IWMI Working Paper 170

An Assessment of Integrated Watershed Management in Ethiopia

Gebrehaweria Gebregziabher, Dereje Assefa Abera, Girmay Gebresamuel, Meredith Giordano and Simon Langan

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Project

The AgWater Solutions Project was implemented in several countries in Africa and Asia between 2009 and 2012. The objective of the project was to identify investment options and opportunities in agricultural water management with the greatest potential to improve incomes and food security for poor farmers, and to develop tools and recommendations for stakeholders in the sector, including policymakers, investors, nongovernmental organizations (NGOs) and smallholder farmers.

The leading implementing institutions were the International Water Management Institute (IWMI), the Food and Agriculture Organization of the United Nations (FAO), iDE, the International Food Policy Research Institute (IFPRI) and the Stockholm Environment Institute (SEI).

For more information on the project or for detailed reports, please visit the project website (http://awm-solutions.iwmi.org/home-page.aspx) or contact the AgWater Solutions Project Secretariat (AWMSolutions@cgiar.org).

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Contents

Summary

In Ethiopia, watershed management programs commenced in a formal way in the 1970s. From that time up to the late 1990s, implementation was typically a government-led, top-down, incentive-based (food-for-work) approach that prioritized engineering measures. During this phase, the programs focused primarily on reducing soil erosion. In the early 2000s, community-based integrated watershed development was introduced to promote watershed management as a means to achieve broader integrated natural resource management and livelihood improvement objectives within prevailing agro-ecological and socioeconomic environments.

Through an analysis of six watershed programs in three regions (Oromia, Amhara and Tigray), we review this latter phase of watershed management in Ethiopia to understand the extent to which the related interventions have supported improved productivity, and environmental and smallholder livelihood outcomes. Across the six watersheds, the results suggest that watershed management has had a positive impact on natural resource conservation, crop-livestock production and productivity, socioeconomic conditions and livelihoods. The data indicate that watershed management has improved farm incomes and food security by an average of 50% and 56%, respectively. Also, in some watersheds, the risk of crop failure due to moisture stress and climate shocks has reduced by up to 30%. However, the nature and scale of the impact varies significantly across the six watersheds. For example, vegetation restoration and land cover has improved by an average of 40% in the three poorly performing (less successful) watersheds, and by about 85% in the three other well-performing (successful) watersheds.

Moreover, the factors that contribute to the success of watershed management are multidimensional, including biophysical, institutional and socioeconomic elements, and watersheds with permeable lithology (e.g., sandstone or alluvial deposits) and a concave shape show good upstream-downstream hydrological linkages, while the opposite is true in areas dominated by limestone lithology. Other factors that were found to significantly influence the 'success' of watershed management include the presence of supporting institutional structures and the extent of community participation.

Several challenges were also identified that threaten the success of watershed management. These include the lack of technical advice and information to support the selection of interventions suitable for the local context; uncoordinated interventions, institutions and actors within a watershed; and, importantly, the uneven distribution of the water management costs and benefits. To address these challenges and support the scaling up of best practices, this study recommends (i) linking physical and biological conservation activities with income-generating and livelihood improvement activities; (ii) tailoring technologies and implementation approaches to prevailing agro-climatic, biophysical and socioeconomic conditions; (iii) co-managing surface and subsurface water resources to improve water productivity; (iv) strengthening institutional mechanisms to foster partnership among stakeholders, and ensure the fair and equitable sharing of costs and benefits; (v) supporting community participation with adequate technical and financial support; (vi) improving access to markets; and (vii) developing guidelines for the collection of baseline data, and monitoring and evaluation of water management interventions.

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INTRODUCTION

Agriculture is the main sector of the Ethiopian economy and contributes approximately 42% to the gross domestic product (GDP) and employs over 80% of the population (MoFED 2010; Diao 2010; ATA 2013). Despite its role, agricultural production is constrained by high climate variability where rainfall distribution is extremely uneven both spatially and temporally, and this has negative implications for the livelihoods of people (Georgis et al. 2010). Drought frequently results in crop failure, while high rainfall intensities result in low infiltration and high runoff causing enhanced soil erosion and land degradation. Land degradation in the form of soil erosion and declining land fertility is a serious challenge to agricultural productivity and economic growth (Lemenih 2004). Studies indicate that the Ethiopian Highlands have experienced high rates of soil erosion and deforestation, resulting in sediment accumulation in downstream reservoirs and rivers (Krüger et al. 1996; Haregeweyn et al. 2005; Lulseged 2005). High population and livestock density, along with rugged topography and erratic rainfall, exacerbate land degradation.

In general, watershed degradation resulted in long-term reduction in the quantity and quality of water and land resources, which negatively impact on the livelihoods of the rural poor who rely on these resources for their subsistence and livelihoods. This spurred the Ethiopian government to launch an extensive soil and water conservation (SWC) program, which began in the early 1970s. In response to the famine in the northern part of the country during the period 1973-1974, for example, the World Food Programme (WFP) supported the Food for Work (FFW) project, which was launched in 1974 initially as an emergency relief initiative. This project later evolved into a development program known as 'Managing Environmental Resources to Enable Transitions' (MERET), linking short-term food assistance with long-term development opportunities and sustainable livelihoods.

Most of the SWC activities between the 1970s and 1990s were tailored towards reducing soil erosion rather than enhancing agricultural production. These activities lack integration between farm and non-farm measures, and were neither effective nor sustainable (Bishaw 2001; Eyasu 2002; Bekele 2003). The intervention was more of a top-down approach with limited participation of beneficiaries. Despite this, the SWC activities had a positive impact on reducing soil erosion and increased land productivity. At the same time, the program has been criticized for prioritizing mechanical measures while ignoring other sustainable land management components, such as conservation land management practices, improved land-use systems and livestock management (Osman and Sauerborn 2001). Since the end of the 1990s, therefore, the SWC activities of the project were developed into a participatory integrated watershed management approach (German et al. 2007) to promote sustainable water and land resources management based on partnerships with the community. Past and present perspectives of watershed management approaches are summarized in Annex 1, Table A1. The participatory, integrated watershed management approach emphasizes improving the productivity of water and land resources in an ecologically and institutionally sustainable way (Farrington et al. 1999). Hence, watershed management has become a central point of the rural development and poverty alleviation agenda. According to the participatory watershed management guidelines (L. Desta et al. 2005), the objective of watershed management is to improve the livelihoods of rural communities and households through (i) SWC for productive uses; (ii) rainwater harvesting for improved groundwater recharge; (iii) promoting sustainable farming systems and agricultural productivity adopting suitable soil, water, nutrient and crop management practices; (iv) rehabilitating and reclaiming marginal lands through appropriate conservation measures, such as planting of trees, shrubs and grasses depending on existing potential; and (v) enhancing the income of smallholders by diversifying agricultural practices and income-generating activities (IGAs). In general, watershed management creates opportunities for reclaiming degraded land, improving soil fertility, water resources development, increasing agricultural production, off-farm activities, diversifying income sources and providing access to markets, where the benefits are realized at household and community level.

