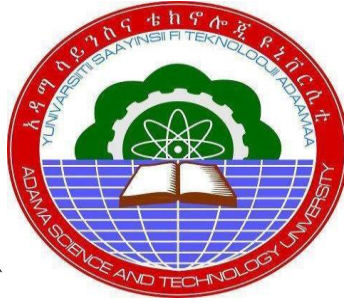




ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

OFFICE OF GRADUATE STUDIES

**Human Encroachment and livestock Impacts on Habitats of Mountain Nyala
(*Tragelaphus buxtoni*) in the Bale Mountains National Park, Oromia**

Regional State, South East Ethiopia

A Thesis

Submitted to the Department of Applied Biology

School of Applied Natural Science

**In Partial Fulfillment of the Requirements for the Degree of Master of
Science in Biology**

By: Adane Wayessa Mammo

Adama, Ethiopia

September, 2017

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By: Adane Wayessa Mammo

Advisor: Dr. Daniel Getahun

Adama, Ethiopia

September, 2017

Declaration

I hereby declare that this MSc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

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This MSc Thesis has been submitted for examination with my approval as thesis advisor/ Supervisor.

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Date of submission _____

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To: Applied Biology Department

Subject: Thesis Submission

This is to certify that the thesis entitled “**Human encroachment and livestock impacts on habitats of Mountain Nyala (*Tragelaphus buxtoni*) in the Bale Mountains National Park, Oromia Regional State, South East Ethiopia**” submitted in partial fulfillment of the requirements for the degree of Master of science in Biology, the Graduate program of the department of Applied Biology, and has been carried out by Adane Weyessa Mammo Id. No GSU/0395/ 06, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby he can submit the thesis to the department.

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Date: _____

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Acronyms and Abbreviations

BMNP	Bale Mountains National Park
EM	Environmental Management
ENMSA	Ethiopia National Metrological Statistical Agency
EWCP	Ethiopian Wildlife Conservation Program
EWCO	Ethiopian wildlife conservation organization
FAO	Food Aid Organization
FZS	Frankfurt Zoological Society
GDP	Gross Domestic Product
GMP	General Management Plan
GPS	Geographic Positioning System
IBC	Institute of Biodiversity Conservation
LCC	Land Cover Changes
LULC	Land Use Land Cover
MELCA	Movement for Ecological Learning Community Action-Ethiopia
SNRMP	Sustainable Natural Resource Management Programme

Abstract

A research conducted on human encroachment and livestock impacts on habitats of Mountain Nyala (*Tragelaphus buxtoni*) from February 2017 to June 2017 in the Bale Mountains National Park, Oromia Regional State; South East Ethiopia. The main objective of this study was to assess the impacts of livestock and human settlement into the habitats of Mountain Nyala. Semi-structured questionnaires was used to collect primary data and literature was reviewed to acquire secondary data in order to assess the socio-economic situation of households, and problems of natural resource management. Two districts were selected because of its accessibility from out of 9 districts in Dinsho woreda found next to the habitats of Mountain Nyala. 172 respondents were selected from two districts by purposively randomly sampling methods for questionnaires data survey. In addition to questionnaires, three focus group discussions were made at two selected districts and one at woreda with a member of 5 to 15 were used to acquire data. Participants of focus group discussion have been selected by purposively sampling methods to gather relevant data for the success of this study. Various data analysis techniques namely descriptive statistics, SPSS version 20 used. Results showed that 76% of households living in and around the Park earned direct benefit from the Park resource, in terms of livestock grazing 43%, farmland 31%, construction materials 18% and firewood collection 8% and affect the habitats of Mountain Nyala. Level of browsing was higher at the edges than inside the Park area. The livelihood benefits of the local community linked to the Bale Mountains National Park were statistically significant ($\chi^2 = 1.416$, $df = 1$, $P < 0.05$) in farmland holding inside the National Park among the Villages. Plant species that are mostly affected by settlers includes *Hagenia abyssinica*, *Hypericum revolutum*, *Juniperus procera* were observation around the study area. The results of the study shows that the local people of Gojera and Hora-Sobba districts in the Dinsho woreda encroached to the territories of the Park with their herds of cattle and affected different plant species which is the home to the Mountain Nyala. For these reasons, the number of Mountain Nyala which usually seen in an open field in the past few years, now their number extremely get decreasing from time to time. Creating awareness among the society concerning the economic benefit of endemic Mountain Nyala species so as to restrict their livestock's and prevents from degradation of wildlife.

