Chapter 3
Ecosystem-Based Integrated and Participatory Watershed Management

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Abstract The chapter describes an integrated and participatory watershed management approach that involves multiple stakeholders in decision-making processes that provides managers (a) opportunities to exchange knowledge, build awareness, and integrate different sectors; (b) build consensus on priorities and aspirations; (c) enable local community to set agenda and outcomes; and (d) build institutions to work for collective actions. Different options were tested under this integrated approach enabling inclusive participation of local community and government agencies enhancing relevance, effectiveness, and sustainability of activities with good outcomes. The approach was implemented in four settlements situated within the Shivapuri Nagarjun National Park, Nepal. The protected area (PA) focuses on habitat protection and management, and wild animals co-exist with indigenous peoples' settlements within the Park boundaries. The three-year pilot work indicates high feasibility for upscaling the approach. The major findings are the following: (a) well-organized and aware buffer zone communities are better environmental stewards to conserve the biodiversity and co-manage the socio-ecological production ecosystems; (b) the buffer zone community if equipped with knowledge and skills can improve their livelihoods and support habitat improvement; (c) new generation of integrated watershed management approach is accepted due to its flexible and adaptive approach; and (d) incentivized and enabling mechanisms and tools are necessary to address historical grievances of the communities and reduce park-people conflict. It was also found that capacitated and empowered people are better conservation partners. The prerequisite is the access and benefit sharing rights of local communities need to be recognized and respected.

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S. Dhyani et al. (eds.), *Nature-based Solutions for Resilient Ecosystems and Societies*, Disaster Resilience and Green Growth,
https://doi.org/10.1007/978-981-15-4712-6_3

3.1 Introduction

Watershed or sub-watershed or micro-watershed is defined as a topographically delineated area whose natural drainage system sends water through a gradient flow to a river system or other water bodies. It can also be described as a land area from which water flows from upstream to downstream in a gravitational drainage system to a water body such as river, lake, or sea (Virginia Tech 2018). In other words, watershed is a naturally occurring unit of landscape, which contains a complex matrix of land use system such as forest, agricultural cropped areas, grass/range land, water bodies, and other categories of land use and land cover types (Wani et al. 2008; Wani and Garg 2009; Wang et al. 2016). Likewise, an ecosystem of a watershed can be expressed as a home to all the living creatures (plants, animals, and micro-organisms) that live in coexistence within a watershed through interacting with each other and with the physical environment of the watershed within and outside (Raju et al. 2008). Through the interaction between and among the living and the physical environment there exists a continuous cycling of nutrient, water, and energy flow within the watershed system (Brandes et al. 2005; Wani and Garg 2009).

3.2 Literature Review

Among the most cited water and watershed management frameworks are participatory integrated watershed management (PIWM) (FAO 1996); integrated water resources management (IWRM), and integrated river basin management (IRBM) (Karki et al. 2011).[1] PIWM is a participatory and multidisciplinary process and approach of conservation, development, and optimal utilization of the available natural resources in a watershed on a sustained basis. It is a people-centered approach as they are mobilized, trained, and empowered as the main decision makers and actors. IWRM is "a process that promotes the coordinated development and the management of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (UNESCO-IHP and NARBO 2011:3). "The river basin approach seeks to focus on implementing IWRM principles on the basis of better coordination amongst operating and water management entities within a river basin, with a focus on allocating and delivering reliable water-dependent services in an equitable manner. Both are holistic approaches that seek to integrate the management of the physical environment within that of the broader socioeconomic and political framework." Different management interventions for the restoration of the BRB have been identified by past studies (GoN/NTNC 2009). As the issues are complex and stakeholders are multiple, improvement of the watershed is

[1]See Mountain Development; http://www.bioone.org/doi/pdf/10.1659/MRD-JOURNAL-D-11-00017.1).

challenging. The Bagmati Action Plan (BAP) has recommended a strategic and systematic approach. In this chapter, we present a multi-stakeholder, multi-sectoral, multi-scale, and multidisciplinary approach linking local action to national policies and regulations. Participatory integrated watershed management (PIWM) approach (FAO 1996; ICIMOD 2011) meets these criteria. The approach involves multiple stakeholders in decision-making processes to provide the team (a) opportunities to share views, needs, and knowledge; (b) build consensus on shared values and aspirations; (c) enable local community to influence project agenda and results; and (d) build commitment and a feeling of ownership to enhance and ensure project implementation. Different options presented in our approach based on sustainable land and water management (SLWM) principles will have a high degree of participation at local community and government levels that will help to ensure relevance of activities with good outcomes for strengthening sustainability of the work.

