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Evaluating watershed management activities of campaign work in Southern nations, nationalities and peoples' regional state of Ethiopia

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Abstract

Background: The Ethiopian government has been implementing watershed management mainly through public campaign work. However, its effects have not been evaluated in many micro-watersheds. This study evaluates watershed management activities and its socio-economic and biophysical role.

Results: Each kebele has institutional arrangements such as development teams comprising 3–35 households, and 5-person labor groups, which mobilize people and penalize absentees (if any). The survey indicated that common lands, subject to free resource exploitation such as grazing, were typically severely degraded. The majority of respondents wait for development agents and campaign work before repairing the conservation structures. Tree species selection was found to be appropriate in most areas. However, poor seedling survival (<5%) was observed in some micro-watersheds. In most micro-watersheds, structure selection, design, construction and spacing was appropriate.

Conclusions: Achievement in rehabilitating degraded lands was seen as excellent lessons for future efforts. The following issues need to be addressed in future watershed management campaign work: poor structure maintenance, low seedling survival, creating defined land user/owner for common land rehabilitated collectively, crop and cattle damage by wildlife residing in rehabilitated micro-watershed, incentivizing development agents, periodic auditing and repairing of built structures and seedling replacement.

Keywords: Conservation structures; Institutional arrangement; Property right; Seedling Survival; Watershed degradation

Background

Sustainable livelihood and increased food production in agricultural based developing countries require the availability of sufficient water and fertile land (Tesfaye 2011). In sub-Saharan Africa, unsustainable livelihoods often contribute to degradation of important watershed resources (Kerr 2002). Among the degrading watershed resources, fresh water and soil fertility take the lead in posing significant socio-economic, ecological, and environmental roles, especially for developing countries including Ethiopia where traditional agricultural-based economy is dominant. As a result of dependency of increasing population on traditional subsistence agriculture, most of

the Ethiopian highlands are experiencing degradation of watershed resources.

Ever since people began manipulating land, various approaches and techniques were practiced to reduce degradation of watershed resources. However, the system thinking or modern watershed (generally a drainage area) management started in mid 20th century and adapted in most countries with the aim of controlling water pollution, sedimentation, soil erosion, flood, and discharge extremes. The watershed management effectively accounts multiple linkages between livelihood and natural resource management (Hope 2007; Tiwari et al. 2008). Vegetation, soil, and water resources can be protected more efficiently through this approach since whole ecosystems and people participation can significantly be considered (Kerr 2002; Srivastava et al. 2010; Price et al. 2011). This contributes for improvement of watershed resources and livelihood of the people (Pathak et al. 2013; Khajuria et al. 2014).

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In Ethiopia, watershed management was initiated in the 1970s to tackle water-caused soil erosion impacts and water shortage in agricultural economy. Since this period, interest in the multiple environmental, economic and social benefits provided by watershed management has greatly increased and accordingly it has been recommended for achieving various purposes in different part of the country (Nigussie 2003; Woldeamlak 2003; Hengsdijk et al. 2004; Kefyalew 2004; Ludi 2004; Admasu 2005; Tamene et al. 2005; Ermias et al. 2006; German et al. 2006; Tamene et al. 2006; Tamene and Vlek 2007; Andualem 2008; Emiru 2009; Kebede 2012; HNCJ Hunger, Nutrition Climate Justice 2013).

There have been challenges (i.e. difficulty for rapid replication, engaging all land users in the watershed, implementation costs, etc.) to implement watershed management in different part of the country. However, as result of strong effort by government and community to overcome the challenges, exemplary successes at the mini-watershed (a drainage area covering 400–2000 ha) or micro-watershed (a drainage area covering less than 400 ha) scale has been recorded and globally appreciated (HNCJ Hunger, Nutrition Climate Justice 2013). Evidence of success includes considerable improvement in water discharge levels in streams and springs, improved water table levels, and reduced sedimentation problems in the water harvesting ponds and reservoirs (Haregeweyn et al. 2005; Haregeweyn et al. 2008).

The current approach that much contributed for success is 'community based participatory integrated watershed management', which requires involvement and contribution of local people. The Ethiopian government understands the essence of this approach as evidences from successfully implemented pilot projects appear promising. Significant effort is occurring to replicate 'community based participatory integrated watershed management' activities in weredas^a of most regions. As a component of this effort, in the last four years a nationwide 30 days public work campaign for watershed management has occurred. In Sidama, Kambata Tambaro, Wolayita and Dawro zone of the Southern Nations, Nationalities and Peoples Regional State (SNNPRS), such activities are ongoing. The 30 days watershed management labor contribution by farmers has been practiced in most weredas of these zones.

However, effect of such watershed management, effectiveness of institutional arrangement, influencing biophysical and socio-economic components, challenges and opportunities for replicating and sustaining the activities are rarely evaluated for most micro/mini-watersheds. Therefore, this study examines components of site specific packages of watershed management activities; evaluates the status of watershed management activities; analyzes effects of watershed management; and explores institutional, socio-economic and biophysical opportunities

and challenges in adopting and sustaining watershed management activities.

Methods

Site description

SNNPRS is one of the nine political regions of Ethiopia. The region borders Kenya to the south, South Sudan to the west, Gambela region to the northwest, Oromia region to the north and east. The region is divided in to 14 zones (Bench Maji, Dawro, Debub Omo, Gamo Gofa, Gedeo, Gurage, Hadiya, Kaffa, Kanbata Tambaro, Segen, Shaka, Sidama, Silte, Wolayita) and 4 special weredas (Alaba, Basketo, Konta and Yem) (Figure 1).