Keywords: Bale Mountain National Park, Conservation, district, livestock, Mountain Nyala,

1 INTRODUCTION

1.1 Background of the study

According to the Millennium Ecosystem Assessment, one of the greatest proximate threats facing biodiversity is habitat loss because of the combined effects of agricultural development and livestock grazing. While the ultimate threats, such as increasing human populations and expanding global markets, are the root causes of biodiversity loss, they are generally beyond the scope of conservation planning. In our country, protected area structure covers 14 percent of its land mass, a percentage that is larger than the global average. From these Bale Mountains National Park in the south-central part of the country hosts the world's main Afro-alpine habitat, 17 endemic mammal species, 57 percent of Ethiopia's endemic bird species and 80 percent of the lasting Ethiopian wolf population, the world's rarest canid (BMNP, 2007). It is located in the southern highlands of Ethiopia within the Regional State of Oromia, the Bale Mountains are the site of the second highest mountain in Ethiopia, Tullu Demtu (4377 masl). The Bale Mountains contain the largest extent of Afro-alpine habitat (over 3000 m) in Africa. It is also a critical water catchment for 12 million people living in the southeastern lowlands and Somalia (Giles, 2015). Although protected areas conserve many of the world's habitats and species, human encroachment, is severely degrading and destroying many of these areas.

Human encroachment into protected areas, which has enlarged almost exponentially over the past few decades, was usually given raised to in the eradication of the larger species, particularly the large mammals (Ellingham, 1990). Destruction of wildlife habitats has continued the leading threat to biodiversity. This damage taking different forms, for example degradation, fragmentation or total loss, is a function of the growing human activities drives mainly by such reasons as poverty, demographic factors, land tenure systems, inadequate conservation status, development policies and economic inducements (Kideghesho *et al.*, 2006). Livestock -wildlife interactions in rangelands has viewed in terms of competition because herbivores with overlapping habitat and diets have obvious potential for competition. The geographical distributions of many species in Africa have been reduced due to hunting, pastoralist, and encroachment into protected areas, habitat modification and disease control. The importance of each of these factors depends on the species, its location and habitat, and density of the human population (Georgiadis *et al.*, 2007).

The effects of human encroachment and livestock impacts increase the biodiversity degradation and ecosystem disturbances in different ways. The occurrence of disease transmission from domestic animals to wild animals like rabies and grazing land competition between wild animals and domestic animals, settlements in the protected area, narrowing of the wild animal's territory and the fragmentation of the biodiversity are the most observed effects reflected on the habitats of wildlife (General Management Plan (GMP) of BMNP, 2011).

Most of the Parks of Ethiopia facing challenges and threats from the human settlements; Bale Mountain National Park is also found under high pressure of human encroachment and livestock impacts from all direction of the Park. Ecosystem degradation caused by increasing human settlements, expanding agriculture and unsustainable natural resource use pose a serious threat to this vastly important area (BMNP, 2007). Human settlement, livestock overgrazing, agricultural expansion and wood extraction resulting from immigration and population growth are those that are currently considered the most severe, widespread and destructive to ecosystem health in Bale Mountain National Park (BMNP, 2011). However, in recent years no such detail study that has been conducted on the magnitude of livestock and human encroachments on the habitats of Mountain Nyala in the National Park. Therefore, this study was designed to identify particularly the impacts of livestock and human encroachment on the ecosystem of Mountain Nyala in Dinsho woreda at two specified district from January 2017 to June 2017. Moreover, it aimed at the loss of natural habitats of the Mountain Nyala and its effect on the ecosystem of BMNP in the selected district.

1.2 Statement of the Problem

Human settlement expansion is the primary cause for biodiversity and ecosystem degradation in the world. Uncontrollable population growth is the major factor for the increasing of the anthropological impact on the ecosystems and environment. As the population number increased from time to time, the impact on the ecosystems degradation also accelerated further. The impacts of livestock and human encroachment on conservation areas were vary from country to country. The major livestock and human encroachment drivers of tropical biodiversity loss are, focusing on their effects, at the species level. These drivers are more serious in major tropical forest regions, especially in Africa (Yosef and Afework, 2011).

Even though, the effects of anthropogenic factors on Bale Mountain National Park were briefly stated by different researchers, information on how local people and livestock affect the Mountain Nyala population was lacking. The current conservation status of Mountain Nyala, as designated is 'Endangered' due to its reduced population and continued decline (IUCN, 2003). A better understanding of the effects of anthropogenic activities including livestock grazing on natural habitat can help decision makers implement conservation plans, so that, conflict of interests between humans and conservation of threatened species can be minimized (Yosef *et al.*, 2011). Consequently, the increasing isolation of protected areas poses a serious threat to the long-term viability of many wildlife populations and migrations in Africa (Newmark, 2008). Thus, the aim of this study was to investigate the effects of encroachment by the local people and livestock on the habitats of Mountain Nyala and its habitat is in the Northern part of the Bale Mountains National Park (BMNP), where the surrounding farmers were predominantly dependent on subsistence farming and livestock rearing.

1.3 Objectives of the Study

1.3.1 General objective

The general objective of the study is to investigate the impacts of human encroachment and livestock on ecosystem of Mountain Nyala in BMNP.

