments and institutional mechanisms shall provide strategic impetus for upholding stakeholders' interest and participation. The following modus operandi has been proposed for the program under the 10FYP (Box 5).

Box 5. Program focus in 10FYP

- Strengthen institutional mechanism across agencies to direct watershed management effectively at different levels of delineation based on biophysical or administrative boundaries.
- River basin level management planning framework
- Sub-catchment level management planning and implementation
- Participatory Micro-watershed management guidelines/manuals
- Mapping of degraded and barren forest lands
- Strengthen human resource capacity to manage watershed management system
- Strengthen plantation forestry through afforestation and reforestation
- Strengthen forest nursery management

While the program document stipulates preparation of a basin-wide masterplan as one important outcome in the 10FYP, this roadmap has differed to propose basin-level

management frameworks as more plausible context for managing watersheds. Past experiences and real-world lessons have shown that the static and prescriptive master-planning approach has limited relevance in dealing with dynamic processes and insensitive to emerging scientific knowledge base. Master plans are resource intensive with little prospect in mainstreaming activities into regular government operations and questionable for long-term institutional sustainability. Basin-wide master plans will lie outside the established area based land use planning processes in Bhutan and, as a result, may have little real ability to effect watershed conditions across the landscape. Nonetheless, basin-level perspective is still relevant as an organizing framework for watershed inventory, assessment, planning and monitoring purposes. A recent analysis by Hansen (2007) questions the necessity, technical justification or viability of adopting a basin wide master-planning approach to planning in Bhutan based on several considerations:

- The actual hydrological benefits may be small where natural erosion and degradation processes far outweigh the effects of land use.
- Basin wide management would take scarce human and financial resources from other priority areas, and possibly weaken Dzongkhag and Geog level planning capacity.

Since WMD is expected to fulfill these functions as the national focal point for watershed management, enduring and effective institutional underpinning could be consolidated further by the following initiatives:

- Permanent membership to board/committee/bodies/constituted dealing in water resources and eco-tourisms, etc. This is to ensure explicit link with broader policy agenda outside the jurisdiction of MoA.
- The primary mandate of nationalizing and mainstreaming watershed management activities into geog development plans and sectoral and sub-sectoral management plans must be vested with the WMD. Such activities will be identified and implemented by incorporating them in the management plans of relevant departments. WMD will coordinate, plan and monitor the activities at the geog level so the competing and complementing land use and resource management activities are harmonized to achieving certain watershed management objectives
- Within the MoA, the WMD must be represented in forums like PPC so that watersheds are officially recognized as the organizing framework for developing policies, strategies and plan in RNR management in a holistic and integrated manner across sub-sectors
- The DYT may be charged with added function to coordinate operational link between WMD and geogs in critical watersheds, support integrated plan for watershed-based activities, ensure technical and financial requirements are fulfilled, M & E of such local area-based activities, outcomes and impact assessment with report to WMD
- The territorial DFOs, in addition to the existing responsibilities must support participatory planning at the geog level, implement watershed management activities in GRF, assist with conflict resolutions in RNR management and coordinate among dzongkhags and geogs under the territorial forest jurisdiction to harmonize objectives.
- The RNRRCs to develop expertise and offer technical assistance to the dzongkhags and geogs in holistic and integrated watershed management practices and technologies in their respective regions.

The choice of technologies for watershed improvement and restoration must be based on some appropriate qualifiers in assessing their suitability. They must be well tested and demonstrated under similar conditions, affordable and simplified for easier adoption preferably a database coded into decision support systems. Appropriate procedures and information need to be put in place to prioritize critical watersheds, identify appropriate technologies at the farmer level, and institutionalize PES in recognizing the value of watershed goods and services that economically link upstream providers/originators and downstream beneficiaries. The following strategies will provide an operational underpinning for the proposed approach to effectively integrate and coordinate activities across the landscape in maintaining and improving the condition of the country's watersheds while at the same time contributing to enhanced rural livelihoods and poverty reduction.

- Adopt river basin wide planning to assess watershed conditions across the country and to identify critical areas of critical sub-watersheds for priority attention. *(Strategic level planning)*
- Plan and implement watershed management activities to enhance watershed conditions and contribute to improved livelihoods through existing area based planning frameworks like geog plans, land and natural resource management plans of central programs *(Operational level planning and implementation)*.
- Integrate human dimension into the implementation process by adopting a participatory, consultative and shared responsibility under a multi-stakeholder arrangement.
- Pursue options for the payment of environmental services by downstream water users to cover the costs of maintaining and improving watershed condition in upstream areas, with a particular focus on mechanisms for poverty reduction.
- Monitor and evaluate the impact of watershed management interventions on biophysical and socio-economic outcomes

Real people's participation takes time and involves painstaking building of capacity at the grassroots level and consolidation of field activities to ensure real sustainability. An effective and impact-oriented watershed management approach demands horizontal coordination for interdisciplinary action, vertical linkages for technology transfer, and the decentralization of authority for fast decision-making. We can only account for all these relevant aspects and issues of watershed management within a long-term program-level framework.

The linkages between land use, soil, the flow of water and other natural resources from a watershed must be recognized and appreciated by both the people using the land and the people planning and managing it for agriculture, livestock, forests, and water benefits and outcomes in a sustainable manner. The practices include a variety of non-structural (land use and vegetative) and structural (engineering) measures undertaken to meet the watershed management goals and objectives. Soil conservation measures can reduce surface runoff, soil loss and minimize environmental damage and degradation. Vegetation changes in terms of composition, structure and density can regulate surface and base flow regimes within normal precipitation range. Riparian buffers and agroforestry help mitigate sediment and nutrient discharge into streams from adjacent agricultural croplands or livestock-grazing areas and other resource mining sites. Maintaining forest cover moderates stormflows and provide greater soil stability in the mountainous terrains with high volume

and intensity of rainfall; but the ability to mitigate landslides, debris flow and flooding diminishes with increasing magnitude of extreme rainfall. The foothills and steep slopes in Bhutan have shallow soils overlying weak, fractured and weathered geologic formations naturally primed for slope failures, debris flow and landslides. Other areas predisposed to such disasters are drainage outlets and floodplains regardless of forests or upland watershed conditions. Groundwater sustains the perennial streams and dominates the dry-season streamflow, and measures to increase infiltration rates and reduce evapotranspiration (ET), or avoid draining wetlands can improve groundwater recharge. Watershed management practices are also responsive to the needs for rehabilitating degraded watersheds to more productive state through vegetative and structural measures. Using the basic principles of watershed hydrology, linkages among practices and consequences associated with the fundamental watershed outcomes in soil conservation, water quality and flow regime are described by the following generic flow diagrams.

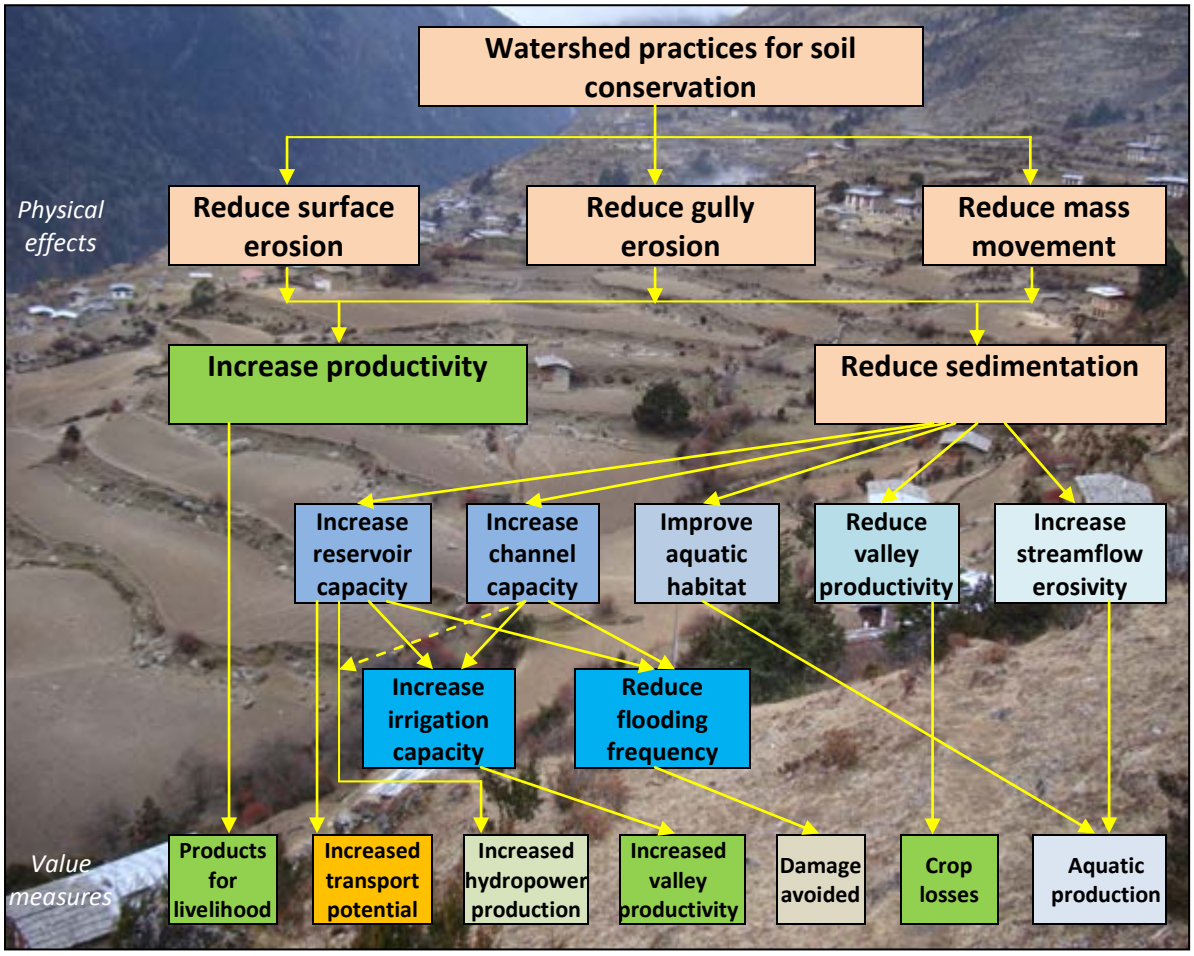


Figure 7. Watershed outcomes of soil conservation practices. (adapted from Gregersen et al., 2007)