OBJECTIVES

In line with its policy objective, the Government of Ethiopia has implemented watershed management activities in different regions and *woredas*[1]. However, the success rate varies in both space and time due to diverse social and biophysical settings, implying that watershed management programs need careful analysis of the social and environmental dynamics to successfully address livelihood and conservation concerns. In this regard, it is important to understand how the watershed management program functions and its governance. The objective of this study was, therefore, to understand how watershed management contributes to livelihood improvement of smallholders and the factors that contribute to the success of watershed management. Specific objectives of the study include: (i) validating the upstream and downstream linkages of watershed management, and its implication for agricultural water management; (ii) comparing past and present watershed management activities, and understanding the differences in the rate of success; (iii) examining the factors that influence watershed management programs, either negatively or positively; and (iv) drawing lessons and providing recommendations for up-scaling successful practices.

DATA AND METHODOLOGY

Data used for this study were collected from six watersheds in three regions of Ethiopia. A multistage sampling procedure was used to select study sites and sample farm households. In the first stage of the sample selection process, Oromia, Amhara and Tigray regions were purposively selected due to the relatively higher watershed management interventions being implemented in comparison to other regions. In the second stage, two watersheds were selected from each of the three regions using specific criteria, including years (age) since the watershed management intervention started, access to markets, elevation, population, average rainfall, agroecology, landscape and success rate of the watershed. Success rate was evaluated based on evidence related to rehabilitated natural resources of the area; availability of food, fodder and fuel; income-generating interventions (such as beehives); increased groundwater potential and stream recharge; improved vegetative cover; and reduced soil erosion and flooding.

Discussions with implementing agencies (i.e., regional bureaus of agriculture, MERET project coordinators in each region, Ministry of Agriculture [MoA], *woreda* office of agriculture and extension agents, and the community) helped to capture the background information needed to classify successful and less successful watersheds. Within this framework, two *woredas* each from Tigray and Oromia, and one from Amhara were selected (Figure 1), and two watersheds (one successful and one less successful) were selected from each of the selected *woredas* (Table 1).

An effort was made to maintain uniformity in agro-climatic and environmental setting of the selected sample watersheds in each region. All the sample watersheds are located on the eastern part of the respective regions where moisture shortage is a limiting factor and watershed degradation is high, often considered as poor land productivity. In the third stage of the sample selection process, a group of youths, model and non-model farmers, and female and male farmers were randomly selected from a list obtained from the respective *kebele*[2] administration. For the key informant

[1] *Woreda* (equivalent to district) is an administrative unit next to a region in the Ethiopian government administrative structure.

[2] *Kebele* (equivalent to community) is the lowest administrative unit next to *woreda* in the Ethiopian government administrative structure.

interviews, knowledgeable and influential people were purposely selected in collaboration with the *kebele* administration and extension office.

The methodology used for this study was, therefore, both quantitative (sample household interviews) and qualitative. The assessment and data collection process involved a review of policy documents, literature and reports, and conducting field surveys. The World Overview of Conservation Approaches and Technologies (WOCAT) guidelines were used to evaluate the impact of watershed management on livelihoods and natural resources. Field surveys were carried out to collect primary data, and understand the physical and biological measures and their impacts. As part of the process, the team made a transect walk in the selected watersheds to observe the activities and impacts of watershed management, which included detailing the type of SWC interventions and their condition, vegetation cover on rehabilitated lands (both woody vegetation and herbaceous), grass cover on rehabilitated lands, availability of permanent water sources and erosion indicators. In addition to the transect walk, data analysis was undertaken to appraise the impacts of watershed management on improving the natural resource base, ecological rehabilitation and socioeconomic conditions.

Focus group discussions (FGDs) and key informant interviews complemented the field surveys to gather information about planning, site and beneficiary selection, implementation and monitoring process, impacts, and policies and strategies related to watershed management. Key topics covered during the key informant interviews and FGDs include administration procedures; inputs; community participation; feedback mechanisms; implementation of physical and biological conservation; water harvesting and soil erosion controls; relevance of the interventions; level of technical experts involved and their competency; integration of experts and the program; key actors, roles and coordination responsibilities; positive and negative impacts of the intervention; monitoring and evaluation (M&E) mechanisms; sustainability; and opinions about the role of the watershed as an agricultural water management solution. Government and nongovernmental actors involved in watershed management, project staff, community leaders and extension workers were among the focus group discussants.

RESULTS AND DISCUSSION

Watershed management has evolved from the incentive-based, FFW program in the 1970s to an integrated watershed management approach creating multidimensional opportunities. Benefits are realized at household and community level, but they are likely to differ across watersheds because outcomes usually depend on specific biophysical, institutional and socioeconomic factors. Table 2 provides a summary of the impacts of interventions in each of the watersheds reviewed in this study. In this section, we discuss some of the results based on the context of upstream-downstream hydrological and institutional linkages, production and economic benefits, and opportunities, challenges and practices to scale up the approach.

Comparing the two watersheds (successful and less successful) in each region, improvement in on- and off-site benefits is higher in Abraha-Atsbaha, Kereba and Goho-Cheri watersheds in Tigray, Oromia and Amhara regions, respectively. Similarly, enhanced biophysical conditions of the watersheds, hence, improvement in off-site benefits, including increased water availability, reduced downstream flooding and siltation, reduced water pollution and increased irrigation, is more visible in the relatively successful watersheds. Socioeconomic benefits, such as diversified income sources, increased recreational opportunities, strengthening of community institutions, better conflict mitigation capacity and improved food security status, emerge due to the successful watershed management interventions.

