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Watershed degradation and the growing risk of erosion in Hawassa-Zuria District, Southern Ethiopia

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Abstract

Watershed degradation has resulted in high risk of erosion followed by risk of flooding in the lowlands and has become the most livelihoods' threatening factor in Ethiopia in general and in the fragile watersheds of Hawassa Zuria District in particular. The objectives of this study were: (a) to assess farmers' practices of land, water and biomass management in order to improve their livelihoods; (b) to assess the existing risks and interventions and the condition of the watershed; (c) to assess the socio-economic patterns of the farmers in the watershed. A group discussion with different stakeholders, key informant interviews and observational survey through transect walks have been used as methods of data collection. The study result has shown that the most threatening factor of degradation is gully erosion due to vegetation removal from the watershed. About 94% of the farmers used and agreed that they stabilised gullies by physical and biological measures; 60% and 88% of the respondents, respectively have indicated diversion of run-off above the gully and improvement of gully catchments as a means of gully erosion measures and reduce flooding risks in the lowlands. Community awareness creation on natural resource conservation and management as well as resolving tenure disagreements can also play role in gully control and land rehabilitation.

Introduction

Nowadays in most parts of Ethiopia, watersheds are facing extreme degradation due to intensive cultivation, overgrazing, increased population, increased deforestation and other human actions (*e.g.* Lakew *et al.*, 2000; Asefa *et al.*, 2003; Takele, 2007). These processes are destroying the balance between natural resources such as soil, air, water and vegetation and human needs in areas that suffer from these changes, and farmers are subjected to climate change shocks (Temesgen *et al.*, 2008). More specifically, soil degradation which takes any of the forms (erosion by water and wind, salification or alkalisation, chemical, physical and biological degradation) is becoming the most livelihoods' threatening factor in the fragile watersheds of Ethiopia resulting into the loss of production capacity. For instance, land degradation in the Ethiopian highlands has brought an estimated annual production loss of up to 2% (Bizuayehu *et al.*, 2002).

One existing intervention in Ethiopia is adoption of the agroforestry approach. Agroforestry has a paramount importance in mitigating the adverse changes in traditional smallholder-farming systems (Shrivastava, 1997; Blay *et al.*, 2004; Temu *et al.*, 2004). Trees have two roles in the farming system. First, through their role in maintaining and restoring the physical environment, crop agriculture is sustained; most notably through the restoration of soil nutrients and energy. Second, the role various tree products play in helping sustain the rural household economy, such as products used directly by the household as food, fuel, construction materials, etc., inputs to agriculture such as fodder, mulch and raw materials for making agricultural implements and storage structures; and products or activities that provide household members with employment and income (Baumer, 1990; Arnold and Dewees, 1997; CIFOR, 2005; Mekonnen *et al.*, 2007), is fundamental. Hence, promotion of tree growing on marginal lands and enhancing the adaptive capacity of farmers to plant trees appear to be necessary in order to create new wood stocks where they are readily accessible to the main body of users. This will help in reducing pressure on the remaining forests, and to re-establish a protective tree cover in environmentally fragile landscapes (Hagmann and Chuma, 2002; IUCN/UNEP/WWF, 1993).

Although natural resources play a key role in the above functions, their unsustainable utilisation by people can result in land degradation, loss of habitat and biodiversity and pollution (Fanta, 1997; CIFOR, 2006). Forests are

declining rapidly mainly due to their conversion to arable lands coupled with overexploitation associated with the ever-increasing demand of communities for wood products encouraged by the rapidly growing human population. The population of Ethiopia in the three censuses of 1984, 1994 and 2007 were 39, 868 572; 53 477 265 and 73 918 505, respectively (CSA, 2008) nearly doubling in this period. The effects of these phenomena, in turn, have affected and continue to affect negatively the socio-economic conditions of the communities as well as the functions of the environment (Badege, 2001; Blay *et al*., 2004).