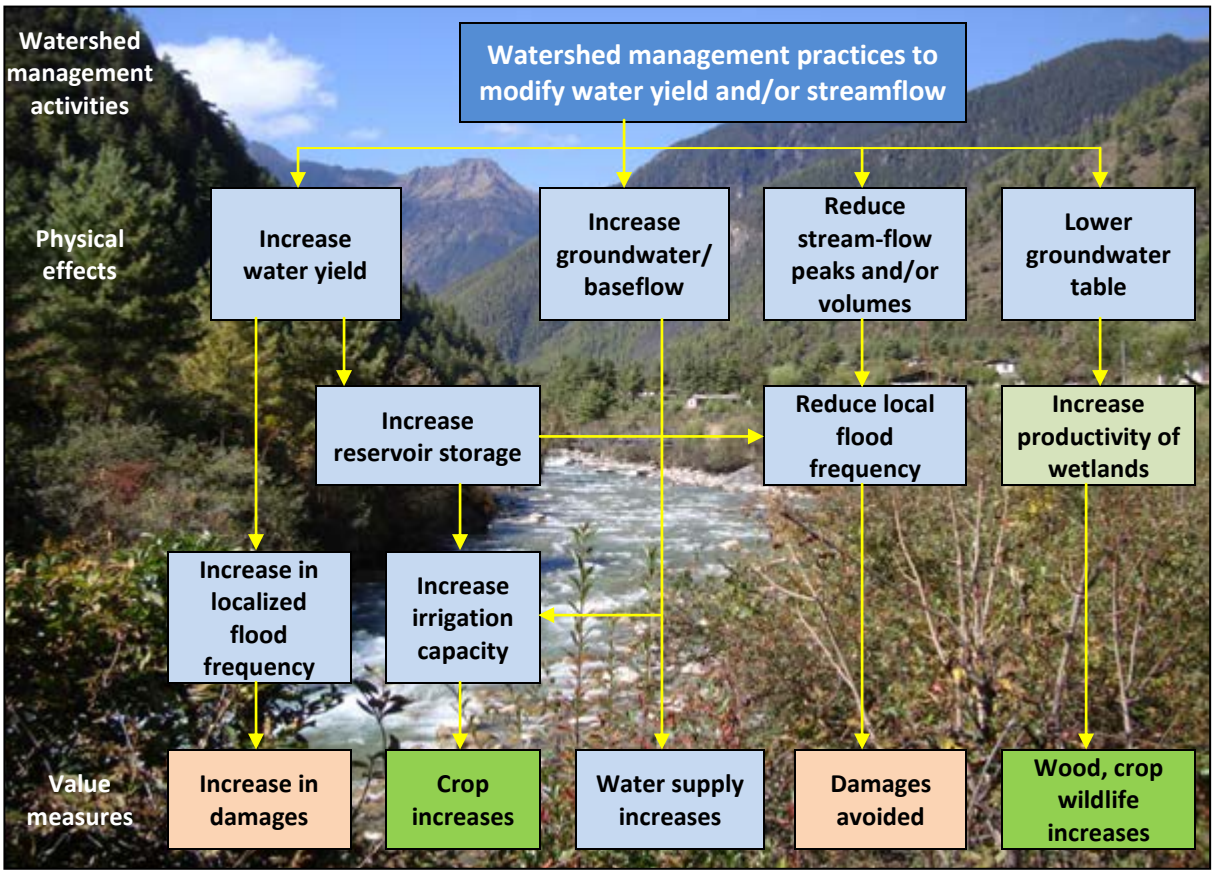


Figure 8. Water yield/streamflow outcomes of watershed management practices

Where Should We Focus Our Efforts? Target Locations

GIS based methods, tools and techniques help to identify and justify areas of interventions particularly at river basin level or larger areas where problem assessment can be difficult. Watershed approach attempts to capture the interaction between humans and ecosystems integrating the concept of human ecology with the political economy of a unit area adopted for development plan and action in the mountains. Agriculture, forest and rangelands often represent potentially significant production resources for local inhabitants. Using watersheds as an organizing unit can be an effective scale for natural resource management. It presents a common reference point for the many different activities and actors that affect the system, and promotes greater integration and collaboration among those actions. It also provides the scope for integration in thought, action and results. Using watersheds as organizing units for planning and implementation of natural resource management means that:

- large regions can be divided along topographic lines that transcend jurisdictional lines
- status and trends analysis can be done on the basis of entire natural systems in concert with social conditions
- communities within the watersheds can better track and understand the impacts of their management activities on the larger system
- each watershed can adjust management measures and policies to meet local goals while supporting larger scale goals as well (such as national and sectoral interests)
- multi-objective planning is facilitated by inclusion in, and reference to, a whole-system context

Participatory integrated watershed management approach means integration of technical aspects with the economic, social, political and cultural dimensions of natural resources conservation and management. Participatory processes are recognized as primordial in watershed management at all stages, from project identification to the appraisal and implementation of activities. Watershed management has become a multi-disciplinary activity in which appropriate institutional and organizational mechanisms are required to coordinate and implement of watershed management activities. It is increasingly seen as an appropriate vehicle not only for environmental conservation but also for the improvement of rural livelihoods. In this regard, there is demand for the development of appropriate technologies that can ensure sustainable economic development and ecologically sound natural resources management. Some of the key areas that require concerted attention to deal with watershed issues and problems are highlighted in Box 6.

Box 6. Key considerations for best practices

- **hydrometeorological and sediment data at the watershed level;**
- **tools for land managers to assess the impacts of catchment management interventions (e.g. modeling "what if" scenarios);**
- **farm-based technologies associated with production culture, soil and water conservation, overall land management, etc.;**
- **bioengineering for stabilization and rehabilitation;**
- **assessment of downstream costs/benefits of upstream interventions;**
- **adaptive research on indigenous technologies;**
- **effective biodiversity management (including agro-biodiversity); and**
- **efficient framework for water assessment through multi-linked catchment landscape.**

It is clear that both socio-economic and biophysical aspects need to be considered in developing policies, strategies and plans for watershed management. People and their interests cannot be disassociated from the biophysical realm in which they live and, as the 10th Five Year Plan makes clear, policies and practices need to become more people-centered. Apart from the ethical aspects of this requirement there are practical reasons. Imperatives in the socio-economic realm frequently drive changes in the biophysical realm with impacts on vegetation, soil and water. Consequently, peoples' livelihoods need to be considered as central to any approach used to improve watershed conditions, which bring into focus critical areas associated with considerable human influence.

Linking human activities to undesirable changes in water and sediment output of the rivers and streams may overstate the role of these activities. Hydrologic and geomorphic processes operate virtually the entire altitudinal range, while human activities in Bhutan are mainly confined to below 3000m elevation. Based on the existing data and information, about 50% of water and presumably greater proportion of total sediment in our rivers are produced from catchment areas above and outside the normal range of human habitation or activity. On the other hand, specific runoff from watersheds is at a maximum in altitudinal belt of considerable human activity (1500-3500m). While hydrological consequences of environmental disturbances in this belt are unlikely to be detectable at the river basin level, it is quite reasonable to assume that local problems of increased runoff or erosion could occur as a result of unwise land use within a given watershed boundary. Such understanding in the biophysical and socioeconomic context can help in identifying areas predisposed to watershed-related impairments. Each watershed possesses unique ecological signature requiring specific treatment to deal with problems and threats undermining its natural structure and functions. Management planning on a river-basin scale is perhaps unrealistic given the limited resources, and untenable for delivering the anticipated outcomes at such a broad scale providing limited insight into the diversity present across watersheds.

In view of the strong conservation policies and a cultural history fostered on environmental ethics, one might be tempted to believe that further attention is unnecessary. In reality, the situation is tenuous considering the inherent vulnerability in terms of physiography and exposure to disturbances; and a sensitive economy that is contingent on the sustained provision of natural resources. Human and livestock populations are concentrated in few productive areas primarily confined to mountainside patches and fluvial flats. This concentrates hydrological impacts to few localized areas of significant human influences, while the rest of the landscape experiences only negligible pressure with little difference in the response outcome. Rather than embarking upon overly inclusive basin-level master plans, a more prudent approach is to focus on management units with practical scope for achieving results in target areas assessed to be hotspots of negative externalities from economic activities (Figure 9).

Watersheds are selected as the practical, tangible units for management intervention, the spatial extent of each resolved to a hydrologically coherent area using GIS tools and techniques. The major river basins are subdivided into watersheds with comparable biophysical characteristics of a natural system concept. A guideline for watershed

classification is available to assess and identify watersheds in critical situation requiring concerted attention. Based on the dimensions of vulnerability expressed as socioeconomic pressure and ecosystem sensitivity within a watershed domain, each situation is evaluated against a set of indicators for attributes of interest. An index of criticality is then derived for each watershed by integrating all indicator scores into a single metric, which is subsequently used to categorize watersheds into three classes of ecosystem quality. Those classified as vulnerable will be prioritized for developing management plans by incorporating additional layers of information through participatory stakeholders' processes and in-depth field surveys. At least four critical watershed plans are expected to undergo the initial management cycle in framing a basis for subsequent revision of the Roadmap. The experience and lessons from earlier cycles will continually refocus priorities and bring more locations under managed watersheds.

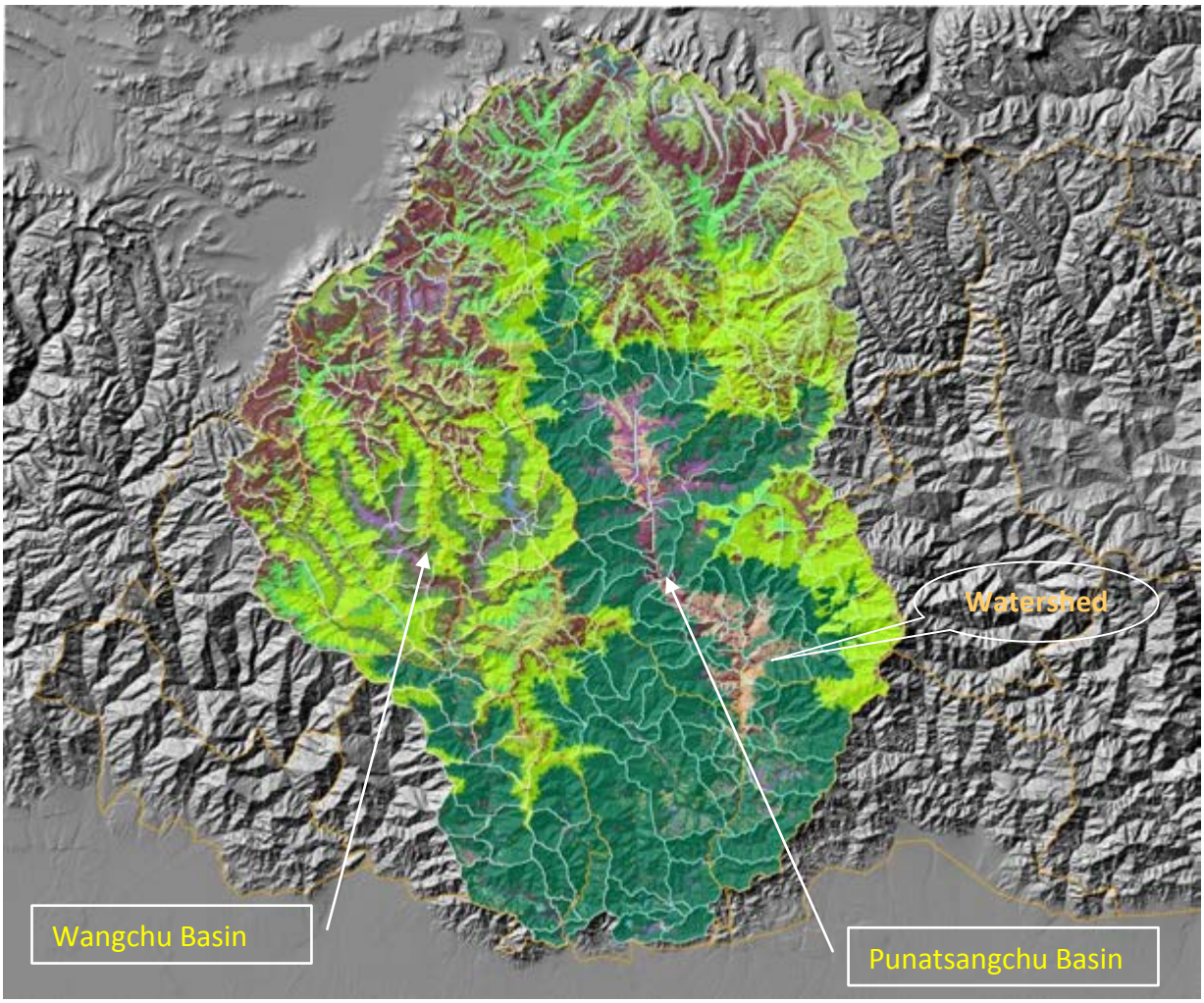


Figure 9. Wangchu and Punatsangchu river basins identified as the focus of watershed management interventions in the next five years. Each basin is delineated into watersheds as the basic units for management planning and implementation.

Navigating the Roadmap - Implementation

The major issues associated with implementing watershed activities, with special focus on cost-effectiveness, synergy, sustainability and equity at the national, watershed and local level, are the lack of implementation authority at the local level, poor inter-agency coordination, contradictory legislation and a lack of clear rules and guidelines for implementing legal provisions. There are also cases of political interventions working against the prescriptions of management plans, the use of inappropriate approaches, proliferation of development paradigms, inadequate and erratic funding, no clear cost sharing for enforcement, lack of capacity for implementation (in terms of both technology and number) with extension workers and local leaders. The following steps must be taken to deal with these issues:

- Review existing legislation and formulating new legislation to address policy issues such as interagency and interdisciplinary collaboration, decentralization of authority and sustainability of resources.
- Bottom-up preparation of watershed plans, with top-down screening to ensure their technical feasibility and policy consistency.
- Best practices should be documented, field tested for local adaptability and included in implementation plans. There is a need for adaptive research, testing, demonstration, replication and dissemination of best practices.
- Generate greater knowledge and understanding on the upstream–downstream linkages and benefit sharing using appropriate mechanisms.
- Plan for improvement with adequate institutional, organizational and coordination arrangements put in place among ministries, stakeholders and disciplines. Coordination capacity should be enhanced through legislation and regulatory measures.
- Training in implementation capacity at all levels with greater harmonization between donors and recipients making longer-term commitments
- Mechanisms in which revenue from watershed resources is used at the local level for community activities.

