Journal of Sustainable Development in Africa (Volume 20, No.1, 2018)
ISSN: 1520-5509
Clarion University of Pennsylvania, Clarion, Pennsylvania

COMMUNITY PERCEPTION OF LAND USE/LAND COVER CHANGE AND ITS IMPACTS ON BIODIVERSITY AND ECOSYSTEM SERVICES IN NORTHWESTERN ETHIOPIA

Feyera Senbeta
Centre for Environment and Development, College of Development Studies
Addis Ababa University

ABSTRACT

Natural ecosystems have severely degraded owing to the continuous land use/land cover (LULC) changes in Ethiopia. This study was conducted to assess community perception about the impact of land cover change on biodiversity and ecosystem services in Abay-Chomen District, Ethiopia. A two-period (1973 & 2016) satellite images analysis and field survey was employed to collect data. GIS was used to analyze land use/land cover changes. The study revealed that natural ecosystems such as forest, woodland and grassland have declined by 22 percent during the study period. Ecosystem degradation including biodiversity loss is the most serious threat to sustainable development in the area. It is recommended that rehabilitation of degraded lands and conservation of remnant natural ecosystems should be embarked up on in order to enhance sustainable development.

Keywords: Biodiversity, Community, Degradation, Ecosystem, Perception, Sustainable

INTRODUCTION

Land use and land cover changes over time in response to economic, social, and biophysical factors (Reid et al. 2000; Ritler 2003; Reyers et al. 2009; Tolessa, Senbeta & Kidane 2017). Many of these changes are set due to human related activities. Despite these changes, for instance, forests have been and are still providing multiple ecosystem services that support livelihoods and protect the environment. A large number of people depend on forests for at least part of their livelihood and well-being (FAO 2006; MacDicken et al. 2015). Forests protect the soil against erosion and reduce the risks of landslides, and also increase the rate of rainwater recharges to groundwater, as well as control the rate at which water is released from watersheds (FAO 1993). However, humankind has already threatened the vast arrays of forests that provide so much to the humanity and the environment. According to FAO (1993) forecast, deforestation and the burning of biomass could contribute about fifteen percent of the greenhouse emission between 1990 and 2025. Land use change due to deforestation can cause extreme climate that may accelerate the occurrence of floods and droughts (IPCC 2007).

Ethiopia was once covered by dense vegetation (EFAP, 1994). According to various sources (Tadesse,Woldemariam & Senbeta 2008;Rusing 200; von Breritenbach 1962), forest and wood land covers about 60% of the total area of the country although the figure declined significantly. Since the turn of the last century, forests have been cleared from large parts of Ethiopia. Today except the south and southwestern parts of the country, the rest are devoid of forest vegetation. According to FAO (2015), forest in Ethiopia is estimated to cover about 11.4 % of the total land surface. Here, land cover change in the form of deforestation is believed to be the causes of forest loss (Darbyshire, Lamb & Umer 2003; Logan 1946; Reusing 2000; Tadesse et al. 2008). Recent estimate shows that the rate of deforestation in the country is as high as 5% per year (Reusing 2000; Tadesse et al. 2008).

Noticeable land cover change related problems have already affected the social, economic, and environmental state of the country. The ever-increasing demand for forest products and forestland together with the increase in human population (~101 million at the moment) is putting unbearable pressure on the remaining forest fragments and their services (PRB 2016; Senbeta 2006; Tolessa, Senbeta &Kidane 2016). As a result, the country is facing an acute shortage of forest resources besides the disrupted ecosystem functions such soil erosion, hydrological imbalance, loss of biodiversity, ecosystem services (Darbyshire et al. 2003; Tadesse et al. 2008;Tolessa et al. 2016). If the current forest conversion continues, the remaining forests in the different parts of the country will be at the forefront sooner or later (FAO 2010; Tolessa et al. 2017). In rural Ethiopia, forest provides environmental and economic benefits /ecosystem services. The continuity of these environmental services is only plausible if sustainable development pathway is followed as this facilitates a coherent and enduring balance among economic, social, and environmental aspects of human activity (Munang, Thiaw & Rivington, 2011; Raudsepp-Hearne et al. 2010). Apparently, if the ongoing trends of environmental degradation is not minimized it can significantly damage ecosystem services and threats sustainable development.

Various studies (Pankhurst 1995; Ritler 2003; Tolessa et al. 2016) have shown that interactions between human activities (social systems) and nature (ecological systems) are key factors affecting forest-cover change in many parts of the world.

However, the complexity of these socio-ecological factors is often poorly understood in many parts of Ethiopia. In order to understand the patterns and trends of deforestation and its impact, this study is critical for exploring the changes. Commonly most of the socio-ecological processes that affect land use types move slowly or sporadically over time, whereby their significance can be missed by contemporary, snapshot studies (Batterbury & Bebbington 1999; Lanckriet et al. 2015).

This study, therefore, aimed to examine the effect of land cover change on ecosystem services in Abay-Chomen district in the northwestern parts Ethiopia. Although a number of studies (Darbyshire et al. 2003; Pankhurst 1995; Senbeta 2006) have assessed deforestation trends in Ethiopia, little efforts are given to evaluate its impact on biodiversity and ecosystem services. Examining the interrelationships between humans and natural resources is complex and involves identifying feedback relationships among people, resources and institutions (Folke 2000; Liu et al., 2007; Medrilzam, Dargusch, Herbohn & Smith 2013). Yet, assessment of local peoples' perceptions about the relationship between deforestation and loss of forest ecosystem services is one of the least explored issues in Ethiopia in general, and in the study area in particular. As the study area is one of the highly deforested and degraded areas, understanding this fact could be crucial for initiating any future rehabilitation/restoration projects. The main objectives of this study are two-fold: (i) to analyze the land use/land cover (LULC) dynamic over the last four decades (between 1973 & 2016) by using satellite images, and (ii) to understand local community perceptions about the impact of deforestation on biodiversity and ecosystem services in the study area.

METHODOLOGY

Description of the study area

The study was conducted in Abay-Chomen District/*Woreda* in the northwestern part of Ethiopia. The district is located between $9^0$31' 42" to 9^0 59' 48" N latitude and 37^0 10' 03" to 37^0 28' 44" E longitude in Horo-Guduru Wollega Zone of the Oromia National Regional State (Figure 1). The area is characterized by an extensive rolling plateau, ranging in altitude between 1,061 and 2,492 meters above sea level (Tefera 2006).