The government of Ethiopia has recently adopted watershed development strategies that strongly commit her to participatory approaches to solve watershed problems which have resulted in ecological, economical and social benefits to farmers (MOARD, 2005). Unstable watersheds induce unstable production systems, and inefficiency of input utilisation as erosion also erodes efforts to increase productivity. To counteract this, it is necessary to undertake proper soil, water and vegetation conservation measures to rehabilitate and reclaim degraded and marginal lands by using a mix of trees, shrubs and grasses (Blay *et al*., 2004).

According to Amare *et al.* (2005), it has been found that the national full nutrient balance of Ethiopia is −122 kg/ha/year for nitrogen, −13 kg/ha/year and −82 kg/ha/year for phosphorus and potassium, respectively, while it was −62 kg/ha/year, +9 kg/ha/year and −42 kg/ha/year of nitrogen, phosphorus and potassium (NPK) respectively, for the Southern Nations Nationalities and People's Region (SNNPR) in south Ethiopia. In the same source, to reduce nutrient export, it was found that permanent crops of agroforestry potential have high soil protection and conservation prospective. It is recognised that increased exploitation of land resources in the upper parts of watersheds results in increased sediment yield and elevated nutrient loads in run-off that reduce water quality and availability to downstream users. Gully erosion is often the main sources of sediments, which is 70% for northwestern Ethiopia (Valentin *et al*., 2005).

Management of gully erosion by different measures of within the gully and intergully zones could enhance soil fertility, which is the measure of the ability of the soil to supply essential nutrients in the right amounts and at the correct proportion at the right time (Valentin *et al*., 2005). It has been concluded that watershed management through the maintenance of vegetation cover, and adoption of agroforestry system could minimise the biological, chemical and physical degradation of the soil and help the soil to provide its functions properly (Bizuayehu *et al*., 2002). Participatory watershed management is about putting people on the land and doing so in a way that does not degrade the very resource on which they depend (Moore, 1994; Shin and Lee, 2004). Integrating activities for conservation and development through people's participation and collaboration among different institutional and social actors is being increasingly recognised as the most promising approach to sustainable natural resource management. Land and vegetation rehabilitation either by agroforestry approach or biological soil and water conservation measures are some of the best efforts to reverse the trend of land degradation (Feyera and Demel, 2002; Venkateswarlu and Sanghi, 2003).

Objectives

The general objective of the study was to pinpoint on how to bring sustainable land, water and biomass management and improve livelihoods in the subwatersheds, and the specific objectives were:

- to assess farmers practices of land, water and biomass management which they undertake to improve their livelihoods in the subwatersheds;
- to assess the existing risks of erosion and flooding and possible interventions that were taken and/or to be taken in the subwatersheds;
- to assess the condition of the watershed and the socio-economic patterns of the farmers in the subwatersheds;
- to assess awareness of the farmers on environmental conservation.

Materials and methods

Area description

In Southern Nations Nationalities and People's Region of Ethiopia there is dense forest diversity and coverage in the fragile ecosystems including montane and afromontane forests. However, has been found that (Amare *et al*., 2005) there is fast degradation of the natural resources in the region. It was learnt that there is high loss of forest biodiversity and degradation in the watershed of Hawassa Lake; particularly, the three subwatersheds of Umbulo-Wacho, Tenkaka and Kajima are severely degraded. These subwatersheds are mainly encountered greater population pressure accelerating natural resources degradation which resulted in low production potential. This was the guiding idea to select the site to conduct the research. The study site is about 20 km south-west of the regional capital Hawassa and 290 km south of Addis Ababa located at 07°01′ 54″ to 07°50′ 36″ N latitude and 38°15′ 39″ to 38°25′ 43″ E longitude, and the altitudinal range is 1700 m to 1850 m a.s.l. The annual mean maximum and minimum temperature are 30 °C and 17 °C respectively, and the mean annual rainfall is 1015 mm.