The program implementation shall pursue a two-pronged approach that will distinguish activities to be carried out on its own at the strategic level, and those activities that must be integrated, incorporated and harmonized into the implementation plans of other area-based development, conservation and management programs within and outside the Ministry. These include the regular development plans of the Dzongkhags and Geogs as well as the land-use specific planning frameworks such those that apply to FMUs, protected areas, community forests, etc. However, there are practical problems that we must address through institutional mechanisms and implementation arrangements for dialogue, discussion and consultation. Watershed boundaries rarely coincide with administrative/political boundaries (Dzongkhags and Geogs) that form the basis of most development planning, or of the land-use specific boundaries (for uses such as FMUs, protected areas, community forests, etc.) that are the basis of many area based management plans that cover much of the landscape. Integrated and holistic implementation needs to be interposed with the development plans of the administrative/political units and the other land-use specific area based plans.

Implementation shall focus on cost-effectiveness, synergy, sustainability and equity at the national, watershed and local levels. The following activities are considered in four cyclic phases and attendant overlapping phases as illustrated and detailed out below:

1. Investigation – starting the process, identify critical watersheds, critical sites of priority attention

2. Planning – incorporate watershed management objectives and activities into area-based management plans

3. Implementation – implement area-based plans, monitor outputs and impacts

4. Review and revision – evaluate outcomes and consequences, revise management plans based on lessons learnt, shortcomings and duplications

5. Capacity building

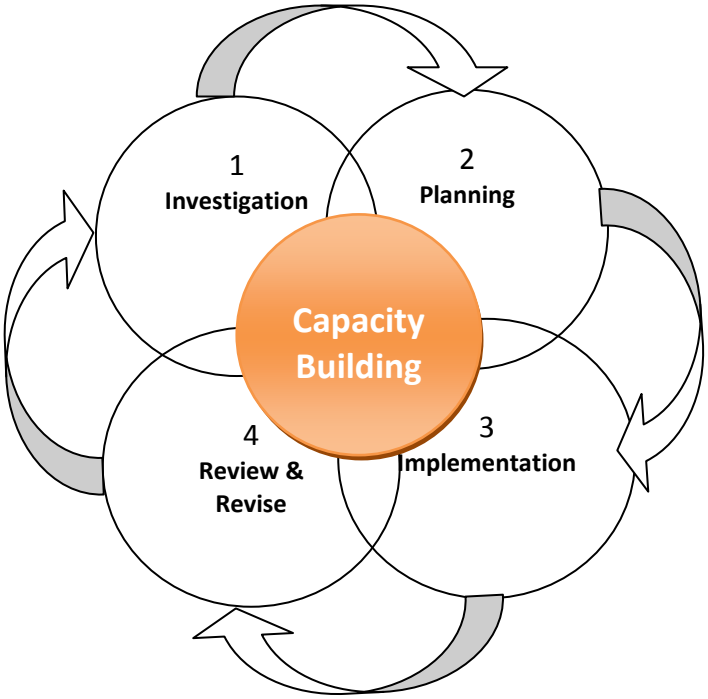


Figure 10. Schematic representation of the implementation phases

Activities

Activities in the watersheds related to land. Land management is directly related with watershed management, with impact on quality, fertility, and capability of land.

I. Investigation phase

1. Assessment of watershed conditions across the country
   a. Selection of criteria to determine the conditions of watersheds
   b. Field a rapid appraisal system for assessing watershed conditions, including among others, exposed surface soil, hillslope characteristics, roads and tracts, disturbance of riparian areas, river-beds and banks, land use system (practical and qualitative)
   c. Develop a system of prioritizing critical watersheds and sub-watersheds for action
   d. Selection of target watersheds for management operations

2. Determine watershed management objectives for target watersheds and align proposed activities with program objectives
   a. Identify plausible causal connection between watershed conditions and watershed management objectives
   b. Identify and prioritize watershed management activities for target watersheds

3. Prepare guidelines to incorporate watershed management activities into area-based management plans

4. Assess the potential of Payment for Ecosystem Services (PES)

***Provisional** Criteria*
1. Paramenters:
   a. *physiographical (relief, terrain, surface features, roughness index, slope length, gradient, aspect);*
   b. *Hydrological (rainfall–intensity, duration, magnitude, volume, evapotranspiration, runoff, sediment loss, water and sediment discharge, infiltration, water storage);*
   c. *geomorphological (drainage density, frequency, pattern, bifurcation ratio); Climatic variables.*

2. Process:
soil degradation, erosion, land use change, floods and droughts, moisture and energy balances, land capability together with net primary productivity inform land management. Farming (cropland/rangeland/pasture/grazing land/orchards/plantations), FMU, P&PAS, Livelihood Forestry (CF, PF, AF) systems for watersheds and their impacts on the hydrological cycle, soil and nutrient losses, yield differences, biotic and abiotic changes.

II. Planning Phase

5. Conduct planning processes e.g. workshops with key stakeholders to agree on actions needed to achieve watershed management objectives (biophysical and socioeconomic in targeted watershed areas and geogs; and include them in the area-based management plans
   a. Joint planning workshop for line departments and central programs. The focus is on operationalizing and strengthening existing planning systems
   b. Participatory consultation for watershed management activities in the geog plan (with details on priority setting, workplan, budgets lead implementers and partners etc.)

6. Gap analysis to identify activities not covered by existing management plans
   a. Prepare a check-list to assess whether watershed management activities are sufficiently taken into account in the area-based plans

7. Seek funds for activities not covered under normal operational budget allocation of the government. However these activities are prerequisite for the success of planned activities
   a. Prepare project concepts and explore donor interests
   b. Identify activities that can be covered by PES funding

III. Implementation and Monitoring Phase

8. Implement watershed management activities within the provision of relevant area-based plans

9. Monitor and report technical, social and financial progress of watershed management activities, outcomes and impacts

a. Monitor implementation of watershed management activities included under area-based plans
b. Monitor watershed management impacts on downstream resources and livelihood of communities in the watersheds

IV. Review and Revision Phase

10. Review watershed management planning based on monitoring, revise processes and practices for the next cycle of activities
    a. Assess whether the activities implemented under various plans have achieved the wm objectives
    b. Rapid appraisal of development, conservation and management impacts
    c. Preliminary work on the preparation of a watershed management operational manual

Evaluation and Reporting

We cannot be certain that a proposed watershed management practice will be implemented as planned; or that it will have the anticipated effects on natural resources, the environment and people's welfare. Our anticipations are based on imperfect knowledge and uncertainties in our understanding given that knowledge. Monitoring and Evaluation (M&E) systems is the key element in planning and implementation of land, flora & fauna and water-use activities within the overall framework of watershed and river-basin management. M&E can facilitate changes in policies, programs and practices in reinforcing links with the desired goals while providing feedback to improve performance of future watershed management practices. The whole cycle has a strong learning function that is integral to the iterative and dynamic process of adaptive management approach as describe in Figure 11.

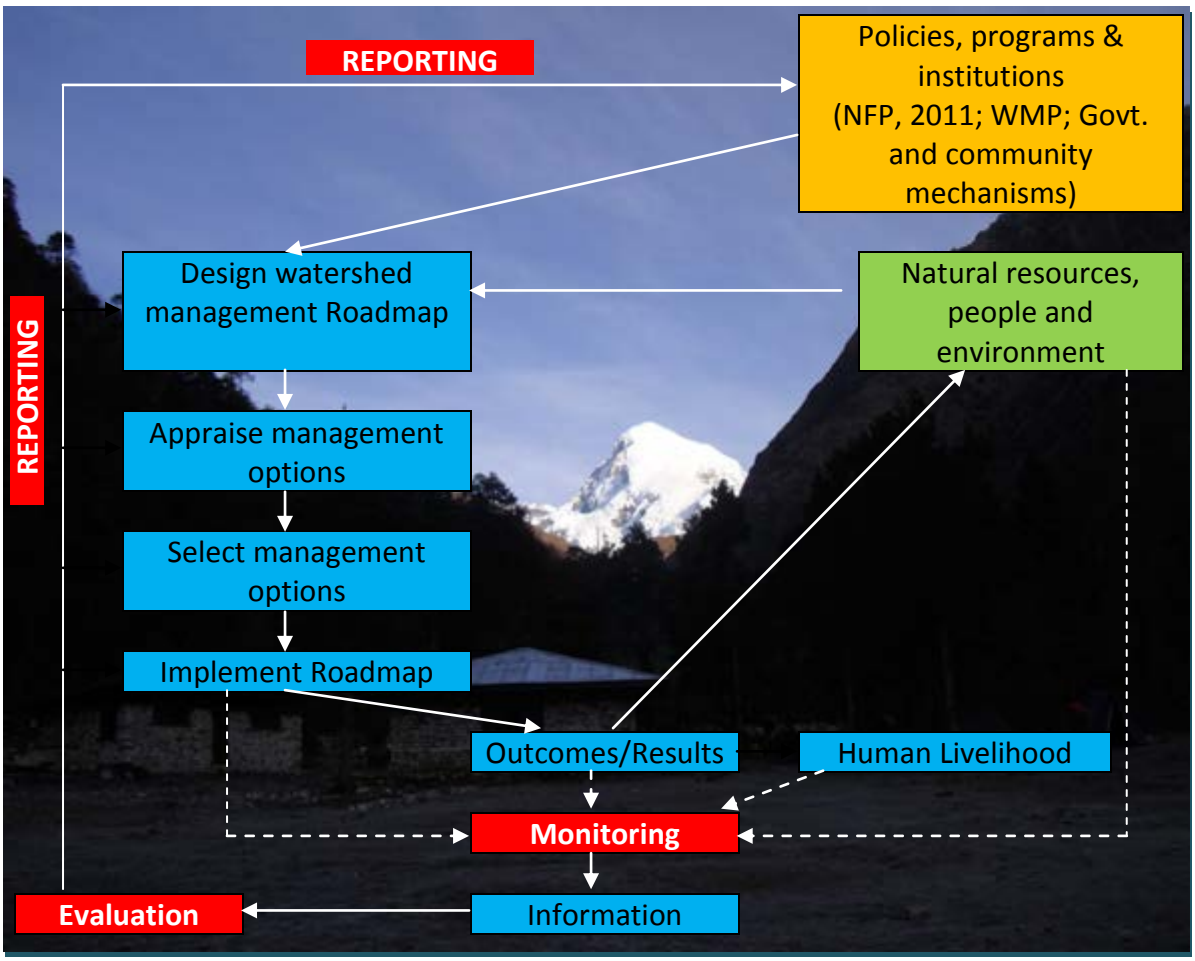


Figure 11. M&E and reporting process for the Roadmap

This Roadmap is meant to guide watershed management initiatives over a proposed cycle of five-year interval. During this time, societal, economic and environmental circumstances may change, and the needs and priorities of watershed dwellers and stakeholders will change as well. As such, this Roadmap is meant to be adaptive and amenable to revision as new insights and understanding advance with experience gained through implementation. This adaptability means that the WMD, under the advice of the NC and MTAC (instruments

envisaged under the Water Act), has the ability to change objectives as needed, along with the actions and policies required to meet these objectives.

The success in implementation will be evaluated primarily by the progress made towards meeting the stated objectives. The secondary means of evaluating progress will be meeting the measure of success listed for each individual action. Thus, if the actions we take do not allow us to reach our objectives we may need to revise actions or add new ones, or alter our objectives to be more realistic. Reports on implementation will be produced annually in order to update stakeholders and watershed communities on the progress towards reaching the objectives. In addition to annual updates this watershed Roadmap will undergo full, comprehensive review at the end of every 5-year cycle.

WMD should adopt innovative monitoring and evaluation methodologies for impact assessment of watershed management integrating rangeland management issues and underscoring balance between human wellbeing and environmental protection. It must also create data sets and increase access to information for M&E through dedicated Information collection and management system utilizing database infrastructure, GIS, indigenous knowledge, etc. M&E must be carried out from the beginning of program, project and activity implementation and on an ongoing basis involving all stakeholders. Post-project evaluations must include both external and internal M&E looking at both the biophysical and the socio-economic aspects. It must be flexible and the guidelines for M&E must ensure effectiveness and transparency.