Integrated watershed management (IWM) is the inclusive management of all the components of natural resources within a watershed such as snow and ice, soil, land, minerals, agriculture, water, plants, animals, and micro-organisms that exist within a particular watershed (Wani et al. 2006). In other words, integrated management of a watershed is the complete management of physical, hydrological, and biophysical resources of a watershed. Besides these natural capitals, the human capital also exists in the watershed and their social, economic, and cultural norms, values, and practices are equally important to consider in an integrated approach to watershed management. Further, there exist constant interactions between and among the physical, hydrological, biophysical, and socioeconomic capitals within the watershed, which need to be considered carefully to get sustainable benefits from the ecosystem-based IWM. Therefore, the ecosystem-based IWM is based on the principle that requires the holistic management of both ecological and sociocultural systems for creating harmony between human and nature.

3.3 Ecosystem-Based Watershed Management Approach

Ecosystem is defined as a community of plants, animals, and smaller organisms that live, feed, reproduce, and interact in the same area or environment (Barrow et al. 2012). Ecosystems have no fixed boundaries. It can be a single lake, a watershed, or an entire region. An ecosystem consists of a dynamic and complex system of plant, animal, and micro-organism or biotic and abiotic components. Examples of ecosystems are agro-ecosystem, aquatic ecosystem, marine ecosystem including coral reef sub-system, desert ecosystem, forest ecosystem, human ecosystem, coastal ecosystem, ocean ecosystem, etc. Grass or range land ecosystem includes steppe, prairies, rainforest, savanna, pampas, taiga, and tundra and built or modified ecosystem includes urban and peri-urban ecosystems. According to Khan Academy, the major points to remember to better understand what ecosystems are (a) an ecosystem consists of a community of organisms together with their physical environment; (b) Ecosystems can be of different sizes and shapes (e.g., marine, aquatic, or

terrestrial); and c) broad categories of terrestrial ecosystems are called biomes (Khan Academy 2020).

Ecosystems with higher biodiversity tend to be more stable with greater resistance and resilience in the face of disturbances and disruptive events, and this is called ecosystem stability. In an ecosystem, the biotic components interact with each other and with the abiotic environments in which they live for nutrient uptake, nutrient cycling, and energy flow for the growth, abundance, and survival of the organisms, which is termed as a functional unit of an ecosystem. Similarly, the structural units of an ecosystem consist of biotic (producers, consumers, decomposers) and abiotic components. In an ecosystem, any change in these structural units (change either in biotic or abiotic units) impacts the functions of the ecosystem, i.e., change in nutrient uptake, nutrient cycling, and energy flow for the growth, abundance, and survival of the organisms that takes place constantly. These principles apply in any terrestrial and aquatic ecosystems of a watershed. Therefore, watershed is an ecosystem with distinct features of water flow through gravitational drainage networks, groundwater recharging, potential for high alteration of geographical features, and upstream-downstream relationships between and among different ecosystem components. Watershed ecosystem has an added feature that it produces vital ecosystem services especially water, food, and energy (provisional services); hydrological, biodiversity, and water purification (regulating services); and different cultures, heritages, languages, and practices (cultural services).

Watersheds are managed for the above ecosystem services based on ecosystem-based management approaches. According to Wikipedia, "Ecosystem-based management is an environmental management approach that recognizes the full array of interactions within an ecosystem, including humans, rather than considering single issues, species, or ecosystem services in isolation" (Christensen et al. 1996).

Therefore, an ecosystem-based approach or ecosystem approach to watershed management (EAWM) can be defined as an applied science and art of implementing integrated ways of management of all biotic and abiotic components that exist within the watershed in order to maintain the ecological integrity and to reach a balance between conservation, utilization, and equitable sharing of benefits obtained from the integrated management of natural resources of all watersheds (Yaffee 1999; Grumbine 1994).

An ecosystem approach to watershed management (EAWM) is not a formula or a panacea to solve all human-ecological problems, but a strategic framework that can be adapted to suit various issues and their solutions while managing the watershed in an integrated manner. In an ecosystem approach to watershed management, a strong link between biophysical functions of watershed and human well-being is promoted, which is very crucial for the survival of all living organisms that occur in an ecosystem of the watershed. Therefore, in an ecosystem approach to watershed management, we need to take into account that humans, their social and cultural diversity, biophysical and physical units are the integral elements of an ecosystem and should be taken into consideration while managing the watershed through ecosystem approach.