FIGURE 1. Map of Ethiopia and location of study *woredas*.

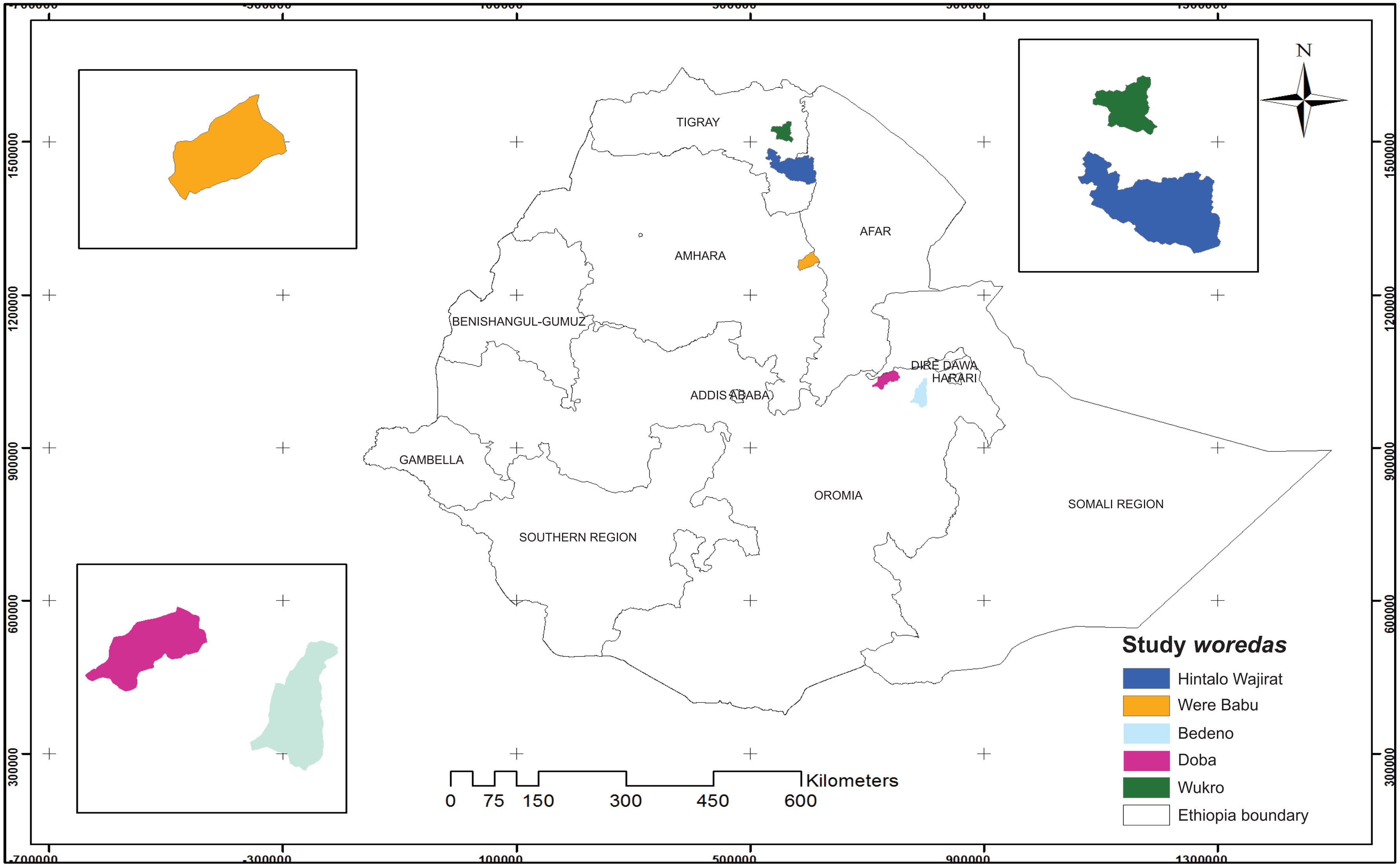


TABLE 1. Description of the sample watersheds.

Description	Tigray		Amhara		Oromia	
	Gerebshelela Watershed	Abraha-Atsbaha Watershed	Goho-Cheri Watershed	Bechyti watershed	Bedesa Kela watershed	Kereba watershed
Years since watershed management has been practiced	33	11	11	11	4	11
Elevation above sea level (meters)	2,095	1,975	2,081	2,300	1,859	2,353
Distance to nearest *woreda* market (km)	10	15	12	5	10	23
Distance to nearest zone market (km)	45	86	47	42	47	64
Distance to nearest big market (km)	10	15	12	5	10	19
Catchment area (ha)	1,500	6,667	693.5	758	475	753.5
Population	NA	4,845	1,552	5,285	1,714	5,225
Average annual rainfall (mm)	500-750	500-750	1,500-2,000	700-1,000	750-1,000	750-1,000
Agroecology	Semi-arid	Semi-arid	Sub-humid	Sub-humid	Sub-humid	Semi-arid
Landscape	Hilly slopes	Hilly and mountainous	Hilly and mountainous	Hilly and mountainous	Mountainous	Hilly and mountainous
Soil texture	Loam	Sandy	Loam	Clay and sandy	Clay and sand	Loam
Soil drainage	Medium	Medium	Good	Poor	Medium/poor	Medium/poor
Geology	Limestone	Sandstone	Basalt	Basalt and shell	Mixed	Basalt

Note: NA – Not available

TABLE 2. Summary of impact indicators and impact ratings for each watershed reviewed in this study.