Topography

The topography of the area is undulating flat to gentle slope hill bases to steep slope hills. The hills are much degraded as

a result of erosion that forms a lot of gullies which start from the hills and extend into the farmlands at the hill bases.

Soil characteristics

The physical characteristics of the soil at the site are as follows: very porous, sandy-loam, shallow at top and along the slope length of the hills and deep at hill base in which augering is done up to 150 cm without difficulty, susceptible to erosion by water, and grey in appearance.

Socio-economy

Mixed farming: Maize (*Zea mays*) is the dominant staple crop in the area which the farmers produce year after year with less chance of crop rotation due to small-sized land holdings. *Ensete ventricosum* and *Eragrostis tef* are also the major crops grown by farmers in the area. Cattle, sheep and goats and equines are the common livestock reared in the area.

Tree farming: *Most* common tree and shrub species available in the watershed include *Acacia spp*. on farm lands and hillsides, *Ficus spp*. on farm lands, *Croton macrostachyus* on range lands, *Euphorbia turcalli* as live fences, *Cordia africana* on farm lands and home gardens, *Azadrichta indica* at home gardens, *Eucalyptus camaldulensis* on border, woodlots, boundary and home gardens[1], *Grevillea robusta* at home gardens and farm borders.[1]

Methodology

- Three groups, one each from a subwatershed, consisting of about 37 randomly selected farmers from each parts of each subwatershed were selected for group discussion to gather information on the management practices the farmers adopted to tackle land degradation, mainly of gully erosion;
- Observational survey through a systematic transect walk along a gully structure running from uphill to downhill and vice versa including gulley inventory such as width and depth was made at each subwatershed with five each randomly selected transects per subwatershed;
- Discussion and interview with 13 selected key informants who have more know-how about the area concerned was made regarding trend of vegetation cover and the consequent risk of erosion and flooding;
- Focus group discussion (FGD) with 64 participants, of which five were women (51 participants from subwatersheds, 17 from each; the 13 key informants were also in the discussion group for information triangulation) with multiple stakeholders including experts, development agents, farmers, watershed committees, administration and non-governmental organisation (NGO) representatives; and also secondary data were gathered on climate as well as animal and human population. The FGD has been carried out to have a common understanding on how to rehabilitate the degraded hills.

[1]Highly demanded by farmers.

Data analysis

Qualitative data such as obtained from farmers, the focus group discussion, key informants' opinions and field observation were interpreted and analysed on the spot. The collected quantitative data were analysed using simple descriptive statistics.

Results and discussions

Opinions from Umbulo Wacho community

It was recognised during the transect walks' field observations that the subwatershed is almost become bare and degraded (Plate 1). However, there is some recovery at the top of the subwatershed due to some intervention by planting *Acacia saligna* by Meserete Christos (local NGO) and control of animals from entering to the site. When farmers were asked what they feel when they see the land degraded that way, and what were the possible causes; they responded, 'we are very discouraged by the loss of trees and soil from the landscapes which was dense woodland before. The cause was ourselves in that we had removed the entire tree and converted the land for agriculture. The consequences has brought the current sever [sic] conditions which even threaten our lives'. The farmers said that 'in *Sidamgna Umbulo* means dense forest and *Wacho* means acacia, that is, *Umbulo Wacho* means dense acacia forest'. They have expressed their willingness to cooperate and participate in a programme which enables them to recover their degraded landscapes.

Opinions from Tenkaka Umbulo community

During group discussion and observational survey, it was learnt that land degradation at hill sides is the major cause of flooding downstream and the formation of most of the gullies (Plate 2). Farmers remarked that they are willing to treat the gullies, but some of the gullies are beyond their control. Tenkaka subwatershed was proposed by farmers for soil bund construction as there was a start-up action by the Safety Net Programme, which requires maintenance and strengthening. But some consensus was not reached with regard to enclosing the area because some farmers become reluctant about the enclosure as the area is their grazing land. Other participants agreed that enclosure system is one

Plate 1 Parcel of a degraded subwatershed (left), gully formation (centre) and discussion on how to solve it (right) (photo, Zenebe M. 2009).