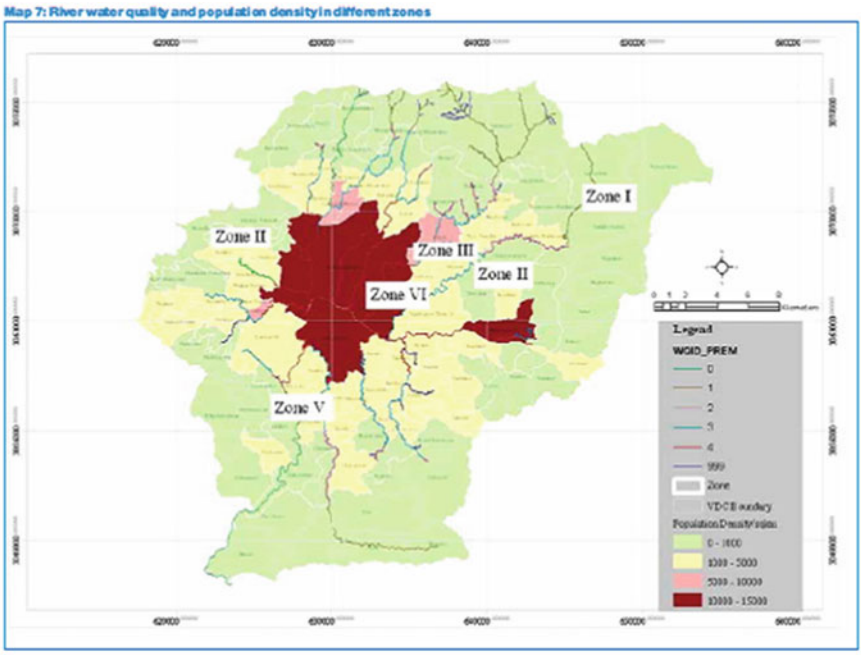
3.4 Importance of Ecosystem Approach to Watershed Management

The importance of EAWM to watershed management can be best illustrated through the following example. Let us assume that a conversion of forest ecosystem into agriculture ecosystem is taking place in a process of enhancing enough food to reduce poverty of inhabitants of watershed. In a process of converting forest ecosystem into an agricultural ecosystem, some physical changes occur within the watershed. These physical changes are biodiversity and land cover changes within the watershed that lead to excessive runoff and low infiltration, thereby causing disruption in energy flow/nutrient cycling and nutrient leaching that take place within the altered ecosystem. Such changes within the system lead to ecological response within the watershed. The result of ecological response is biological displacement due to stress and disruption in existing biological communities. Finally, the ecological response leads to the weakening of the quality of life of the people due to erosion, flooding, air and water pollution, land degradation, and loss of productivity of land. Poor quality of life of inhabitants of watershed occurs, which further leads to foster more destruction and change in ecosystem searching for better quality of life.

3.4.1 A Case Study: Shivapuri Nagarjun National Park (SNNP) Watershed, Nepal

3.4.1.1 Brief Description of the SNNP Watershed

The Shivapuri Nagarjun National Park (SNNP) is the only national park located in the Middle Hills or lower Himalayan ecological region of Nepal. Two unique features of this park are (a) indigenous and local communities live within the park along the upstream slopes of the Bagmati River that originates from the uppermost watershed point located within the core area of the park and (b) it is the only national park representing the middle hills region of Nepal. Four major settlements Mulkharka, Chilaune, Kunegaon, and Okhreni inhabit close to 400 households and 1500 people.



The indigenous and local communities whose traditional farming and forest products gathering practices have been affected by the declaration of the national park are caught in the vicious cycle of environment conservation, poverty, and habitat destruction since very beginning. The primarily farming people communities are practicing their livelihood activities under a protected area (PA) regime of restricted use of their traditional forest-based resources especially fire wood, fodder and food collection, cultivation of agricultural crops, and use of river and spring water in order to provide good habitat for wild animals and plants.