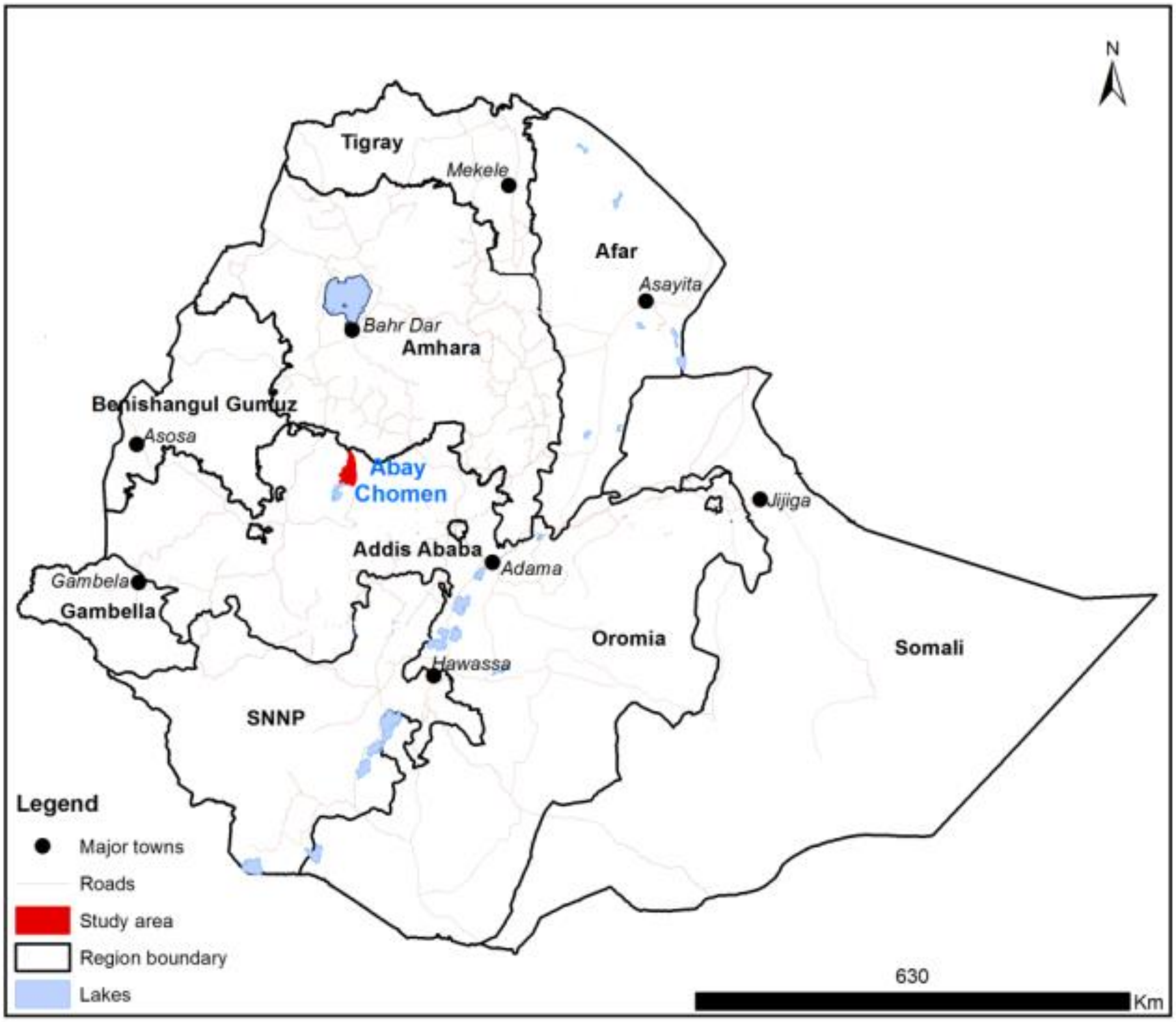

Figure 1. Map of Ethiopia showing the location of the study area.

The major dominant soil types in the district are Arenosols, Eutric Nitosols, Chromic Vertisols and Eutric Cambisols (Bellete 2014). The soils have a texture of clay-loam, clay, or loam which are very susceptible to water erosion (Habte 2016: Tefera 2006; Tefera and Sterk 2008). In terms of climate, the average annual rainfall in the area is around 1820 mm; with about 80% of rain falls between May and September (Bellete 2014).The mean monthly temperature varies from 14.9ºC to 17.5º C. Owing to severe forest clearance over the past many years, the area is barely covered by forest at the moment (personal observation). The presence of very big relic scattered *Podocarpus falcatus* trees on farmlands illustrates how the study area was once covered by forest. Woodlots are common around homesteads which are mainly dominated by eucalyptus species.

The major means of livelihood in the area is mixed farming– crop production and – livestock rearing. *Teff*, wheat, barley, maize, pulses, and some oil crops are the most commonly grown crops (CSA 2013). While cows, sheep, goat and donkey are the main domestic animals reared by the local community in the area. Due to long years of frequent and intensive cereal cultivation, the inherent land productivity has already been declined (Bellete 2014; Boru and Kositsakulchai 2012). Because of land scarcity, fallows are hardly practiced these days although crop rotation is highly practiced (e.g., beans/peas-*teff*- niger seed-maize). Energy sources are mainly biomass based energy; and fuelwood are collected from forest patches and tree left on farms and woodlots.

According to the 2007 Population and Housing Census of Ethiopia, the total population of the district was 48,316, of whom 24,972 were men and 23,344 were women, and about 19.54% of its population was urban dwellers (CSA 2008). In 2017 the total population of the district was estimated to be 63,095.

The study district is extremely crammed by large development projects owned by the government. These are hydropower dams construction, namely Finchaa (constructed in 1973), Amarti (constructed in 1973) and Nashe (constructed in 2012); and Finchaa Sugar Factory and its sugarcane plantation (started in the 1980s). These development projects have significantly influenced land use/land cover of the study area. Although the hydropower dams played a significant role in supporting the national economy through electrification, supplying water for sugar factory and its plantation in the downstream and introduced fisheries in the area, local communities were not compensated properly for the land they lost and grievances are quite common (Hundara 2017). Owing to the interrelated effects by the projects, the local communities in the watersheds are nowadays confronted with a number of challenges like decline in crop and livestock production, deforestation, loss of wild animals and continuous soil erosion (Hundara 2017; Tefera 2006; Bellete 2014).

Methods

In order to assess the relationship between deforestation and ecosystem services, both land use/land cover and socioeconomic data were gathered. Satellite images of 1973 and 2016 were used to analyze land use/land cover change, specifically the forest cover change in the study area. Moreover, interviews and discussions were held with local community members to examine deforestation trends and its consequences on ecosystem services in the area in January and February 2017. Methods employed in data generation and the natures of datasets are described below.

Spatial data

The spatial data was used to quantify LULC change using Landsat 1 (1973) and Landsat 8 (2016) images downloaded from United States Geological Survey websitehttp://glovis.usgs.gov/(Table 1). In selecting the satellite images, attempts have been made to select cloud free images. The oldest high quality satellite image available is MSS 1973. Hence, the 1973 image was selected to establish initial land use cover from which the consequent land use change was monitored. Both images were geo-referenced to WGS1984 UTM zone 37^0North and radiometrically corrected. After downloading the images, I clipped them to the study area boundaries. Images from Landsat 1 were resampled to 30-meter resolution before clipping the images to the study area boundary so as to make the same resolution with that of Landsat 8 images.

