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Global Perspectives
Research Article

Local Perception on Effect of Land Degradation in the Blue Nile River Headwaters

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Keywords
land degradation; livelihood impact; farmers' perception; Ethiopia

Abstract
Poor land-use practices have threatened the livelihood of rural people in Ethiopia. This study assessed the local perception of the impact of land degradation on rural livelihood in the Blue Nile river headwaters, North Gojjam sub-basin. To achieve this objective, questionnaires were administered for 414 sample households and series of focus group discussions and detailed interviews were held with participants. Descriptive statistics were used to analyze quantitative data while qualitative data were buildup using narration and simple description approaches. The finding showed that all local farmers perceived that land degradation was the main local ecological problem since 2008 in the form of soil erosion, soil nutrient depletion; soil acidity and soil biodiversity loss. Most of them (62.54%) perceived as land degradation severity was high and increasing through time, primarily on cereal crop land. Population growth, using animal dung and crop residue for domestic cooking and heating energy, free grazing, using crop residue for construction, absence of fallowing, poor farming, steep slope, and using inappropriate SWC technologies are the main causes of land degradation in the study area. Most local farmers observed as land degradation has decreased crop and livestock productivity, firewood, and surface water resources accessibility. These resulted in the decline in households' food security and net income over the last 10 years. The finding showed that farmers used traditional ditche, hillside terrace, soil bund, stone bund, check dam, and waterway to reduce land degradation. To reduce the effect of abject land degradation and to improve rural livelihood in the north Gojjam sub-basin, adopting landscape friendly sustainable land management technologies, encouraging various off-farm livelihoods strategies, upgrading livestock feeding systems, and inspiring sustainable energy sources are very urgent.

1. INTRODUCTION

Agriculture is the backbone of the Ethiopian economy and the bases for more than 80% of employment, 85% of the export revenue, and 45% of the gross domestic product (GDP) (Bewket & Sterk, 2002; Etsay, Negash, & Aregay, 2019). However, agricultural production has been affected by acute land deprivation over a century (Berry et al, 2003; Saguye, 2017). In Ethiopia, the assessment result of land degradation on livelihood scant and contrasts considerably, the country has lost billions of dollars per year in the form of topsoil erosion and biodiversity loss (Berry et al., 2003; Dubale, 2001; Hurni et al., 2010). For example, in the 1986 cropping season alone, due to topsoil loss reduced about 2.2% of agricultural production (FAO, 1986). Likewise, in 1990 alone because of reduction soil depth by soil erosion resulted in a grain production loss from 57,000 to 128,000 tons which would have been adequate to feed more than 4 million people (NCSS, 1991). In the same way, livestock production loss was projected from 35,000 to 78,000 tropical livestock unit (TLU) in 1990 (NCSS, 1991). These losses resulted in 2.5 to 7.5-million-dollar reduction, comparable to 0.5 to 1.1% of the 1990 crop season agricultural GDP reduction of the country (NCSS, 1991). As well, approximately 3% of agriculture GDP directly loss as a result topsoil nutrient loss (Berry et al., 2003).

In the upper Blue Nile region, Gojjam is well known by the ample cereal crop production and export to other regions (Ewunetu et al., 2021a; Zeleke, 2001). But, the landscape productivity has been continuously treated by climate change, abject soil degradation, and poor land management (Simane et al., 2016; Zeleke and Hurni, 2001). Soil erosion is an acute problem in the region and on average, about 46t ha-1yr-1 topsoil has been lost (Ewunetu et al., 2021b). Similarly, the recent evidence indicates that about 32%, 35.4%, and 30.5% of the region showed low, moderate, and high level of land degradation, respectively (Ewunetu et al., 2021b). As a result, the local community has been changed from food surplus to food deficit since the last five decades (Simane et al., 2012).

The influence of land quality reduction can be assessed in several ways and different scientific approaches (Warren, 2002), such as, measuring of soil characters, satellite remote sensing image ecological assessment, expert opinions and economic growth estimation (Muloo et al., 2019; Reed and Dougill, 2002). But, science has its own limitation and therefore, may not always provide a perfect conclusion (Fairhead and Leach, 1995; Muloo et al., 2019). Thus, there is increasing calls for mixing and systematically recognized knowledge with those of the farmers' local knowledge on the current land degradation problem research to articulate policies and plans to achieve sustainable land management (SLM) program (Mairura et al., 2008; Muloo et al., 2019; Ouma and Sterk, 2006). Local community tend to have a perception about the level of land degradation on the ecosystem services, although they may not right call the word land degradation (Mairura et al., 2008; Ouma and Sterk, 2006). Because, farmers work closely on agricultural field have a better knowledge about land degradation problems. This knowledge has been built from the day-to-day reflection of changing in the caring capacity of the ecosystem services to support community's livelihood. This types of environmental land users' knowledge are known as local knowledge (Muloo et al., 2019; Purcell, 1998).