The 2007 census by Ethiopia's Central Statistical Agency (CSA) estimated that the SNNPRS region had a population of about 15 million (with annual growth rate of about 2.9%) from which 89.98% were rural inhabitants, making it Ethiopia's most rural region (Central Statistical Agency 2007). The region comprises an area of 105,887.18 km². The eastern, northern and central part of the region is densely populated whereas the southern and western part is sparsely populated.

The region has a diversity of agro-ecological zones, ranging from Berha (semi-arid) at south Omo to Wurch in Gamo Gofa zone. Accordingly, the lowland area (mainly part of south omo zone) of the region receive less than 600 mm annual rainfall and highlands of Shaka, Kaffa, Dawro, Wolayita, Kambata Tambaro, Sidama, Gamo Gofa zones receive more than 1200 mm per year (SNNPRS-BoFED 2004). Average temperature of lowland exceeds 20°C and about 28°C is reported for extremely hot area. Average temperature of 10–20°C is recorded for highland areas, for which less than 10°C also exists. Generally, different part of the region is characterized by climate categories of hot semi arid climate, tropical climate II, tropical climate III, warm temperature climate I, and warm temperature climate II (SNNPRS-BoFED 2004). Owing to its diverse agro-ecological zones, a range of plant species grow in the region. The region is rich in perennial crops such as *Ensete ventricosum*, *Coffea arabica*, and *Catha edulis*. Cereal crops such as *Triticum aestivum*, *Hordeum vulgare*, *Zea mays*, *Sorghum bicolor*, *Eragrostis tef*, *Phaseolus vulgaris*, *Pisum sativum*, *Vicia faba*, *Ipomoea batatas* and *Manihot esculenta* are widely cultivated in the region. Coffee based agroforestry is widely adopted. Planting fruit/tree species around homestead is commonly practiced. Soil types such as dystric nitosols, orthic acrisols, pellic vertisols, chromic luvisols, eutric fluvisols, eutric nitosols, mollic andosols, and chromic vertisols dominantly characterize different part of the region (SNNPRS-BoFED 2004). The three basins: Omo-Gibe, Baro-Akobo, and Rift valley lakes drain big area of the region.

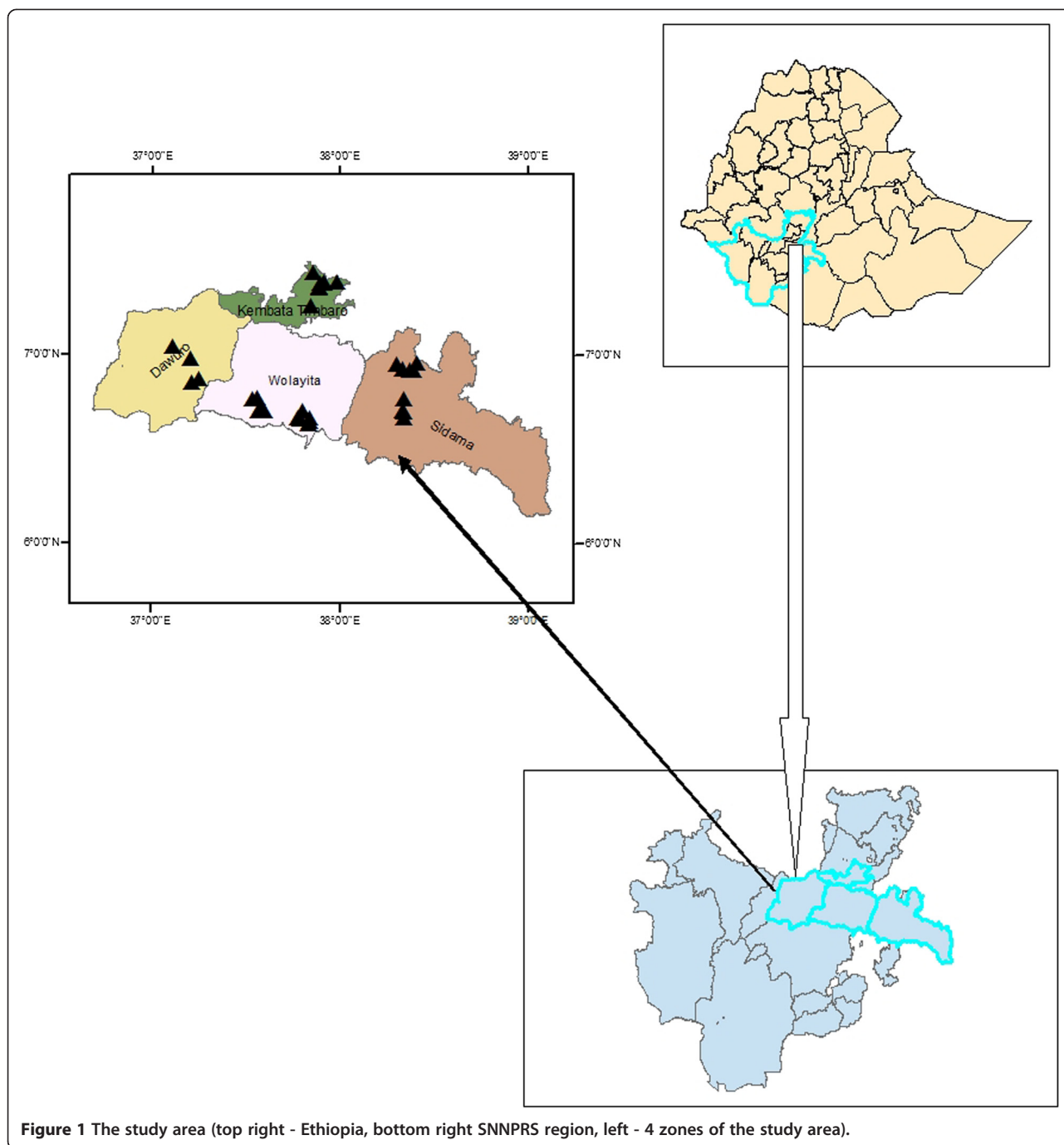


Figure 1 The study area (top right - Ethiopia, bottom right SNNPRS region, left - 4 zones of the study area).