Plate 2 Part of selected subwatershed (top centre) and the two gullies at its outlet (top left and right) and discussion with farmers (bottom) (photo, Zenebe M. 2009).

option to recover the degraded site, and they can use the grass by cut and carry system to their livestock.

Opinions from Kejima Umbulo community

Farmers had explained that there is a need to undertake a development action in this particular subwatershed (Plate 3). The farmers who participated in the discussion have agreed that it is the responsibility of the community to take action in order to rehabilitate the degraded watershed. They also agreed on the need to create awareness in reluctant participants on the development works for their local development and environmental conservation. Upon discussion, farmers commented that there is some improvement in the

Plate 3 Subwatershed (left), a gully at its base (right) and discussion with farmers (photo, Zenebe M. 2009.

Table 1 Chronological dynamic changes at Wacho, Tenkaka and Kajima subwatersheds

	Dynamic changes				
Period	Vegetation	Population	Soil erosion	Temperature	Rainfall
Pre – 1974	• Good vegetation cover • Abundance and richness was high	Low	• High-infiltration rate • Low-erosion rate • Less flooding risk and sedimentation	Normal	Normal
1974–1991	• Vegetation cover started to decline • Abundance and richness was declined		• Surface run-off was accelerated • Rill and sheet erosion had risked farmlands	Warmer	Variable
Since 1991	• Deforestation was accelerated and there exist small planted exotic and some retained trees in the landscape	High	• Severity of erosion has increased • Huge gullies become common here and there	Warmer and variable	Erratic and variable

recovery of vegetation in the watershed in general and in this subwatershed in particular. They remarked that the utilisation of resources such as grass after the recovery of the subwatershed should be on cut and carry system with fairly and equal resource distribution and agreed to set by laws in the future.

Comprehensive community opinions from the three subwatersheds

Focus group discussion with key stakeholders from each subwatershed revealed that participatory approaches are the tools for successful watershed management. The subwatershed committee members as being one of the key stakeholders have raised during the discussion that the main problem to manage the hills is land ownership rights. If there is land ownership, even one single person could manage those severely degraded hills within a short period of time. But on communal land, undertaking planting efforts have encountered failure. 'We had planted the hills two to three times before now, but the survived seedlings are very insignificant in number', said the participants. This was due to lack of follow-up, monitoring and evaluation from the technical staff and community. It was mentioned that dedication and commitment of the community and administration bodies is key to affect planned objectives in natural resources management. There is a need for awareness creation for the community and to build a confidence of ownership that the resource is theirs and can be utilised wisely for them. By doing so, they can improve their local environment and enhance their livelihoods.

Because people participation and collective action are critical ingredients for watershed management, as could be understood from FGD with the community. From the discussion, the following key ideas were forwarded by participants as causes of watershed degradation:

- 'There were naturally grown trees on the hills such as *acacia* species, *Croton macrostachyus* and *Dodonia angustifolia* as I know in my age since 1941 but they are lost this days due to overuse', said an elder (Table 1);
- In the pre-1991years before the government change, there was at least a grass cover on the hills as there was a