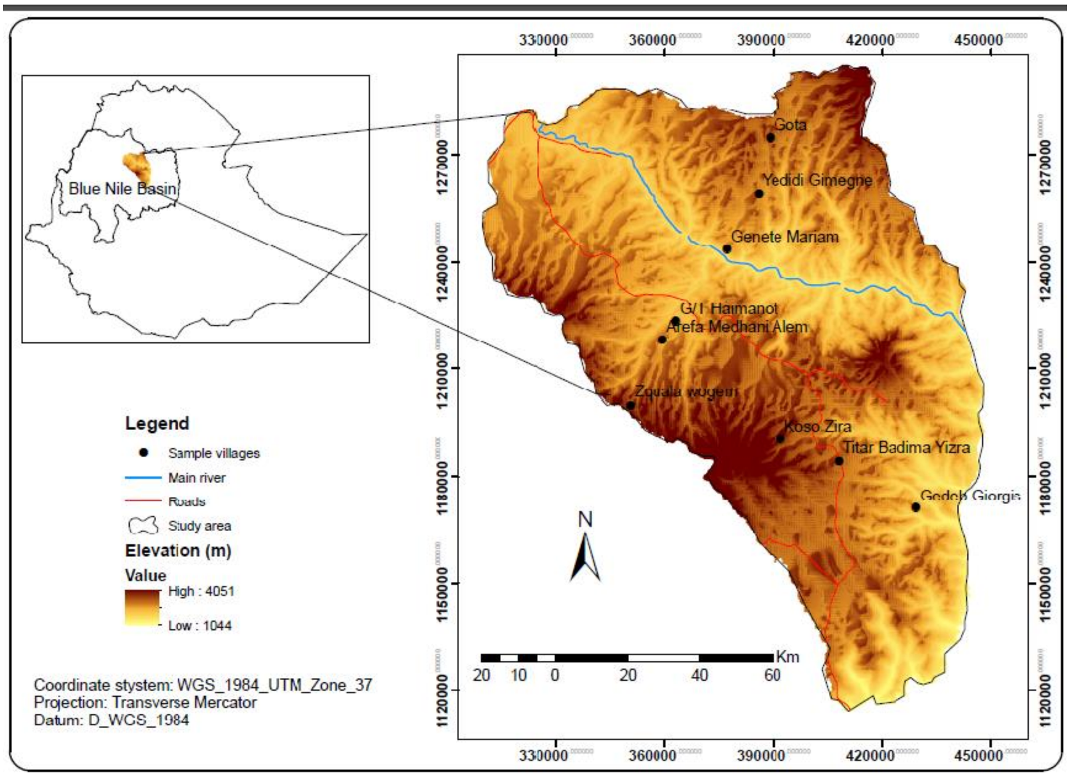
Farmers in Ethiopia have a long experience about the problem of land degradation (Amsalu and de Graaff, 2007; Nigussie et al., 2017; Saguye, 2017). Because they living on the land for through their life and their everyday ways of living are highly depending on land resources observation. As a result, farmers may categorize cultivated land whether fertile or infertile based on caring capacity of grazing land and crop productivity experiences (Joshi et al. 2019; Muloo et al., 2019). Understanding of local community's perception on environment problem is an essential in making sound sustainable land management (SLM) policy and strategies, but such types of updated evidence are limited in the north Gojjam sub-basin in particular and Ethiopia in general (Amsalu and Graaff, 2006; Berry, 2003; Bewket, 2012). Therefore, the main objective of this study is to assess local land users' perception on the recent rural livelihood effect of land degradation in Blue Nile river headwaters, the case of north Gojjam sub-basin. Specifically, the objectives are: to understand the local land users' perception on land degradation types, rate and trend, which is a necessity in making SLM programs and to show the key livelihood effects of land degradation problems associated with farmers' knowledge.

2. MATERIAL AND METHODS

2.1 Study area

North Gojjam sub-basin is one of 16 sub-basins of the upper Blue Nile, which founded in Amhara region, North Western Ethiopian highland and astronomically it situated between 10.8° N to 11.9° N latitude and 38.2° E to 39.6° E longitude (Figure 1). The sub-basin is one of the main water sources of the Abay/Blue Nile River and covers 1,431,360 hectares, which lies between Guna and Choke Mountains. Its overall population was estimated about 3,565,892, settled in scattered and dispersed areas by creating small villages in foot hillsides. The estimated average population density was ranged from 260 to 270 people per km2 (CSA, 2015). It is in general known by its uneven terrain landscape, which encompasses various types of relief configuration, including mountains with plains, valleys, steep slope, and hills. The elevation of the sub-basin is ranged from 1044 and 4051 meter above mean sea level. The most dominant agro-climatic zones of the sub-basins' are high wurch (extreme cold & wet), moist wurch (cold & humid), moist dega (cool & humid), moist woinadega (semi-humid), dry woinadega (semi-arid), moist kolla (warm semi-humid), dry kolla (semi-arid) and bereha (hot arid) (Simane et al., 2013). The rainfall is described by mono-modal rainy season (summer season) that covers from June to September. Its distribution across the study area is uneven; the highland tends to be wetter than the lowlands (Ewunetu et al., 2021a). Inter-annual variability in rainfall has a significant impact on subsistent agricultural activities. According to climate harmonize rain fall international precipitation stations CHRIPS (2018) data, the annual rainfall is ranged from about 1184.09 mm to 1654.53 mm.