The land area of eastern, northern and central part of the region is comparatively degraded due to increased pressure from dense populations and long-term cultivation.

Methodology

For this study, Sidama, KambataTambaro, Wolayita and Dawro zones were strategically selected. From each zone, two weredas were selected for accessibility with a four-wheel drive vehicle and the existence of a range of agro-ecological categories. In each wereda, all four-wheel

accessible kebeles^b were categorized into agro-ecological groups. After these considerations, a kebele was randomly selected from each agro-ecological category and all micro-watersheds within the kebele, where watershed management has been implemented by campaign work, were considered for evaluation (Table 1).

When the watershed management activities were implemented on common land, checklist guided focus group discussions were conducted with the farmers living around the impacted area. In the case where

Table 1 Sampled zone, wereda, kebele, micro-watershed

Zone	Wereda	Kebele	Micro-watersheds
Sidama	Borecha	Yiriba Dubancho	Garato, Lelanto
		Hanja Chafa	Chafa, Bantola
		Koran Goge	Harfato, Koncha
	Dale	Debub Kege	Golota, Begasine
		Megara	Alelecho, Manto-Danchame
		Kalete Senete	Gorbito,
Kambat-Tambaro	Damboya	Kota Kombola	Dilamo, Lantate, Eja
		Ha'amancho	Oliso
		Megere	Welecho
	Angacha	Zebecho	Ajacho, Koruwa, Halega
		Bucha	Kinham, lower Bucha, Ajacho
		Gede Genet	Bukuna, Bubuyesa, Farkasa
Wolayita	Humbo	Abela Faracho	Kole, Alata, Lal'ana
		Abela Sifa	Shafa, Basa, Loke
		Ela Kabala	Tewaye Hamasa, Tebo Hamasa
	Ofa	Yakima	Hoze, Halozia, Busho
		Sadoye	Sadoye
		Soresha	Bongota, Tuba, Awash
Dawro	Loma	Addis Bodare	Tida, Dulae
		Gendo Walcha	Toni
		Gedo Buna	Kuta
	Mareka	Mari Madara	Ali
		Gobo Shamena	Wuni

watershed management activities occurred on small-holders land, individual interviews were conducted. Five percent of the households were randomly selected for these interviews. Fifteen group discussions (each comprising 5–15 participants) were conducted in micro-watersheds. About 260 heads of household interviews were conducted (Table 2).

Discussions were conducted with each wereda watershed experts and kebele agricultural development agents. Secondary data, especially kebele achievement reports were reviewed.

When possible, field observations and expertise evaluations were conducted on watershed management activities in the micro-watersheds. The accomplished activities were evaluated using the following criteria:

- Compliance of the watershed management activity with the principles of watershed logic, especially commencing interventions such as constructing physical soil and water conservation structures from ridge or upper part of the micro-watershed and

Table 2 Number of farmers participated in group discussion and interview in each considered kebele

Kebele	Number of participants in group discussion	Number of land users interviewed and farm field visited
Yiriba Dubancho	9	10
Hanja Chafa	15	18
Koran Goge	11	14
Debub Kege	6	-
Megara	5	19
Kalete Senate	8	-
Kota Kombola	7	11
Ha'amancho	9	10
Megere	7	18
Zebecho	-	15
Bucha	-	18
Gede Genet	5	18
Abela Faracho	5	14
Ela Kabala	5	8
Yakima	6	16
Sadoye	8	20
Soresha	7	10
Gendo Walcha	-	15
Gedo Buna	-	12
Mari Madara	-	8
Gobo Shamana	-	6

progressively proceeding to valley or lower part of the micro-watershed.

- Status of physical soil and water conservation structures:
 - Proportion of broken physical soil and water conservation structures.
 - The stabilization of physical soil and water conservation structures with biological measure (planting recommended grass/shrub/tree species on the structures).
 - Appropriateness of physical soil and water conservation structures selection (considering factors such as rainfall amount, soil texture, slope gradient, and existing land use).
 - Design of physical soil and water conservation structures by considering soil texture, rainfall amount, slope gradient and land use.
 - Compliance to recommended specification such as foundation for stone bund and channel depth, channel width, length, and berm for various other physical soil and water conservation structures.
- Existing management and maintenance of physical soil and water conservation structures.

- Seedlings planted and its management: appropriateness of species selection as affected by agro-ecology and related factors, survival percent of seedlings planted on common land in past two years, and on-going management.

An archive review was conducted at the kebele offices. The rainfall data for Yirba Dubancho, Yirgalem, Durame, Angecha, Humbo, Gesachare, and Gesuba stations was collected from Ethiopian Meteorological Agency, Hawassa Branch office. Micro-watershed elevation was measured using an altimeter. Survival of seedlings planted in the previous two years in common land was assessed by taking systematically distributed samples. Descriptive statistics was used to analyze the collected data.

Result and discussion

Due to an exploitive land use history, the study area's cultivated and grazing land has been degraded as characterized by: low fertility, gully and rills formation, moisture stress, declining productivity, etc. The objectives of watershed management in the studied micro-watersheds were related to these issues and mitigation activities focused on reducing further degradation and rehabilitating these impacted lands.