1.3.2 Specific objectives

- To describe the impacts of human encroachment and livestock on the habitats of Mountain Nyala.
- To identify the plant species that are affected by human encroachment and livestock grazing to the Park.
- To determine the attitude of local people toward the resources of the Park.
- To identify factors that accelerated the degradation of the habitats of Mountain Nyala.

1.4 Research Questions

1. Does increasing of human encroachment and livestock affect the habitats of Mountain Nyala?
2. What are the main factors that affect the habitats of Mountain Nyala?
3. Do the land cover changes have negative impacts on natural habitats of Mountain Nyala?

4. What are the attitudes of local people toward the wildlife resources in BMNP?
5. Which plants species were more affected by settlers around the habitats of Mountain Nyala?

1.5 Scope and Limitations of the Study

The study specifically focuses on investigating factors that hinders the habitats of Mountain Nyala in Bale Mountain National Park South-east Ethiopia in Bale Zone. Factors that challenges the habitats of Mountain Nyala was too wide in its components .It may not be possible to address all factors for degradation of the habitats of the animal in this research due to limited time and resources. Further, the study was done under several constraint challenges, particularly during the process data collection. The time spent is not sufficient to collect the necessary data from the selected districts situated at different areas. This is due to inaccessibility of some of the household found scattered from the study area.

2 LITERATURE REVIEW

2.1 The BMNP and Human Encroachment to Its Territory

The Bale Mountains have the highest incidence of animal indemnity of any terrestrial habitat in the world, which, together with 163 endemic species of flowering plants (Hillman, 1986 and Williams *et al.*, 2002) provided the main reason for the establishment of the Bale Mountains National Park (BMNP) in 1971 (Hillman, 1988). Williams *et al.* (2002), described the BMNP as the single most important conservation area in the Ethiopian highlands. The National Park is part of Conservation International's Eastern Afro-montane Biodiversity Hotspot Area (Williams *et al.*, 2002), and is one of the 69 Important Bird Areas (IBAs) designated in the country, harboring about 280 bird species, of which six are endemic, seven are globally threatened and 44 (88% of the total in the country) are Afro-tropical highland biome species (EWNHS, 2001).

Furthermore, the importance of the hydrological services that the area provides to Southeastern Ethiopia and parts of Somalia have currently led the National Park to be internationally recognized as a globally important conservation area (GMP of BMNP, 2007). Despite such great conservation importance, the BMNP is exposed to severe human-induced threats from expanding settlement, agricultural and livestock grazing (Stephens *et al.*, 2001).

As soon as the Park was established in 1970, its initial boundary was delineated by EWCA in 1974 but not gazette at that time. Another attempt was made by Dr. Jesse Chris Hillman to revise the boundary in 1986. Due to the effort made by EWCA in collaboration with Bale zone and Dinsho woreda administration the Park legally gazette on February 2015 (BMNP Wikipedia. html). However, one of the pitfalls behind the proposed boundary was that local communities were neither consulted nor considered; during the process of initial boundary identification. According to the records of visitors and reports of the Park of different times, there was little non-permanent settlement at southern part of the Park, especially around Rira area and Hareenna forest that they were relay on forest honey production (GMP of BMNP, 2007).

As the General Management Plan (GMP of BMNP, 2013) fail to consider and consult the local community and delineate the boundary, more encroachment has brought a major challenge to the effective and efficient conservation of the national Park. Another factor is lack of clarity of the boundary among the dwellers that led to poor law enforcement and consequently to unsustainable

natural resources exploitation. In the other hand, during the establishment of the Park, there was little information on the biophysical and socio-economic aspects of the Bale Mountains region as a whole, obscuring the overall significances of the mountains. Nevertheless, researches conducted then since 1980s, have uncovered the importance of the area, and the various threats facing it. Based on the previously collected and new data acquired from field-based researches, from 1984 to 1986, a management plan developed for the Park in 1986. However, due to financial and expertise constraints, it remained kept on shelves and the problems and challenges identified on these management plan existed still now. From the identified challenges of the Park, expansion of encroachment is the core one (Hillman, 1986).

2.2 Population Growth and Trends of Threats and Challenges

Prior to 1960's no permanent settlements in the Bale Mountains, except some seasonal pastoralist movements during dry seasons. In mid 1980s, it estimates that only about 2500 people inhabited in the Park boundary. At present settlement expansion increase rapidly and it estimated about 35,000 people with more than 135,000 head of livestock encroached in the Park (BMNP, 2013). The consequence of the rapidly increasing of encroachment temporally and permanently increase interactions between wildlife and domestic animals. Given the current trend and irreversibility of habitat degradation in the fragile ecosystems of the Ethiopian highlands, it is possible that a number of wildlife species could face local extinction in unprotected areas outside the BMNP. This makes their conservation in the BMNP particularly important for the survival of species. The major threats for the long-term survival of the Ethiopian Mountain Nyala population in the BMNP and other parts of its range are: 1) habitat loss and fragmentation; 2) overgrazing by livestock, which affects its prey basis; 3) human encroachment to their habitats; and 4) traffic kills (Williams, 2002; Asefa, 2008).