Figure 1 Location and elevation of the study area



The widespread soil types are Vertisols, Leptosols, Alisols and Luvisols. The geology of the study area is dominated by Basalt; mainly the lowlands are occupied by sandstone (Yilma & Awulachew, 2009). The distribution of the land use land cover for study area were agriculture (70.67%), grazing land (12.49), bush and shrub land (8.21%), plantation forest (3.6%), bare land (3%) and forest land (2%) (Ewunetu et al., 2021a). The dense natural forest found mainly on river banks, hillsides and in some marginal areas. Eucalyptus globules forest is dominant of the introduced trees. Agriculture sector is characterized by a smallholder based mixing crop-livestock farming system. Various types of cereal crops have produced to a great amount; however, fruits and vegetable production were very low. The main crops types include cereals (wheat, barley, teff, and maize, sorghum), pulses (bean, Pea), and oilseeds (nug, "teliba," cabbage). Similarly, the main livestock types in the study area are cattle, sheep, goats, horses, donkey, mule and poultry.

2.2 Data Sources and Collection Methods

A multistage sampling technique was used to acquire the data for this study. Based on population density, administration, and geographical location criteria, three districts were selected from the sub-basin (Table 1). Then, nine rural villages (three from each district) were selected from the lower, middle and upper parts of the districts (Figure 1 and Table 1). Lastly, 414 household heads were obtained from the lists of farm households acquired from each respective local development agents' bureaus. The sample size in each respective districts and villages was determined via the proportional stratifying sampling technique (Table 1).

Table 1 Distribution of sample households by administration and agro-ecology.

Zone	District	Kebele/Village	Agroecology	Total HH	Sample HH	
					No	%
East-Gojjam	Enarj Enauga	Koso-zira	Dega	932	34	8.21
		T/ B/ Yizar	Wonina dega	1151	43	10.39
		Gedeb Georgis	Kolla	1649	61	14.73
West-Gojjam	Dega Damot	Ziqual-Wogem	Dega	1154	43	10.39
		A/Medhanyalem	Wonina dega	1120	42	10.14
		G/T/Haymanot	Kolla	642	24	5.80
South- Gonder	Andabet	Gota	Dega	1644	61	14.73
		Yedidi Gimegne	Wonina dega	1250	46	11.11
		Genete Mariyam	Kolla	1616	60	14.49
Total	-	-	-	11158	414	100

In addition, from the nine sample villages' /kebeles/, a total of 127 Focus Group Discussion (FGD) participants were taken from different social classes. Similarly, key informants were selected from the community leaders, elders, Development Agents (DAs), and their supervisors.

Objective type and open-ended questioners were prepared for farmers' so as to collect the required data. The validity and reliability of the prepared questionnaires were established based on earlier studies; local development experts input and pilot test on 20 randomly selected households in a similar or same district. Based on the comment gained, some questions were refined, amended, rearranged and omitted to improve its quality. Finally, questionnaires were translated to the local language (Amharic). The questionnaires were administered by trained enumerators under the close supervision of the author. Moreover, in-depth interviews and series of FGDs were conducted to triangulate quantitative data.

2.3 Data analysis

Field data were organized and summarized using various approaches. Numerical data were analyzed by the methods of descriptive statistical tools such as percentage, frequency distribution and mean value using STATA14 and the results presented by different Tables and Graphs. While data collected from FGDs, in-depth interviews and observation were analyzed and described through simple text analysis and narration techniques.

3. RESULTS AND DISCUSSION

3.1 Household Characteristics

As Table 2 shows, of the total sample household in the study area the majority (83%) were male headed whereas the 17% household head were female, who were mainly widows and divorced. The age of the household is an important factor that affects respondents their use of soil conservation practices. As indicated in Table 2, the average age of the sample households was 50 years and a minimum of 22 years old and a maximum was 85 years old. During the survey season, the family size of the households was between 2 and 11 members with a 0.81 average dependency ratio and had a 5.38 average family size. About 46.5% the respondents were illiterate while 25.9% attend adult and Church education. Only about 18.5% attend primary (1-8 grade) and the rest 8.86% attend secondary (9-12 grade) school.

The average landholding size was 1.03 ha and ranged in size was found between 0.15 and 4 ha and most plots were dispersed at different agro-ecology and land forms. Surveyed farmers cultivated on average 3 plot of land, ranged from 1 to 11 plots numbers. Most farmlands cultivated for subsistence annual cereal-legume crop production. Though, the land tenure right has been under public since the 1975 (Amsalu & Graaff, 2006), currently almost 94% of the respondents received land certification card. Whereas evaluating farmland properties, on average, about 21% of sample households reported that their cultivated land was steep, 43% moderately steep, and 36% farm households had a plain slope. On the other hand, about 35% of sample respondents acknowledged that their plots were fertile where most of their farmlands were perceived to have moderate to very severe erosion status. About 63% of the sample respondents stated that as they had received constructive advice from local experts, whereas 39% of them also attended formal sustainable land management related training from local expertise. On the other hand, about 35% of the surveyed farmers had their own mobile/radio, as well as 87% of them were joined in a farmers' cooperative group during the survey season. Local farmers in the study area walk about on average two hours to arrive to the nearest agricultural input–output market from their home. Furthermore, as indicates in Table 2, on average sample farmers had 4.13TLU. About 18% of were involved in off-farm activities, while 45% of them had obtained credit from formal institutions during the survey season. Moreover, Table 2 indicated that surveyed household heads had an average annual income of ETB 67,664.6 (USD1 ≈ ETB 29) in the survey season.