Role of the 'development team' in enhancing participation of local people

In public campaign work, people participate by contributing labor, farm tools, etc. in watershed management activities through a 'development team'. In each surveyed kebele, small 'development teams' have been organized. The number of members on a team depends on the local situation. The largest development team, with 35 members, existed in Sadoye kebele (Ofa wereda of Wolayita zone) and the smallest, with 3 members, was observed in Mari Madara kebele (Mareka wereda of Dawro zone). The team is responsible for developing and administering internal regulations that enforce, encourage, or punish absentees from campaign work. Since the implementation of watershed management campaign work is based on group consensus, the punishment on absentees is not particularly serious. For instance, in Zebecho, Soresha, Gede Genet, Ela Kabal, Abela Faracho and Adis Bodare kebele, some development teams only give advice and exercise no monetary or other penalties. The development teams in Gobo Shamenena, Zebecho, Megara, and Soresha kebele require that the absentees compensate missed work on another day(s) if they don't have convincing reasons for not participating. Some development teams in Bucha, Hanja Chafa and Gendo Walcha kebeles financially penalize the absentees and use the collected money for strengthening the development work (e.g. purchasing farm tools). Gendo Walcha kebele uses some of the

funds to partially pay guards to protect the enclosed site. The social and moral sanctions imposed by respective 'development team' members in a give locality seeks to encourage/enforce the members to participate in the watershed management work. Other study (Enwelu et al. 2014) also recognizes the importance of local rules and regulation in community participation. A study by Lullulangi et al. (2014) confirmed that community effort and norm in watershed resource management such as planting protective trees has positive contribution.

Work norm and supply of tools

In recent years and especially in 2013/14 campaign years, the watershed management activities in each kebele involved various community groups in the public work projects (Figure 2). The youth, women and head of households (adult male) participated in the various allocated tasks. In all the kebeles, the highest proportion of work has been achieved by the adult male group. For instance, in Debub Kege, Kota Kombola, Ha'amancho, Zebecho, Bucha and Sadoye kebeles respectively 45, 60, 60, 68, 83 and 95% of the work was accomplished by the adult male group. The remaining proportion of the watershed management activities were implemented by youth and women groups. In the respective order of these kebeles, 30 and 25, 15 and 25, 15 and 25, 12 and 20, 10 and 7, 2 and 3% of the activities were accomplished by youth and women respectively. The average soil bund construction is about 6 meters/day for male groups and 3 meters/day for women groups. In areas with hard or rocky soils these averages are not achieved.

Constructing physical soil and water conservation measures by those teams to achieve the intended norm requires various tools for lay out, digging, rock breaking, excavating, embanking etc. In Adis Bodare and Gedo



Figure 2 Public campaign workers building soil and water conservation measures in Hanja Chafa kebele, Chafa micro-watershed.

Buna, farmers use their own tools for such watershed management activities. Tools are provided by some weredas for the kebeles where equipment shortages exist as identified through preliminary assessments. This is part of the government contribution through the wereda agriculture office. Some kebeles (Hanja Chafa, Debub Kege, Kalete Senate, Kota Kombola, Zebecho, Abela Sifa, Mari Madera, and Gobo Shamena) confirmed they received one or more of the required tools through the wereda. Since these management activities are occurring simultaneously in all the kebeles in a given wereda, supplying sufficient tools is a challenge for kebeles, especially if they are not being supported by other organizations (e.g. Non Governmental Organizations, NGO).

Property rights and land degradation

Many of the micro-watersheds where management activities have been centered are characterized by gully formation, which indicates severe erosion of top soil and poor vegetation cover. Severely degraded micro-watersheds have common histories in land use including change in land ownership. The communal lands tend to be more susceptible to exploitative use and degradation problems.

In the Dale wereda (Golota micro-watershed of Debub Kege kebele), during the Imperial government (prior to 1974) the land was covered with forests and harbored abundant wildlife. Land was privately owned during that period. When the land was shifted from private to communal during the Derge government, the forest was removed by unregulated tree cutting and charcoal production. The land became eroded and degraded. A similar situation occurred with the Gorbato micro-watershed in Kalete Senete kebele.

A once severely degraded, but now recovering area is Dilamo micro-watershed of Kota Kombola kebele where privately owned land during Imperial government was converted to common land during the Derge government. The land was progressively degraded starting from the time it was used for common grazing and resource extraction and remained as barren wasteland until three years ago when watershed management intervention began.

Land in Oliso micro-watershed of Ha'amancho kebele has a similar history. Once privately owned and covered with thick forest, during the Derge regime the land was changed to common grazing land and soil erosion created serious degradation. About 60 years ago, there was small gully at lower part of the micro-watershed which later deepened and also elongated to the upper part of micro-watershed. As result of sever degradation for any economical use, farmers owning the land has ignored it and permitted land for common use such as grazing. This degradation created 'common land' now treated and appears promising resource for productive use in near future.

In Kota Kombola kebele, part of the Eja micro-watershed was used for intensive grazing and became severely degraded. Since 2011, watershed management activities have improved the land conditions (i.e. gullies filled, soil regenerating, grass growing) although the land is still considered common property. Similarly, in Welecho micro-watershed of Megere kebele, big gullies formed many years ago have been aggravated by intensive grazing. In Manto- Danchame micro-watershed, the land was naturally rock in lower watershed, but has now extended by an additional 50 meters uphill in past about 40 years. The land was owned by private called 'keberite' during Imperial government but since Dergue government it has been communal land and the forest has been removed creating gully and land dissection consequences. In line with these observations, other studies also reported that land ownership has influence on soil conservation and its management (Gebremedhin and Swinton 2003; Bewket 2006). Land ownership and tenure influence motivation of land owner on watershed management (Rosenberg and Margerum 2008; Teshome et al. 2014).