The consequences of expansion of encroachment and other challenges of the BMNP have the following problems, food competition between wild and domestic animals, increase of unsustainable use of natural resources, prevalence of fire incidence prominent in Erica forest. The consequence of these threats are the main cause of habitat degradation and reduction of vegetation cover through deforestation, overgrazing and expansion of agriculture in to fragile and incompatible areas as explained above food competition between livestock and wildlife for limited resources, hindrance of vegetation regeneration and expansion of invasive species. Soil

erosion, flow rate reduction of perennial rivers and siltation of dams (example, Melka Wakena Dam), over harvesting of resources, particularly woody material for fuel and construction purpose, and blocking wildlife corridors through expanding settlement and agricultural land (GMP of BMNP, 2013).

At its inception in late 1969, there were few permanent settlers in the Park. However, Brown predicted with unnerving accuracy that the agricultural expansion of the plains surrounding the mountains would permanently push rural people to higher and higher altitudes and into areas, they previously used only on a seasonal basis. This has now happened, and the number of permanent houses within the Park has been increasing exponentially. General management plan of Bale Mountain National (2011) indicated that approximately 3,700 households with an average of seven people per house for 25,900 people living within the Park (GMP of BMNP, 2011).

Rapid population growth over the past two decades has led to a significant expansion of human settlements in the Bale ecosystem, both within and outside the Park boundaries. Corresponding land conversion and agricultural encroachment threatens the area's conservation value as well as the sustainability of traditional livelihoods and resource-access mechanisms. While the observed population growth is largely a result of extremely high fertility rates and the adherence to traditional practices such as early marriages and polygamy among the local population, migration has also contributed to population growth since the mid- 1990s (Dereje, 2015).

2.3 Livestock Grazing in the BMNP

The global livestock sector is growing faster than any other agricultural sub-sector, providing livelihoods to about 1.3 billion people and contributing for about 40 percent of the global agricultural output (FAO, 2008). As a result of growth in human population and increased demand for meat, global population of livestock has increased from 23,343.7 million in 2000 to about 28,282.2 million in 2009, with a concomitant increase in numbers that of sheep's and goats from 1805.7 million to 1939.2 million (FAO, 2010). The livestock sector is, economically, socially and politically strong in developing countries. It provides food and income to around 1.3 billion of the world's poor, especially in dry areas, where livestock are often the only source of livelihoods. The rangelands that result from grazing and browsing are important natural

resources, managed for a variety of agricultural, forestry, hunting, recreation and conservation objectives (Gordon *et al.*, 2004).

The impact of livestock on the environment is substantial with 26% of the earth's terrestrial surface is used for livestock grazing and 33% of global arable land used to grow feed grains (FAO, 2008). This contributes to extensive land and habitat degradation. Livestock grazing is a powerful driver of plant population dynamics and community succession (Fuhlendorf *et al.*, 2001). Grazing can affect both soil nutrient and water-holding capacity through influences on erosion of topsoil with reduction in plant cover and by decreasing infiltration rates through soil compaction. Soils disturbances from grazing may replace native vegetation with alien plants, potential to degrade the habitat.

Cattle grazing produce strong effects on the structure and dynamics of grassland plant communities. Effects of grazing on plants and soil could also affect the animal communities inhabiting grasslands, as they depend on vegetation for food and rely on cover and soil for foraging safely and/or for building temporary or permanent burrow systems (Lin and Batzli, 2001). Understanding the effects of grazing at the population, community, and ecosystem levels is critical for making appropriate management decisions. However, the impacts caused by grazing on a particular ecological system depend upon many factors, such as evolution of the system in the presence of large mammalian herbivores, habitat type and its ecological status, climate, taxa under study and seasonal timing and intensity of grazing (Proulx and Mazumder, 1998).

Similarly, for millennia, the natural ecosystems of Ethiopia were altered because of human and natural factors. Most of the highlands and some of the lowlands were converted into agricultural and pastoral lands. The need to maintain the integrity of protected areas by preventing livestock and human settlement encroachment into them is very crucial. Large mammal populations theoretically are best conserved in landscapes where large protected areas are surrounded by buffer zones and integrated into a greater ecosystem (Patience Gandiwa, 2011). Multi-use buffer zones, including those containing complex agro-forestry systems, are promoted as one strategy to provide both economic benefits to people and conservation benefits to wildlife (Fig.1) (Patience Gandiwa, 2011).