Shivapuri Nagarjun National Park (SNNP) is the Ninth National Park established in 2002. It was initially established as a protected watershed and wildlife reserve in 1976. It is located in the country's mid-hills on the northern fringe of the Kathmandu Valley and at an altitude between 1350 m and 2732 m. It covers an area of 159 km^2 including parts of Kathmandu, Nuwakot, Dhading, and Sindhupalchowk districts with 23 Village Development Committees (Fig. 3.1). Climatically, the park is located in a transition zone between subtropical and temperate climate. The annual average precipitation is around 1400 mm that occurs mostly from May to September. Temperatures vary from 2 to 17 °C during winter, which rises to 19 to 30 °C during summer. The SNNP watershed has always been an important water catchment area and prime source of drinking water supplying several hundred thousand cubic liters of water daily to the Kathmandu Valley. More than nine tributaries of the main river Bagmati and other small rivulets and streams discharge about 30 million liters of water per day. SNNP is an excellent representative site of the ecosystems of middle hills of Nepal as it is located midway between Eastern and Central Himalaya. It is rich in biodiversity having some of the nationally and globally threatened wild

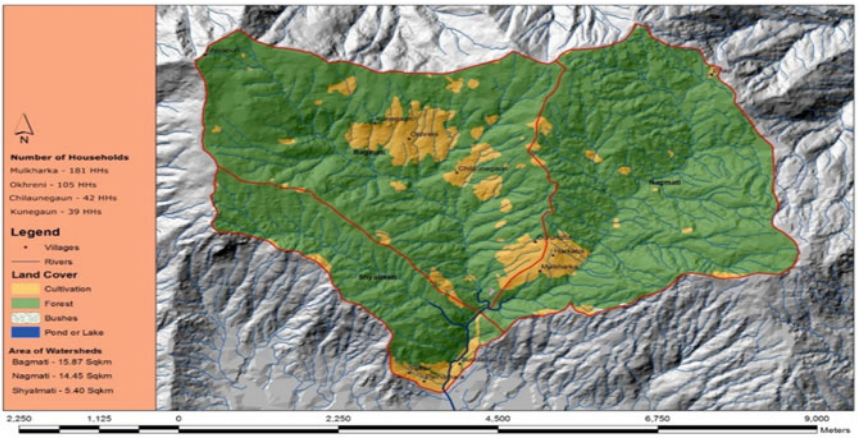


Fig. 3.1 Upstream watershed of Bagmati River focusing the 4 settlements: Mulkharka, Chilaune, Okhreni, and Kunegaon (Source: NGO Package 1—Watershed Management. Project Document, 2016

animals, birds, and butterflies. It has subtropical to lower temperate forests and associated vegetation. It is a good site for research and study in forestry, park management, ecosystem management, socio-ecological interactions, and cultural values of biodiversity especially water as well as hiking, trekking, panoramic views of Himalayan mountain peaks along with meditation, bird watching, and long-term ecological studies. The SNNP is highly important for its cultural and religious heritage—most important of all being the origin of River Bagmati from Baghdwar or Mouth of a Tiger. The River fed by more than five main sub-rivers meanders through the city of Kathmandu with several shrines and temples located along its bank throughout its course in the valley. The people of the Kathmandu valley with its close to three million populations around the park follow Hindu and Buddhist culture. Some important places for cultural and religious importance in the park are Nagi Gumba, Bagdwar, Bishnudwar, Jamacho, Manichur Mahadev, Kageshwori, Sundarimai, Baudeshwor, Tarkeshow, Pachali Bhairav, Mahadevasthan, Shivapuri Peak, and Sundarijal. These are the important pilgrimage destinations for Hindus and Buddhists.

Shivapuri National Park is easily accessible from Kathmandu city, so it attracts many visitors and tourists for hiking, camping, picnic as well as enjoying adventure tourism activities like rock climbing, mountain biking, and some sports events. There are many popular trekking routes within the park. Trekking routes to Gosaikunda, Helambu, Nagarkot, and Langtang National Park pass through this park. Impressive view of the high Himalayan peak towards the North; Nagarkot hills towards the East; Nagarjun hills towards the West; and Kathmandu valley, Phulchowki and Chandragiri hills towards the South can be seen from the Shivapuri Peak (Source: Shivapuri Management Plan; FAO 1996).

Description of the Upper Bagmati Watershed.