Tree/shrub species selection, survival rate and management

A component of biological soil and water conservation, tree/shrub seedlings are often planted in watershed management areas. Species selection and survival rate for common lands were considered in this study whereas seedlings planted on individually owned land were not considered as this information is not easy to gather. In general, the species selection is vital as it determines future available products, seedling survival, and agro-ecological compatibility.

Species that can survive poor sites and also improve soil properties are generally preferred to rehabilitate degraded land through watershed management. In this regard, maintaining the Eucalyptus species in degraded communal land at Garato micro-watershed is not appropriate as this species restricts undergrowth and as result poorly contributes to soil conservation and land rehabilitation (Fikreyesus et al. 2011). Eucalyptus is also highly nutrient and water-consuming.

The micro-watershed areas that have been rehabilitated by retaining existing and regenerated trees and shrubs need technical support to continue sound management and utilization. In Ela Kabala kebele, the lower watershed of 2012 and 2014 intervention is in commonly owned woodland. The objective of this micro-watershed management is to enhance grass growth for livestock, which currently has poor grass availability. Thus, the shrubs should be harvested under technical guidance and implemented to meet the farmers' interests. Retaining the shrub component will probably not contribute to the intended goals.

In Tuba micro-watershed of Soresha kebele, development agent reported that none of the seedling planted in

2012 survived due to late planting in reference to the rainy season, and seedlings were planted without polyethylene tubes. In addition, water logging properties of soils influenced the survival rate. On other hand, the poor survival of seedlings in micro-watersheds of some kebeles such as Soresha, Yirba Dubancho and Koran Goge (Table 3) is related to land degradation problem. Since the degraded land has poor soil fertility and water holding capacity, seedling survival is negatively affected.

When the ecology of the micro-watersheds are surveyed for their suitability for dominantly planted tree and shrub species most of the micro-watersheds were found to be appropriate (Azene and Birnie 1993) (Table 3).

Soil and water conservation structures: specification and selection

Depending on slope, rainfall and workable soil depth, each soil and water conservation structure has specific standards. Research findings suggest that structures built below these standards are less effective in controlling erosion. Sometimes a poorly constructed structure becomes dangerous as it aggravates erosion by collecting the surface runoff and enhancing collective high volume flow. Therefore, maintaining the construction standards is obligatory. In Alelecho micro-watershed of Hanja Chafa kebele (Figure 3), some of the structures built in 2014 are in need of improvement. For example the trench depth, which is less than the 50 cm requirement, needs improvement. The *fanya juus* and trenches have either no, or a narrow berm, to reduce back flow of soil into the channel. Similarly, a narrow berm was observed in the *fanya juus* built in 2014 at the Welecho micro-watershed (Megere kebele). Mounding and compacting of embankment soil was poorly managed. Stone bunds can be built in areas where sufficient stone can be collected. The specifications for these structures need to be followed to reduce their dismantling and increase their soil

conservation effectiveness. Among the specifications, a properly installed foundation (to the depth not less than 20 cm) is required. However, a weak or no foundation was observed in most stone bunds built in micro-watersheds of Alelecho, Bongota, Tuba, Sadoye, Tewaye Hamasa and Alata.

Soil and water conservation structures built on cultivated land need to be suitable for farming activities, including easy travel across a farmland. To achieve this, the recommended maximum length of a structure should be 40–50 meters CFSCDD Community Forests and Soil Conservation Development Department (1986) with a gap of 5–10 meters before restarting (if required). In Welecho micro-watershed of Megere kebele and Teba Hamasa micro-watersheds of Ela Kabala, soil bunds over 100 meters long were observed.

According to CFSCDD (Community Forests and Soil Conservation Development Department) (1986) and Lakew et al. (2005), most of implemented structures are appropriate for the sites (Table 4). However, in micro-watersheds of some kebele such as Yakima, Mari Madara, and Zebecho, soil bunds and *fanya juus* were constructed on crop lands with steep slopes (>40%). In principle, such steep sloped lands are less feasible for crop cultivation. In practice, due to land shortage, it becomes necessary to cultivate these lands. These structures can be suitable for such slopes with cautious design and management CFSCDD Community Forests and Soil Conservation Development Department (1986). In comparison, in micro watersheds of Kalete Senete, Megere, Abela Faracho, and Abela Sifa kebele, soil bunds and/or *fanya juus* has been built on the land with slopes less than 3% (Table 4). Soil erosion for such slopes can be managed by less costly activities such as grass strips, unless the area has critical water shortage to establish the grass. Practically, conservation of the water, itself, in water scarce lands, may demand the structures.