Performance indicator variables	Tigray		Amhara		Oromia	
	Gerebshelela watershed	Abaha-Atsbaha watershed	Goho-Cheri watershed	Bechyti watershed	Bedesa Kela watershed	Kereba watershed
Service	**Impact on access to services**					
Health	Low	Moderate	Moderate	High	Moderate	Low
Education	Moderate	Moderate	High	High	Moderate	High
Extension and technical	High	High	Moderate	Moderate	Moderate	Moderate
Employment (off farm)	Low	Moderate	Low	High	Low	Low
Markets	Low	Moderate	Moderate	High	High	Moderate
Energy	Low	Low	Moderate	Moderate	Low	Moderate
Roads and transport	High	Low	Low	Moderate	Moderate	High
Drinking water and sanitation	Low	High	Moderate	Moderate	Low	High
Credit and financial services	High	High	Moderate	Moderate	Low	High
On-site benefits	**Impact on on-site benefits**					
Increased crop yield	Medium	High	Medium	Medium	Little (5-20%)	High
Increased fodder production	Medium	High	High	Medium	Medium	High
Increased fodder quality	Medium	High	High	Little	Little (5-20%)	High
Increased animal production	Medium	Medium	High	High	Negligible (0-5%)	High
Increased wood production	Medium	High	High	High	High	High
Reduced risk of crop failure	Medium	High	Little	Medium	Negligible (0-5%)	High
Increased drinking water availability	Low	High	Medium	High	Little (5-20%)	High
Increased water availability for livestock	Medium	High	Medium	Medium	Little (5-20%)	High
Increased irrigation water availability	Negligible	High	High	Medium	Medium	High
Reduced expenses on agricultural inputs	No reduction	High	Little	Little	Negligible (0-5%)	Medium
Increased farm income	Moderate	Medium	High	High	Little (5-20%)	High
Diversification of income sources	Moderate	Medium	High	High	Little (5-20%)	High

(Continued)

TABLE 2. Summary of impact indicators and impact ratings for each watershed reviewed in this study (Continued).

Performance indicator variables	Tigray		Amhara		Oromia	
	Gerebshelela watershed	Abaha-Atsbaha watershed	Goho-Cheri watershed	Bechyti watershed	Bedesa Kela watershed	Kereba watershed
On-site benefits	**Impact on on-site benefits**					
Increased production area (new cropland)	Little	Medium	Medium	Little	Little (5-20%)	Medium
Decreased labor constraint	High	High	High	Little	Little (5-20%)	High
Decreased workload	High	High	High	Moderate	Negligible (0-5%)	High
Simplified farm operations	Little	Little	Little	Little	Little (5-20%)	Little (5-20%)
Increased product diversification	Medium	High	High	High	Negligible (0-5%)	Medium
Socioeconomic benefits	**Impact on socioeconomic benefits**					
Increased recreational opportunities	Medium	High			No	Little
Strengthening of community institutions	Medium	High	Little	Moderate	Little (5-20%)	High
Improved conservation/erosion knowledge	Medium	High	Medium	Moderate	Little (5-20%)	High
Conflict mitigation	High	High	High	Little	Little (5-20%)	High
Improved situation of socially and economically disadvantaged groups (gender, age, status, ethnicity)	Medium	High	Medium	Moderate	Little (5-20%)	High
Improved food security and self-sufficiency (reduced dependence on external support)	Medium	Medium	Medium	High	Little (5-20%)	High
Improved health	Medium	High	Medium	Moderate	Little (5-20%)	Medium
Biophysical characteristics	**Impact on biophysical characteristics**					
Groundwater table	5 to 50 meters	<5 meters	5-50 meters	5-50 meters	5-50 meters	<5 meters
Available surface water	Poor	Medium	Poor	Medium	Poor	Poor
Increased water quantity	Medium	High	High	Moderate	Little (5-20%)	High
Increased water quality	Little	High	Little	Moderate	Little (5-20%)	High
Biodiversity	Low	High	Medium	Medium	Medium	Medium
Reduced evaporation	Medium	High	High			Medium

(Continued)

TABLE 2. Summary of impact indicators and impact ratings for each watershed reviewed in this study (Continued).

Performance indicator variables	Tigray		Amhara		Oromia	
	Gerebshelela watershed	Abaha-Atsbaha watershed	Goho-Cheri watershed	Bechyti watershed	Bedesa Kela watershed	Kereba watershed
Biophysical characteristics	**Impact on biophysical characteristics**					
Reduced surface runoff	Medium	High	High	Moderate	Medium	High
Improved excess water drainage	Medium	High	High	Little	Medium	Medium
Recharge of groundwater table	Medium	High	High	Moderate	Medium	High
Reduced climate risks (floods, droughts, storms)	Medium	High	Medium	Moderate	Negligible (0-5%)	High
Reduced wind velocity	Medium	High				
Improved soil cover	Medium	High	High		Little (5-20%)	Medium
Reduced soil loss	Medium	High	Medium	Moderate	Medium	Medium
Reduced soil crusting	Medium	Negligible				
Reduced soil compaction	Medium	High	Medium			Medium
Reduced salinity	Not observed	High				
Increased animal diversity	Medium	High	Medium	Little	Little (5-20%)	High
Increased plant diversity	Medium	High	High	Little	Little (5-20%)	High
Reduced invasive alien species	Not observed	Medium				
Increased beneficial species (earthworms and pollinators)		Not observed		Little		
Increased biological pest/disease control	Medium	Medium	Little	Little	Little (5-20%)	Little
Increased/maintained habitat	Medium	High	High	Moderate	Low	High
Off-site benefits	**Impact on off-site benefits**					
Increased water availability (springs, groundwater)	Medium	High	High		Little	High
Reduced downstream flooding	Medium	High	High		Little	Medium
Increased dry season streamflow	Medium	High	High		Negligible	Medium

(Continued)

TABLE 2. Summary of impact indicators and impact ratings for each watershed reviewed in this study (Continued).

Performance indicator variables	Tigray		Amhara		Oromia	
	Gerebshelela watershed	Abaha-Atsbaha watershed	Goho-Cheri watershed	Bechyti watershed	Bedesa Kela watershed	Kereba watershed
Off-site benefits	**Impact on off-site benefits**					
Reduced downstream siltation	Medium	High	High		Negligible	Medium
Reduced groundwater or river pollution	Medium	High	Medium			
Improved buffering or filtering capacity (by soil, vegetation)	Medium	High	Medium			
Reduced wind-transported sediments	Medium	High	Medium			
Reduced damage to downstream crop fields	Medium	High	Medium		Little	High
Reduced damage to public or private infrastructure	Medium	High	Medium		Little	High
Increased irrigated area	Negligible	High	Medium		Medium	High
Increased number of shallow wells	Negligible	High	Medium			
Increased duration of water availability	Negligible	High	High			