The Bagmati River is the main river of the Bagmati basin. The River originates from Baghdwar, which is located in SNNP in 15 km northeast of Kathmandu. The Bagmati River flows through the Kathmandu Valley crisscrossing a number of important religious and cultural sites including Pashupatinath and Gokarneswor temples. Most of the important temples, traditional monuments, ghats, stupas, and shrines are located along the river banks and are used for different cultural and ritual purposes. The Bagmati River is fed by natural springs and monsoon rainfall. The average annual rainfall in the catchment is about 1900 mm, of which about 80% occurs during monsoon (June–September). The Bagmati basin is characterized as medium or dry basin fed by springs and monsoon rainfall (WECS 2008).

SNNP has several watersheds of different sizes ranging from the micro- to sub-watersheds. Nagmati, Bagmati Nadi, and Shyalmati rivers are the main upstream sub-watersheds of main Bagmati River. Bagmati River Basin Improvement Project (BRBIP 2016) had recently contracted the Joint venture of The Centre for Green Economy Development, Nepal (CGED, Nepal), and Integrated Development Society, Nepal (IDS-N), to implement the project titled "NGO Package 1—Watershed Management" in Shivapuri Nagarjun National Park (SNNP). The project had selected upstream watershed of Bagmati River (Bagmati Nadi) within SNNP as a planning and working unit to focus and demonstrate ecosystem-based IWM. Several programs were implemented with due consideration of ecosystem-based IWM.

3.5 Ecosystem Services Provided by the Watershed

Any watershed or sub-watershed or micro-watershed contains several ecosystems. The ecosystems could be forest, grassland (rangeland), shrubland, desert, agriculture, and aquatic ecosystems. The ecosystems of watershed provide direct and indirect benefits in terms of services and goods to the people living both in upstream and downstream of the watershed. The upstream watershed of Bagmati River has forest, agriculture, shrubland/grassland, and aquatic ecosystems. The ecosystems have provided all the four ecosystem services like Provisioning, Regulating, Cultural, and Supporting/Habitat services to the people living in the core area of upstream watershed and the buffer zone of national park (downstream and periphery of watershed).

Among the provisioning services, the most important services are the water, food, and fuel energy. Among the regulating services, hydrological services including weather regulations, reduction of runoff/peak-flow and sedimentation through natural buffering capacity, moderating climate, reduction of water and air pollution, controlling of soil erosion/landslides, and maintaining ground-water recharge are the important services. Similarly, the supporting services include support to wildlife habitat, maintaining ecological integrity, facilitating hydrological cycle, and ensuring ecosystem functioning, and support for soil formation and nutrient cycling. Under cultural services the ecosystem provides recreation, education, aesthetics,

adventure, and spiritual services including the enhancement of cultural heritage of people living in the watershed.

The specific ecosystem services provided by SNNP are described as follows:

3.5.1 Provisioning Services (MA 2005)

This include the material products obtained from upstream watershed ecosystems, including food, fiber, fuelwood, timber, grass, fresh water and air, genetic resources, crop, fruit, and livestock productions. There is also legal and illegal hunting of wild animals that provides meat, medicinal plants, and minerals. Equally important is regulating service chief among which are hydrological and river discharge services besides terrestrial and aquatic biodiversity and air, water, and land pollution reduction services. The supporting services include habitat maintenance service (MA 2005).

Management Strategy: The management strategy adapted by the local communities focused on plantation of forest and fodder trees, fruit trees, and grasses, as well as organic farming. As trees and plants grow, they help remove more CO_2 from the atmosphere through photosynthesis and effectively lock it away in their tissues, thus acting as carbon sink or carbon stores. Also, they help provide basic needs of the local people like timber, fuelwood, grass, fruits and nuts, NTFPs, and fresh air and water. Vegetation management and organic farming have increased the soil fertility of the agriculture land and forest floor to supply nutrients to plants communities and increased forest cover also filter and act as watershed improvement treatment.

- Trainings on quality drinking water, water storage, purification of water, ensuring water flow through manipulation of vegetation and trees, organic farming, waste disposal, and clean energy were provided to the local people. Solid waste management activities have been carried out by the local people, which have reduced the pollution level of soil, water, and air inside the upstream watershed.
- Plantation and maintaining the trees and vegetation in the upstream watershed have regulated the pests and vector-borne diseases that attack plants, animals, and people.

3.5.2 Regulating Services

This includes water purification, climate regulation, flood control and mitigation, soil retention and landslide prevention, pollination, and pest and disease control.