Box 7. Features of a good monitoring, evaluation and reporting system are:

- Participatory, result-based M&E system that is cost-effective and time-efficient with Input-Output indicators to show results and impacts in relation to objectives
- A Guideline that is simple and compatible with government system featuring core GNH criteria;
- Uniform reporting system that provides telling feedback on effectiveness and relevance of activities, including information on past efforts and future improvements

Although the general principles of watershed hydrology are understood with reasonable degree of certainty, the connection between natural disturbances and/or management, and the ensuing hydrologic responses is still not clear. This uncertainty creates difficulties in monitoring the impact of upstream activities on downstream water parameters. Physical monitoring and verification of on-site and off-site impacts of watershed management measures on the biophysical conditions and the livelihood of the rural watershed inhabitants may take many years of long-term experimentation. Cause-effect relationships and cumulative effects of land-use practices on watersheds can quickly be predicted using hydrologic simulation models by representing biophysical processes with mathematical formulations. Long-term stochastically derived data and information collected over space and time are used as inputs to these models from which simulated responses can be analyzed to derive estimates of the magnitude of effects or events of interest. The hydrologic affects of changing land-use practices on a watershed or in a river basin can often be examined for varying scenarios of climatic change through the use of GIS (Geographic Information System) and computer simulation modeling applications like ArcSWAT.

Conclusion

Poverty reduction is the primary goal of the 10FYP emphasizing the importance of mainstreaming environmental issues into the development planning process to maximize conservation, sustainable development and utilization of natural resources. Promote balanced development paying equal attention to livelihood opportunities and environmental preservation. The Ministry of Agriculture is expected to shift its primary focus from protection and conservation to sustainable management system anchored in the decentralized decision making, devolution of power/authority, participatory and people centered approaches in implementation. An integrated watershed management system must be adopted as an organizing framework for multi-sectoral, multi-disciplinary, and multi-stakeholder intervention in securing the ecosystem goods and services for the benefit of poverty reduction, sustainable livelihood and economic development of people living in the watersheds.

The most pragmatic strategy to fulfill the program objectives is to set out on a multi-pronged, two-stage intervention of initially conducting a river basin-wide planning to assess watershed conditions and identifying critical areas for priority attention. The second stage is to integrate, incorporate and harmonize watershed management activities into the action plans of the area-based development, conservation and management programs within and outside the RNR sector, in a participatory, consultative and shared implementation responsibility under multi-stakeholder fora.

In view of the above causes for concerns, just reasons for optimism, and the sheer significance of watershed in the environmental regulation and contribution to the socioeconomic development of the country, this Roadmap is expected to serve as a new paradigm for rationalizing and consolidating strategies and investments in fostering innovations to manage coupled human-environment systems, and thereby:

- Advance and sustain the hydropower potential of Bhutan's watersheds
- Contribute toward ecotourism development by preserving ecological resilience and environmental integrity to maintain landscape aesthetics and natural refugia.
- Support poverty reduction objectives by enhancing the productive potential of the watershed resources and secure their beneficial functions.
- Match competence and capacity with the level of engagement demanded under the considerably expanded watershed management program in the 10FYP, and further elaboration in subsequent plans
- Streamline the mandates and functions of collaborating institutions and agencies to facilitate coordination and complementary responsibilities in planning, implementation and monitoring and evaluation of watershed management activities under the area-based integrated framework encompassing geog development plans, land use and natural resources management plans of the central programs.
- Mainstream integrated watershed approach as the basis for planning conservation and development interventions involving multiple stakeholders, sectors and disciplines along the principles of gross national happiness.
- Promote innovate financial mechanisms like payment for ecosystem services, incentives for conservation and compensatory schemes for generating offsite benefits; and in the

process integrate benefit-sharing principles with balanced development policies to ensure equity and social justice, and finally

- Operationalize watershed management program through a matrix management setup to obviate the need for large bureaucratic structure to achieve comparable end results and positive impacts.

The central theme of this Roadmap is to make it mandatory for watershed development to be planned, implemented and maintained by the watershed communities themselves; adopt a common approach anchored in the principles of watershed hydrology to bring about uniformity and complementarities among the watershed-based programs implemented by various agencies; and institutionalize the approach in a National Watershed Committee and local-level management groups representing key stakeholders to review the progress and provide policy directions to the national watershed program.

Finally, the watershed approach embedded in the framework of the Roadmap is consciously primed to deliver the following benefits:

- To provide a context for integration using watersheds as practical, tangible management units that people understand while focusing and coordinating efforts, and finding common ground and meeting multiple needs
- To provide a better understanding and appreciation of nature's interrelated processes, linking human activities to natural response mechanism in ways that can benefit people drawing on the positive aspects of watershed processes
- To yields better management through generating ecologically-based, innovative, cost-effective solutions, forging stronger working relationships, and supporting consistent, continuous management

Its strength lies in its flexibility without being prescriptive since watersheds differ in structure, constituent components and functions to prompt different management strategies at different points in time. Likewise, different communities vary in the benefits they want from their watersheds over space and time, thus making watershed management a dynamic and continually readjusting process of adapting to changes in the biophysical and socioeconomic conditions.

Glossary

adsorption	the process by which pesticides and other chemicals are attracted to the surface of a soil or organic particle
aerobic	environmental conditions characterized by presence of dissolved oxygen; used to describe biological or chemical processes that occur in the presence of oxygen
aggradation	raising the bed of a watercourse by deposition of sediment
aggregate	mass or cluster of soil particles
agricultural pollution	liquid, dissolved, and solid wastes from all types of farming; including runoff from pesticides, fertilizers and feedlots, erosion and dust from plowing, animal manure and carcasses, crop residue and debris
agricultural runoff	portion of precipitation on an agricultural drainage area that does not infiltrate into the ground; the drainage area may include areas of crop production, pastures, rangeland, or feedlots
algae	any organisms of a group of chiefly aquatic microscopic nonvascular plants; most algae have a chlorophyll as the primary pigment for carbon fixation; as primary producers, algae serve as the base of the aquatic food chain; an overabundance of algae in natural waters is known as eutrophication
algal bloom	rapidly occurring growth and accumulation of algae within a waterbody; it usually results from excessive nutrient loading and sluggish circulation regime with a long residence time; persistent and frequent blooms can result in low oxygen conditions
alluvium	sediment deposited by flowing water, such as in a riverbed, floodplain, or delta
alternative strategies	a set of one or more strategies developed during the planning process to solve resource problems identified during the assessment
ambient water quality	natural concentration of water-quality constituents prior to mixing of either point or nonpoint source load of contaminants
anaerobic	environmental condition characterized by zero oxygen levels; describes biological and chemical processes that occur in the absence of oxygen
anoxic	aquatic environmental condition characterized by zero or little dissolved oxygen
anthropogenic eutrophication	the accelerated aging of a lake as a result of human activities; normally due to nutrient and sediment loading
aquifer	underground layers of porous rock saturated with water
assessment	the translation of scientific data into policy-relevant information suitable for supporting decision making and action
background levels	levels representing the chemical, physical, and biological

	conditions that would result from natural geomorphological processes such as weathering or dissolution
bankfull flow	Condition where flow fills a stream channel to the top of bank and at a point where the water begins to overflow onto a floodplain
base flow	he flow of a stream in dry weather, which comes from a watershed's groundwater; sometimes called seasonal low flow
baseline	An initial set of observations or data used for comparison or as a control; a starting point
basin	the largest single watershed management unit for water planning, that combines the drainage of a series of subbasins; often have a total area of thousands of square kilometers
bathymetric	measurements of lake basin, such as water depth, sediment depth, relief of bottom, or volume
benchmark	a surveyor's mark made on a stationary object of previously determined position and elevation and used as a reference point in surveys
benthic community	life on the bottom of waterbodies or in the sediments of a waterbody
benthos	Refers to plants or animals that live on the bottom of lakes, streams, or oceans
best management practices	measures (structural, vegetative, and management) that are the most effective and practical means
bioassessment	biological assessment; the evaluation of an ecosystem using integrated assessment of habitat and biological communities in comparison to empirically defined reference conditions
biodiversity	a variety of natural plant, aquatic, and animal communities within the watershed
biota	the animals and plants that live in a particular location or regions
blue-green algae	algal form that may cause water to turn green, gray, or brown during late summer periods; some forms may be toxic in large concentrations
bog	A type of wetland that accumulates appreciable peat deposits. It depends primarily on precipitation for its water source and is usually acidic and rich in plant matter, with a conspicuous mat or living green moss.
brownfield	a site that was previously used for industrial or other purposes that may have contaminated the soils there
buffer strip or zone	strips of erosion-resistant vegetation between a waterway and an area of more intensive land use
calibration (model)	the process of adjusting model parameters within physically defensible ranges until the resulting predictions give a best possible good fit to observed data
channel	a natural stream that conveys water; a ditch or open manmade conveyance for the flow of water

channelization	deepening, widening, and straightening a channel of a stream to increase its water-carrying capacity; the activity usually results in the loss of riparian vegetation
confluence	point where two or more watercourses intersect
consensus	a process that results in a decision that everyone can live with and everyone agrees to support and work toward
conservation tillage	any tillage and planting system that maintains at least 30% of the soil surface covered by residue after planting to reduce soil erosion by water
contaminant	any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, or soil
cost–benefit analysis	a quantitative evaluation of the costs that would be incurred versus the overall benefits to society of a proposed action
crop rotation	growing different crops in recurring succession on the same land, as opposed to continuous culture of one crop
data quality	the totality of features and characteristics of data that defines its ability to satisfy a given purpose; the characteristics of major importance are accuracy, precision, completeness, representation, and comparability
data validation	a systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use; data validation consists of data editing, screening, checking, auditing, verification, certification, and review
degradation	(1) a decline in the viability of ecosystem functions and processes; (2) a geologic process by which streambeds and floodplains are lowered in elevation by the removal of material. Severe forms of non-natural degradation are associated with land disturbance and urbanization, including channel incision, down cutting, widening, and associated floodplain abandonment and habitat loss.
delineation	The process of identifying a watershed boundary on the basis of topographic information
detachment	the process by which a substance becomes mobilized or available for transport
detention	the slowing of flows draining over the surface by temporarily holding the water on a surface area in a storage basin
deterministic model	a model that does not include built-in variability; same input will always equal the same output
direct runoff	water that flows over the ground surface or through the ground directly into streams, rivers, and lakes
discharge	volume of water per unit time moving past a fixed point
diversion	individually designed conveyances across a hillside
drainage	the removal of excess water from land by means of ditching or subsurface infiltration
drainage basin	a part of a land area enclosed by a topographic divide from

	which direct surface runoff from precipitation normally drains by gravity into a receiving water
drainage density	the ratio of the total length of streams within a watershed to the total area of the watershed; thus drainage density has units of the reciprocal of length; a high value of the drainage density would indicate a relatively high density of streams and thus a rapid storm response
drainage tile	pipe installed for internal drainage purposes
drainage pattern	the configuration of arrangement in plan view of the natural stream courses in a watershed; it is related to local geologic and geomorphologic features and history
dynamic model	a mathematical formulation describing and simulating the physical behavior of a system or a process and its temporal variability
dynamic simulation	modeling the behavior of physical, chemical, and biological phenomena and their variation over time
easement	a limited right someone else holds over land
ecological conditions	the degree of functionality or health of an ecosystem, measured by a broad array of indicators of condition that includes biotic characteristics and abiotic characteristics
ecological integrity	a measure of the health of the entire area or community based on how much of the original physical, biological, and chemical components of the area remains intact
ecoregion	a physical region defined by its ecology, based on similar soils, land surface, natural vegetation, and current land use
ecosystem	a system of interrelated of animals, plants, and the physical–chemical environment within which they function and interact
effluent	the treated or untreated liquids that flow out or are discharged from a water treatment plant, sewer, or industrial outfall
empirical model	use of statistical techniques to discern patterns or relationships underlying observed or measured data for large sample sets; does not account for physical dynamics of waterbodies
enhancement	in the context of restoration ecology, any improvement of a structural or functional attribute
environmental framework	natural and human-related features of the land and hydrologic system, such as geology, land use, and habitat, that provide a unifying framework for making comparative assessments of the factors within and among watersheds
ephemeral	refers to flow that dries up as some time during the year, usually summer
erosion	the wearing away of the land surface by running water, wind, ice, or other geological agents including such processes as gravitational creep
eutrophication	the process of enrichment of waterbodies by nutrients; eutrophication of a lake normally contributes to its slow evolution into a wetland and ultimately to dry land; may be