Hydrological Linkages

The upstream and downstream areas of a watershed are linked through hydrology. This implies that land management in the upstream areas can lead to an increased availability of water resources across the watershed, particularly in the downstream part of the watershed under some types of hydrogeological conditions, which is in part affected by land management strategies. At the same time, degradation of the upland areas not only impacts the area of erosion, but it can also have negative impacts in downstream areas. The combined effect of area enclosures, gully rehabilitation, and SWC measures enhances infiltration, and can lead to improved water availability and regulated seasonal streamflow fluctuations. They can also reduce surface runoff, and downstream flooding and siltation. Previous studies (such as G. Desta et al. 2005; Nyssen et al. 2000, 2007; Vancampenhout et al. 2006; Asefa et al. 2003; Girmay et al. 2008, 2009a, 2009b; Mekuria et al. 2007) showed that natural resource management in the Ethiopian Highlands has reduced the rate of soil erosion, sedimentation in downstream reservoirs and river systems, improved soil moisture and increased crop yields. Although not all watershed development efforts are successful, information from four of the six watersheds reviewed showed that new shallow wells emerged after the watershed management intervention, due to increased groundwater recharge and raising of the subsurface water level, which in turn led to increased irrigated area and increased crop yields across the sample watersheds (Table 3).

TABLE 3. Watershed management and its impact on the number of new wells and expansion in the irrigated area.

Watershed	Number of new wells	Increased irrigated area (ha)	Increased crop yield (quintal/ha)
Bechyti	4	12	6
Goho-Cheri	4	17	9
Abraha-Atsbaha	629	280	19
Kereba	5	85	20

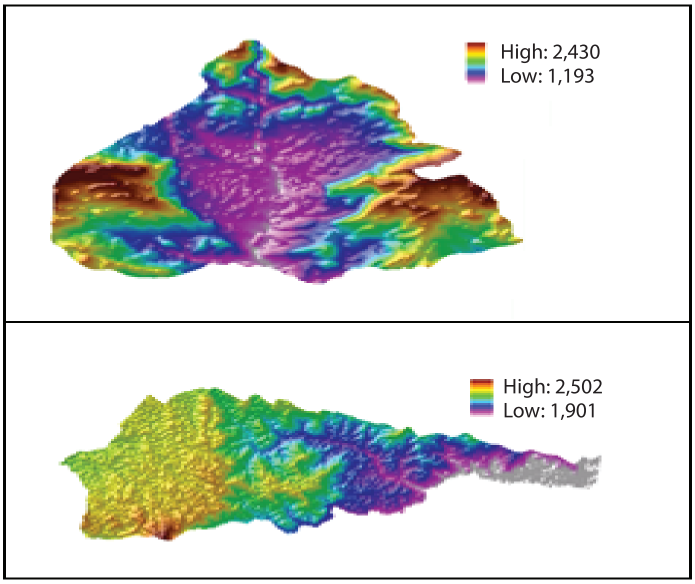
For example, groundwater tables, which were deeper before the watershed management intervention, elevated to about 5 m after the intervention. However, because the economic gains of environmental rehabilitation are realized in the long term (Kiersch 2002), there may be a delay in realizing some of the economic impacts that may result in low net present value of watershed management investments.

One of the factors that contributes to successful upstream-downstream hydrological linkages is permeable geological formation. For example, the Abraha-Atsbaha watershed, one of the most successful watersheds in the country, is concave in shape with permeable lithology (sandstone and colluvial deposit) and predominantly sandy soil (Figure 2).

Good upstream/downstream hydrological linkages are observed when:

- the watershed has a concave shape and is larger (e.g., Abraha-Atsbaha);
- the watershed has permeable lithology with good storage capacity (e.g., sandstone, colluvial deposits) and predominantly sandy soil; and
- there is no excessive use of water in upstream areas.

FIGURE 2. Shape of the Abraha-Atsbaha watershed and its upstream-downstream hydrological linkages.



In Abraha-Atsbaha watershed, SWC activities on upland slopes had a very rapid (less than 3 years) and positive effect on groundwater recharge. Such positive and rapid response is probably a key factor in spurring the community and its leadership to undertake further measures.

Institutional Linkages

Hydrological relationships across a watershed can influence a large number of stakeholders due to the use and management of resources. Moreover, hydrological relationships within a watershed often go beyond administration boundaries, and ownership rights with limited regulation and institutions governing the rights and duties of different stakeholders. The linkages are weakened, especially when the downstream impacts are outside the target watershed. Such a phenomenon was observed in some of the sample watersheds, such as Bechyti, Goho-Cheri, Bedesa Kela and Kereba. In the case of Goho-Cheri watershed, for example, members of the community have concerns that their investments in watershed management in the upstream area have resulted in the formation of swampy areas and perennial rivers in the valley bottom of the adjacent Afar region, while the downstream community has not contributed to the upstream watershed management efforts. This shows that managing watershed externalities within and outside the watershed requires cooperation among various stakeholders. It also requires the establishment of institutions and bylaws that can address the benefit and cost sharing systems.

Soil Erosion Control, and On- and Off-site Impacts

As a result of SWC, gully reclamation, area enclosures and reforestation activities undertaken through the watershed management program, an improvement in soil depth has been observed in most of the sample watersheds (Figure 3). The most common land management technologies that have been practiced in the watersheds include soil and stone bunds, hillside terraces, deep trenches, check dams, diversion ditches and sediment storage dams. On the hillside landscapes, there were efforts to stabilize the conservation structures through tree planting, which also resulted in economic and ecological benefits. On cultivated areas, on the other hand, grasses and legume plants are widely used to stabilize and reinforce SWC structures. Soil fertility improvement measures, such as the use of compost and nutrient-fixing plants, are mostly used on cultivated lands. Key community informants from Bechyti, Goho-Cheri, Kereba, Bedesa Kela, Abraha-Atsbaha and Gerebshelela perceived that watershed management in their communities has contributed to a reduction in soil erosion by 60%, 75%, 90%, 35%, 80% and 50%, respectively.