Management Strategy: The management strategies focused was: (a) construction of bioengineering-based erosion and landslide prevention, (b) slope failure prevention structures, and (c) trainings on IPM-based organic farming. Biophysical Hazard

reduction through these has enhanced the safety of the upstream watershed dwellers from the natural disasters and climate change impacts.

3.5.3 Cultural Services

They are the nonmaterial benefits from ecosystems including recreation, aesthetic experience, spiritual enrichment, and cognitive development, as well as their roles in supporting knowledge systems, social relations, and aesthetic values.

Management Strategy: For this, the management objectives of ecosystem-based IWM were primarily focused on providing training on developing ecotourism through developing ecosystem and biodiversity to attract local and international tourists, thereby increasing the local economics of the people living in the upstream of the watershed.

3.5.4 Habitat Services

Habitat services are those that are necessary for the production of all other ecosystem services including provisioning of habitat for species, primary production, nutrient cycling, and maintenance of genetic pools and evolutionary processes.

3.6 Key EAWM Strategies Adopted

A participatory and integrated ecosystem-based watershed management (EAWM) strategic framework was developed for implementing an adaptive management of the SNNP watershed. The aim was to apply EAWM tools to deal with the complex and dynamic nature of the PA ecosystems inside the watershed and to enhance the knowledge and capability of the park and community leaders to understand both the functions and structure of the socio-ecological production ecosystem (SEPE) within the watershed. This is a strategy for the integrated management of land, water, and living organisms of all kinds—plants, animals, fungi, different pollinators, and micro-organisms that can help promote conservation and sustainable use of natural resources within a watershed in an equitable manner. Thus, the application of an EAWM aimed to help to create a balance among the conservation, sustainable use, and the fair and equitable sharing of the benefits available from the use and management of natural resources of the watershed. The aim was also to improve the degraded habitat and reduce the wildlife damage of crops and properties of the buffer zone community. The approach applied used locally tailored scientific methodologies informed by indigenous and local knowledge and practices focused on the levels of socio-ecological organizations of different components, which encompass

the essential structure, processes, functions, and interactions among organisms and their environment (Handbook of the UN Convention on Biological Diversity, second edition, 2003).

Recognizing the vague and complex definitions of watershed and ecosystem, the simplest strategies as stipulated by CBD were adopted while managing the ecosystem based on integrated and participatory management of upstream watershed ecosystem services establishing clear links with the local and downstream users and beneficiaries. The social, cultural, and economic values, benefits, and priorities of watershed communities were clearly identified and livelihood improvement and watershed rehabilitation programs implemented. Designing and working on assisted watershed capital improvement and community management principles to alleviate the vulnerability and poverty of local inhabitants, the first stress was to set priority and develop collective actions to sustainably utilize the essential ecosystem services from the IWM point of view.

Boundary of working unit for such an integrated watershed ecosystem management has to be landscape or catchment that has forest, shrubs, agriculture, and wetlands as land use units. These units are clearly defined in consultation with local people and park authorities within the upstream watershed of Bagmati River. The communities living in upstream watershed of this park landscape were made aware, sensitized to be inclusive in all their actions, and trained to maintain and upgrade the terrestrial and aquatic ecosystems especially agricultural ecosystem of the watershed and to enhance the ecosystems ability to respond to a variety of internal and external stressors and pressures. Changing hydrological regime of the watershed was also studied and considered while designing and implementing intervention programs in the watershed. Scientific information and proven technologies of watershed management were introduced, which were easily adaptable to local conditions and adopted by the inhabitants. These tailored technologies ensured the watershed management interventions were close to the ecosystem integrity that yields social, economic, and cultural benefits.

3.7 Inclusive Approaches

Selection of all activities and management decisions were done based on the principle and good practices of Gender Equality and Social Inclusion (GESI) and empowerment. The approach gave priority to the upstream watershed inhabitants in order to build up natural capital by enhancing social and human capital as well as living quality of local people who were trained as the frontline watershed managers and workers. Indigenous and local skill and knowledge of the inhabitants on ecosystem approaches to watershed management was improved by providing appropriate trainings on ecosystem and IWM. Active and meaningful participation and involvement of upstream watershed inhabitants and stakeholders were pursued while implementing the ecosystem-based watershed management activities.