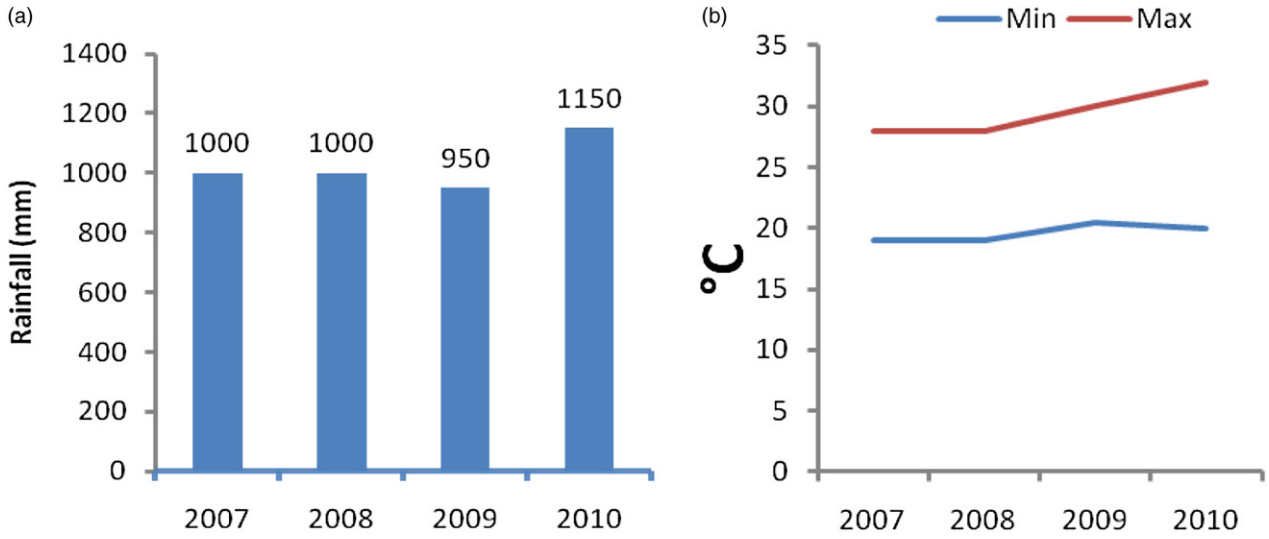

Figure 1 (a) Mean annual rainfall (mm) and (b) annual minimum and maximum temperature (°C) of Hawassa Zuria District.

follow-up from the technical staff, but at present there is no follow-up;

- There is lack of intervention to rehabilitate the degraded hills, and the floods come from the hills severely eroding our farmlands and resulting in loss of crop production;
- The hills are common lands under the control of the local administration, but it is the farmers neighbouring the hills that participate at planting for example, but during benefit sharing, farmers from far away also take the benefit, this had created discouragement to the farmers near by the hills;
- Farmers explained their need to differentiate clearly who will be the primary beneficiary of the end products, such as grass or wood, after the hills have been recovered. This is because resource sharing is the critical problem to manage the subwatershed as experience showed in the recent past;
- Farmers claimed that the local administration must give an approval of ownership right to farmers neighbouring the hills with full responsibility to manage and benefit from the end products. In that case, we can build confidence to manage the resources, said the farmers;
- It was also pinpointed by the participants that, in the past, several efforts were made to rehabilitate the watershed, but success was limited due to inappropriate watershed management principles such as from top to downhill soil and water conservation treatment approaches.

Biophysical dynamic changes in Wacho-Tenkaka-Kajima subwatersheds

The outcome of field survey and assessment of secondary data has shown that there is a general and gradual decrease in the vegetation cover in Wacho, Tenkaka and Kajima subwatersheds as a result of accelerated deforestation. This might be amalgamated with the increasing population and climate variability which leads in rainfall and temperature fluctuations (Table 1). The rainfall varies from normal to erratic, and the temperature from normal to warmer as compared to normal. The soil has lost its fertility because of intense erosion which results in loss of crop production.

Table 2 Rainfall pattern of Hawassa Zuria district according to information from ARDB

	Rainfall pattern as compared to normal		
Year	Rainfall amount	Rainfall onset	Rainfall distribution
2006	Normal	Normal	Variable
2007	Normal	Early	Erratic
2008	Normal	Normal	Uniform
2009	Less than Normal	Late	Erratic
2010	More than Normal	Normal	Unusual

Change in weather patterns and land degradation

According to the information from the district Agricultural and Rural Development Bureau (ARDB) and the response of the farmers according to their long experience, it was recognised that there is some temperature increase in the district and slight variation in the annual average rainfall (Figure 1a, b &Table 2). As a result of erratic rainfall and vegetation degradation from the hill sides, there is a resultant decrease in biomass and crop production in the district in general and in the watershed in particular. As of the information from the same bureau, due to a slight increase in the average annual temperature, the evapotranspiration rate also increased, and soil moisture content has decreased.