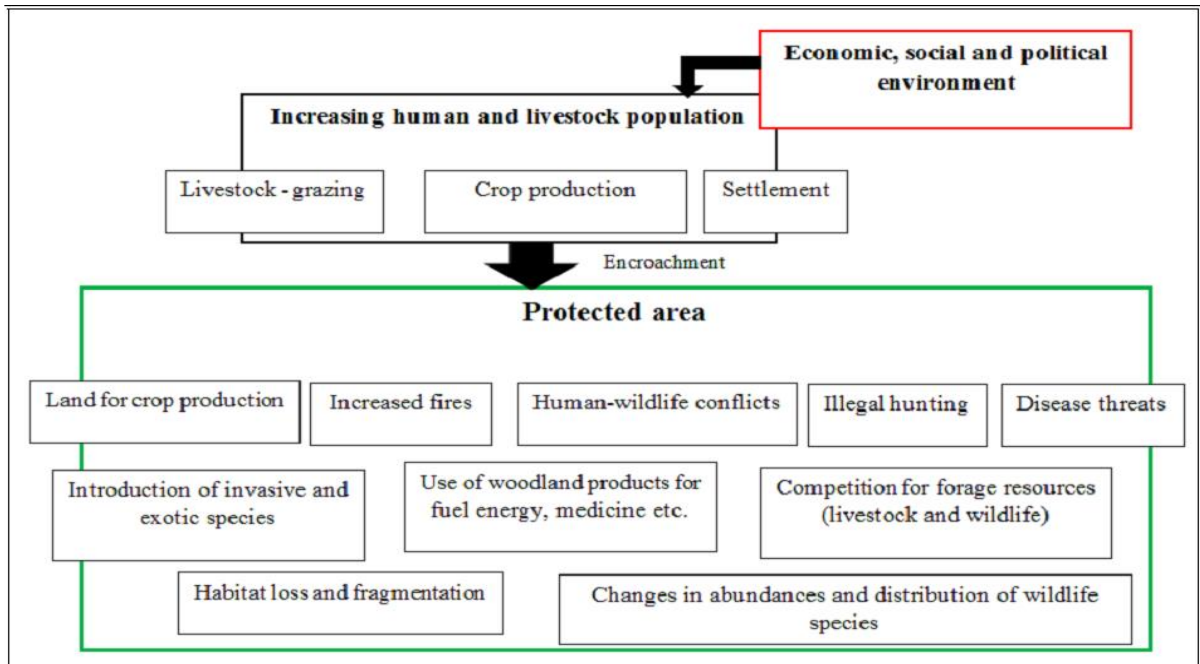


Figure 1: A conceptual framework outlining the major factors driving encroachments into a protected area and the likely impacts of this encroachment. (Source: Gandiwa, 2011)

Bale Mountains National Park faces many threats due to the impact of human. One of the major threats to the Park is grazing. For example, within the Gaysay grassland area, a prime Ethiopian Nyala habitat, cattle density is estimated at 250/km². Other threats include increasing encroachment within the Park. Currently, many people live within the Park's boundaries and increasing pressure on the natural resources of the area and diminishing natural habitats of wild animals. With these encroachment come domestic dogs, which pose a great threat to the Ethiopian wolf. Dogs transmit rabies and canine distemper (Sillero-Zubiri and Macdonald, 1997). In the current agricultural subsistence, livestock, particularly cattle, were sent to higher grazing grounds during the months when crops are growing in lower altitudes and into the forest for shade during the dry season. The Park has been under increasing pressure from the rapidly growing pastoralist population and their livestock (Marino *et al.*, 2006).

2.4 Land-cover Change in Protected Area

Land-cover change (LCC) particularly forest cover change is a key driver of global environmental change and has important implications for many national and international policy Issues. LCC in Ethiopia mainly driven by population pressure and associated activities made by

the people (Gessesse, 2010; Shiferawu A, 2011). This change impact on biodiversity and ecological balance since, the currently expanding and growing land use more of related to human activities. Forest is one of the basic resources on which people depend for their livelihood and domestic purpose beyond the service or environmental value, but degraded at the expense of other land use expansion. That is agriculture and urbanization (settlement). Nevertheless, the abundant forest resource of Ethiopia is dwindling from time to time. The consequence of degradation is potentially so severe in biodiversity rich areas such as Bale zone, which is one of the biodiversity hotspot in area in horn of Africa. In addition, changes in land cover, especially when coupled with climate variability and change, are likely to affect ecosystems and the many important goods and services that they provide to society. Determining the effects of land-cover change on the Earth system depends on an understanding of past land-use practices, current land-use and land-cover patterns, and projections of future land use and cover, as affected by human institutions, population size and distribution, economic development, technology, and other factors.

Research conducted in Ethiopia has shown that there were considerable Land cover changes in the country during the second half of the 20th century. Most of these studies indicated that deforestation and encroachment of cultivation into marginal areas were the major causes of land degradation, particularly in the highland part of the country (Shiferawu, 2011). The study conducted in South Wollo shows the major driving forces for these changes were natural factors such as steep slope, drought and Climate change. The human driving factors include population growth and density, over intensification of land use, farm size, land tenure status, and policies on land use. Study conducted in Chilimo-gaji forest cover change and population pressure related with socio-economic factors like expansion of agricultural lands, demand of fuel wood and constructional materials are the major causes of forest cover change (Gessesse, 2010). According to (Kiros, 2008) over the past 41 years, agricultural land areas increased significantly at the cost of the surface area for natural vegetation (woodland and shrub land) and in recent decades reductions in woodland and expansion and intensification of agriculture were associated with road construction, settlement expansions and population pressure in the highlands of Tigray, Northern Ethiopia. Consequently, land degradation in the form of soil erosion, and declining of biodiversity seems to have reached a critical stage attributed through forest cover change processes (Gessesse, 2010 and Shiferawu, 2011).