3.2 Local Farmers' view on the extent of land degradation

Cultivated land is a vital resource in the north Gojjam sub-basin as most community depends on subsistence agriculture. However, sever land degradation has been reduced agricultural productivity. Regarding this, majority of the respondents reported that land degradation is the central challenge of their wellbeing. As indicated in Table 3, about 62.54% and 18% of the served farmers confirmed that land degradation is highly and moderately affected agricultural land productivity, respectively. In the focus group and individual discussion, local farmers described that topsoil has been eroded by runoff water activated by erratic rainfall, poor land management and rugged topography. This result is similar to the finding of soil loss estimation tested by (Ewunetu et al., 2021b) using revised universal soil loss equation model analysis. The result showed on average 46t $ha^{-1}yr^{-1}$ and a total of 65.21 million tons of topsoil has been lost annually from this study area.

Table 2 Characteristics of survey household heads.

Characteristics	Dega Damot	Enarj Enauga	Andabet	Total
Gender (%)				
Male	18.5	16.2	17	82.9
Female	81.5	83.8	83	17.1
Average Age	49	50.83	50.32	50.32
Level of Education				
Illiterate	41.5	45.7	52.3	46.5
Write and read	25	24.9	27.8	25.9
Primary school	21.2	20.9	13.4	18.5
Secondary school	11.58	8.5	6.5	8.86
Higher education	0.72	-	-	0.72
Family size (ha)	6.21	5.25	4.3	5.38
Dependent ratio	0.76	0.8	0.84	0.81
Average land size (ha)	1.03	1.07	1.1	1.05
Plot number	2.55	3.23	2.75	2.95
Slope position of land (%)				
Steep slope	54.9	23.04	32.18	36.71
Moderate slope	34.4	55	46	45.13
Gentle / plain slope	10.7	21.96	21.82	18.16
Number of livestock (TLU)	5.12	3.9	3.41	3.671
Credit access (%)	36.13	38.03	38.0	34.78
Average total annual income (ETB)	70154.61	68943.35	63591.32	67,664.64

ETB = Ethiopian Birr

The majority (51%) of the respondents reported that soil erosion increasing for the last 10 years. Similarly, most surveyed farmers (57.5%) declared that land degradation is the most severe on cereal cropland on their locality (Table 3). Similarly, in detailed interview farmers said that the rate of topsoil loss is the highest on cereal cropland than other land use types on the similar landscape. Likewise, local farmers accepted the disparity of the rate of soil loss from plot to plot depends on the remoteness from their home. Regarding this, the majority (80%) replied that soil erosion problem is less on the homestead because homestead land is the nearest to the families' eye and different household consumption and animal fodders remnants dropped on it; therefore, water infiltration rate is the highest in this plot than other plots (Table 3).

3.2.1 Local Perception on Land Degradation

In the north Gojjam sub-basin, the main types of land degradation identified by local farmers were reduction of soil productivity and visible soil erosion. Farmers used different indicators to weigh the level of land degradation, include the reduction of crop production, soil depth, soil color, exposure of plant roots above soil surface, and formation of gully and rill on their farmland. Moreover, the surveyed local farmers ranked the severity of land degradation types on their locality as increasing, decreasing, and no change trends since 2008 (Figure 2). The result revealed that about 66.6% of respondents described as the severity of rill erosion has been increasing for the last 10 years. Similarly, the formation of gullies was acknowledged by 50.6%, 33.4%, and 16% as have been decreasing, increasing and the no-change respectively on their locality (Figure 2). Likewise, during the field survey, it observed from small to large gullies on several land use types, especially, on grazing land use. On the other hand, riverbank erosion was acknowledged by, 57% farmers as there was increasing its expansion since 2008 attributable to water erosion particularly in Gummara, yimmanie and Chiye rivers banks were reputedly mentioned. They reported that vertical roads used by livestock and human were the main factor of gully erosion. As we observed in the field and confirmed by local farmers, traditional drainage ditches (*fesses*), which made by individual farmers by oxen plow was the main causes for gullies formation. The result of this study is similar to the studies conducted before a decade by (Amsalu and Graaff, 2006) in Beressa watershed, central highlands of Ethiopia and (Bewket and Sterk, 2002), in Chemoga watershed northwestern Ethiopia, farmers were reported that the main forms of soil erosion are rill and gully on their locality.

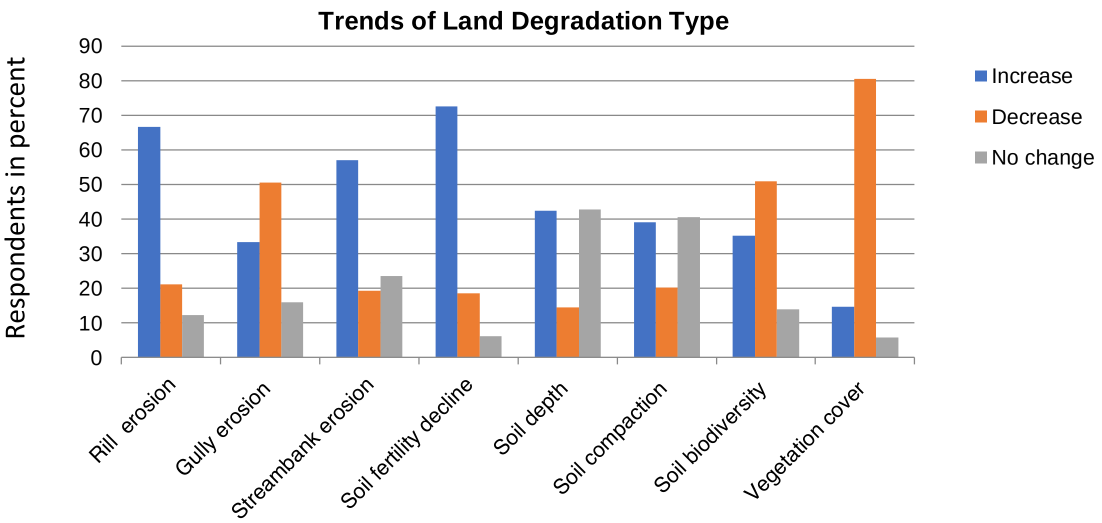
Table 3 Farmers' perception on land degradation in the north Gojjam sub-basin