Table 3 Planted species, seedling survival and their appropriateness

Kebele	Considered micro-watersheds	Elevation range (m)	Mean annual Rainfall (mm)	Dominantly planted species on common land	Survival %	Comment on planted species
Yiriba Dubancho	1	1980-2020	1070.6	<i>Acacia saligna</i>	5	Appropriate
Hanja Chafa	2	1928-1945	1070.6	<i>A. saligna</i> , <i>Grevillea robusta</i>	25	Appropriate
Koran Goge	1	1925-1940	1070.6	<i>A. saligna</i>	7.5	Appropriate
Debub Kege	1	1730-1734	1209.1	<i>A. saligna</i> , <i>Gravilea</i>	65	Appropriate
Megara	2	1765-1792	1209.1	<i>Olea</i> , <i>Cordia</i> , <i>G. robusta</i> , <i>A. saligna</i>	70	Appropriate
Kalete Senete	1	1970	1209.1	<i>A. saligna</i> , <i>G. robusta</i>	50	Appropriate
Kota Kombola	3	2000-2110	1156.5	<i>G. robusta</i> , <i>Acacia decurrens</i> , <i>A. saligna</i>	43	Appropriate
Ha'amancho	1	2100-2200	1156.5	<i>A. saligna</i> , <i>A. decurrens</i> , <i>Cupressus lusitanica</i>	60	Appropriate
Ela Kabala	1	1520-1580	1132.3	<i>G. robusta</i>	85	Appropriate
Soresha	1	1570-1673	1056.1	<i>Jacaranda mimosifolia</i> , <i>G. robusta</i>	2	Partially appropriate



The principle of watershed management requires starting from the upslope/ridge and progressively intervening toward the lower watershed. The intervened micro-watersheds in public campaign work heed administrative boundaries as it is confined within a kebele or wereda. However, the micro-watershed boundary may not fit the administrative boundary making the structures ineffective. In Bantola micro-watershed, intervention of the upper watershed commenced three years after the treatment of the area below it. This occurred because the upper watershed (even though a comparatively small area) belongs to another kebele. A similar case was observed in Welencho micro-watershed of Megere kebele. In Garato micro-watershed of Yirba Dubancho kebele, effective intervention was undertaken to rehabilitate degraded lands even though the lower watershed that is being protected from the severe water flows is in another wereda. Even though only a few fragmentations in the intervention process were observed, from the perspective of making watershed management effective, when fragmentation does occur, there needs to be collaboration in planning and management activities.

Challenges in practicing activities and in sustaining outcomes

Key informants and development agents indicated various site specific challenges with watershed management activities. The key informant in Bucha kebele explained that soil is too hard to dig and it is difficult to achieve the work norm stated in Work norm and supply of tools. In the lower watershed of this kebele, planting grass on soil bunds/fanya juu is poorly practiced compared to other parts of the micro-watershed, which may be due to the large land area per household, as the area's population density appears to be low. In contrary, in many areas land shortage challenges the size of channel and embankments. In various kebeles, farmers reduced conservation structure embankment widths in order to have more land for crops. This resulted in many soil and water conservation structures being overtopped by flooding.

Sustaining community participation in structure construction and management is other challenge in Abela Faracho and Abela Sifa kebeles. Participant numbers are small because it is a democracy and during the off season, cattle graze on farm land and disrupt the stability of structures. In addition, farmers do not like having stone bunds built close to their houses as they tend to be good snake habitat. In Abela Sifa kebele, since there was payment for constructing structures by NGO and safety net, the farmer hesitates to accept campaign work. In this kebele's Shafa micro-watershed, the surface flow resulting from few days' rainfall overtopped and significantly damaged the structures due to poor design and management.

In Ela Kabala kebele, experts and farmers explained that monkeys residing in the watershed management - woodland area and damage their crops. In Sadoye and Megere kebele (Welecho micro-watershed), beginning in 2011, hyenas have moved into the managed watershed and have hurt cattle and people. This has had a negative effect on the community's perception about the management activities. The progressive decrease in number of participants after a few days of campaign work is another challenge in Ela Kabala kebele. In Tuba micro-watershed of Soresha kebele, water accumulating in the soil bund increased land sliding at the upper end of gully. In addition, water logging inhibited seedlings survival.

Good practices that help maintain or improve the micro-watersheds' functioning were observed in some of the kebeles. In Angacha and Borecha wereda, 78 and 76% of the respondents (respectively) practice a tie and graze system that help to regulate degradation of the micro-watershed by livestock. The remaining 22 and 24% of the respondents in the respective weredas practice grazing openly on common land. In most kebeles of Kambata Tambaro zone, there is an agreement to implement zero grazing on cultivated land, which supports sustainability of the built structures and maintains soil fertility.

Table 4 Commonly implemented soil and water conservation structures in respective micro-watersheds and their appropriateness

Kebele	No of evaluated Micro-watersheds	Elevation (m a s l)	Average annual Rainfall (mm)	Slope (%)	Commonly Implemented physical soil and water conservation structures	Appropriateness of structures selection
Yiriba Dubancho	2	1980-2020	1070.6	13-30	soil bund, fanyajuu, trenches	Appropriate
Hanja chafa	2	1928-1945	1070.6	10-30	soil bund, fanyajuu, trenches, micro- basin, stone bund	Appropriate
Koran Goge	2	1925-1940	1070.6	5-21	trenches, micro- basin, eye brow	Appropriate
Debub Kege	2	1730-1734	1209.1	5-15	Trench, soil bund, fanya juu	Appropriate
Megara	2	1765-1792	1209.1	3-6	Fanya juu, stone bund, trench	Appropriate
Kaleta Senete	1	1970	1209.1	1.5	Soil bund, cutoff drain, eye brow, trench	Appropriate from the point as it formed depressed land due to erosion
Kota kombola	3	2000-2110	1156.5	10-40	Soil bund, fanya juu, trenches, micro-basin	Appropriate
Ha'amancho	1	2100-2200	1156.5	26.5	Soil Bund, Fanya juu, trench, Micro-basin	Appropriate
Megere	1	2040-2160	1156.5	1.5-30	Soil Bund, Fanya juu, trench, Micro-basin	Partially appropriate
Zebecho	3	2200-2729	1565	20-45	Soil Bund, Fanya juu, trench, Micro-basin	Partially appropriate
Bucha	3	2060-2170	1565	5-20	Soil bund, fanya juu	Appropriate
Gede Genet	3	2100-2180	1565	5-20	Soil bund, fanya juu	Appropriate
Abela Faracho	3	1386-1417	1132.3	1.5-3	Soil bund fanya fuu	Partially appropriate
Abala Sifa	3	1440-1449	1132.3	1.5-3	Soil bund fanya fuu	Partially appropriate
Ela kabala	2	1520-1580	1132.3	3-17	Soil bund fanya fuu, trenches	Appropriate
Yakima	3	1920-2200	1056.1	10-55	Stone bund, soil bund, fanya juu	Partially appropriate
Sadoye	2	1700-1780	1056.1		Soil bund, fanyajuu	Appropriate
Soresha	3	1570-1673	1056.1	3-10	Stone bund, soil bund, fanya juu, micro-basin, trench, check dam	Appropriate
Addis Bodare	2	1351-1399		5-35	Stone bund, soil bund	Appropriate
Gendo Walcha	1	1970-1870	1731.1	3-25	Soil bund	Appropriate
Gedo Buna	1	2598-2610	1731.1	10-30	Soil bund, fanya juu	Appropriate
Mari Madara	1	2400	1731.1	10-67	Soil bund	Partially appropriate
Gobo Shamana	1	1900-2200	1731.1	10-30	Soil bund fanya juu	Appropriate