3.8 Implementation of Ecosystem-Based Integrated Watershed Management Programs

Several ecosystems-based IWM programs have been implemented in the upstream watershed of Bagmati River in SNNP. This is the only ecosystem-based IWM program that has been implemented in the upstream watershed particularly focusing the protected area of the mid-mountain ecological zone. The programs were implemented in the upstream watershed of Bagmati River focusing the four settlements (Mulkharka, Chilaune, Okhreni, and Kunegaon), which are situated in the core area of SNNP. These four settlements were declared as buffer Zone and the project's target group was 367 Households/BZ user groups of the four settlements (Fig. 3.1).

Key ecosystem-based IWM interventions for providing ecosystem and watershed management benefits to the targeted BZ users groups were detailed in the following sections.

3.8.1 Promotion of Green Environment through Mobilization of Local Participation

In this program, efforts were made by the local farmers to minimize erosion from outward sloping agriculture land by planting grass, fodder and fruit trees in the private farmland. About 7748 planting materials have been distributed to the 1045 local farmers freely (Figs. 3.2 and 3.3). The farmers were given adequate trainings on plantation, maintenance, and care of the plants they had planted in their farmland. Almost 367 HHs had planted 6758 seedlings of several winter and summer fruit plants, fodder trees, and grass saplings covering almost 12.5 ha of sloping agriculture land. These programs have raised the awareness of the households in the promotion and maintenance of forest ecosystem and green environment in their settlements. The planted saplings of forest tress, fodder and fruit trees, and grass

Fig. 3.2 Planted Alnus nepalensis and natural regeneration of grass

Fig. 3.3 Napier grass planted by farmers

seedlings have started bearing fruits and forage to the livestock, which have reduced the farmer's dependency on natural forest of national park.

3.8.2 Enhancing Farmer's Capacity on Ecosystem-Based Integrated Watershed Management

Sustainable ecosystem-based IWM requires effective and extensive participation of local people. For their effective and sustained participation, the local people should have adequate knowledge and capacity for ecosystem-based IWM. The NGO Package 1—Watershed Management project had launched several demonstration and hand-on trainings on ecosystem and IWM to the BZUGs of the four settlements of SNNP and park authority.

Some of the key capacity enhancement programs provided to the BZUGs were:

- Training programme on understanding of ecosystem and IWM, construction and demonstration of bioengineering-based check dam and erosion control activities, environmentally sustainable improved cookstoves, plantations techniques of trees, shrubs, and grass, and so on.
- Trainings and awareness program on the integrated watershed and ecosystem to educate the households of the project area regarding the consequences of ecosystem and watershed degradation and benefits of well-managed ecosystem and integrated watershed, and how to minimize the conflicts between park management and community people were provided.
- Trainings to the farmers and households of the four settlements in organic farming, tunnel farming, and ecotourisms.
- For demonstration, about 150 households were supported to adopt organic farming practices by distributing organic seeds and conducted field visit to 30 farmers on organic farming and Integrated Pest Management (IPM).
- Trainings and demonstrations to at least 250 households in the use of more efficient stoves.
- Training and demonstration were conducted to 100 households of the four settlements in adopting eco-friendly household toilets, solar energy, and solid waste management systems.

Fig. 3.4 Farmers participating in various capacity enhancement trainings and demonstrations

- Among the trainees, socially excluded and women groups were given high priority in almost all training and demonstration programs (Fig. 3.4).

3.8.3 Participatory Stakeholder Interactions

There existed an excellent collaboration between and among the multiple stakeholders in the Project. The park staff, the project team, the Buffer Zone User Groups and Committees (BZUGs and BZUCs) were constantly engaged. This built the strong foundation for co-producing a long-term and sustainable upper Bagmati watershed management strategy and action plan. Increased awareness among settlers and leadership of BZUGs and strengthened capacity of BGUC chair helped create a long-term community-based ecosystem-based livelihood and income generating activities for the people. This incentivized the BZUGs to implement the watershed management plan jointly prepared by the project. The farmers are also trained to engage in participatory monitoring and joint planning, peer learning through visiting neighbors' farms, and conducting joint workshops, training, and exposure visits along with park staff. These multidimensional stakeholder engagement efforts created an enabling environment to work in a co-operative and collaborative manner

to make the ecosystem-based watershed management a truly integrated and participatory process.

3.8.4 *Environment and People-Centered Conservation Measures for Maintaining Land Productivity*

This is an important ecosystem-based IWM intervention, in which on-farm conservation practices through applying sustainable and environment friendly cultivation using local resources and traditional knowledge and practices have been used.