Impact on Vegetation and Biodiversity

Prior to the implementation of watershed management, vegetation cover was in an extremely poor condition due to the combined effects of population and livestock pressure which led to land degradation. Population increases led to increasing land fragmentation through small landholdings, which forced farmers to cultivate on steep slopes. As a result, land degradation and soil erosion were aggravated. Following the practice of watershed management, however, improved vegetation cover was noted in all sample watersheds (Figure 3). The number of vegetation species in each watershed varies between three and five, and included, for example, *Olea europaea subsp. africana, Becium obovatum, Leucas oligocephala, Euphorbia abyssinica, Acacia etbaica, Opuntia ficus-indica, Echinops hispidus, Calpurnia aurea, Eucalyptus, Acacia saligna* and *Dodonaea angustifolia.*

Based on the responses from the key informants, for example, change in the area with vegetation cover varies between 40% and 85%, with the highest change in the Abraha-Atsbaha watershed. In addition to vegetation cover and environmental rehabilitation, watersheds contribute to providing improved access to firewood and biomass. Improved fodder production is one of the main benefits obtained from watershed management, even in the less successful watersheds. Our discussions with the community and key informants in the sample watersheds showed that animal feed shortages were reduced by about 50%, 60%, 45%, 95%, 100% and 80% in Bechyti, Goho-Cheri, Bedesa Kela, Kereba, Abraha-Atsbaha and Gerebshelela watersheds, respectively.

Based on stakeholders' perceptions, the impact of watershed management on rehabilitating natural resources and attaining ecological benefits was rated as high, medium or low. The Abraha-Atsbaha and Kereba watersheds in Tigray and Oromia regions, respectively, were rated as the best performing watersheds. The Gerebshelela watershed from Tigray, Bechyti from Amhara, and Bedesa Kela from Oromia were rated as the lowest performing watersheds (Figure 4).

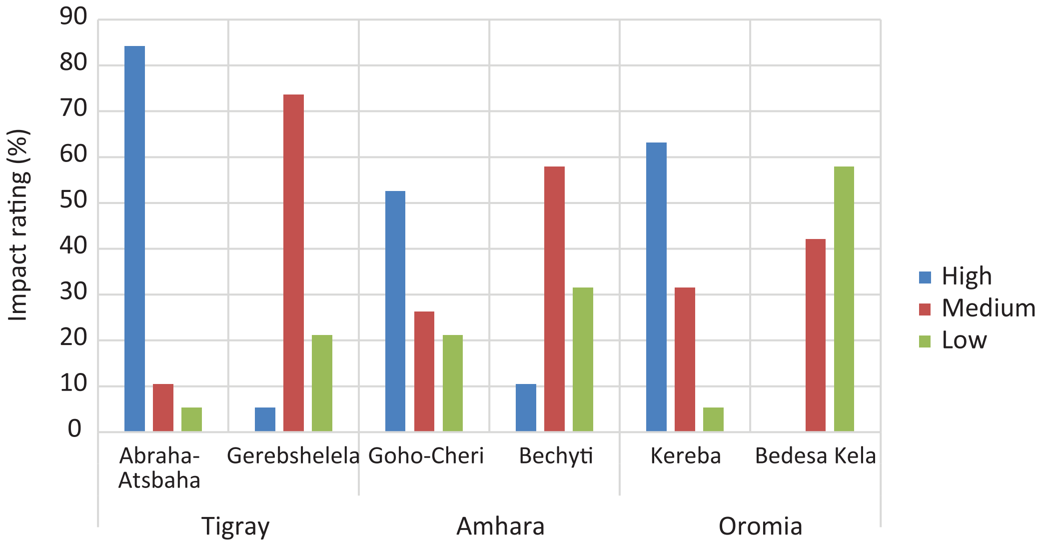
FIGURE 3. Vegetation restoration and improved biodiversity in (a) Kereba, and (b) Abraha-Atsbaha watersheds.

(a)

(b)

Photos: Dereja Assefa Abera and Girmay Gebresamuel, Mekelle University, Ethiopia.

FIGURE 4. The impact of watershed management on rehabilitating natural resources and attaining ecological benefits.



Impact on Gully Rehabilitation and Land Productivity

Gully formation and expansion is one of the major problems in degraded watersheds that reduces the cultivable area and grazing lands. On the other hand, gullies facilitate surface runoff from upstream degraded landscapes carrying a large amount of sediment and posing a problem of siltation in downstream dams, rivers and cultivated or grazing lands. For example, prior to watershed management being practiced in Abraha-Atsbaha, sand sediment from surrounding degraded hillsides was normally deposited on downstream grazing lands and croplands, and was a source of pollution leading to poor soil fertility. Results from this field study showed that, due to watershed management activities, previously degraded areas and gullies have been rehabilitated and reclaimed, allowing farmers to grow fruits, forages, trees and vegetables. Since gullies are usually associated with excess runoff and loss of vegetative cover, gully rehabilitation typically consists of slope stabilization, improvement of gulley catchments to reduce and regulate runoff rates (peak flows), diversion of surface water above the gully area, and stabilization of gullies by structural measures and accompanying revegetation. In particular, at Goho-Cheri watershed, expansion of the cultivated area and the development of springs have resulted from the wide implementation of gully rehabilitation measures (Figure 5). The resulting sediment and erosion control has had an enormous off-site benefit on downstream communities. Usually, the community use multipurpose biological measures, such as *Elephant grass, Eucalyptus saligna, Sesbania, Rhodes grass* or *leucaena*, to stabilize the physical structures and gully sides. However, the intensity of gully rehabilitation measures is not sufficient, as the process of gully formation continues due to ongoing land management and population pressures.

FIGURE 5. Gully rehabilitation measures at Goho-Cheri watershed.

Impacts
Degraded land area transformed into productive cultivable land
Cultivation of fruits, forages, trees and vegetables
Improved access to food
Enhanced spring and groundwater recharge
Reduction in flooding and sedimentation in downstream areas

Photos: Dereje Assefa Abera and Girmay Gebresamuel, Mekelle University, Ethiopia.

Impact on Surface and Subsurface Water Availability

Anecdotal and photographic evidence suggests that watershed development activities generate significant outcomes in surface and subsurface water resources (Figure 6). The reemergence of dried springs and increasing river flows during dry periods are some of the observed impacts in most of the

FIGURE 6. The impact of watershed management on surface and subsurface water availability. (a) developed springs (Gerebshelela), (b) shallow and hand-dug wells (Abraha-Atsbaha), (c) hand-dug wells (Goho-Cheri), and (d) water harvesting pond (Bedesa Kela).