	accelerated by human activities
explanatory variable	a statistical term for "variable" that helps explain the variability in the dependent term
feedlot	a lot or building or a groups of lots or buildings intended for confined feeding, breeding, raising, or holding animals
fen	A type of wetland that accumulates peat deposits. Fens are less acidic than bogs, deriving most of their water from groundwater rich in calcium and magnesium.
floodplain	a nearly flat area of land along the course of a stream that is naturally subject to flooding
flow regime	The magnitude, timing, duration, rate of change and frequency of flows
fluvial	pertaining to or produced by action of a stream; or existing, growing, or living in or near a stream
fluvial geomorphology	the effect of rainfall and runoff on the form and pattern of riverbeds and river channels
flux	the rate at which a measurable amount of material flows past a designated point in a given amount of time
food chain	a sequence of organisms, where each uses the next-lower member of the sequence as a food source
food web	the totality of interacting food chains in an ecological community
geographic information system (GIS)	a system that integrates layers of spatially oriented information either manually or automatically
geomorphology	the study of the evolution and configuration of landforms
global positioning system (GPS)	a system capable of providing worldwide navigation and positioning by pinpointing locations
grassed waterway	a natural or constructed waterway used to conduct surface water from or through cropland
groundwater	water that accumulates in the spaces between alluvial material (sand, gravel, silt, or clay) or in fractures of rocks
habitat	the area where a plant or animal naturally lives
headwaters	the origin and upper reaches of a river or stream
holistic	emphasizing the importance of the whole and the interdependence of its parts
hydric soil	a soil that is saturated, flooded, or ponded long enough to support the growth of wetlands vegetation
hydrodynamic model	mathematical formulation used in describing fluid flow of circulation, transport, and deposition processes in receiving water
hydrologic cycle	the circuit of water movement from the atmosphere to earth and its return to the atmosphere through various stages or processes, such as precipitation, interception, runoff, infiltration, storage, evaporation, and transpiration
hydrologic modification	any change in the natural stream configuration such as channelization or dredging

hydrologically distinct	defined by drainage basins or watersheds rather than arbitrarily defined by political boundaries
hydrology	the study of occurrence distribution and chemistry of all waters on or below the Earth's surface and in the atmosphere
hydromodification	changing the flow, and thereby habitats, of natural water systems; this process includes the construction of dams, stream channels, and canals
hypoxia	the terms "hypoxia" and "hypoxic waters" refer to waters with concentrations of less than two parts per million of dissolved oxygen, which is generally accepted as the minimum level required to support most animal life and reproduction
impairment	a detrimental effect on the biological integrity of a waterbody caused by an impact that prevents attainment of the designated use
impervious cover	any surface in the urban landscape that cannot effectively absorb or infiltrate rainfall or runoff
implementation plan	an outline of steps and activities by a set time
infiltration	the gradual downward movement of water from the surface into the subsoil
integrated pest management (IPM)	a mixture of chemical and other, nonpesticide, methods to control pests
interflow	the lateral flow of water through soil
intermittent stream	flow at certain times of year
inventory	the collection of natural resource, economic, and social information within the watershed
irrigation return flow	surface and subsurface water that leaves a field after the application of irrigation water
knowledge base	refers to how widely scientific understanding is shared within the scientific community
leachate	water that collects contaminants as it trickles through wastes, pesticides, or fertilizers
load or loading	an amount of matter or thermal energy introduced into a receiving waterbody; to introduce matter or thermal energy into a receiving water
loading capacity	the greatest amount of loading a water can receive without violating water-quality standards
macroinvertebrate	invertebrate are the aquatic insects that spend a portion of their life cycle in the water, usually among the rocks and sediment deposits on the bottom
management measures	best practical and economically achievable measures
marsh	A type of wetland that does not accumulate appreciable peat deposits and is dominated by herbaceous vegetation. Marshes may be either fresh water or saltwater and tidal or non-tidal.
mass wasting	downslope transport of soil and rocks due to gravitational stress
meta-data	information that describes the content, quality, condition, and

	other characteristics of data
metrics	specialized variables that can be combined with a rating and used in an index
mitigation	actions taken to avoid, reduce, or compensate for the effects of environmental damage; among the broad spectrum of possible actions are those that restore, enhance, create, or replace damaged ecosystems
morphometry	measurements of the physical structure (e.g., length of streams, slope, depth, shoreline length) of a watershed or waterbody
natural waters	flowing water within a physical system that has developed without human intervention, in which natural processes continue to take place
nonpoint source pollution	nonpoint source (NPS) is so named because the pollutants do not originate at a single point sources such as industrial and municipal waste discharge pipes; also known as people or diffuse pollution; in general, nonpoint source pollution is a compilation of land runoff, precipitation, percolation, and atmospheric deposition; while some NPS pollution occurs naturally, most NPS problems are the result of inappropriate land use or management
nonstructural methods	nonphysical approaches, vegetative, cultural
numerical model	model that approximates a solution of governing partial differential equations that describe a natural process; the approximation uses a numerical discretization of space and time components of the system or process
nutrients	elements or substances, such as nitrogen or phosphorus, that are necessary for plant growth; large amounts of these substances reaching waterbodies can become a nuisance by promoting excessive aquatic algae growth
oligotrophic	a nutrient-poor condition
overland runoff	portion of precipitation that flows from a drainage area on the land surface or in open channels
partnership	an association of persons joined in an undertaking as shares or partakers
peak runoff	the highest value of the stage or discharge attained by a flood or storm event; also referred to as flood peak or peak discharge
percolation	The movement of water downward through the subsurface to the zone of saturation
permafrost	Perennially frozen layer in the soil, found in alpine, arctic, and antarctic regions
publicly owned treatment works (POTW)	any device or system owned by a state or municipality that is used in the treatment of municipal sewage or industrial wastes of a liquid nature
reach	a section of a stream
receiving waters	waters of a watercourse or waterbody that receive treated or

	untreated wastewater or nonpoint source runoff
restoration	return of an ecosystem to close approximation of its presumed condition prior to disturbance
retention	the prevention of runoff from entering the drainage system by storing it on a surface area or in a storage basin
riffle	a rocky shoal or sand bar located just below the surface of the water
rip rap	A combination of large stone, cobbles, and boulders used to line channels, stabilize banks, reduce runoff velocities, and filter out sediment
riparian areas	the land area that borders streams, wetlands, lakes, and rivers and that directly affects and is affected by the water quality and flow; this area often coincides with the maximum water surface elevation of the 100-year storm. The transition zone along a watercourse which acts as the interface between upland ecosystems and watercourses
riparian zone	the border or banks of a stream; although this term is used interchangeably with "floodplain," the riparian zone is generally regarded as relatively narrow compared to a floodplain
runoff	the portion of rainfall, melted snow, or irrigation water that flows across the surface or through underground zones and eventually into streams; runoff has three components: surface runoff, interflow, and groundwater flow
scoping modeling	a method of approximation that involves simple, steady-state analytical solutions for a rough analysis of the problem
SCS curve number	Number used to determine runoff, as a result of rainfall, for a specific land area based on the area's hydrologic condition, land use, soil, and treatment
sedimentation	a broad term that embodies the process of particle erosion, transportation, and deposition by flowing water and wind
seepage	percolation of water through the soil from unlined canals, ditches, lateral watercourses, or waste storage facilities
siltation	particles carried in water that are deposited on the bottom of a waterbody
silviculture	the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis
simulation	the process that mimics some or all of the behavior of one system with a different, dissimilar system, particularly with models
spatially referenced data	assigning specific geographic locations to data
spring	An area where groundwater flows naturally onto the land surface
stakeholder	any person, agency, or organization with a stake or interest in

	the watershed management plan; individuals who live, work, or play in the watershed; in addition to businesses operating in the watershed or relying on resources from watershed, civic, social, conservation, and environment associations and organizations are recognized as stakeholders; local, state, and federal organizations and governments are also considered stakeholders
storm sewer	a sewer that carries only surface runoff, street wash, and snow melt from the land; storm sewers are completely separated from those that carry domestic, industrial, and commercial wastewater
stormwater	runoff from a storm, snow melt runoff, and surface runoff and drainage
stratification	formation of water layers each with specific physical, chemical, and biological characteristics; as density of water decreases due to surface heating, a stable situation develops with lighter water overlaying heavier and denser water
stream order	a method of classifying streams according to their relative position in the stream network; a stream with no tributaries is considered a firstorder stream; when two first-order streams combine together, they form a second-order stream, and so on
stressors	factors that threaten the well-being or health and long-term viability of an ecosystem, species, or a population
structural management practices	construction of physical entities, engineering work
substrate	the material making up the bed or bottom of a stream or other waterbody
subwatershed	a smaller geographic section of a larger watershed unit whose boundaries include all the land area draining to a point where two second-order streams combine to form a third-order stream
surface runoff	precipitation excess not retained on the vegetation or surface depressions and not lost by infiltration and thereby is collected on the surface and runs off
suspended solids or load	organic and inorganic particles (sediment) suspended in and carried by fluid (water); suspended sediment usually consists of particles <0.1 mm, although size may vary according to current hydrological conditions; particles between 0.1 mm and 1.0 mm may move as suspended or be deposited (bedload)
sustainability	meeting the needs of the present without compromising the ability of future generations to meet their own needs
swamp	A type of wetland that is dominated by woody vegetation and does not accumulate appreciable peat deposits. Swamps may be fresh water or saltwater and tidal or nontidal
thermal pollution	the discharge of water sufficiently warm to lower dissolved oxygen levels, cause eutrophication, affect the life processes of aquatic organisms, or degrade the quality of drinking water or

	recreational use
topography	the physical features of a geographic surface area including relative elevations and the positions of natural and manmade features
trophic state	a classification of the condition of a waterbody pertaining to the degree of eutrophication; trophic states include oligotrophy (nutrient-poor), mesotrophy (intermediate nutrient availability), eutrophy (nutrient-rich), and hypertrophy (excessive nutrient availability)
turbidity	a measure of water clarity (opacity) caused by suspended sediments and organic materials in water
Universal Soil Loss Equation (USLE)	An equation used to predict the average rate of erosion of an area on the basis of the rainfall, soil type, topography, and management measures of the area
upstream waters	rivers, creeks, and tributaries that empty to another; also, any water located in the opposite direction of the current of a river, creek, or other tributary
urban runoff	stormwater from city streets, usually carrying litter, sediment, petroleum products, lawn fertilizers and pesticides, road deicers, and organic wastes
validation	the process of determining how well the mathematical model's computer representation describes the actual behavior of the physical processes under investigation; a validated model will have also been tested to ascertain whether it accurately and correctly solves the equations used to define the system simulation
variable	term used to describe a quantity that has no fixed value
vegetative controls	control measures or practices that involve plants to reduce erosion and treat runoff
vegetative strips	grasses or legumes planted in collection ditches to help trap sediments and protect the ditch from erosion
verification (of a model)	testing the accuracy and predictive capabilities of a calibrated model on a data set independent of the data set used for calibration
water allocation	Generally, a regulated withdrawal of water from a ground or surface source on the basis of total volume and/or rate of withdrawal
water budget	A water budget is an account of all the water inflow, outflow, and storage changes in a watershed. It describes and quantifies the pathways water takes as it moves through the hydrologic system, including precipitation, infiltration, run-off, evapotranspiration, consumptive use, recharge, etc.
water quality	the biological, chemical, and physical conditions of a waterbody, often measured by its ability to support life
water-quality standards	minimum requirements of purity of water for various designated uses; the three components of water-quality standards include the beneficial uses of a waterbody, the

	numerical and narrative waterquality criteria necessary to protect the uses of that particular waterbody, and an antidegradation statement
water table	the upper limit of the part of the soil or underlying rock material that is wholly saturated with water; in some places an upper or perched water table may be separated from a lower one by a restrictive layer; the level of groundwater
watershed	the geographic area that drains to surface waterbodies; a watershed generally includes lakes, rivers, wetlands, estuaries, surrounding landscape, and contributing groundwater
watershed approach	a watershed approach is a coordinating framework for environmental management that focuses public and private sector efforts to address the highest-priority problems within hydrologically defined geographic areas, taking into account groundwater and surface-water flow
watershed-based trading	a market-driven approach that involves trading arrangements among point source dischargers, nonpoint sources, and indirect dischargers in which the buyers purchase pollutant reduction at a lower cost than what they would have to spend to achieve the reduction themselves; sellers provide pollutant reductions and may receive compensation; the total pollution reduction must be the same or greater than what would have been achieved if no trade occurred
watershed community	The group of residents, landowners, businesses and the units that use, govern, and make decisions about resources and development within a watershed
watershed management plan	a document by the watershed partnership that identifies all natural resources, the problems and concerns impacting those resources, management approaches, and strategies to address those problems, goals, and objectives for the proposed activities, and the schedules and milestones for the activities
watershed management process	a four-step process, implemented through a partnership, that supports a flexible, dynamic approach for developing and implementing local solutions and watershed basis
watershed monitoring	monitoring primarily designed to sample and assess the characteristics and condition of a watershed, or to sample and assess specific entities on a watershed basis
watershed project	a group of activities undertaken in a geographic area to restore the beneficial uses of a resources already affected, degraded, or threatened
wetlands	areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions

Acronyms and Abbreviations

10FYP	10th Five Year Plan
ADP	Area Development Project
CFMG	Community Forestry Management Group
CFMP	Community Forest Management Plan
DDM	Department of Disaster Management
DFO	Divisional Forest Officer
DGM	Department of Geology and Mines
DOA	Department of Agriculture
DOE	Department of Energy
DoFPS	Department of Forests and Park Services
DOE	Department of Industries
DOL	Department of Livestock
DOR	Department of Roads
DPH	Department of Public Health
DzFO	Dzongkhag Forest Officer
FMU	Forest Management Unit
FRDD	Forest Resources and Development Division
GLOF	Glacial lake outburst flood
GNH	Gross National Happiness
GRF	Government Reserved Forest
HMSD	Hydromet Service Division
ICDP	Integrated Conservation and Development Project/Program
IWRM	Integrated Water Resources Management
MDG	Millennium Development Goals
MEA	Ministry of Economic Affairs
MOAF	Ministry of Agriculture and Forests
MOH	Ministry of Health
MOHCA	Ministry of Home and Cultural Affairs
MOWHS	Ministry of Works and Human Settlement
NC	National Committee of IWRM
NEC	National Environment Commission
NRDCL	Natural Resources Development Corporation Limited
NRM	Natural Resources Management
NSSC	National Soil Service Center
NWFP	Non Wood Forest Products
PA	Protected Area
PES	Payment for ecosystem/environmental services
PHED	Public Health Engineering Division
RNR	Renewable Natural Resources
RNRRDC	Renewable Natural Resources Research and Development Centre
RSPN	Royal Society for the Protection of Nature
SFD	Social Forestry Division
SFM	Sustainable Forest Management
SLM	Sustainable Land Management
SLMP	Sustainable Land Management Project

SWAT	Soil and Water Assessment Tool
TCB	Tourism Council of Bhutan
WSM	Watershed Management
WMD	Watershed Management Division
WWF	World Wildlife Fund
WWMP	Wang Watershed Management Project

Description of Terms

Dzongda	District Administrator
Dzongkhag	District
Geog	Block
Sokshing	Area for leaf litter collection
Thram	Land title document
Thromde	An urban place
Tsamdro	Grazing area
Chathrim	Act
Gup	Block Commissioner
Mangmee	Block community representative

ANNEX I: Watershed Management Division (WMD)

A Watershed Management section was created within the Social Forestry Division of the Department of Forestry in 2002 following recommendations on the creation of a separate Division to manage the emerging issues of Social Forestry and Watershed Management. Social Forestry has now moved into the mainstream of forest policy implementation, but Watershed Management lagged behind. Part of the reason for this is related to the institutional difficulties associated with trying to implement a program that requires a multi-disciplinary and integrated approach to both planning and implementation. The concept of managing watersheds in a holistic manner means that multiple actors are involved, from private farmers through various government ministries, departments and agencies to corporate entities, all with their own agendas. Devising an approach of working with these multiple actors to achieve a whole-of-catchment outcome is inherently challenging. To meet these challenges a Watershed Management Division was proposed for creation in the Department of Forests in January 2009. Following on this proposal, the Division was created through a cabinet executive order in April. Besides the primary mandate in implementing the watershed management program, it is also charged by the Ministry to function as the sector's focal point for environment, climate change, rangeland and wetlands. The Division's functions and responsibilities, therefore, fall within the purview of several environmental and natural resources policies and acts, and deemed as an integrative force across legislations and sectors.

For a long time, institution building for watershed management has been mentioned as one of the most neglected parts. A need has been reiterated every time disconnects become apparent to the decision-makers for improved understanding and identification of the institutional and organizational arrangements required for effective watershed management. While an appropriate legislative framework is an important tool to support watershed management policies, it is evident now that policies and legal instruments can no longer be considered as principal constraints to implementing sustainable watershed management program.

The draft National Forest Policy (2009) identifies watershed management as one of the key policy areas for the future to manage all watersheds effectively for sustainable livelihoods and reliable supply of high quality water. The national policy objective related to Watershed management has been treated as the vision for a national Watershed Management Program to develop implementation strategies and guidelines.

The Department of Forests has the primary responsibility for planning and coordination for watershed management, although responsibilities for specific land management aspects are spread across many agencies, including agriculture and livestock as well as Dzongkhags, Geogs, municipalities, private farmers and other land users. Such situation of uncertainties and overlaps in responsibilities and roles is proposed to be addressed through the following measures expected to be adopted under the new system of watershed management:

- Institutionalizing WMD as the focal point for coordinating multi-sectoral and multi-agency efforts in watershed management;

- Strengthen cooperation and collectivism among Institutions to identify a reference point and a common voice in WMD to reinforce their commitment in terms of priority and investment;
- Put in place a national research framework for watershed management reflecting local priorities;
- Take such watershed research programs forward collectively by all stakeholders (communities, scientists and donors).

Accordingly, watershed management program shall be operationalized through the WMD as a functional division of DOFPS-MOAF with its own management setup. Past experiences have indicated that inter-departmental arrangements for performing integrated, multidisciplinary tasks to achieving watershed objectives are problematic with limited scope of institution building. The need for separate agency is justified given the long-term commitments that go beyond the normal planning cycle and project periods. Through the establishment of WMD, there is now a single agency mandated to coordinate the protection and management of watersheds. Its organizational structure and institutional space shall provide an integrated and holistic approach to manage a mosaic of ownership, responsibility and usage.

Mandate and Functions

The WMD is charged with a high-level mandate to engage multi-stakeholders subsuming subsectoral roles and responsibilities at the watershed level, and to work with multiple stakeholders, actors and partners. As of now it is officially recognized to coordinate and collaborate as the focal agency of the Ministry in the areas of watershed (including rangeland and wetlands) management, climate change and environmental preservation. It is expected to bring together the interests and establish a common ground for sectors and subsectors to achieve cumulative rather than replicative end-effects. As the mandate encompasses ecosystem domains, the division is also entrusted to negotiate and formalize a process for payment, governance and plough-back mechanism for ecosystem good and services, and formalize benefit-sharing and user-pay principles. Besides interfacing between sectors on the ground, the division is also charged to monitor and evaluate watershed-based activities and impacts thereof, with subsequent reporting to relevant authorities and stakeholders. The mandate is defined in three broad areas as:

- Plan, coordinate, monitor and report nation-wide watershed management activities
- Coordinate RNR sectoral roles and responsibilities related to environment, climate change including enhancement of information and research to support policy implementation and development
- Pursue innovative financial and institutional mechanisms for participatory and integrated watershed management, including options for payment of ecosystem services (PES), and develop appropriate modalities

As the WMD is mandated to link, coordinate and engage in broader water policy agenda of the country to collaborate with relevant agencies at all levels to incorporate watershed management objectives into the sectoral plans, programs and activities; the following functions must be fulfilled:

1. Watershed assessment country-wide to assess vulnerability and identify critical watersheds for management interventions at desired level of aggregation
2. Conduct gap analysis of watershed management activities within the relevant area-based planning methodology, followed by situation analysis to determine the important watershed-based activities implemented or not implemented under any existing program interventions, achievements and impacts
3. Partnership with relevant agencies to identify and prioritize, negotiate, engage, interface and collaborate in activities contributing to watershed management objectives initially focusing on critical areas
4. Ensure that such activities are included in the respective partner agency's work and action plans, while streamlining investments and activities to promote complementarities and reduce duplications
5. Prepare in collaboration with concerned, relevant agencies best practices guideline for addressing imperative and incorporating watershed management activities in the area-based implementation plans
6. Adopt participatory approach to planning and implementation of such activities within the geog planning framework and other management plans bringing together key actors for joint operation on common issues
7. Institutionalize, develop and operationalize a PES framework beginning with water for hydropower generation. Subsequently, explore prospects for rewarding other ecosystem services emanating from the watersheds
8. Monitor and evaluate the performance of watershed activities and their impacts in terms of development, conservation and resource management
9. Research consequences of policy and management decisions on the watershed functions including research into global change, climate change, impacts with contribution toward anticipatory planning process
10. Pilot study into the carbon sequestration potentials of watersheds and actions necessary to enhance the carbon sink capacity
11. Develop a baseline for watershed incorporating all socioeconomic, cultural and biophysical components by collecting, collating and building a national watershed database
12. Education and awareness on the watersheds, their management, national significance, the program of government interventions, and institutional mechanisms for implementation
13. Training, networking, participation for capacity building in watershed management
14. Documentation, communication, dissemination of process, progress, achievements, impacts, future directions, follow-ups, guidelines, etc.
15. Report to the Ministry on the works of agencies in the watershed with recommendations and suggestions

Watershed Management Division with a mandate to perform the functions listed above would not produce a watershed management plan per se. Rather the plan is essentially made up of an amalgamation of many activities which have an explicit link to watershed management objectives that find their expression in existing planning frameworks.

Organizational setup

The Roadmap can only be pursued through a competent and capable organizational entity fixed in an institutional arrangement for operationalizing the watershed management program. A set of core mandates and functions described earlier reflect on the gravity of program engagement for its purpose and outcomes. The mandate and functions will be executed in consultation and coordination with all agencies that have a mandate to produce area based management plans, and particularly at the Dzongkhag and Geog levels. Wherever required, the Division shall liaise with offices within and outside the Ministry of Agriculture to effectively deliver the services with respect to watershed management and soil conservation. The National Soil Service Centre (NSSC) under the Department of Agriculture shall be consulted for any kind of soil survey and analysis. Similar coordination will be conducted as and when required with other institutions.

The institutional base of WMD will be within the Department of Forests as a functional division and administratively accountable to it on the functions associated with watershed management including rangelands. In the matters of environment, climate change and wetlands, it shall engage and report directly to the Secretariat of the Ministry. For now, the division is housed in the WWF building in Kawajangsa. The WMD is organized into three technical sections to rationalize the existing capacity in strategic planning, management and technical skills, and implement the activities within an operational matrix of stakeholders (Figure 12). These sections are:

1. Water and Climate Section (WCS)
2. Rangeland and Farming Systems Section (RFSS)
3. Forestry Section (FS)

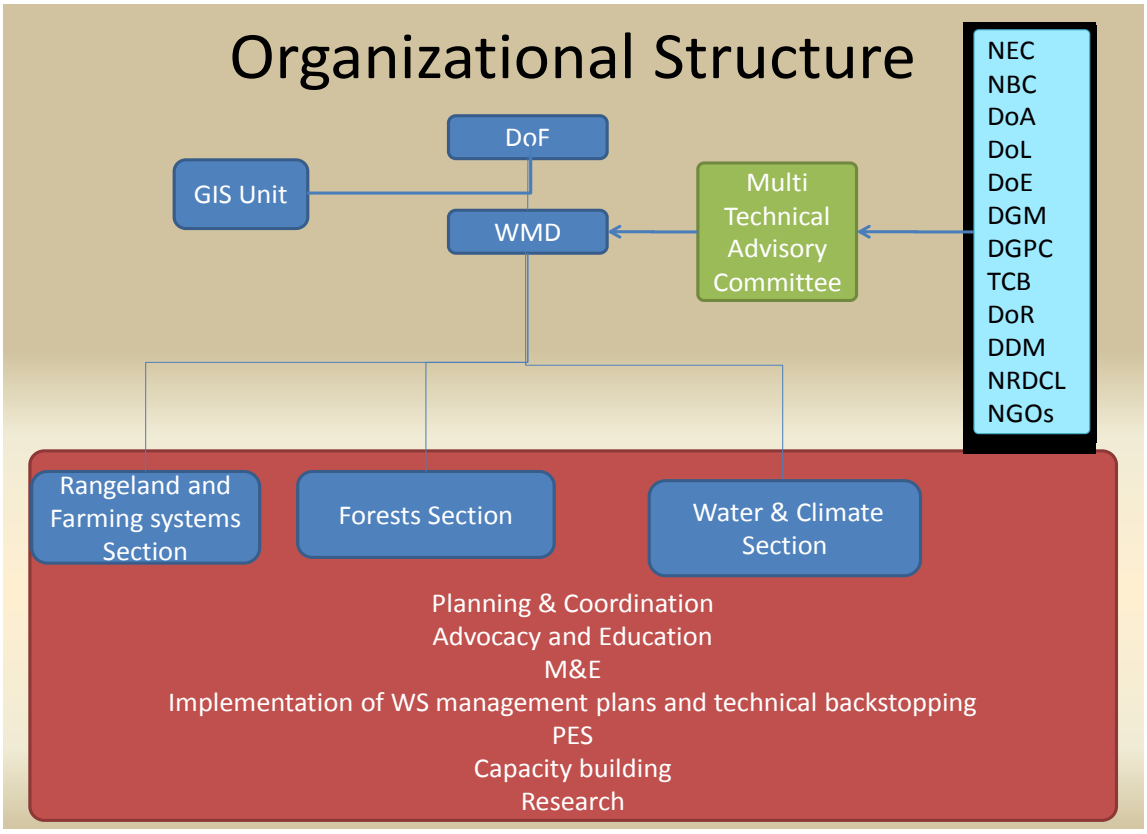


Figure 12. Organogram of Watershed Management Division

An administrative unit and a GIS unit will assist the Sections in providing administrative support and data and information management services respectively. The sections are managed by professionals transferred from within the Ministry with sound conceptual understanding of the watershed-related issues and opportunities and the ability for strategic and operational action under complex institutional environment. The GIS unit and the Farming Systems component of the RFS Section are non-functional at this moment as the Ministry has not yet allocated the required staff. As the division move toward full integration into the institutional machinery, further elaboration of roles and responsibilities will be necessary back by commensurate staff strength. In essence, watershed management activities must be the responsibility of all individuals, groups and agencies managing land, water, atmosphere and the biological resources in a specified watershed, but must be coordinated by WMD. The following lists the current personnel status of WMD (not all of them has joined yet).

Table 2. Proposed human resource capacity of WMD.

Position	Number	Field	Section
Head of the Division	1	RNR	Management and Administration
Chief Forest Officer	1	Forestry	Forestry Section
Forest Officer	3	Forestry	Forestry Section
Dty. Chief Research Officer	1	Rangeland	Rangeland & Farming Systems Section
Rangeland Officer	1	Rangeland	Rangeland & Farming Systems Section
Dty. Chief Research Officer	1[1]	Agriculture	Rangeland & Farming Systems Section
GIS Officer	1[1]	GIS	GIS unit
Sr. Hydromet Officer	1	Hydromet	Water and Climate Section
Hydromet Assistant	1	Hydromet	Water and Climate Section
Adm/Acc Assistant	1	Support	Management and Administration
Office Assistant	1	Support	Management and Administration
Driver	1	Support	Management and Administration
	14		

Twelve technical staff along with six additional support staff, and four administrative support staffs will be needed to carry out these functions in a fully operating national program. It is recommended that the management come up with human resource management plan and conduct a training needs assessment for the staffs. The proposed human resource requirements are indicated in Table 2.

In addition to the central level staff listed above, a watershed management focal person should be appointed in each Dzongkhag which has been targeted for priority activities to:

- Liaise with the WMD and RTAG;
- Member of the relevant Dzongkhag committee handling watershed activities;
- Coordinate and facilitate the integration of watershed activities into Geog and other relevant area based management plans;
- Report to the WMD on expenditure, activities and outcomes.

This person could be the Dzongkhag Forestry Officer.

[1] vacant

Institutional and Operational Arrangement

It is envisioned that the program be operationalized by a small, multidisciplinary core group based in WMD with actual implementation roles transferred to the partners agencies and institutions within and outside of the MOAF. Planning and coordination is expected to be initiated and led by WMD under the advisement and direction of the National Committee (NC) on Integrated Water Resource Management (IWRM), which itself is yet to be constituted, pending parliament's ratification of Water Bill and institutional enforcement mechanisms. IWRM is the core strategy adopted for implementing the provisions of this legislation, and the NC is seen as the apex body for steering the institutional apparatus of river basin management framework. It is important that the watershed management program is implemented in a manner that is harmonized with many other water related policies. Thus, the roadmap projects an explicit link with broader policy agenda of the country beyond the immediate mandate of the Ministry of Agriculture. It is perceived that watershed management activities will be added to a variety of existing area based planning frameworks, rather than be the subject of an additional layer of planning with all of the attendant bureaucracy involved. A conceptual organizational framework for institutional and operational arrangements is shown in Figure 13 below. Suggested functions and composition of this committee are given in Annex II.

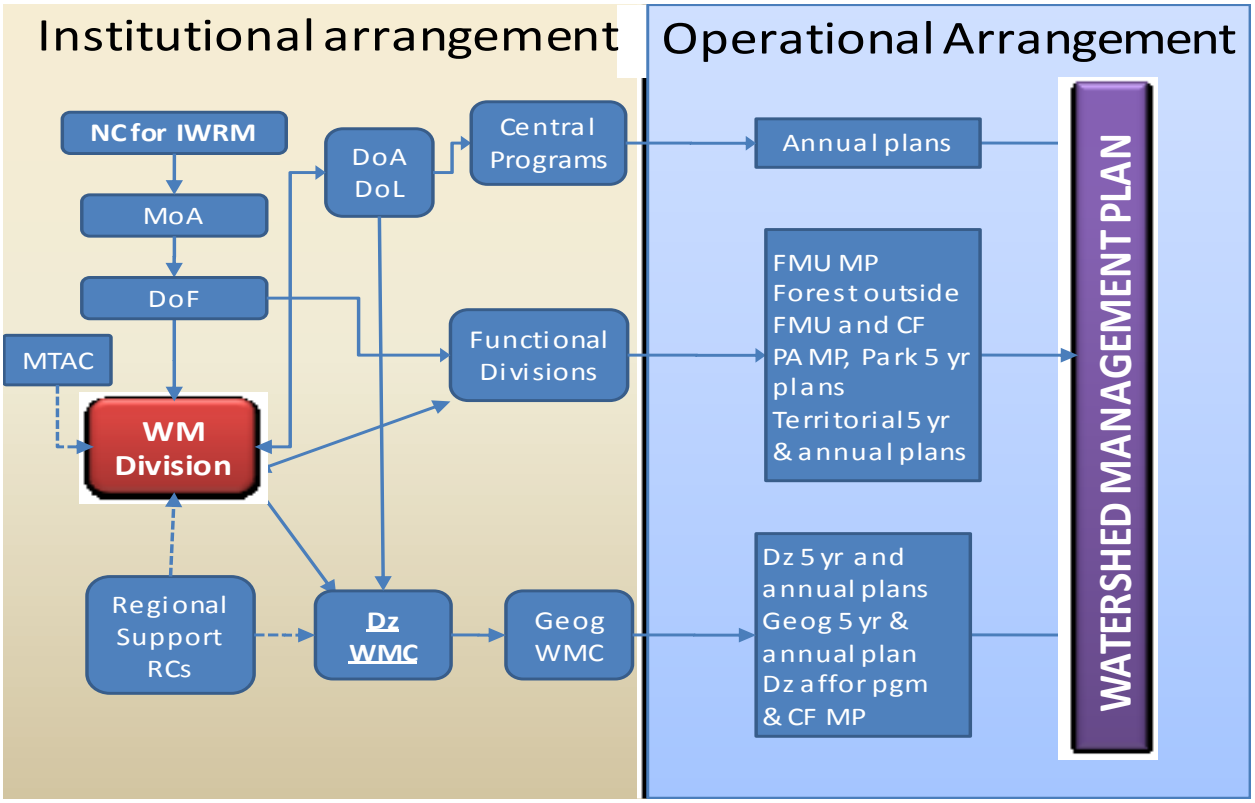
The primary mandate to incorporate watershed management activities into area based planning frameworks will need to rest with the most relevant implementation agency and, in the present structure of government this is the Ministry of Agriculture. Identification and implementation of relevant activities in selected watersheds will be carried out through the management plans of the relevant Departments. The Department of Forestry has this mandate for about 72% of the country and a variety of agencies have a role in most of the arable land, particularly the Departments of Agriculture and Livestock.

Coordination between different line agencies at Dzongkhag and Geog levels will be critical to ensure that overall planning is done in a holistic and integrated manner. In particular, the DFOs will need to be involved to ensure that their planning for Government Reserved Forest land within the Geog is harmonized with other land uses. In view of area based planning, **the Geog level plan becomes the major vehicle for bringing together the disparate interests of the various sectors (including livestock, agriculture and forestry), irrespective of the land "ownership"**. The Sustainable Land Management Project is developing and testing participatory approaches to land management using a sustainable land management framework. The intended outcomes of the SLM interventions generally contribute directly to watershed management outcomes. A functional committee at the Dzongkhag level will be needed to ensure coordination and integration of relevant sectors to identify activities to enhance watershed conditions at Geog level under the five-year and annual plans. The existing committees could be used to minimize the establishment of additional structures. It is pertinent that territorial divisions (TDs) be represented in such committees as the scope of local watershed initiatives could extend into the GRFs and FMUs. Since forest hegemony is vested in the state, their involvement will ensure harmonization between national and local interests and open up channels for mediation on policy and technical aspects.

The Roadmap foresee the need for a national inter-agency Multi-Technical Advisory Committee (MTAC) and a Regional Technical Advisory Group (RTAG) in each of the RNR-RDCs to support the Dzongkhags in their planning, implementation and monitoring, at least in the initial stages of program implementation. The MTAC of the SLMP project may be revived and rationalized to assume an expanded terms of reference that include all watershed issues instead of limiting its involvement to land-only management. These bodies are expected perform as technical referral points providing advisory inputs and offer common solutions taking into account sectoral perspectives in a negotiated process. They can also support or contribute to the program of developing capacity and expertise needed to characterize and quantify the complex interactions and interrelationships between upstream land-uses and downstream water parameters. The Terms of References of MTAC and RTAG are outline in Annex II.

The geog watershed management groups will form the basal tier of such institutional contraption structured on community-based initiatives, fully field oriented and facilitated jointly by WMD and Geog administration. Each group will rally around a set of local issues and opportunities that are usually overlooked by agencies operating at a larger scale. The scope of their functions depends on their specific problems and purposes. Their legal status is formalized under the authority of Geog Chathrim.

Figure 13. Institutional arrangement of integrated watershed and river-basin management.



Annex II: TORs for Various Committees

1. National Committee for IWRM

Suggested composition: Chair (Minister, MOAF), Member Secretary (Secretary, NEC), government secretaries (MOAF, MEA, MOWHS, MOH, MOHCA, GNHC, NLC), chairman of Bhutan Water Partnership) as members.

- Ensure that the programmatic direction of the Watershed Management Program is consistent with the country's water related policies.
- Provide a high level mandate for the Watershed Management Program to coordinate with relevant sectors to achieve defined watershed management objectives in priority watersheds as well as across the country

2. Multi Technical Advisory Committee

Multi Technical Advisory Committee will consist of following Members: NEC, NBC, DoA, DoL, DoE, DGM, DGPC, TCB, DoR, DDM, NRDCL and NGOs

- Link broader policy and technical agenda on watershed within and outside the jurisdiction of MOAF
- Participate in MTAC meetings
- Advise policy and intervention measures on watershed management issues
- Review implementation of watershed management plans
- Act as focal persons of their respective agencies

3. Regional WM Technical Advisory Group

Regional Watershed Management Technical Advisory Group will consist of Regional Research Centers.

- Facilitate technical support to the watershed management activities
- Provide guidance in watershed management planning process
- Identify appropriate watershed management technologies

4. Dzongkhag WM Committee

Dzongkhag Environmental Committee will also act as Dzongkhag WM Committee with Dzongkhag Forestry Officer as the Member Secretary. Following are the members of Dzongkhag Watershed Management Committee: Chairperson (Dasho Dzongda), DzFO, DAO, DLO, DEO, DE.