2.5 Human Settlements

Before the establishment of BMNP, human population density and its impacts on the biodiversity of the area was not that much significant. However, from time to time, the impact has been increasing dramatically especially starting from the year 1970. In 1998, there was an estimated human population of just 2,500 and 10,500 head of livestock in the area (Hillman, 1986). However, in 2003, the number of inhabitants was estimated over 40,000, representing a 16-fold increase in 20 years' time (GMP of BMNP, 2007). This population growth and expansion has lead the Park to experience greater expansion of farmlands with changes in the pattern and seasonality of land-uses in addition to high pressure from livestock grazing (IBC, 2007).

The BMNP has been under increasing pressure from a rapidly growing human population. The population is increasing almost linearly. As the result of this growth, existing settlements are growing, and new settlements are appearing in previously unsettled and environmentally sensitive areas. The emerging of new settlement is mainly associated with the rapid immigration from the surrounding lowlands (Temesgen, 2015). As a result of the expansion of villages, the habitats of the Park are seriously affected and found under critical condition. Moreover, people who have settled inside or on the fringes of the Park make heavy use of the Park's resources. The increased settlement and more intensive exploitation of resources by humans in the past have resulted in the degradation of the environment (Temesgen, 2015). Human settlement in general for example affect mammalian population in the afro-alpine and subafroalpine ecosystems through direct alteration of their natural habitat or causing loss of vegetation covers which particularly expose small mammals to increased rates of predation and sometimes competing for food resources (GMP of BMNP, 2011). Marino and Sillero- Zubiri *et al.* (2006) that state in the eve of the foundation of the BMNP, human settlement was not the main problem of the Park.

3 MATERIALS AND METHODS

3.1 Description of the Study Area

3.1.1 The Establishment of Bale Mountains National Park

The Bale Mountains National Park (BMNP) was established in 1970 primarily to save the endemic Mountain Nyala (*Tragelaphus buxtoni*) and Ethiopian wolf (*Canis simensis*), the alpine zone and the tropical forest on the Southern slopes. The Bale Mountains area was merely visited by naturalists; only one visitor, German naturalist and explorer Carlo Von Erlanger, was recorded between 1899 and 1901. In 1950s, the Finnish Geographer, Helmersmeds, had made three Journeys to Bale and travelled from Goba through Rira to Delo-Mena, and the British botanist, Herbet Mooney, visited the Sanete plateau and the Hareenna forest in 1962 (Hillman, 1986).

In 1960s, B.N. Weerts, obtained a concession of 400 hectares of land in the Gaysay valley, North of Dinsho town, for sheep farming. He had constructed developments at Dinsho hill, and sheep camp at Gaysay. Meanwhile, he decided to abandon the area. He rather suggested that the area has a great potential for wildlife conservation, particularly for the Mountain Nyala. During the same period, International Union for Nature Conservation (IUCN) classified the endemic Mountain Nyala (*Tragelaphus buxtoni*) as globally threatened species. Hence, Dr. Leslie Brown went to the Bale Mountains to investigate the status of the Mountain Nyala and he made two journeys (in 1963 and 1965) to the area. His conclusion with regard to the status of Mountain Nyala was not endangered, but in urgent need of conservation, and then a National Park should be created in the Bale Mountains for this purpose. His recommendation was accepted and Ethiopian Wildlife Conservation Authority (EWCA) established the Park on the area. Accordingly, the present BMNP was officially recognized in 1970 (GMP of BMNP, 2013).

Bale Mountain National Park was established by the Ethiopian Wildlife Conservation Authority (EWCA) and its' area were 2200 km² but now it is approximately 2150 km² (BMNP Wikipedia.html). The 2007 national census report shows that the total population of the Dinsho woreda was 39,124 (CSA, 2008). The woreda has nine districts, of these; Gojera and Hora-sobba were selected based on their proximity to the Park and accessibility for research.

3.1.2 Location

The Bale Mountain National Park is located in Bale Zone of Oromia Regional State (Fig. 2). It is about 400 km far from Addis Ababa and 30 km from Zonal capital Robe. The BMNP is located 6°29' to 7°10'N latitude and 39°28' to 39°57'E longitude and surrounded by five district namely; Adaba with North, Goba South, Delo-Mana with South, Hareenna-Bulk with West and Disnho with East (Hillman, 1986). Dinsho district is selected for the study because of its accessibility (General Management Plan (GMP) of BMNP, 2007).