Table 1. Description of Satellite images used for the study area.

Path/Row	Spacecraft id	Sensor id	Pixel size	Image ID	Date acquired
169/53	Landsat 8	OLI_TIRS	30 meter	LC81690532016047LGN00	2016-02-16
182/53	Landsat1	MSS	60 meter	LM11820531973032GMD03	1973-02-01

Unsupervised classification method was used to classify each image into different land use/cover classes. But before applying the unsupervised classification method, I divided the study areas into different homogenous units based on spectral character of the land features and topography. Following sub-setting of the images into different homogenous units, the unsupervised classification was applied to each sub-image. About 100 random points were generated in ArcGIS 10.4 and the random points were then converted to KML and exported to Google Earth to collect the ground truth points (Anderson et al. 1976). The final class labelling was done by displaying each piece of unsupervised images over original false color composite Landsat images. Each adjoining classified Landsat subsets were checked for consistency, and inconsistencies were corrected. Finally, after each sub-sets of Landsat scenes were labelled properly with better accuracy, all the sub-sets were merged and used for change analysis.

Socio-economic data

The study district has about 18 *kebeles* (*kebele* is the smallest administrative unit in Ethiopia) of which 6 *kebeles (*namely, *Homi, Jare sole, Qare, Diga, Gobaya and Ganji)* were randomly selected as there was no major differences among *kebeles* in terms of forest cover at the moment. In each *kebele*, one Focus Group Discussion (FGD) was organized with the community representatives. The participants were drawn from elderly, women, youth, religious leader and *kebele* administrator. Additionally, separate in-depth interview was held with two knowledgeable community elderly in each *kebele*. Key informant interviews were also conducted with the district natural resource experts. Both key informants and FGD members were asked open ended questions concerning the key characteristics of their environment, historical relations between the environment (biophysical, political and socio-economical) and the rural society. Furthermore, issues related to the historical trends of forest cover change, biodiversity loss, threat to ecosystem services and forest management across the different regimes were discussed. Field observation was also made through transect walk. During the interview, the informants were also asked to disclose what they heard from their fathers or grandfathers about forest cover change over years. More importantly, the informants were asked to disclose the lost ecosystem services due to forest loss in the area. There can be many more variables of interest than data points when we focus on a particular situation by triangulating data sources. The aim of the discussion was to understand the local process, mainly the forest cover change, how and why forest cover change happened.

Secondary data were compiled from related literature, research reports, government documents and review of different legislations to look into the rural development interventions in the district during different regimes.

Data analysis

Spatial data

Spatial dataset of satellite images were processed using Arc GIS 10.4 to quantify the LULC change between 1973 and 2016. Unsupervised classification with maximum likelihood algorithm was adopted. The quality of the training dataset used is of fundamental importance to a classification and major determinant of classification accuracy (Foody & Mathur 2006). Training areas were set based on the researcher's knowledge of the area as well as with the consultation of key informants. Apparently, six major land cover types were identified in the study area (Table 2).

Table 2. Land use/land cover (LULC) types and their description.

Land cover type	Description	Remark
Forest land	An area occupied by forest	
Woodland	Land covered with scattered woods or trees.	
Irrigated land	Land mainly used for sugar cane production using irrigation.	Not found on 1973 image
Annual cropland & settlement	Landscape dominated by crop field and settlement with a few trees and garden plants mixed in to the system	
Grassland	Land where grass or grass-like vegetation grows, and mainly used for grazing.	
Water body	Land covered with water	

Socioeconomic data

Data collected through interview and discussions were thematically analyzed. Major themes highlighted include land use/land cover change, ecosystem services, loss of biodiversity and ecosystem services and other trends of environmental changes.

RESULTS

LULC analysis

The Land use/ cover change (LULC) of Abay-Chomen district (1973 -2016) was calculated from the land use classes in the classified satellite images (Figure 2) The overall accuracy assessment table was generated using the computed confusion matrix tool in Arc map; and accordingly the Kappa Index was 0.76 and user accuracy was 85 percent. As indicated by Anderson, Hardy, Roach &Witmer (1976) for a reliable land cover classification, the minimum overall accuracy value computed from an error matrix should be 85 percent and hence, this dataset satisfies the minimum standard of 85 percent stipulated.

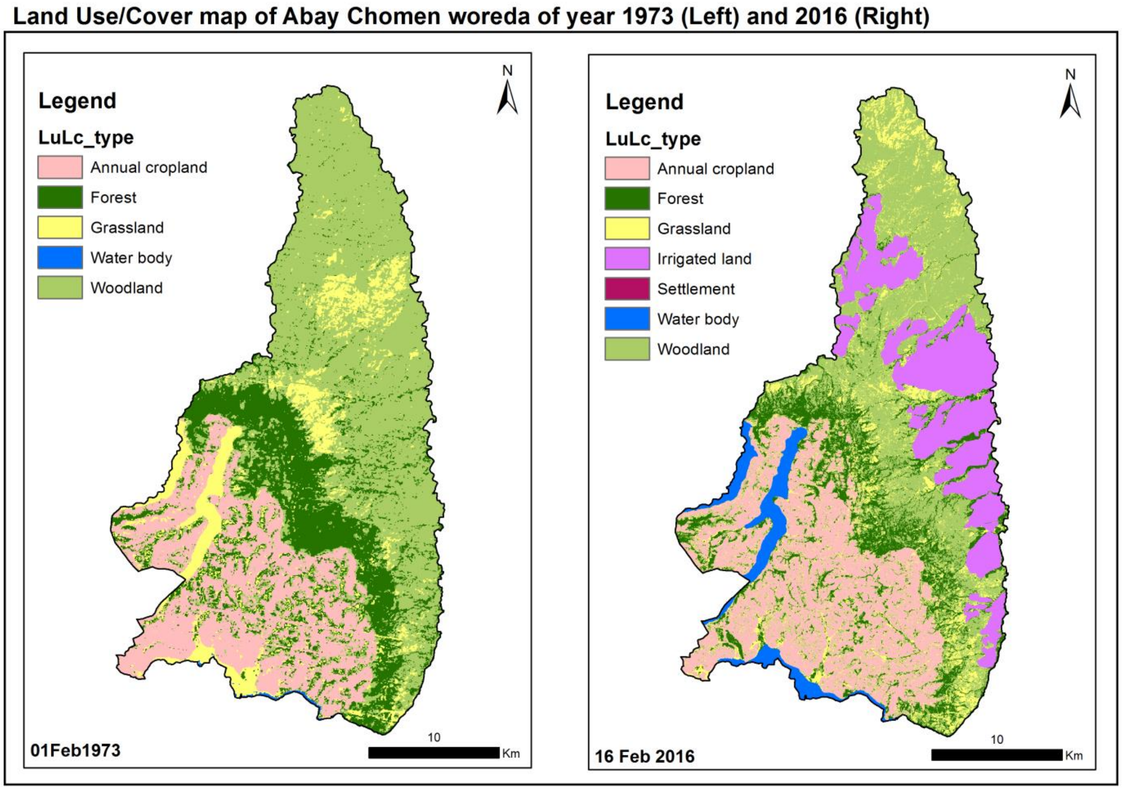

Figure 2.LULC map of Abay-Chomen District of year 1973 -2016.