(a)

(b)

(c)

(d)

Photos: Dereje Assefa Abera and Girmay Gebresamuel, Mekelle University, Ethiopia.

watersheds, although the level of changes varies from watershed to watershed. In the well-managed and successful watersheds, such as Abraha-Atsbaha, Goho-Cheri and Kereba, there has been an increase in groundwater recharge and a significant decrease in surface runoff. The rise in the groundwater table is relatively high in Abraha-Atsbaha and Kereba watersheds, probably attributed to their geology, texture and landscape characteristics. For example, in Abraha-Atsbaha watershed, groundwater can be found at depths of less than 5 m, as compared to depths of more than 50 m prior to watershed management interventions. The impact is more visible on groundwater recharge than surface runoff.

Impact on Crop and Livestock Production and Productivity

Watershed management activities are supplemented with water harvesting technologies and the construction of shallow wells for agricultural production. Over time, the increased availability of water for supplementary or full-scale irrigation, coupled with improved agronomic practices, has resulted in increased land and crop productivity. Since the implementation of watershed management, a 200-300% increase in crop productivity has been observed in Abraha-Atsbaha, Kereba and Bechyti watersheds (Table 4). Productivity in Bedesa Kela and Gerebshelela watersheds was low mainly due to the unsuitability of biophysical characteristics and the short time span since the implementation of watershed management activities. For instance, it has only been 4 years since watershed management activities began in Bedesa Kela watershed, while low rainfall and drought for two consecutive years has hampered crop production and productivity. On the other hand, although Gerebshelela is one of the oldest watersheds (more than 30 years old), inappropriate SWC practices, poor soil fertility and low community participation are among the main factors that contribute to low production and productivity. In general, prior to the implementation of watershed management activities, cropping systems were purely rainfed, and limited to the cultivation of cereal crops and pulses. Since the introduction of watershed management, however, crop diversification has taken place both on irrigated and rainfed farms, because farmers have started to produce high-value irrigated crops and fruits for the market. The productivity gains in upstream areas are mainly from in-situ rainwater conservation, while downstream farmers have increased access to groundwater for irrigation enabling them to produce more than one crop per year. Nevertheless, the study revealed that inefficient water use remains a problem in some of the watersheds, such as Abraha-Atsbaha, implying the need for improved extension services and water productivity.

Due to overgrazing on most of the communal pasturelands, animal feed was the most critical problem for livestock development in the study sites. Following watershed management interventions, however, the availability of animal feed has increased significantly through the

TABLE 4. The impact of watershed management on crop production and productivity.

Watersheds	Average farm size of households (ha)	Increase in irrigated area (%)	Increase in crop production and productivity (%)	Improvement in fodder availability (%)
Abraha-Atsbaha	0.75	20-50	300	100
Gerebshelela	0.75	5	5-20	80
Bechyti	0.4	5-20	250	50
Goho-Cheri	0.36	5-20	20-50	60
Kereba	0.25	20-50	200	95
Bedesa Kela	0.5	5-20	5-20	50

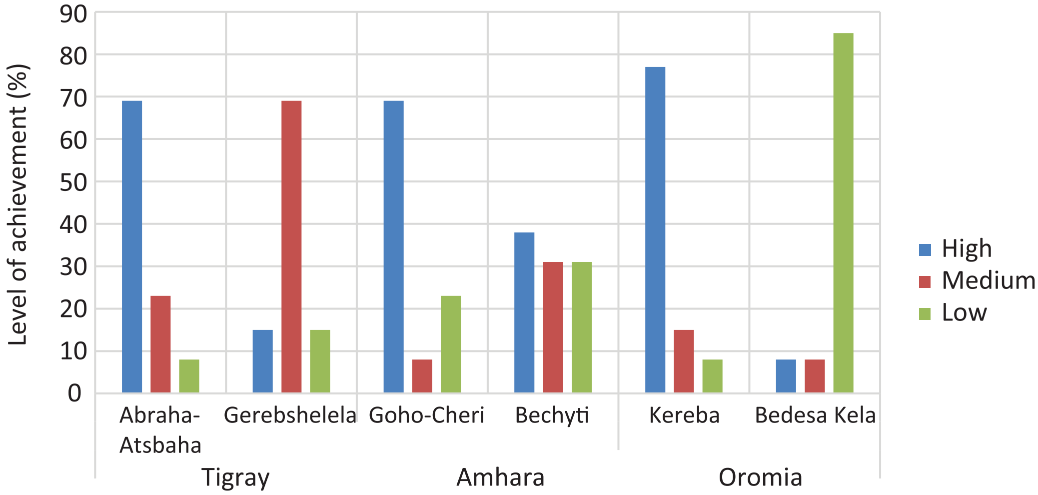
practice of zero grazing, and the cut-and-carry feeding system. However, the management of controlled grazing and institutional set-up differs from region to region. For example, in the Goho-Cheri and Bechyti watersheds in the Amhara region, communal grazing lands and forestlands have been distributed among the community members, implying that grazing land is privately owned. On the other hand, in Tigray and Oromia regions, grazing land is owned by the community, implying that access to grazing land and use rights are controlled by community leaders as per rules and bylaws. In the latter, each member of the community has a right to collect feed resources, but to only graze within the controlled watersheds.

Socioeconomic Impacts

The socioeconomic impacts of watershed management were assessed based on income, income diversification, assets owned by farm households, employment opportunities, food security, health and education. Most of the key informants interviewed suggested that their socioeconomic conditions improved since watershed management activities began in their communities. They perceived that their farm income increased by an average of 50%, which resulted in a 20-90% improvement in farm household food security. The highest improvement in food security was reported in the Abraha-Atsbaha and Kereba watersheds (Table 2). Risk of crop failure reduced by more than 50% in the successful watersheds and by about 10% in the less successful watersheds. Access to health and education improved between 20% and 50% as compared to conditions prior to watershed management interventions. Different IGAs, such as apiculture, livestock fattening and irrigation, have emerged following watershed management programs. Moreover, the introduction of watershed management programs has had a positive impact on women's empowerment. In Goho-Cheri watershed, women farmers were trained to produce locally-made, energy-saving stoves for the market and this generated additional income.