- Identify, plan and implement the watershed management related activities involving more than geog.
- Administer linkages with WMD and RTAG
- Integrate and synchronize the geog watershed related activities into annual geog plans

- Mediate conflicts in implementation of WM plans/activities
- Ensure reporting of watershed activities to WMD

5. Geog Watershed Management Committee

Members: Chairperson (Gup), Member Secretary (GAO), members (AEO, LEO, FEO, Mangmee)

- Plan and implement the watershed management related activities in the geog.
- Mediate conflicts in implementation of WM plans/activities
- Ensure reporting of watershed activities to WMD through DzWMC

ANNEX III: Funding Mechanisms

The 10FYP capital outlay for watershed management is been approved at Nu. 68 million; but the government has not actually committed public funds in real term, or is there a strategy to mobilize external (bilateral or multilateral) resources to address budgetary deficits. While the recurrent costs are covered generously, obviously using outlandish economic and allocative metrics, it is clearly not the efficient and effective way of investing public resources into knowledge, information and infrastructure; when in fact the government is not so keen to vouch for capital expenditures. Provision of development can no longer be premised on speculative budgeting, but must be grounded in a secure financing position. This raises the fundamental issue of mindless parsimony in public common goods and general services, while being surfeit in few specific, less-than-public operating expenses verging on decadence. Unless the government reforms its fiduciary practices based on transparency, fairness, and public justice, people and environment centric programs like watershed are done for and will fail.

Since the start of watershed management activities under SFD at the start of the new millennium, and until that function is transferred to the new WMD, very little was achieved in integrating the watershed principles and practices into the programs and projects of natural resource management, or implementation through area-based, landuse specific plans. The failure to make inroads may be due to ineffectual approaches at both individual and agency levels, but more likely so with fund amount being either inadequate or due to lengthy procedures that encumber disbursements instead of facilitating the process. Without some rationalization and remodeling of the national budget and accounts system of rules and procedures, taking well-planned actions and getting results in watershed management could remain a difficult proposition for some time to come. At the moment, occasional need-based funding support from partners like SNV and DANIDA are proving to be more productive and effective with visible results in capacity building and field activities.

In the normal course of events regular government budgets are allocated to approved programs and their activities. In cases where new initiatives or approaches are being tested prior to mainstreaming them, externally funded projects are often used to provide the necessary technical and financial support to test and refine and approaches. However, external projects are, by their nature, temporary constructs. The SLMP is one such example. External project support would be very useful for the nascent watershed management program to test and refine the approaches and practices needed to achieve holistic and integrated planning and to support the process of institutionalizing these approaches into the relevant parts of government. To ensure institutional success, activities in the design and planning phase of watershed management could be supported through multilateral and bilateral funding windows.

Of increasing interest is the practice of payments for environmental services (PES) to replace subsidies with market-based incentives and compensation for adopting sustainable and environment-friendly actions in protecting watersheds and safeguarding their provisioning capability. WMD is taking a lead role in institutionalizing PES mechanisms based on the user-pay principle whereby downstream land and water users pay upstream landowners and

users for environmental services that maintain water quality or control downstream flows for the benefit of the downstream land and water users.

The concept of PES has real prospect of being adopted as a financial strategy in watershed management. Ecological services do represent a tremendous economic value that is often not factored into our economic system due to the failure of markets to value such services. Regulations of land-use practices designed to preserve watersheds place a disproportionate share of the conservation costs on upstream land users without giving them corresponding access to benefits. Upstream landowners have no incentive to protect watersheds, and downstream beneficiaries have no reason to pay for watershed services that have traditionally been free. PES can provide a market-based arrangement in which upstream land users can recover the costs of ecosystem stewardship and be incentivized to protect the watersheds. PES initiatives may range from informal, community-based initiatives, through more formal, voluntary contractual agreements between individual parties, to complex arrangements among multiple parties facilitated by intermediary organizations.

PES is being piloted at one location for drinking water; and another two have been identified to explore the potentials in hydropower sector and ecotourism. The experience and lessons from the pilot phase will afford the needed expertise and information for scaling up in space and time, as well as seeking out other promising and potential ecosystem services. Further, at a juncture when the government is seriously considering to factor in the environmental costs and benefits in it financial system, PES is well placed to be recognized as a innovative mechanism to translate external, non-market values of the environment into real financial incentives for local actors to provide environmental services. Areas with greatest PES potential in Bhutan are:

- Carbon sequestration in plants and soil
- Biodiversity conservation
- Watershed protection
- Landscape aesthetics for nature and ecotourism

The WMD could act as an intermediary between the users (buyers) and the providers (sellers) of these services. Its role would be to:

- Identify those land management practices that could contribute to the provision of the service (initially in critical parts of critical watersheds).
- Prepare contractual agreements with the landholders (or groups of landholders) for the provision of the services (by specifying activities, quality standards and timelines).
- Transfer payments to the landholders subject to compliance agreements.
- Carry out compliance monitoring to ensure that the agreed activities are being carried out.
- Report to the buyers of the service on the compliance and on overall outcomes and impacts.

Hydropower corporations in Bhutan are taxed and additionally transferring some fixed amount to the MoAF to finance land-use practices that is expected to improve the quality and quantity of water delivered to the hydropower plants. An important policy statement that is implicit in the expression of support for benefit-sharing arrangement, or corporate social responsibility for that matter, is the reinvestment of 1% revenue from hydro power

into upstream watershed management activities likely to benefit downstream water quality and quantity for power generation. An initiative that emerged out of this policy stipulation is the Compensatory Plantation Project implemented by SFD with funds from DGPC under the terms of a MoU signed with GNHC. Other areas of watershed management actions that are eligible for payment under this funding source include riparian plantation buffers, upland runoff management, storage and recharge operation, sediment and flow processing, etc. These and similar investments into the improvement of watershed conditions and incentivizing good stewardship can accrue financial benefits if sensibly internalized as real and precautionary measures to cut back on operating and maintenance costs of expensive machineries and components. Watershed-based projects should be attractive to any hydropower corporation because they can favorably impact net profit, balance of payment and income redistribution. Long-term consideration is a critical variable; while short-term losses avoided are as important as increases in production.

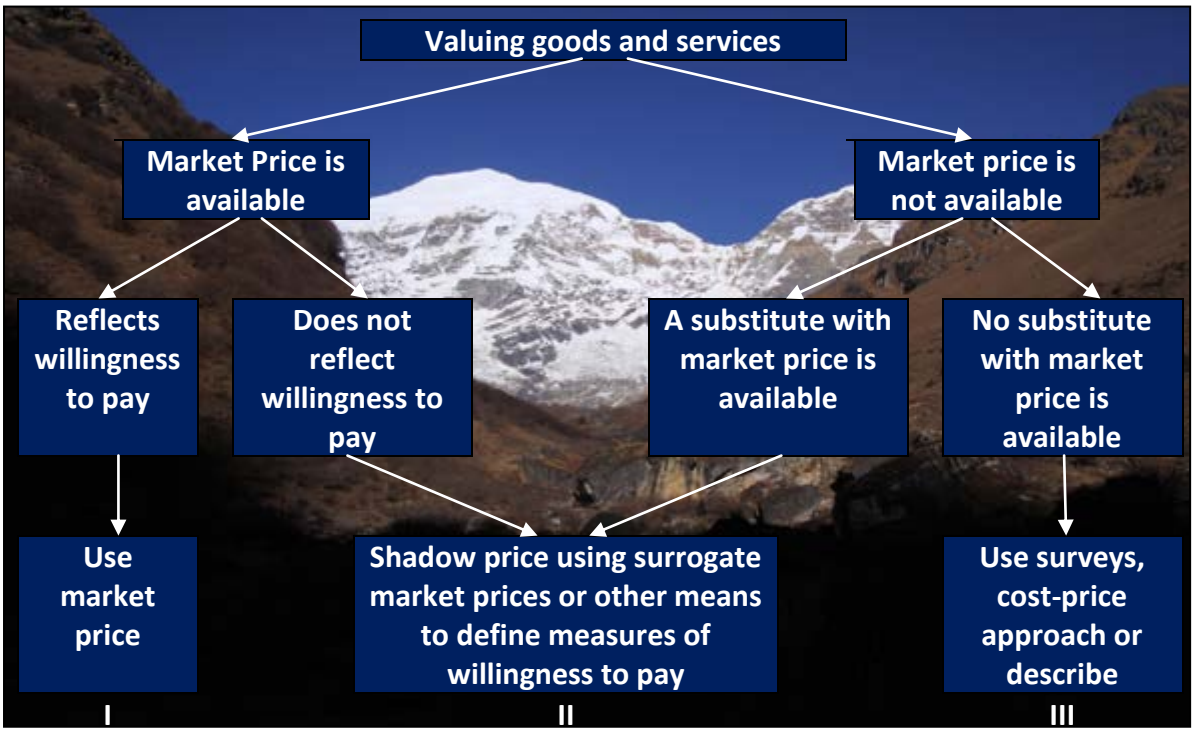


Figure 14. Valuation conditions and approaches

However, initiatives to promote PES mechanism can get frustrated with the present governance and regulatory system that condones fragmented ownership and conflicting jurisdictions resulting from single subject mandates of many agencies. Besides, it is still very difficult to demonstrate and quantify the actual benefits of the services to those who are asked to pay for them, and it is extremely difficult to create a mechanism that is based on both proper scientific measurement of the impact of the policies and reliable valuation of the benefits of these impacts. The reason that PES is still around reflects the general appreciation for the important interactions between land and water, and reinforces further the imperatives and urgency for ecologists and economists to cooperate in developing an effective accounting system for vital ecological services. The non-market benefits and costs associated with these services must be accounted for through proper economic valuation methods (Figure 14).

Other market-based funding mechanisms are rapidly evolving through community-based initiatives, public-private partnership opportunities, and active involvement of CSOs and NGOs in creating a civic space that nurture shared visions to deliver and finance watershed protection aimed at internalizing negative impacts on water quality and flow. In the international arena, Bhutan has impeccable reputation in its commitment to environmental upkeep; being guided by a vision with profound reverence for nature that underscores harmonious coexistence. There is considerable knowledge and experience within the country in capitalizing on the opportunities afforded by its image of ecological exclusivity. Biodiversity conservation, climate change adaptation and mitigation, and ecosystems integrity are key selling points to leverage funds for watershed management. These funding entry points are the integral features of watersheds, which thus far have been overlooked in most policies, programs and practices. Rather than treating each facet of watershed ecosystems in isolation, an integrated and holistic approach encompassing land, water and biomass resources, including the natural linkages between them, is needed in order to consolidate finance and optimize social and economic welfare outcomes. Therefore, public grants dispensed through governmental budgetary contributions, bilateral and multilaterals development assistance and project support through environmental and natural capital trust funds must converge at the watershed level in a cost-effective, time-efficient and co-financing arrangement.

Beyond the public payment systems and grant options, there are potential market-based funding mechanisms that are pertinent to ecologically and economically sensible watershed stewardship. Reducing emission from deforestation and forest degradation, the role of conservation and sustainable management of forests, and enhancement of forest carbon stocks; collectively referred to as REDD+ is currently being negotiated under the UNFCCC process. This multilateral instrument is expected to provide a legal regime to link climate change mitigation services of forests to the funds pledged under the Convention, and also to open forests to carbon markets under various emission trading systems. Since watershed management regimes incorporate best practices in the restoration and enhancement of ecosystem structure and functions, the carbon storage and sequestration services will be eligible for generation of tradable carbon credits, and revenue generation that can be plowed back to finance further interventions.

Besides PES and REDD+ funding avenues, it is worthwhile to mention other options that are manifest in several incentive-based and benefit sharing approaches implemented in a wide variety of situations. Nature-related ecotourism is one case in point where communities benefit from visitors buying local products and locals providing seasonal tour-guide services, which consequently motivate local communities to take care of the natural resources and landscape features that appeal to the visitors. Yet others include traditional covenants and indigenous practices in the systems of access and use of land, water and biomass resources that encapsulate the basic essence of balancing sustainability and resilience with economic benefits derived from natural ecosystems. There are also countless examples from elsewhere on innovative approaches and positive incentives drawing on the popular sentiment for ecological reparation and redeem past hedonistic lifestyle that compromised a great deal of nature. While sales of conservation easements and development rights may sound little bit radical at this juncture, leasehold compacts for biodiversity and carbon offsets and environmental rent schemes hold realistic prospects for Bhutan to attract

generous inflow of investment into sensible watershed management. Last but not the least, depending on who benefits from quantifiable watershed goods and services, allied policies and programs also need to create enabling environments for the adoption of protected areas and critical watersheds by investors and interest groups or individuals from within and outside the country. It may also be worthwhile to explore market mechanisms like water pricing methods, valuation techniques and selective privatization of services as the strategy for sustaining watershed management.

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The Watershed Management Division (WMD) was established in 2009. The mission of WMD is to ensure effective and integrated watershed management to maintain and improve water & watershed conditions and contribute to sustainable livelihoods through provision of watershed services.

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