Overall, six major LULC types were identified (Table 3) which includes forest land, Water body, Irrigated land, Annual cropland & settlement, Grassland and Woodland. Forest, woodland and grasslands were reduced by 22.65 percent during this period (between 1973 and 2016) while the other land uses increased. The majority of woodland lost to irrigated land whereas forest and grassland were converted to smallholder agriculture and water body. There was nearly 16.45 percent increase in irrigated land from nil percent in 1973. Since 1973, three hydropower dams namely, Finchaa, Amariti and Nashe were constructed in the study district, which apparently increased irrigated land and water body. A smallholders' agricultural land was also increased by 2.42 percent between 1973 and 2016.

Table 3. Land use/land cover change of Abay-Chomen district (1973 -2016).

LULC types	Year 1973		Year 2016		Change (1973- 2016)	
	Area (ha)	%	Area (ha)	%	Gain/loss (ha)	Gain/loss (%)
Annual cropland	15297.9	21.02	17061.57	23.45	+1763.67	+2.42
Irrigated land	0	0	11970.33	16.45	+11970.33	+16.45
Forest	15228.4	20.93	9574.65	13.16	-5653.75	-7.77
Woodland	33642.5	46.24	24121.44	33.15	-9521.06	-13.09
Grassland	8461.8	11.63	7159.23	9.84	-1302.57	-1.79
Water body	131.04	0.18	2874.42	3.95	+2743.38	+3.77
Total	72761.64			72761.64		

Community perception of ecosystem services changes

Local community members in the study area have identified about 14 different ecosystem services. These include six provisioning services (freshwater supply, wild food, timber, fuelwood, medicinal, fiber), four regulating services (soil erosion control, climate regulation, maintenance of soil fertility, water purification), three cultural services (aesthetic, spiritual and hunting) and one supporting service (biodiversity repository). Communities in the study area were also asked to affirm whether these ecosystem services in their locality have been increasing or decreasing over the last 50 years. Accordingly, all discussants voiced the declining of ecosystem services over the years. They underlined that the ecosystem services have been degraded by a large array of human activities. Foremost, among the immediate threats mentioned were the continuing destruction of natural habitats like forest/woodland; and the conversion of forestland into other land use types like agriculture and settlement. Other imminent threats mentioned were climate change, fire and overexploitation.

Likewise, when an 82-year-old man was asked to describe the state of ecosystem services in the area, he stated as follows:

> *When I was teenager I used to hunt wild mammals like* bushbuck (*Tragelophus scriptus),* reedbuck (*Redunca redunca),* buffalo (*Syncerus caffer) and many other wild animals with my Dad in the nearby forests. But today this is all history-as both the forest and the animals have gone forever. He further stated that, today, it is seldom possible to encounter mammals like* Bushbuck, Warthog (*Pacocehoerus africanus), and* Waterbuck (*Kobus ellipsiprymnus),* Crested porcupine (*Hystrix cristata) and* Leopard (*Panthera pardus) due to habitat loss and fragmentation. He further stated that, if you see any of these animals in the landscape today you feel as if you are blessed.*

Another 79–year-old key informant who used to practice traditional healing exercise also expressed her opinion about ecosystem services change in the area as;

> *Many of the plant species I was using to treat my patient were lost along with the degradation of natural ecosystems like forest. As a result, I abandoned the practices some 20 years ago. Currently I am not practicing at all and couldn't able to pass my knowledge to my children as most of the medicinal plant species had been locally extinct, e.g., Embelia schimperi, Clematis simensis, Maesa lanceolata, Buddleja polystachya, Ocimum lamiifolium* and *Brucea antidysenterica.*

Many of the informants felt that having lived a long life in the area led them to notice the change that has happened over the past decades. An 89-year-old informant explained regarding the current and historical wild edible plants status in the area as:

> *I was born and grown up in Qare village. When I was a young person, forest and grassland covered a significant proportion of our locality (~ more than 75 percent). Apparently, there were many wild edible plant species in the ecosystems and I used to collect and eat thembeen . The key and abundant wild edible plant species used to occur in the area include: Carissa spinarum, Rosa abyssinica, Syzygium guineense, Ficussur, Oncoba spinosa, Dovyalis abyssinica, Acanthus sennii and Phoenix reclinata. At the present, most of these species have already threatened due to deforestation and forest degradation and it is seldom*

possible to get and collect their fruits. This is a tragedy as we have kept destroying our environment! I feel sorry for our grandchildren who may not be able to see some of these useful plant species anymore.

According to these informants, many of the valuable species have locally been endangered or extinct mainly due to the conversion of forest, woodland and grasslands to humanized landscapes. Overharvesting or overexploitation of some of the useful plant and animal species has been mentioned as a critical threat to their existence due to population growth and associated land fragmentation.

Community perception of biodiversity loss

All the FGD discussants and key informants reiterated that the abundance and diversity of both plant and mammal species have been endangered or locally extinct in their vicinity. Loss of natural ecosystems like forest was mentioned as the main cause for the loss of both plant and mammal species in the area. According to the International Union for Conservation of Nature (IUCN), an endangered species is a species which has been categorized as high risk of extinction in the wild; whereas extinction refers to when no known individuals remaining in the wild. The present finding revealed that both 'extinction' and 'endangered' refer to local conservation status of the species; i.e., local extinction/endangerment of the species. Accordingly, the local communities have listed about 16 mammals, 17 birds and 45 plant species used to be common in the area which are barely visible in the study area today. Table 4 shows the list of mammals' species used to be common but no more frequently existing in the area.

Table 4. List of mammal species categorized as locally endangered or extinct in the study area.