Attributes	**Dega Damot**		**Enarj Enauga**		**Andabet**		**Total**	
	No	%	No	%	No	%	No	%
The current soil erosion in your cultivated land is______________.								
High	82	74.79	90	65.49	87	51.97	259	62.54
Moderate	19	17.65	17	12.68	38	23	74	17.88
Low	6	5.88	22	15.49	35	21.08	63	15.23
I don't know	2	1.68	9	6.34	7	3.95	18	4.35
The rate of land degradation for the last 10 years in your cultivated land is_______________.								
Has become increasing	53	48.74	79	57.04	80	48.03	212	51.21
Has become decreasing	18	16.81	13	9.15	19	11.18	50	12.08
No change	36	32.77	46	33.1	68	40.79	148	35.75
I don't know	2	1.68	2	1.41	-	-	4	0.97
In which land-use type degradation is more severe?								
Crop land	56	51.26	74	53.85	110	66.00	240	57.49
Grazing land	33	30.25	35	25.17	40	24.00	108	26.09
Forest land	20	18.49	26	18.88	13	8.00	60	14.73
All are the same	-	-	3	2.10	3	2.00	6	1.69
Where soil erosion is higher in your cultivated land?								
Near to residence	10	10.2	15	12.30	27	29.67	52	16.72
Faraway from residence	88	89.8	104	85.25	57	62.64	249	80.06
No difference	-	-	3	2.46	7	7.69	10	3.22

Soil fertility degradation is one of the main chemical land degradation indicator (Marques et al., 2016; Stavi and Lal, 2014). Regarding this, majority (73%) of local respondents recognized as depletion of soil nutrient has been increased for the last 10 years (Figure 2). Moreover, most farmers in FGDs and in-depth interview generalized that soil fertility has been degraded through time as a result of using crop residue and manure for domestic energy, soil erosion, free grazing, and absence of fallowing and using crop residue for construction, meager farming, and using inappropriate SWC technologies and cultivating steep slope.

Similarly, local development agents also associated soil/land degradation with poor local farming and cropping system.

Figure 2 Perceived types and rate of land degradation since 2008



Other chemical land degradation indicator is soil acidity, which has been increasing for the last 10 years in the study area. However, the majority of land users (87.5%) do not use lime to reclaim soil acidity due to the shortage of lime supply. This result is parallel to the geospatial analysis outcome conducted by (Ewunetu et al., 2021b) in the north Gojjam sub-basin, that showed soil acidity is one of the key types of chemical land degradation type in the north Gojjam sub-basin. A similar result was reported before a decade at Beressa watershed, central highlands of Ethiopia by Amsalu and Graaff (2006). Nonetheless, the result is unlike the study conducted by Bewket (2012), most of the farmers included in the survey (>62%) perceived as their plots are a medium level in the Chemoga watershed. This indicates that soil degradation in the form of soil acidity and reduction of organic matter has been increased.

Physical land degradation (i.e. soil compaction and soil depth reduction) in our study area was the other problem. Regarding this, about 40.5% of respondents reported that there is no change in the state of soil compaction in the last 10 years (Figure 2). Similarly, in FGDs frames explained as there is no soil compaction on their farm field. But, local farmers reported that due to soil compaction, rainwater infiltration into the soil has been decreased through time for the last decades. Likewise Figure 2 shows that out of the total sample, 42.5% of respondents perceived as soil depth reduction has been increased on plots for the last 10 years. Likewise, the result from in-depth interview revealed that soil depth has been decreased attributable to the runoff water and continuous cultivation, particularly on steep slope. This implies that the reduction of soil depth is one of the problems of physical land abasement in the north Gojjam sub-basin and the result is similar to the fining of (Amsalu and Graaff, 2006), who reported that the loss of soil from cropland reduced the soil depth in Beressa watershed.

There are several types of biological land degradation indicators, such as decline of biomass, loss of soil biodiversity, and the increase of diseases/ pests (Marques et al., 2016; Stavi & Lal, 2014). In the north Gojjam sub-basin, 51% of respondents showed that decreasing in soil living organisms on their farmland while about 35% said that there was abject reduction of soil living things for the last 10 years. Also, most (81%) of the respondents claimed that natural vegetation covers alarmingly decreased in the last 10 years (Figure 2). Similarly, FGD participants replied that both small fauna and flora have been declining through time on their locality, comprise algae, fungi, and a wide variety of soil fauna, such as ants, earthworms, beetles, insects, termites, and burrowing rodents. The above result is similar to the finding of remote sensing data analysis result conducted by Ewunetu et al., (2021b), found that the combined spatial multi-criteria analysis of chemical, biological and physical land degradation indicators revealed that about 1.14%, 32%, 35.4%, and 30.5% of the sub-basin exhibited very low, low, moderate, and high degradation level, respectively. Generally, comprehensive land degradation problem in the north Gojjam sub-basin increased for the last 10 years.