In Garato micro-watershed, the common land is used for grazing and is poorly guarded. Thus, the effect of watershed management is minimal. In Garato micro-watershed, all the interviewed farmers expressed appreciation for the good effects created by the soil conserving structures. However, some farmers demolished the campaign-built structures and/or poorly maintained sections broken by flooding or livestock.

In Sadoye kebele and some other micro-watersheds (i. Golota, Alelecho, Manto-Danchame, Gorbato, and Awash) on common lands, exclosures are created along with various interventions, such as planting seedlings, and these areas are guarded by employed personnel. Payment for

people to guard the management areas is arranged by the woreda agriculture office, either from their normal budget or through a safety net program (if the kebele is a beneficiary of the program). Even though the community understands they have invested their labor to improve the land and thus have a stake in the project's success, they tend to expect the guards to protect the area. In practice, such guarding is difficult to sustain because of uncertainty of wages from temporary sources and the changing interest of the community towards the land use.

In Alelecho, Bantola, and Golota micro-watersheds and Soresha kebele, there is a plan to handover the rehabilitated common land to a jobless youth association who will

sustainably manage the land. This intention appears hopeful provided that there is sufficient discussion with the community, a clear plan is developed, regulations on resource utilization and management are agreed upon, and relevant technical support implemented.

Intensive rainfall, livestock, and land use processes can damage the physical soil and water conservation structures such as soil bunds, stone bunds, *fanya juus*, trenches, and micro-basins. Therefore, it requires frequent removal of sediment from channel and other maintenance activities. In micro-watersheds of Soresha and Sadoye kebeles where management activities occur on common land, the maintenance work is undertaken by the community through labor investment or safety net program support. On individually owned land, structures built by the public campaign are expected to be maintained by the owners. Through field observations and discussions with key informants, it was determined that most of the land owners in Kota Kombola, Ha'amancho, Megere and Zobecho kebeles are both undertaking the normal maintenance work and also strengthening the structures (soil bunds and *fanya juus*) with 'desho' grass (*Pennisetum pedicellatum*). In Angacha and Damboye wereda, good interest for repairing the structures was observed with 86% of respondents willing to maintain the conservation practices by investing family labor and the remaining 14% preferring to wait for external support.

Even though some efforts exist, the trend of repairing structures built by public campaign work, and which land users are expected to maintain, is poor in the assessed micro-watersheds of 19 kebeles (excluding the above 4 kebeles). Generally, they tend to wait for public campaign work and development agents to take care of the maintenance. For instance, about 78% of respondents in Borecha wereda wait for campaign work and 22% attempt to repair by using family labor. Some farmers ignore the structure after they have been damaged by rain and livestock and others remove the improvements during the tillage process. Reasons such as lack of awareness and household labor shortage can be considered as excuses for these behaviors, but the existing situation hampers the long-term defensive function of these structure and challenges productive land sustainability.

Another challenge of watershed management public campaign work is the poor program adoption and replication. The rate of replication and adoption of the introduced technology by land users is important for sustainability. The ongoing public campaign is actively promoted for only a month and less active for 11 months of the year. In this survey of 23 kebeles, efforts were made to determine replicated and adopted farmers or farmers who built a significant number and length of structures by involving the family labor. Except for the traditional stone bunds in Adis Bodare kebele, no significant replication or adoption effort

occurred. In previous studies many site specific socio-economical and biophysical situations influenced the replication and maintenance of structures (Amsalu and de Graaff 2006; Bewket 2006; Nyangena 2007; de Graaff et al. 2008; Kebede 2014).

In Kota Kombola kebele, there is significantly big degraded and abandoned area (Figure 4), which requires huge investment than the local labor. This challenges the community to achieve watershed management for entire kebele within few years. In all considered kebeles, the achievement data obtained from records/reports did not fit the amount of activity audited in many micro-watersheds. This also needs serious attention and discussion with the concerned institutions.