Scientific name	Family name	Common name
Civettictis civetta (Schreber, 1776)	Viverridae	African Civet
Colobus guereza (Rüppell, 1835)	Cercopithecidae	Gurereza
Crocuta corocuta (Erxleben, 1777)	Hyaenidae	Spotted Hyaena
Hystrix cristata (Linnaeus, 1758)	Hystricidae	Crested porcupine
Ichneumia albicauda (G. Cuvier, 1829)	Herpestidae	Mongoose
Kobus ellipsiprymnus (Ogilby, 1833)	Bovidae	Waterbuck
Lycaon pictus (Temminck, 1820)	Canidae	Hunting dog
Orycteropus afer (Pallas, 1766)	Orycteropodidae	Aardvark
Phacochoerus africanus(Gmelin, 1788)	Suidae	Warthog
Panthera pardus(Linnaeus, 1758	Felidae	Leopard
Potamochoerus larvatus (F. Cuvier, 1822)	Suidae	Bush pig
Redunca redunca (Pallas, 1767)	Bovidae	Bohor Reedbuck
Sylvicapra grimmia (Linnaeus, 1758	Bovidae	Bush Duiker
Syncerus caffer (Sparrman, 1779)	Bovidae	Buffalo
Tachyorycetes splendens (Rüppell, 1835)	Spalacidae	African Mole-rat
Tragelophus scriptus(Pallas, 1766)	Bovidae	Bushbuck

Source: Own survey 2017

Table 5 shows the list of bird species categorized by the local community members as being endangered in the study area. Some of these game birds are usually hunted for their meat, e.g., Harwood's Francolin and Guineafowel.

Table 5. List of bird species categorized as locally endangered or extinct in the study area by community.

Scientific name	**Family name**	**Common name**
Alopochen aegyptiaca (Linnaeus,1766)	Anatidae	Egyptian Goose
Bostrychia hagedash (Latham, 1790)	Threskiornithidae	Hadada Ibis
Bubo lacteus (Temminck, 1820)	Strigidae	Greyish Eagle-Owl
Bucorvus abyssinicus (Boddaert, 1783)	Bucorvidae	Abyssinian Ground-hornbill
Buphagus erythrorhynchus (Stanley, 1814)	Sturnidae	Red-billed Oxpecker
Campethera nubica (Boddaert, 1783)	Picidae	Nubian Woodpecker
Colius striatus (Gmelin,1789)	Coliidae	Speckled Mousebird
Gyps africanus (Salvadori,1865)	Accipitridae	White-headed Vulture
Haliaeetus vocifer (Daudin, 1800)	Accipitridae	African Fish Eagle
Milvus migrans (Boddaert, 1783)	Accipitridae	Black Kite
Necrosyrtes monachus (Temminck, 1823)	Accipitridae	Hooded Vulture
Numida meleagris (Linnaeus,1758)	Numididae	Helmeted Guineafowel
Poicephalus flaviforns (Rüppell, 1845)	Psittacidae	Yellow-fronted Parrot
Pternistis harwoodi (Blundell & Lovat, 1899)	Phasianidae	Harwood's Francolin
Rougetius rougeti (Guérin-Méneville, 1843)	Rallidae	Rouget’s Rail
Tauraco leucotis (Rüppell, 1835)	Musophagidae	White-cheeked Turaco
Tockus nasutus (Linnaeus,1766)	Bucerotidae	African Grey Hornbill

Source: Own survey 2017

Likewise, the list of useful plant species used to be common in the area (and now either locally endangered or extinct) is shown in Table 6. Informants also underscored the disappearance of some reptiles such as snake and frogs.

Table 6. List of local endangered or extinct plant species in the Abay-Chomen district (Abbreviations: BH- Beehive; DE-Detergent; FE-Fruit/Flower edible; FI-Fiber; FO- Fuel wood; HF- Honey bee flora; M-Medicinal; T-Tiber).

Scientific name	Family name	Local name	Habit	Use
Acacia abyssinica Hochst. ex Benth	Fabaceae	Laftoo	Tree	HF
Acanthus sennii chiov	Acanthaceae	Sookooru	Shrub	FE
Albizia gummifera (J. F. Gmel.) C.A.Sm.	Fabaceae	Mukarbaa	Tree	HF
Arundo donax L.	Poaceae	Shobboko	Shrub	BH
Bersama abyssinica Fresen	Melianthaceae	Lochissa	Tree	FO
Brucea antidysenterica J.F.Mill.	Simaroubaceae	Qomagno	Tree	M
*Buddleja polystachya*Fresen.	Loganiaceae	Anfaree	Tree	M
Calpurna aurea (Ait.) Benth	Fabaceae	Cekka	Tree	M
Carissa spinarum L.	Apocynaceae	Hagamssa	Shrub	FE
Clausena anisata (Willd.) Benth.	Rutaceae	Ulmayi	Tree	M
Clematis simensis Fresen.	Ranunculaceae	Hidda	Climber	M
Croton macrostachyus Del.	Euphorbiaceae	Baakanissa	Tree	M
Diospyros abyssinica (Hiern) F. White	Ebenaceae	Lookoo	Tree	T
Dodonaea angustifolia L.f.	Sapindaceae	Itacha	Shrub	M
Dombeya torrida (J.F.Gmel.) P. Bamps	Malvaceae	Danissa	Tree	FI
Dovyalis abyssinica (A. Rich.) Warb	Flacourtiaceae	Koshomi	Tree	FE
Echinops ellenbeckii O. Hoffm.	Asteraceae	Qarabicco	Tree	M
Ekebergia capensis Sparrm.	Meliaceae	Soomboo	Tree	T
*Embelia schimperi*Vatke	Myrsinaceae	Hanku	Climber	M
Erythrina brucei Schweinf.	Fabaceae	Walensu	Tree	T
Ficus sur Forssk.	Moraceae	Harbu	Tree	FE
Gnidia lamprantha Gilg	Thymelaeaceae	Didikssa	Tree	FI
Hypericum revolutum Vahl.	Hypericaceae	Uleefooni	Tree	M
Ilex mitis (L.) Radlk.	Aquifoliaceae	Katoo	Tree	T
Maesa lanceolata Forssk.	Myrsinaceae	Abbayi	Tree	M
Maytenus obscura (A. Rich.) Cuf.	Celastraceae	Kombolca	Tree	FO
Myrsine africana L.	Myrsinaceae	Kachame	Shrub	M
Nuxia congesta R. Br. ex Fresen	Loganiaceae	Nafuroo	Tree	FO
Ocimum lamiifolium Hochst. exBenth.	Laminaceae	Ancabi	Tree	M
Olea europaea L. ssp. cuspidata	Oleaceae	Ejerssa	Tree	M
Olinia rochetiana A. Juss.	Oliniaceae	Noole	Tree	M
*Oncoba spinosa*Forsk.	Flacourtiaceae	Kombolca	Tree	FE
Osyris quadripartita Salzm. Ex Decne.	Santalaceae	Wattoo	Tree	M
Phoenix reclinata Jacq.	Arecaceae	Metti	Tree	FE
Phytolacca dodecandra L'Her.	Phytolaccaceae	Handoode	Shrub	DE
Pittosporum viridiflorum Sims	Pittosporaceae	Soole	Tree	FO
Prunus africana (Hook.f.) Kalkm.	Rosaceae	Homi	Tree	T
Ritchiea albersii Gilg	Capparidaceae	Arabe	Tree	FE
Rosa abyssinica Lindley	Rosaceae	Qaqawi	Shrub	FE
Salix subserrata Willd.	Salicaceae	Alaltu	Shrub	M
Schefflera abyssinica Forst. &Forst. F.	Araliaceae	Gatama	Tree	HF
Syzygium guineense ssp. Guineense (Willd.)DC	Myrtaceae	Badessa	Tree	FE
Syzygium guineense ssp. macrocarpum F. White	Myrtaceae	Gosu	Tree	FE
Urera hypselodendron (A. Rich.) Wedd.	Urticaceae	Lankissa	Climber	FI
Vernonia amygdalina Del.	Asteraceae	Ebicha	Tree	M