During field assessment in the watershed and from the farmers' interview, it was found that there are some interventions such as soil bunds already started to combat land degradation by the ARDB, Food Security and Disaster Prevention and Preparedness Bureau and NGOs (Table 3). However, the management options undertaken were not satisfactory in their effectiveness and efficiency to stop the land degradation to the required level, and there is continuous gully erosion which risks the livelihood of the farmers due to poor construction design and lack of maintenance, and the degree of existing intervention was low (Tables 4 and 5). However, some individual farmers have managed fruit trees (*Manifera indica, Annona muricata, Papaya carica, Persea americana* and *Psidium guyava*) at their homestead by supplying moisture to the seedlings by flood irrigation. This approach is also a means to control flooding. The work of such farmers should be encouraged and scaled up to other neighbouring farmers. Gullies, if not treated at their first stage, shallower depth and narrower width, they will become more severe and beyond the control of farmers to rehabilitate them when they reach at their third stage of development by which they are deeper and wider (Table 4).

Table 3 Farmers' responses on gully control measures; based on interview

Gully control measures	Frequency % of respondents who favour the measure (n = 112)
Diversion of run-off above the gully	60
Improvement of gully catchments	88
Stabilising gullies by physical and biological measures	94

Table 4 Gully development stage inventory in the study area

Gully development stages	%	Depth	Width	Shape
First stage	29	< 1 m	1–3 m	U-shape
Second stage	24	1–5 m	4–6 m	U- V-shape
Third stage	47	> 5 m	> 6 m	V-shape

Human and livestock population as a cause of land degradation

The total population of Hawassa Zuria District is 139 891 of which the population in Wacho-Tenkaka-Kajima subwatersheds accounts 13.4% (EPC, 2007). Based on the information from the elders who have lived long in the subwatersheds, it was recognised that there is high human population increase (which is 101 206 when extrapolated from the EPC, 2007 to the year 1994) in the area resulting into land shortage for cultivation, leading to the consequent encroachment of hillside woodlands into farm lands. The

Table 5 The land management options and the situation of existing intervention in Wacho, Tenkaka and Kajima subwatersheds based on transect and field assessment

Management options	Degree of intervention	% of assessed farms/fields for each degree of intervention
Land management (N = 112)*	Low	62.2
• Contour trenching	Low	86.3
• Terracing on farmlands	Low	79.0
• Use of minimum tillage	Not operational	100.0
• Reclaim gullies by physical and biological measures	Low	79.6
• No land management at all	Nil	37.8
Water management (N = 112)		38.0
• Water harvesting techniques	Medium	19.5
• Moisture retention (Mulching) methods	Low	85.9
• Control of run-off	Low	75.4
• Increasing infiltration rate	Low	84.7
• No water management at all	Nil	62.0
Biomass management (N = 112)	Medium	46.1
• Conserving the remaining vegetation on the hills	Medium	15.2
• Enriching the degraded land by tree planting	Medium	26.1
• Use of grass by cut and carry system from the 'enclosure area'	Not operational	100.0
• Adopting agroforestry trees on the farmlands to diversify production and generate income	Medium	59.5
• No biomass management at all	Nil	53.9

*The percentage for submanagement options is for those farmers who did management at their farm/fields, not from the total of 112 farmers assessed. There is overlapping of activities on the same farm and the sum of percents of the submanagement options is not summed up 100%.

grabbing of dense acacia woodland for agriculture has caused severe land degradation followed by erosion. It was understood that almost 70% of the district has been under annual crops, and only about 2% and 3% of the district is covered by woodlands and plantation forests respectively.

The livestock population in the district in general and in the three community villages in particular is also high (Figure 2) and has resulted the overgrazing of grazing lands which leads to accelerated soil erosion and the resultant siltation of Hawassa Lake and the surrounding wetlands. This in return affects aquatic biodiversity.