Lessons learned from watershed management practices

The watershed management activities have acted as practical models for understanding environmental issues and rehabilitating degraded land. Participatory integrated watershed management has been implemented in degraded micro-watersheds for four consecutive years by public campaign approach. The effective and quickly responding impacts of implemented practices in 'severely degraded' micro-watersheds demonstrate the real possibilities of rehabilitating degraded areas. Related effort and significant achievement was reported for Nepal (Tiwari et al. 2008). In India, such watershed management improved ecological and environmental status of the resource and positively enhanced socio-economic situation of the community in the watershed (Pathak et al. 2013).

In Hanja Chafa kebele, farmers were not interested in participating in management work because the land was badly degraded and it appeared it would be hopeless to restore. However, after structures were built, grass began to regenerate/grow, tree species appeared and flooding was reduced in the restored area (Figure 5d). In semi-arid area of India, such watershed management improved ground and surface water resources (Khajuria et al. 2014). Another study in Millsboro indicated that watershed management activities such as improved nutrient and land cover management reduced nutrient load in water (Sood and Ritter 2010). In Blue Nile basin watershed management also significantly reduced soil erosion (Amdihun et al. 2014).

In Alelecho micro-watershed, the severely degraded land appeared hopeless to try and restore. Following management work, the farmers saw a surprising change. The rainwater was controlled, grass began to grow, and seedling survived. The farmers learned that the watershed improvement activities were a good investment toward the future. Similarly, in Dilamo micro-watershed, Kota Kombola kebele, the previously degraded area containing a network of gullies and exposed parent materials, was hardly suitable for humans even to cross. Intensively managed



Figure 4 Partial view of abandoned degraded land in Kota Kombola kebele, waiting for watershed management.

since 2010, significant rehabilitation has occurred characterized by abundant grass, controlled water runoff, suitable micro-climates, and improved soil fertility. A farmer reported 'the fertility and land cover is improved in such a way that people who knew this area previously, but

have been gone for a while, may hesitate/get confused on accepting the improved situation'. Areas like this help to develop awareness and serve as a real-live demonstration.

The improved survival and vigorous growth of seedling in Golota micro-watershed of Debub Kege kebele



Figure 5 (a) Introduced fodder grass in zobcho kebele (b) *cajanus cajan* in Gendo Walcha kebele (c) typical soil bund modified to reduce the land occupied by it in Gede Genet kebele (d) exemplary rehabilitated land by watershed management in Hanja Chafa kebele.

has been achieved by planting seedlings in pits filled with forest soil and imported compost. The area serves as a model for tree seedling planting on poor land. In Gede Genet, Bucha and other kebeles the farmers modified the soil bunds to reduce the area of land occupied by the structure (Figure 5c). The effectiveness of this new design is still being tested. In most micro-watersheds, farmers attempt to make the embankment of structures productive by growing fodder grass (Figure 5a) and *cajanus cajan* (Figure 5b).

Even though landslides are not frequently observed as result of building physical water impound structures, they were seen in soil bunds built in Soresha kebele in Tuba micro-watershed. This land slide sensitivity needs to be considered for future management planning as it is important lesson. This risk of land slide might be due to poor subsurface water flow due to local geology.

Conclusion and recommendation

In most of the surveyed micro-watersheds, even though improper land use affected soil productivity on individually owned lands, common use lands were universally severely degraded and will demand intensive investment to restore. All watershed management by public campaign work had the objective to rehabilitate such degraded lands. To alleviate these problems, the government attempted to mobilize communities by using preferred conservation structures. The survey revealed that in each studied kebele there is strong organizational structure that helps to inform and mobilize people for intensive watershed management work. The kebele development teams have authority and responsibility to motivate participation, and to punish absentees in campaign work. It was this team that significantly contributed to the achievement of observed results. These results, such as well established tree/shrub plantations, rehabilitated lands, fodder grass established on bunds, and the planting of soil fertility improving species such as *Cajanus cajan* can be considered as excellent land management lessons which can motivate the public to participate in such labor-intensive tasks.

In the studied micro-watersheds, most of the species planted on these degraded lands were suited to the agro-ecology and poor site conditions. However, the poor survival observed in some micro-watersheds needs technical and planting time consideration. In most micro-watersheds, structure selection, design, construction and spacing were appropriate. However, in some micro-watersheds errors need correcting such as poor stone bund foundations, bunds with narrow berms, shallow channel depth, and too long bunds without space for land users to move across farmland. In addition, the effort to repair the broken/sediment filled structures is poor in many area and needs attention, which influence the long-term fate of these structures.

Micro-watersheds, where the habitat and vegetation has improved, often see an increase in wildlife use. Farmers complained that these animals damage their crop and/or attack their livestock. This might create a negative perception towards the management work. Ways to effectively control the impacts caused by wildlife needs to be investigated.

Experts in many kebele were optimistic on finishing the first round of campaign work, wanting to complete the entire kebele within a few years. However, in some kebeles, such as Kota Kombola there are large areas, with serious degradation problems that will require long-term intervention and probably external support (Figure 4). In all kebeles, the actual work needs to match the reported accomplishments. Managed watersheds, especially common lands, need arrangements to assure future sustainable management and utilization.

Endnotes

^aweredas is roughly equivalent to district and is the next higher administrative division to kebele in the country.

^bkebeles is the lowest government structure in the country.

^c'keberite' The local leader who own comparatively wide rural land and rent for other landless farmers during regime of emperor Haileseilase.

Abbreviations

BoFED: Bureau of Finance and Economic Development; CFSCDD: Community Forests and Soil Conservation Development Department; CSA: Central Statistical Authority; NGO: Non Governmental Organization; SNNPRS: Southern Nations, Nationalities and Peoples Regional State.

Competing interests

The author declares that he has no competing interests.

Author's contributions

KW: designed the research idea, field method, collected data, analyzed data, interpreted data and produced report.

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