Source: Own survey 2017

DISCUSSION

LULC analysis has shown that natural ecosystems have decreased during the study period (1973–2016) in the study area. This is understandable as water body and agricultural land expands at the expense of forest, grassland and woodlands. The main feature of the transformation of water body was the move of the country for self-sufficiency of electricity through hydropower dam expansion and export oriented sugar industry development through irrigation in the study area. Conversely, the key informants reiterated that over the last six to seven decades, forest cover has been continuously vanished mainly due to wood extraction (fuel wood, construction), agricultural land and settlement expansion coupled with population growth, poverty and policy failures. This increase in agricultural cultivation supports the claim that population increment necessitates food production, a key requirement for man's survival. This further supports the view that economic growth and population increase accelerated land use change in the study area (Lanckriet et al. 2015; McCann 1997; Reid et al. 2000).

The present study has also depicted that ecosystem services have deteriorated mainly owing to the conversion of natural ecosystems to agricultural ecosystem and over exploitation in the study area. This finding is in consistent with other findings elsewhere (Leh, Matlocka, Cummingsa & Nalley 2013; Kindu et al. 2016; Martinez et al. 2009). In the present study, land cover change is identified as an important driver of change of ecosystems and their services. According to Ehrlich, Ehrlich & Holdren (1977) and Daily et al. (1997) threats to ecosystem services were driven by two broad underlying forces. The first driver is rapid and unsustainable growth in the scale of the human enterprise: population size, per-capita consumption, and also environmental impacts that technologies and institutions generate as they produce and supply those consumables. The other underlying driver is the frequent mismatch between short-term, individual economic incentives and long-term societal well-being. Given the vital role the ecosystems play in sustaining a growing human society their sustainable management are critical. Humanity has the ability to make development sustainable by ensuring ecosystems services for current use without compromising the ability to provide them in the future (MEA 2005; Munang et al. 2011). We must therefore protect, restore and manage ecosystems, particularly those that have been most degraded.

The present study has also portrayed that continued natural ecosystem change has accelerated loss of biological resources in the study area. The study area was once covered by dense moist evergreen Afromontane forest vegetation (Friis, Demissew & Breugel 2010). As displayed in LULC maps (Figure 2) and described by the local community, the natural ecosystems such as forest, grassland and woodlands have significantly been destroyed along with their associated biodiversity in the study area. Local communities have identified about 78 mammals, birds and plant species that are already either endangered or locally extinct due to ongoing land cover changes in the study area. Over the past two decades, various studies (Brook, Ellis, Perring, Mackay & Blomqvist 2013; Cardinale et al. 2012; Mace et al. 2014; MEA 2005) have shown that loss of the world's biological diversity reduced the productivity and sustainability of natural ecosystems and decreased their ability to provide ecosystem services. Continued human pressure on mammals and important plant species reduces their population sizes and exerts selection pressure resulting in reduced population size (Chapin et al 2000; Conover, Munch & Arnott 2009; Ehrlich & Ehrlich 1992; Thompson 1994). For example, the number, kinds and traits of species present determine the organismal traits that influence ecosystem processes, so mediating energy and material fluxes directly or altering abiotic conditions (i.e., limiting resources, disturbance and climate) that regulate process rates (Chapin et al 2000). Past destruction coupled with the more recent habitat loss and fragmentation raising the possibility that today's ecological communities are so short of large species that human activities have reduced not simply species diversity and ecological interactions but also the future potential of their evolution (Donlan et al. 2006; Yule, Fournier & Hindmarsh 2013). According to Walker (1992) some species make unique contributions to ecosystem functioning and, therefore, their loss could cause unprecedented impacts. However the possibility of significant losses of functions increase as more species are lost and as redundancy is reduced (Walker 1992; MEA 2005). Greater redundancy represents greater insurance that an ecosystem will continue to provide both higher and more predictable levels of services (Yachi & Loreau 1999). Central to this is that biodiversity is the key to supporting resilient, productive and healthy functioning ecosystems and therefore underpins the provision of ecosystems services (MEA 2005).

Since 1973, there has been a continuous natural resource governance system change along with regime changes in Ethiopia. In 1974, there was a change in the feudal regime to a military regime; and the military regime nationalized lands by abolishing private and common property of the land, thereby giving a usufruct rights for all (Reid et al. 2000; Tolessa et al. 2017). The current government, the Ethiopian People Revolutionary Democratic Front (EPRDF), which came to power by removing the military regime in 1991, also followed the preceding regime's land policy. This policy made land and land related resources absolutely owned by the state, which in turn was unable to monitor and enforce laws (Tolessa et al. 2017). Consequently, natural resources like forest were heavily extracted and/or converted to agriculture land and settlements. On top of that, Agriculture Development Led Industrialization (ADLI) policy of the current government has also encouraged investors and the public institution to emphasis on large-scale farming –which is partly the cause for Finchaa Sugarcane plantation expansion for sugar production in the study district.

In Ethiopia, over-population, extensive farming, uncontrolled logging, lack of proper policies and conflict /political instability have caused severe environmental degradation for so many years (EFAP 1994; Lanckriet et al. 2015; Nyssen et al. 2008). In the study area, the interplays between land use changes and unsustainable development projects-such as hydropower dam construction has also influenced natural ecosystems in many parts of the district. Most of these factors have been and are still tempted by anthropogenic factors and accelerated by inappropriate agricultural practices, and inappropriate institutional and policy applications, population explosion, improper settlement expansion, poverty and lack of serious political commitment (McCann 1997; Pankhurst 1995; Pimentel et al. 1995; Reid et al. 2000). Many of the respondents, for example, reiterated the inconsistency of land tenure, instability of institutional setup and lack of mainstreaming environmental management have exacerbated the problems of land degradation and threat to ecosystem services. Both the farmers and experts have disclosed the prevailing challenges associated with land degradation in many parts of the area that include: declining in land productivity due to nutrient depletion, dearth of forest products, and food insecurity. The local communities further highlighted the severe livestock population decline in the area mainly due to the conversion of grazing and forest/woodland to agricultural land and water body. Some three to four decades ago, the study area was recognized as hub of livestock population. However, today one can see few livestock population in the area. Overall, the past and the present development strategies of Ethiopia has given due emphasis on economic growth and limited attention on the other pillars of sustainable development, i.e., social, and environment. Thus, there is a need to promote sustainable development that improves human capacity to manage ecosystem services that enhance human well-being and resolve environmental degradation.