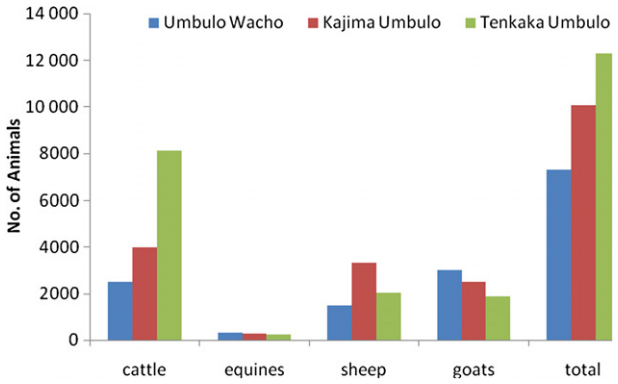

Figure 2 Animal population in Wacho, Kajima and Tenkaka subwatersheds.

Risks assessments

From the feedback of experts, farmers and observational transect walk and based on the characteristics of the subwatersheds (Table 6) it has been recognised that:

- gullies are damaging the farm lands and houses of some farmers in the proximity;
- erratic and heavy rainfall and very short rainy season, whereas prolonged dry season has reduced crop production;
- siltation of Hawassa Lake results from the erosion sediments from the watershed;
- advancement of the gully heads to the upper ends of the watershed is occurring;
- man-made factors, such as improper land use, hill top grazing, road construction, livestock-vehicle-footpath trails and physical factors including rugged topography, sandy-loam soil less resistant to erosion, poorly managed vegetation cover and heavy rainfall within short time, were found to aggravate gully formation in Hawassa Zuria District.

The major threats observed in those particular subwatersheds were deforestation, soil erosion, overgrazing, malpractice in land use management – uphill cultivation, poor rain water management, vegetation damage, uphill settlement- and population pressure. Watershed degradation results to the following: loss of production and land productivity, poverty and livelihoods vulnerable to shocks, increasing mud load in streams and rivers causing the decrease in water

Table 6 Assessment study on the characteristics of Wacho, Kajima and Tenkaka subwatersheds

Watershed parameters	Description of the parameters
Climate	• Mean annual rainfall is about 1015 mm • Mean annual temperature is about 24 °C • Humidity is less than 30% • Frequency of drought is almost decadal
Land forms	• The slope aspect in most of the watershed is east facing • The watershed form is undulating
Soils	• The physico-chemical aspect is coarse textured, grey coloured and sodic- alkaline • The soil depth is shallow at hill's top and along the slope gradient and deep at the base of the hill • The land use capability class of the soil is low to medium
Vegetation	• The density is very low • It is savannah type grass dominated woodland • The canopy cover is less than 5% • The degradation status is very high
Surface water	• Run-off is high • Storage/infiltration is low • Evapotranspiration is high
Land degradation	• Gully erosion and over grazing are the main causes • The severity of degradation is high
Land use	• Present common land use is farming and rangeland • The cropping pattern is maize • Crop productivity is declining • The land use change from woodlands to farm is high • The land use main problem is lack of land use planning and traditional form of cultivation

quality and quantity, vegetation removal leading to loss of biodiversity, leaching and removal of nutrients from the hills because of poor land management increased salt concentration in the lower streams (the resultant damage to irrigated crops), siltation of Hawassa Lake and the surrounding wetlands (and subsequent damage to aquatic biodiversity) and increased risk of flooding hazards in the lowlands (the resultant damage to infrastructure, settlements, human lives and aquatic environments).