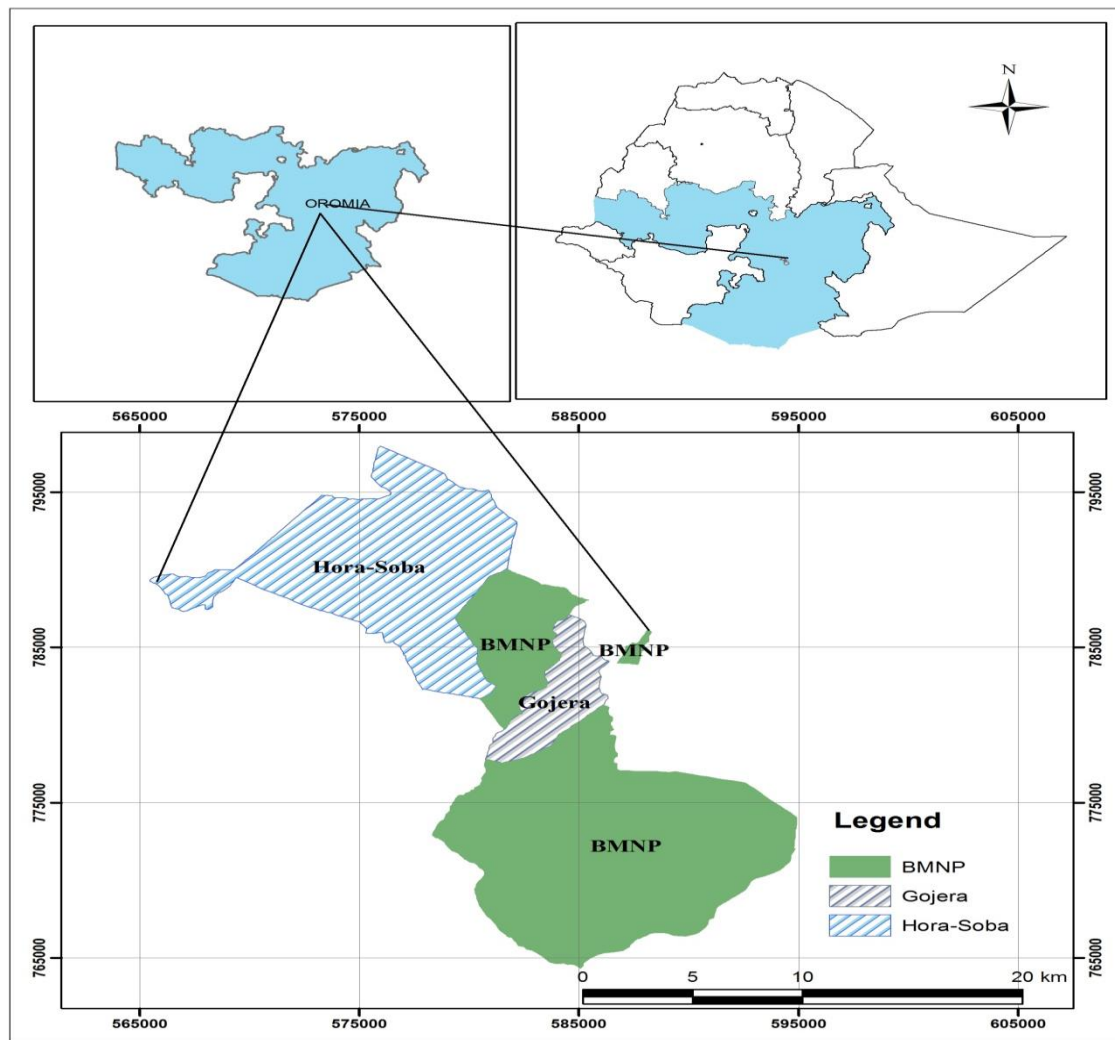


Figure 2: Map of the study area (Source: Ethio Arc GIS)

3.1.3 Topography

The Bale Mountains National Park (BMNP) is situated in the Southeastern highlands of Ethiopia, in the Oromia Regional State of Bale Zone. The Park encompasses 2,150 km² areas. Bale Mountains National Park contains the largest continuous area (over 1,000 km²) of afro-alpine habitat in Africa (Yalden, 1988). Tullu Demtu Mountain is found in BMNP which is 4,377 meters above sea level. It is the highest peak in Southern Ethiopia and the second highest in the country next to Ras Dashen. The North to South and East to West width of the Park is 74 and 53 kms, respectively. The Park can be divided into four topographic regions: the northern grass land and woody land between 3,000 to 3,550 masl; the central plateau and peaks of Afro-alpine plateau between 3,800 to 4,377 masl and the Southern escarpment with natural forests of 2,000 to 3,200 masl altitude (Hillman, 1986; IBC, 2007).