Watershed management integrated with apiculture has resulted in employment creation and environmentally friendly IGAs. In addition to its contribution to household economy, apiculture promotes the production of bee forage, vegetation and pollination, leading to improved vegetation cover and biophysical stability. In Kereba, for example, most of the households own, on average, two to three beehives. In Abraha-Atsbaha, the youth and landless community members were grouped together to use the community watershed for apiculture farming. Increased demand for labor, as a result of increased irrigation and cropping intensity, created employment opportunities. Due to improved income, a considerable change was observed in the livelihoods and asset ownership of farm households. Moreover, successful watershed management triggered farm household investment and technology adoption. Evidence from Abraha-Atsbaha showed that over 600 households have invested in shallow or hand-dug wells, where 340 and 500 households have adopted motorized and treadle pumps, respectively. Similarly, rainwater harvesting technologies, such as geo-membranes used for the lining of ponds and water storage systems, have been widely adopted by smallholder farmers in Goho-Cheri watershed. Different indicators (Table 2) were used to capture the socioeconomic impact of watershed management. Most of the impacts on access to services are indirect benefits of watershed management measured by walking distance to the service centers. Results presented in Table 2 indicate that access to services do not seem to correlate with the success or failure of watershed management. On the other hand, on-site, socioeconomic, biophysical and off-site benefits are closely related with watershed management, implying that successful watershed management results in an improvement in these benefits. The results (Figure 7) show that the three successful watersheds (i.e., Abraha-Atsbaha, Goho-Cheri and Kereba) achieved the highest performance levels in terms of on-site, socioeconomic, biophysical and off-site benefits.

FIGURE 7. Socioeconomic impacts of watershed management.



However, irrespective of the differences in the level of performance, the performance of on- and off-site benefits was found to be positive in all watersheds[3].

CONCLUSION

This study identified, through the use of household interviews, key informant interviews and FGDs, that an integrated watershed management approach is effective in integrating both upstream and downstream impacts with different income-generating components of the watershed program. It was also identified that the majority of SWC practices in the watersheds resulted in a significant positive impact on water availability and land productivity. Watershed management has contributed to more sustainable development through concerted efforts of water harvesting and improved agricultural productivity. It has also contributed towards groundwater and surface water recharge, which, in turn, has realized opportunities for smallholder irrigation and helped communities become more resilient to climate change.

Strong community participation and a demand-driven approach are among the driving forces of successful watershed management. In most of the successful watersheds, it has been observed that watershed committees, together with the community and the project coordination office staff, are responsible for problem identification and priority setting. Community priorities must be assessed for technical and financial feasibility, and hence the implementation process combines demand-driven and technically feasible approaches. In general, the successful results of community participation and demand-driven approaches may indicate that an externally driven or blanket approach to developing and implementing watershed management strategies is inappropriate. The most innovative aspect of watershed management is, therefore, the importance given to the development of local capacity and institutions. Experience shows that, in the past, watershed management was implemented merely to address the problem of watershed degradation and was rarely linked with poverty alleviation. However, the recent integrated watershed management approach links resource conservation with

[3] The level of achievement and thresholds for being high, medium or low was based on the perceptions of key informants.

livelihood improvements by facilitating the practice of various IGAs. This study has also confirmed that farmers have enormous endogenous knowledge and creativity, which many externally driven development programs often fail to consider; hence, it is apparent that the knowledge and efforts of local communities need to be encouraged and recognized with adequate technical support.

The biophysical and geological characteristics of watersheds are some of the most important factors that affect the success of watershed management. For example, watersheds with permeable geology and soil texture have resulted in good water percolation, a stable aquifer leading to groundwater recharge and then an increase in irrigated agriculture. Therefore, the spatial integration between upstream and downstream is high. Moreover, micro-watersheds are more flexible and effectively integrate conservation activities with livelihoods.

An enabling environment for scaling up and sustainability of best watershed management practices can be provided by the existence of a favorable policy framework. However, there are several challenges that pose a risk to the success of watershed development. One of the most important challenges to watershed management is the uneven distribution of costs and benefits between upstream and downstream communities, because the benefits of upstream communities are relatively smaller than the benefits of downstream communities, while most of the costs are borne by the upstream communities. Therefore, ensuring a fair and justifiable benefit and cost sharing system may be of paramount importance. Addressing this challenge also requires an innovative institutional setup to address watershed externalities and collective action.

To conclude, for successful watershed management and effective up-scaling of best practices, this study recommends the following: (i) develop technologies that are suitable for a specific watershed and smallholder farmers. Emphasis should be given to technologies that improve conservation of the resource base, while eliciting short-term benefits for the local people; (ii) improve surface and subsurface water management to increase water productivity; (iii) develop institutions and mechanisms that improve partnerships among stakeholders; (iv) devise mechanisms that ensure fair and equitable division of costs and benefits, especially between upstream and downstream communities; (v) ensure community participation with adequate technical and financial support; (vi) link physical and biological conservation activities with IGAs and livelihood improvement activities; (vii) improve access to markets. There are cases where high-value commodities are produced under watershed management, but access to markets and post-harvest management technologies is limited. The majority of the high-value commodities are usually perishable, irrigated vegetables. Therefore, there is a need for effective integration of production, marketing and agro-processing to obtain the maximum benefits from the value chain; and (viii) develop guidelines for the collection of baseline data and M&E.

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APPENDIX

TABLE A1. Past and present perspectives of watershed management approaches.

Watershed management strategy	Watershed management implementation approach	
	1970-1999	2000 onwards
Watershed management approach	Top down	Community-based integrated watershed development
Community participation mechanism	Incentive-driven/forced	Full participation at various levels (planning-implementation-M&E)
Objective of watershed management	Food for work Reducing soil erosion	Improve the natural resource base and livelihoods
Scale of watershed intervention	Large scale	Small scale (micro-watershed)
Policy support	Very limited	High
Technology	Dominated by physically engineered structures	Integration of several technologies (physical and biological measures, agricultural intensification, IGAs)
Investment cost	High	Moderate
Monitoring and follow-up	Poor implementation and follow-up of maintenance by beneficiaries	Improved M&E mechanism (results-based M&E)
Outcome	Low survival of plants and revegetation; low ecological and livelihood benefits	Improved conservation of natural resources, increased ecological benefits, improved income of farmers

Source: Authors’ review of policy/strategy documents.

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