Conclusion and recommendation

In Wacho, Kajima and Tenkaka subwatersheds, the surrounding hills are bare of trees with some grass cover. Currently, the risk of erosion to the hills and hillside farmlands is high, and this will continue to pose more danger if there will be no intervention at the subwatersheds. However, there are some interventions on hills, such as enclosure from domestic animals gone astray, trenching and tree planting effort. But this seems not successful because the farmers have shortage of grazing lands so that they couldn't prevent domestic animals into the enclosed subwatersheds. This will require strong institutional arrangements by creating awareness to the people of the community through extension and public education so that they will be determined and committed to manage the subwatersheds. The administrators as well should strengthen their follow-up and land use policy reforms. There were some efforts by individual farmers in that they have planted some tree species like *Grevillea robusta* and *sesbania sesban* at their farm borders and homesteads and some in woodlots such as *Eucalyptus*. Some individual farmers have managed fruit trees (*Mangifera indica, Annona muricata, Papaya carica, Persea americana* and *Psidium guyava*) at their homestead by supplying moisture to the seedlings by flood irrigation. This approach is also a means to control flooding by diverting a considerable volume of the flood into manageable water utilisation that reduces flooding in the lower fields. The work of such farmers should be encouraged and make known to other neighbouring farmers, too.

There must be consensus on the problems to be addressed and on the desired research and development objectives among key stakeholders, such as farmers, NGOs, government offices, etc., to bring about effective watershed resources management. Partnership must be built on mutual trust, respect and ownership. The partners must combine both the hard and soft approaches to conduct participatory watershed management to reduce the existing risks and improve the livelihood of the farmers. Teams that able to work effectively across disciplines with clear institutional roles, commitment and good team management at each level of an institutional hierarchy is crucially important. Free-thinking management from the stakeholders is needed for

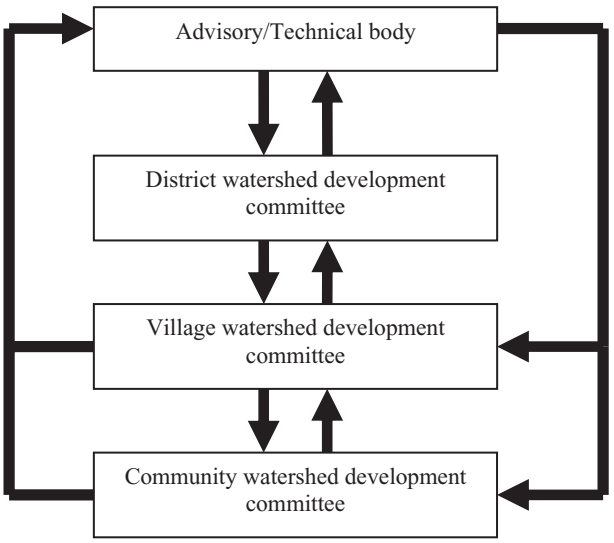

Figure 3 Institutional arrangements and information flow when undertaking watershed management operation at Hawassa Zuria District.

watershed management in Hawassa Zuria District. The following model (Figure 3) has been proposed by the multidisciplinary discussion group in order to bring effective and efficient watershed management in Hawassa Zuria District.

In order to minimise the watershed degradation and encourage sustainable development, the following risk aversion strategies should be recommended:

- effective participatory natural resources management planning;
- natural resources policy reforms by local government;
- land use planning rules and regulation by local government as well as local bylaws;
- reclamation of severely degraded watersheds through community participation;
- market-oriented livelihood support strategy setting by local government;
- setting rehabilitation methods and conservation-based development strategy that increase land productivity;
- development of resources valuation models and encouraging payment for environmental services by creating awareness on willingness to pay.

In this study, it has been recognised that participatory watershed management could improve the watershed qualities such as vegetation recovery, water retention and soil improvement. For example, participatory gully treatment with grassroots-high level linkage has enabled farmers in recovering huge gullies than treating these gullies independently by individual farmers. This corresponds to other studies(Harrington, 1999; Asefa *et al.*, 2003; Blomley and Ramadhani, 2005) that participatory natural resources management in the watershed had resulted in

improvements in water discharge and quality, increasing signs of natural regeneration in degraded areas as well as increase in biodiversity.

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