On-farm conservation involves management of the farm resource to conserve soil and water and improve production through various measures. The activities conducted by NGO—Pkg 1 Watershed Management Project in Shivapuri Nagarjun National Park (SNNP) included package program of vegetative, structural measures and land surface treatment activities applied in the farmland, which included planting of trees, herbs, or grass on marginal lands or unused lands in between and/or within farmlands, planting grass, fodder and fruit trees and leguminous shrubs on the terrace risers and slopes mainly to reduce erosion, and increase productivity of the outward sloping farmland. Vegetable seeds, grass seeds and saplings, fruit tree seedlings, and bamboos rhizomes were distributed to the farmers for the participatory planting in their own farmlands and degraded land in the vicinities of their settlement (Figs. 3.2 and 3.3).

3.8.5 *Degraded Land Rehabilitation*

Degraded land rehabilitation was another important ecosystem-based IWM intervention carried out in the upstream watershed of Bagmati River. The activity was implemented through using local resources, traditional knowledge and practices, which have protected the value of the biophysical environment and the ecosystem of the upstream watershed by minimizing the human induced stresses on the existing watershed resources. Also, the activity attempted to bring the deteriorated land back to its original position through conserving and improving soil condition and introducing new flora on the land.

Generally, the activities included tree, shrub, and grass planting with necessary conservation techniques and micro-gully plugging through bioengineering-focused engineering structures. Two gabion wire check dams were constructed at two gullies and bioengineering valued trees, shrubs, and grass were planted at the slopes of the gullies (Fig. 3.5). These two structures have protected tons of soil from being eroded from their micro-catchments, and the deteriorated lands are almost back to their original position.

Fig. 3.5 Construction of bioengineering-based gabion wire check dams to control gully erosion

3.9 Conclusion and Lessons Learned

Shivapuri Nagarjun National Park (SNNP) consists of various watersheds of different sizes ranging from micro-watershed to big watersheds like Bagmati River watershed. Irrespective of the size of watershed, all watersheds are built up with various ecosystems like terrestrial and aquatic ecosystems. Within a watershed there exists a strong relationship between terrestrial and aquatic ecosystems. Any perturbation in the terrestrial ecosystem impacts the life of the organisms living in the aquatic ecosystem. Similarly, in any watershed there exist a strong relationship between upstream and downstream of the watershed. Any destruction in the ecosystem of upstream watershed results in immense impacts in the ecological services available in downstream. Based on the unique relationship between watershed and the users of its ecosystem services, the ecosystem based approach of IWM is considered one of the best strategies for enhancing the sustainability of the watershed management, which, in turn can provide other ecological benefits like fresh air, clean water, regulation of hydrological flows and adaptation to the climate impact, support for soil formation and nutrient cycling, enhancement of cultural, educational, aesthetic, and spiritual services for the survival of all the organisms including the human being inhabiting the watershed.

A number of lessons were learned and some were built in the subsequent activity planning and implementation. The important lessons are:

1. Winning the trust of the people and creating an environment of mutual respect and appreciation between the project staff and the project staff helped the team to achieve the full engagement of farmers and stakeholders in the project activities.
2. Quality of the engagement: We learnt early on that participation not representation has to be ensured for a quality and outcome-oriented engagement that was achieved by launching series of awareness raising sessions that made the BZUGs aware of the value of collective actions wherein the community's collective efforts were shown to be much more than the sum of the individual actions.

3. There is always an issue of prioritization between conservation and sustainable livelihoods—which comes first. Our lesson is clear. The way to sustainable conservation, for that matter harmony between human and nature, starts from sustainable livelihoods. We therefore put a lot of emphasis on organic farming, commercial fruit and vegetable farming, and ecotourism promotion before asking farmers to plant trees and stop felling green trees for cooking and heating.
4. Domestic liquor making and selling in the informal market is a serious and a complex issue which needs an out-of-box solution: providing them with attractive livelihood options through some "smart incentives" such as secure job for one family member of the household whose food security or livelihoods depend on liquor making and selling.
5. Project period matters in environmental projects—Three (3) year period for watershed improvement and management through plantations and livelihood improvement is too short to achieve outcomes and show real impact as the poor and deprived households need to first realize the improvement in their livelihoods (e.g., income rise in real terms) and then only they can be convinced to stop cutting green trees and support conservation measures.

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