Figure3 Soil erosion in Z/wogem kebele

Figure 4 Gully erosion Yedidi Gimegne kebele

3.2.2 Impacts of land degradation on rural livelihood

The impact of land deprivation on rural livelihood is severe as almost all population in the study area relies on the mixing (crop-livestock) production method. According to the local farmers', land quality degradation has been reduced, surface water resource, agricultural productivity, food access, firewood, and net income of rural community since 2008 (Figure 3).

Impacts on Crop Productivity

In Ethiopia, crop production is determined by several factors, such as soil quality, climate variability, water availability, farm inputs, and land users' knowledge (Mekuria and Mekonnen, 2018) . Nevertheless, land degradation intensified by climate extremes is the main threats of optimal crop productivity in the study area. Regarding this, about 63.2% of sample respondents acknowledged as crop yield per hectare reduced compared to before a decade on their farmland (Figure 3). Likewise, information from FGDs and in-depth interviews reported that land deprivation is the main challenge to produce potential crop productivity in the study area, particularly without external input most farmlands did not support expected crop yield. As a result, farmers shifted from crop production to eucalyptus plantation in the sub-basin, mainly in most the highland region. The result of this study similar to the study conducted by (Amsalu and Graaff, 2006), who found that the decrease of farmland productivity was confirmed by almost all of the interviewed rural households in Beressa watershed.

Farmers rated the causes of crop yield reduction from the most critical to not critical ones on their cultivated land since 2008. Accordingly, soil fertility degradation and shortage of farmland were agreed by 92.5% and 54.6% surveyed households as the most critical cause for the decline of crop yield, respectively. Scarcity of rainfall and waterlogging were as well reported as the critical problems for crop yield reduction by 26.5% and 57.4% of the respondents, in turn. Whereas crop disease and erratic rainfall were considered as not critical and fairly critical factors by 20.3% and 33.8% of the respondents, respectively for the decrease of crop yield (Table 4). The result of this paper is comparable to the research conducted by Gashu and Muchie (2018), which found that land deprivation affected crop production in Northwestern Ethiopian highland. In sum, the result showed that land degradation plays great role to the low potential of crop production for the last 10 years in the north Gojjam sub-basin.

Table 4 Factors for the reduction of Agricultural yield in the north Gojjam sub-basin

Causes	**Local respondents (%) n= 269**				
	Most Critical	Very Critical	Critical	Fairly Critical	Not critical
Soil degradation	54.6	23	10	7.8	4.6
Water scarcity/ Drought	30	25.4	26.5	13	4.9
Irregular rainfall	11.9	14.6	14	33.8	25.7
Shortage of farmland	92.5	4.5	2	2	-
Crop pests and/or diseases	16	15.4	9.7	20.3	38.7
Poor farming	11.4	15.4	10.6	20	42.6
Lack of oxen	-	2.5	-	2.5	95
Waterlogging	22.8	12.1	57.38	7.3	0.5

-Impacts on Livestock Productivity

In Ethiopia, livestock has a several role for rural livelihoods (Mekuria and Mekonnen, 2018). Like elsewhere in Ethiopia, cattle are highest in number in the study area followed by sheep, goat, donkey, horse, and mule. According to local farmers, livestock in the study area are central elements for the whole farming activities include for draught power, transport, sources of cash for external farm inputs, and manure and dung production. Small ruminants like goats, sheep, and poultry are kept typically by land-scarce and poor for commercial purposes. Though, the productivity of livestock has been declining through time due to land degradation. As presented in Figure 3, about 51.6% of the respondents reported that the impact of land degrading on livestock productivity has been increasing for the last 10 years. Also, farmers in-depth interview recognize the quality and quantity of meat, milk, and milk production have been declining for the last 10 years. This results in the reduction of households' income and food access. According to key informants, the feeding system of livestock in the dry season is crop residue while in the rainy season is grazing. But these feed resources are inadequate, and has been declining over time (Table 5).

Table 5 Causes of livestock productivity decline since 2008

Causes	Rank by local farmers (%) n=414				
	1st	2nd	3rd	4th	5th
Scarcity water	10.3	55.5	35	-	-
Shortage of grazing land	88.2	5.5	3.5	1.7	1.3
Shortage of labor			3		97.
Parasites/disease	-	-	5	95.2	-
Drought	1.5	39	53.5	3.5	2.5
Average travel time (walking) for accessing water for livestock in minute					34.7

Local farmers were ranked the causes of livestock productivity reduction. On the other hand, Shortage of grazing land was rated 1st whereas water scarcity at the 2nd rank by the majority of respondents (Table 5). Water scarcity for livestock has become more severe for the last 10 years because rivers, springs, streams, and ponds are dehydrated. As a result, farmers travel on average 35minutes to access water for livestock (Table 5). The result of this study is comparable to the study conducted by (Amsalu and Graaff, 2006), which found that livestock numbers have decline in the Beressa watershed. Generally, this showed that livestock feeding system still backward i.e. no improved and processed in the sub-basin.