CONCLUSIONS

Natural ecosystems still continued to be under severe degradation and conversion pressures in many parts of the world including Ethiopia. These practices have been critically threatening biodiversity and ecosystem services. As revealed in the present study, land use/land cover change severely threatened biodiversity and ecosystem services in the study area. Uncontrolled exploitation of natural resources and unsustainable development are indeed the major causes of ecosystem degradation including biodiversity loss in the study area. Hence, sustainable development that combines economic, social, and environmental aspects of human activity must therefore be taken into consideration to bring about enduring development that embraces ecosystem management. Hence, Ethiopia's environmental management policy should be geared toward the protection of existing natural ecosystem such as forest blocks and fragments of primary forest. In other words, strengthening of a conservation policy should be the most proactive means to enhance the value of the remaining natural ecosystems for the country's biodiversity conservation and to combat environmental degradation and land use conversion. To reverse these challenges, there must be broad-scale rehabilitation projects around the country. For instance, forest users must have some incentive mechanisms to conserve forests, which make them a more attractive option than clearing for agriculture. Thus, payment for ecosystem services should be introduced as incentive mechanisms to overcome the devastating effects of environmental degradation trends in the study area and beyond. The study district is located in the Blue Nile basin; and apparently it has local, national and regional importance in many ways. As there are three hydropower dams operating and supplying energy to the country, introduction of payment for hydrological services should be worthwhile for combating environmental degradation in the study area.

ACKNOWLEDGEMENTS

The author is very grateful for the thematic research project of Addis Ababa University for financial support. The local communities are also highly appreciated for their willingness to provide information and support during data collection. The author also would like to thank Mr. Zeleke Kebebew for the support during the course of the study.

REFERENCES

Anderson, J.R., Hardy, E, Roach, J, & Witmer, R. (1976). A Land Use and Land Cover Classification System for Use with Remote Sensing Sensor Data. *Geological Survey Profession Paper* 964: 1-28.

Batterbury, S, & Bebbington, A. (1999). Environmental histories, access to resources and landscape change: an introduction. *Land Degrad. Dev*.10 (4): 279–289.

Bellete, T. (2014).*Fertility Mapping of Soils of Abay-Chomen District, Western Oromia, Ethiopia* (Unpublished MSc Thesis). Haramya University.

Boru, A. & Kositsakulchai, E. (2012). Land Use Change Analysis Using Remote Sensing and Markov Modeling in Fincha Watershed, Ethiopia. *Kasetsart J. (Nat. Sci.)* 46: 135 – 149.

Brook, B.W., Ellis, E.C., Perring, M.P., Mackay, A.W. & Blomqvist, L. (2013). Does the terrestrial biosphere have planetary tipping points? *Trends Ecol. Evol***.** 28(7): 306-401.

Cardinale, B.J. et al. (2012). Biodiversity Loss and its Impact on Humanity. *Nature* 486: 59-67.

Chapin, F.S., Zavaleta, E.S., Eviner, V.T., Naylor, R.L., Vitousek, P.M., Reynolds, H.L., Hooper, D.U., Lavorel, S., Sala, O.E., Hobbie, S.E., Mack, M.C.& Díaz, S. (2000). Consequences of changing biodiversity. *Nature* 405:234-242.

Conover, D. O., Munch, S. B. &. Arnott, S. A. (2009). Reversal of Evolutionary Downsizing Caused by Selective Harvest of Large Fish. *Proc. Royal Soc. B*276: 2015–20.

CSA. (2008). *The 2007 Population and Housing Census of Ethiopia*. Statistical Summary Report at National Level. Addis Ababa, Ethiopia: Central Statistical Agency (CSA).

CSA.(2013). *Agricultural Sample Survey 2012/2013: Area and Production of Major Crops*. Statistical Bulletin 532.FDRE/CSA, Addis Ababa, Ethiopia.

Daily, G., Alexander, S., Ehrlich, P., Goulder, L., Lubchenko, J., Matson, P.A., Mooney, H.A., Postel, S., Schneider, S.H., Tilman, D. & Woodwell, G.M. (1997). Ecosystem services: benefits supplied to human societies by natural ecosystems. *Issues in Ecology 2.Ecological Society of America*, Washington DC.

Darbyshire, I., Lamb, H. & Umer, M. (2003). Forest clearance and regrowth in northern Ethiopia during the last 3000 years. *The Holocene* 13 (4): 537-546.

Donlan, C.J. et al. (2006). Pleistocene Rewilding: An Optimistic Agenda for Twenty-first Century Conservation. *The American Naturalist*168: 660–81.

EFAP. (1994). *Ethiopia Forestry Action Program: The challenges for Development*. Addis Ababa, Ethiopia. Vol. II.

Ehrlich, P.R. & Ehrlich, A.H. (1992). The value of biodiversity.*Ambio*21:219-226.

Ehrlich, P.R., Ehrlich, A.H. & Holdren, J.P.(1977). *Ecoscience: Population, Resources, Environment*. Freeman and Co., San Francisco.

FAO. (1993). *The Challenge of Sustainable Forest Management: What Future for the World's Forest*? FAO, Rome.

FAO. (2006). *Global Forest Resources Assessment 2005. Progress towards sustainable forest management*. FAO Forestry Paper 147, Rome.

FAO. (2010). *Global Forest Resources Assessment: Main Report.* FAO, Rome.

FAO. (2015). *Global Forest Resources Assessment, How Are the World's Forests Changing?* FAO, Rome.

Folke, C. (2006). Resilience: the emergence of a perspective for social– ecological systems analyses. *Glob Environ Change*16: 253–267.

Foody, G.M. &Mathur, A. (2006). The use of samll training sets containing mixed pixels for acurate hard image classification: training on mixed spectral responses for classification by a SVM. *Remote Sensing of Environment* 103:179-189.

Friis, I., Demissew, S. & van Breuge, L. P. (2010). *Atlas of the potential vegetation of Ethiopia*. Copenhagen: Royal Danish Academy of Science and Letters.

Habte, A. (2016).*The Dynamics of Land use Land cover change on the Stream Flow in Fincha-Amerti -Neshe Sub-basin: Abay basin, Ethiopia* (Unpublished MSc Thesis). Addis Ababa University.

Hundara, M. (2017).*The Impacts of Hydropower Projects in Ethiopia: The Case of Finchaa-Amarti-Nashe (FAN) Project in HoroGuduru, Western Ethiopia* (Unpublished MA Thesis). Addis Ababa University.