-The Impact on Households' Income and Food Security

The acute land degradation has been changed the rural community from food surplus to food scarcity in the north Gojjam sub-basin. Regarding this, about 56% of the surveyed local farmers reported as their income is increasing for the last 10 years (Figure 3). Likewise, farmers in the FDGs conclude that their income has been increased due to the increasing market price of agricultural yield. However, their expense has been increased due to the increasing of agricultural inputs price, government and social duties. As a result, the income of the households gained from agriculture did not compensat expenditure and debt. About this, the majority (86.4%) of the surveyed local farmers stated that their expenditure has been increasing (Figure 3). The finding of this research is in line with the study conducted by Holden and Shiferaw (2004) which reported as crop yield reduced in the subsequent years due to the reduction of topsoil depth. Besides, about 69.6% of local farmers reported that their food supply has been decline for the last 10 years (Figure 3). Likewise, farmers in open discussions described that, unlike the preceding period; in recent years the most farmers are only able to produce food to meet their family needs. Local elders asserted that before 3 decades as they had harvested excess agricultural yield not only for family feeding but also for the market because they had enough and fertile cultivated land to produce crops and rear livestock effectively. This finding is comparable to the results of (Ighodaro et al., 2016) who testified that abject land degradation was affecting rural livelihoods and food security in South Africa.

-Impacts on Water Resources

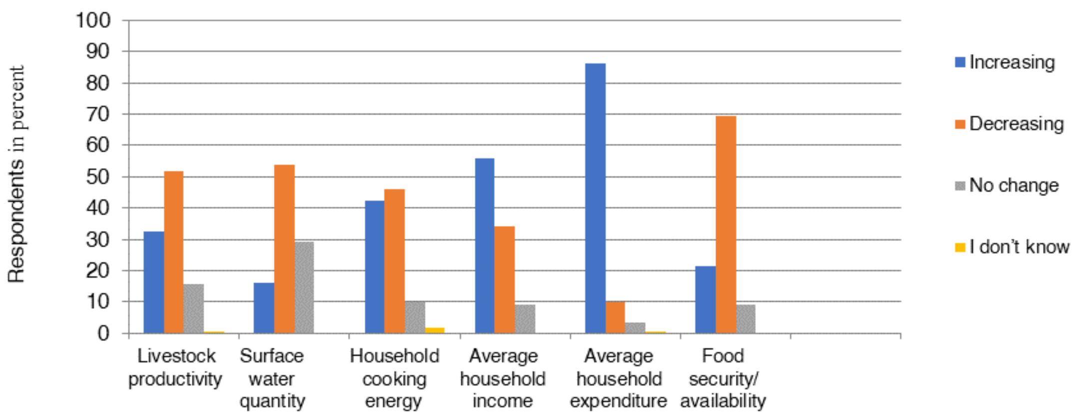
According to districts water resource development offices, north Gojjam sub-basin is the water tower of the region. The area is endowed with varied clean water resources, like springs, streams, ponds, and rivers. But, the surface water bodies have been decline over time due to abject land degradation for the last 10 years. According to FGDs result, the quantity and quality of water had been decreasing because of decreasing soil depth, soil erosion, deforestation, decline rainfall pattern and expansion of eucalyptus plantation. Furthermore, they clarified that soil cannot absorb much rainwater thus rainwater flow into rivers and streams by carrying fertile soil. Therefore, rivers become decrease and streams, springs, and ponds have been drying. This result was confirmed by 53.6% survey respondents, who stated that the quantity and quality of surface water bodies in their locality have been decreasing over time (Figure 3). Commonly, the community experienced three months (March to May) of water scarcity, in the driest months. In general, in history, although the north Gojjam sub-basin receives high rainfall, the local witness reported that water quality and quantity have been decreasing. From this, it can be generalized that land humiliation highly affected surface water resources in the study area.

In the study area, population growth is resulting in increasing the pressures on natural forests attributable to increasing demand for firewood in the last 10 years. The majority (46.14%) of respondents said that degradation of natural forests results in firewood and burning material scarcity (Figure 3) for the last 10 years. Almost all communities in the sub-basin rely on firewood, crop restudies, and dung for domestic energy for cooking and heating via the traditional three-stone stove. As a result, households in the sub-basin were forced to walk long distances to collect firewood from the nearby forests, and some farmers bought wood and used crop residues and animal dung for cooking and heating. On average, households are walking about 50 minutes to collect firewood (Table 6). Among the respondents, about 44.78% of the respondents were self-sufficient with firewood because they have eucalyptus trees. Even though in recent periods, energy-saving stoves were introduced by development agents only 20% of sample respondents were used this technology (Table 6).

Table 6 Households' sources of energy in the north Gojjam sub-basin

Sources of energy	**Ranked by local farmers (%) (n=414)**				
	1st	2nd	3rd	4th	5th
Wood from Eucalyptus	52.	17.3	10.8	11.5	8.8
Croup residue	22.5	48.5	24.4	2.8	2.6
Indigenous trees	8.5	13.8	26.9	45.4	5.4
Animal dung	17	20.7	39.3	13.5	9.4
Others	0	0	0	26.8	74.2
Average distance to collect firewood			50.5 minutes		
Firewood energy self-sufficient	Yes = 44.8		No = 55.2		
Energy-saving technology	Yes=20.8		No = 79.2		

Figure 3 Perceived impacts of land degradation on communities' living for the last 10 years.



Overall, the result shows that abject land degradation adversely affected the rural livelihood in the north Gojjam sub-basin. Mainly, it highly challenged to crop and livestock productivity, household cooking energy, surface water resources, income, and food security. These results in the rural households operate a subsistence level of living. Besides, indirectly abject land degradation affects the rural livelihoods through ever-increasing external agricultural input requirements coupled with the rising price to converse declined soil to produce food crops. The other implication of this study shows that farmers in the north Gojjam sub-basin are well perceived the adverse effects of land degradation on their livelihood strategies. Farmers' perception on their environment provides critical evidence on the understanding of their farmland management (Bewket, 2012; Legesse et al., 2012; Ouma and Sterk, 2006). Thus, land users perception the impact of land resource degradation on livelihood strategies can inspire farmers to work out various strategies to reduce the effect or look for other choices to cope up with the problem. Besides, the recent level of poverty is seriously aggravated by low agricultural yield caused by abject land degradation in Ethiopia (Zeleke, 2002). This forces the community to live under a vicious circle of poverty with environmental degradation.

3.3 Local Perception and practices on the soil and water conservation (SWC) Measures

Almost all local farmers in the study area perceived and used various SWC technologies to stop topsoil loss. Most land users used the up and down (crisscross) farming system to mix the soils. Traditional ditches were the main structural SWC technologies used by all local people to prevent soil; fertilizers and seed from runoff water. Though ditches are perceived by almost all respondents as averting soil loss, it is a key cause for gully formation. These technologies were prepared for each crop season during preparation of cropland before and after sowing seeds. Contour plowing was not used by the majority of local farmers along the contour.

Likewise, cutoff drain was used by local farmers on upper cropland. According to local land users, this measure applied to protect the soil, seed, and fertilizer from runoff water which comes from forest, grazing and/or other cultivated lands before enters into prepared land and curved to other drainage systems. Similar to cut of the drain, waterway was mostly built by more than one framer to drain water downslope between their cultivated lands. It collects run-off water from different sources of conservation measures such as from cut-off and drains ditches. Then it drained the runoff water into gullies, streams, and rivers. During field survey, older farmers illuminated that the width of the waterway is depending on the amount of runoff water, the steepness of the slope and length of the waterway and catchment area. A check dam was applied to prevent various gullies and waterways from more expanded two sides. It is built across the floor of the waterway or gullies to slow water flow and stops the gullies from getting wider and deeper. Local framers in the north Gojjam sub-basin made the check dam from wooden plots, stone and tree branches. But, during transaction walking on the field, we observed constructed check dams were seen being destroyed in varied gully floors.

Most farmers in the study area used soil bund, which introduced by the extension agents. Similarly, stone bund was used in sloppy farmland and stone accessible areas, mainly, on private and communal grazing land. Nevertheless, in some areas, both stone and soil bund technologies were not properly used and a lack of maintenance was common in different landscapes. Hillside terraces were used at very degraded and shallow soil land forms. As the name indicates, hillside terraces are mainly built on steeper land to reduce run-off water and to allow sufficient time for water infiltration. Community-based reforestation and afforestation were implemented on very degraded and communal lands, however, most planted trees were not gowning due to lack of follow-up after planting. Free grazing was the one of the key reason for the unsustainable reforestation and afforestation practices in the north Gojjam sub-basin.

4. CONCLUSION AND POLICY IMPLICATIONS

Land degradation is a key threat for rural living in the Ethiopian Highlands. This study assessed the effect of land degradation on rural livelihood using local land users' view in the north Gojjam sub-basin. Cross-sectional data were collected from 414 randomly selected households, FGD and key informant participants and observation. The result indicated that land degradation is one of the major threats to land productivity. Local farmers stated that the magnitude of land degradation is higher and its rate of degradation has been increasing through time, particularly on the cereal cropland in the spring season. The study showed that land degradation, in the form of soil nutrient depletion, soil erosion, soil acidity, and loss of vegetation cover, has been increasing since 2008. Rill and gully erosion is yet solved, however, these types erosion have been increasing and the result is higher for topsoil loss.

Moreover, the result showed that land degradation has been continued its adverse impact on agricultural productivity, which is the main source of livelihood in the north Gojjam sub-basin. Different water resources such as ponds, springs, and streams have been disappearing from the earth's surface and the rivers have been shrinking since 2008. Moreover, burning materials supplies have been incessantly declining, and thus, rural households are forced to walk a long distance to collect firewood domestic used. These cumulative effects of abject land degradation tied with land shortage and climate change result in persistent food insecurity in the north Gojjam sub-basin.

Based on the finding of this study, the following policy recommendations are proposed:

1. It advised that family planning is important to reduce the pressures on limited land resource bases because the scarcities of land resources are resulting from population growth in the study area.

2. Local farmers used volatile substances rain-fed farming method, thus intensive farming system have to applied through encouraging investment for agricultural sector transformation to absorb the increasing population in the study area.

3. Although livestock in the area is the key engine for agricultural activities and food security, its productivity is very low. Thus it is better improving feeding systems and livestock heredities using forage technologies to generate a high yield from a few livestock. Moreover, SLM activities should be integrated with the livestock feeding system.

4. North Gojjam sub-basin's rural community is dependent on traditional biomass energy for domestic use. Therefore, sustainable energy sources should be promoted.

5. Unsustainable land use is the main causes for low productivity of agriculture sector and food insecurity. Therefore, to reduce land degradation for improving rural living, investment on landscape-friendly SWC technologies should be promoted.

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