IPCC. (2007).*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignorand H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kindu, M., Schneider, T., Teketay, D. & Knoke, T. (2016). Changes of ecosystem service values in response to land use/land cover dynamics in Munessa–Shashemene landscape of the Ethiopian highlands. *Science of the Total Environment* 547: 137–147.

Lanckriet, S., Derudder, B., Naudts, J., Bauer, H., Deckers, J., Haile, M. & Nyssen, J. (2015). A political ecology perspective of land degradation in the north Ethiopian. *Land Degrad. Dev*.26: 521–530.

Leh, M.D., Matlocka, M.D., Cummingsa, E.C. & Nalley, L.L. (2013). Quantifying and mapping multiple ecosystem services change in West Africa. *Agriculture, Ecosystem and Environment* 165: 6–18.

Liu, J. et al. (2007). Complexity of coupled human and natural systems. *Science* 317: 1513–1516.

Logan, W. E.M. (1946). An introduction to the forests of central and southern Ethiopia. *Imperial Forestry Institute Paper*24:1-58.

MacDicken, K.G., Sola, P.B., Hall, J.E., Sabogal, C., Tadoum, M. & de Wasseige, C. (2015). Global progress toward sustainable forest management. *For. Ecol. Manage*. 352: 47–56.

Mace, G. M. et al. (2014). Approaches to defining a planetary boundary for biodiversity. *Glob Environ Change* 28:289–297.

Martínez, M.L., Pérez-Maqueo, O., Vázquez, G., Castillo-Campos, G., García-Franco, J., Mehltreter, K., Equihua, M. & Landgrave, R. (2009). Effects of land use change on biodiversity and ecosystem services in tropical montane cloud forests of Mexico. *For. Ecol. Manage.*258: 1856–1863.

McCann, J. C. (1997).The Plow and the Forest: Narratives of Deforestation in Ethiopia 1840-1992. *Environmental History* 2(2):138-159.

Medrilzam, M., Dargusch, P., Herbohn, J.& Smith, C. (2013) .The socio-ecological drivers of forest degradation in part of the tropical peatlands of Central Kalimantan, Indonesia. *Forestry* 87 (2): 335–345.

Millennium Ecosystem Assessment (MEA). (2005). *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

Munang, R. T., Thiaw, I. & Rivington, M. (2011). Ecosystem Management: Tomorrow's Approach to Enhancing Food Security under a Changing Climate. *Sustainability* 3:937-954.

Nyssen, J., Naudts, J., De Geyndt, K., Haile, M., Poesen, J., Moeyersons, J. & Deckers, J. (2008). Soils and land use in the Tigray Highlands (Northern Ethiopia). *Land Degrad. Dev*. 19: 257–274.

Pankhurst, R. (1995). The History of Deforestation and Afforestation in Ethiopia Prior to World War I. *Northeast African Studies* 2(1): 119-133.

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Shpritz,L., Fitton, R., Saffouri, R. & Blair, R. (1995). Environmental and economic costs of soil erosion and conservation benefits. *Science* 267: 1117–1123.

PRB (Population Reference Bureau). (2016). *2016 World Population Data Sheet*. Population Reference Bureau.

Raudsepp-Hearne, C., Peterson, G.D., Tengö, M., Bennett, E.M., Holland, T., Benessaia, K., Macdonald, G.K. and Pfeifer, L. (2010). Untangling the Environmentalist's Paradox: Why Is Human Well-being Increasing as Ecosystem Services Degrade? *BioScience* 60(8): 576-589.

Reid, R.S., Kruska, R.L., Muthui, N., Taye, A., Wotton, S., Wilson, C.J. & Mulatu, W. (2000). Land-use and land-cover dynamics in response to changes in climatic, biological and socio-political forces: the case of southwestern Ethiopia. *Landscape Ecol.* 15: 339–355.

Reusing, M. (2000). Change detection of Natural High Forests in Ethiopia Using Remote Sensing and GIS Techniques. *IAPRS*33:1-25.

Reyers, B., O'Farrell, P.J., Cowling, R.M., Egoh, B.N., Le Maitre, D.C. & Vlok, J.H. (2009). Ecosystem services, land-cover change, and stakeholders: finding a sustainable foothold for a semiarid biodiversity hotspot. *Ecology and Society*14 (1): 38.

Ritler, A. (2003).*Forest, land use and landscape in the Central and Northern Ethiopian Highlands, 1865–1930. (*Unpublished PhD Dissertation). University of Berne, Switzerland.

Senbeta, F. (2006). Problems of Environmental Degradation: Implications on Rural Development in Ethiopia. In: K. Berhanu & D. Fantaye (Eds.), *Ethiopia-Rural Development Policies: Trends, Changes and continuities, (*Pp. 255-269), Addis Ababa University Printing Press.

Tadesse, D., Woldemariam, T. & Senbeta, F. (2008). Deforestation of Afromontane rainforests in Ethiopia. In:I.B.Sanchez & C.L. Alonso (Eds.), *Deforestation Research Progress.* (pp. 21-39). USA, Nova Science Publishers, Inc.

Tefera, B. (2006). *People and Dams: Environmental and socio-economic changes induced by a reservoir in Fincha´a watershed, western Ethiopia* (Unpublished Doctoral Dissertation). Wageningen: UR.

Tefera, B. & Sterk, G. (2008). Hydropower-induced land use change in Fincha'a watershed, western Ethiopia: Analysis and impacts. *Mt Res Dev*. 28 (1): 72-80.

Thompson, J.N. (1994). *The Coevolutionary Process*. Chicago Univ. Press, Chicago.

Tolessa, T., Senbeta, F. & Kidane, M. (2016). Landscape composition and configuration in the central highlands of Ethiopia. *Ecology and Evolution* 6:7409-7421.

Tolessa, T., Senbeta, F. & Kidane, M. (2017).The impact of land use/land cover change on ecosystem services in the central highlands of Ethiopia. *Ecosystem Services* 23:47–54.

von Beritenbach, F. (1962). National forestry development planning: A feasibility and priority study on the example of Ethiopia. *Ethiopian Forestry Review* 3(4): 41-68.

Walker, B.H. (1992). Biodiversity and ecological redundancy. *Conservation Biology* 6:18-23.

Yachi, S. & Loreau, M. (1999). Biodiversity and ecosystem productivity in a fluctuating environment: The insurance hypothesis. *Proc. Natl. Acad. Sci. U.S.A.*96: 1463–1468.

Yule, J.V., Fournier, R.J. & Hindmarsh, P. (2013). Biodiversity, Extinction, and Humanity's Future: The Ecological and Evolutionary Consequences of Human Population and Resource Use. *Humanities* 2**:**147–159.

ABOUT THE AUTHOR

Feyera Senbeta, Associate Professor, Centre for Environment and Development, Addis Ababa University