3.1.4 Climate

The rainfall distribution pattern of Dinsho district is characterized by eight month rainy season from late April to October and dry season, from November to March is known by extremely cold nights and warm days. In general, the area receives annually 600 mm to 1000 mm rainfall in lower altitude areas and the annual rainfall ranges from 1000 mm to 1400 mm in the higher altitude areas (Williams, 2002). Rainfall in BMNP is bimodal, with average long rain during July to October and average short rain during December to March (Fig.3). Over 60% of the annual rainfall occurs between April to November (wet season) (ENMSA, 2017).

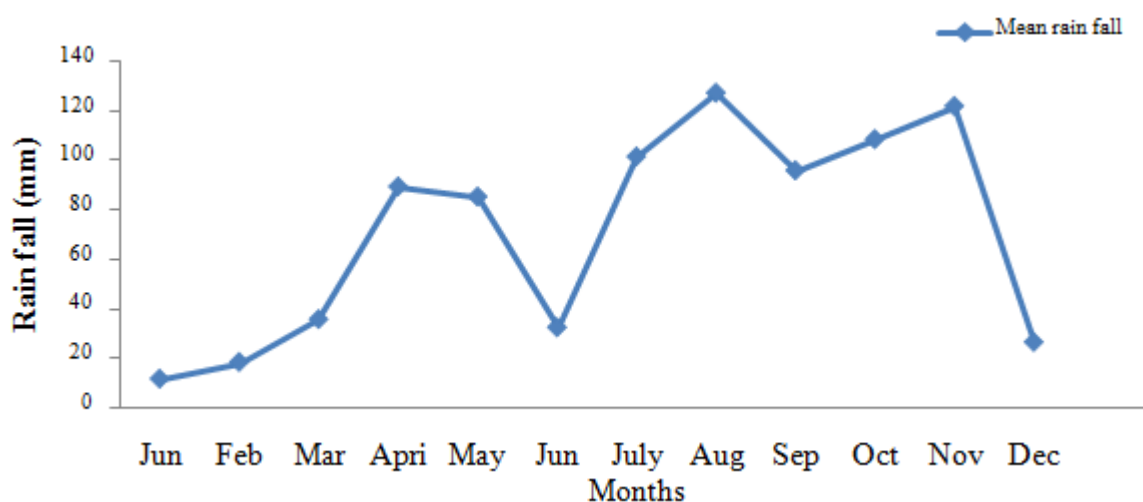


Figure 3: Mean monthly rainfall of the study area for the period of 2012 – 2016 (Source, ENMSA)

Temperature of the area is variable, particularly in areas of the highest altitudes during the dry seasons and more or less the same pattern of temperature during the wet season. The highest average temperature is 19.08°C in April and the lowest average temperature is 2.34°C in January and the average temperature of the Park normally ranges between 2°C and 20°C (Fig.4) (ENMSA, 2017).

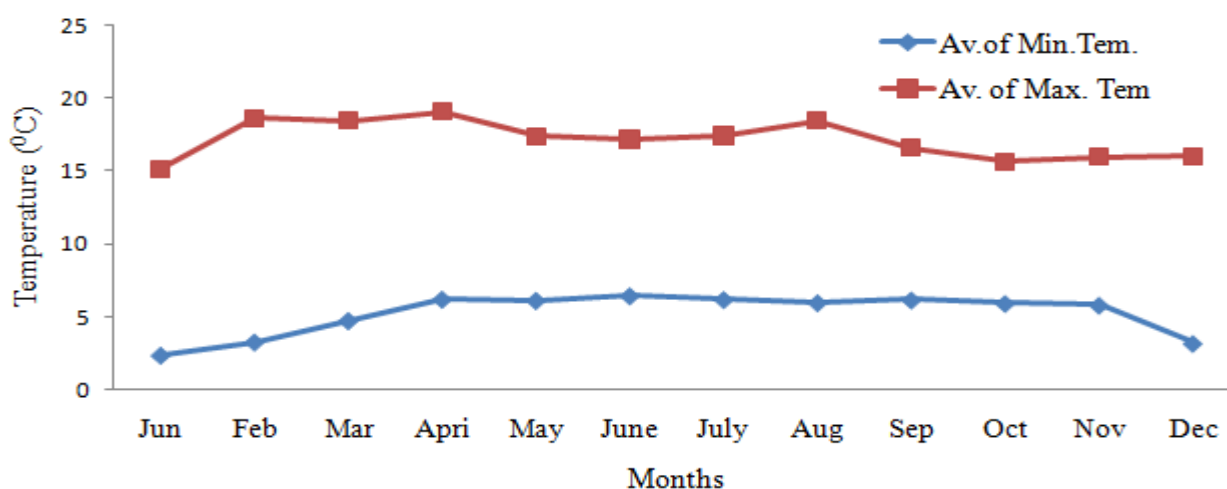


Figure 4: Mean monthly maximum and minimum temperature of the study area for the years 2012-2016 (Source, ENMSA)

3.1.5 The flora and fauna

Bale Mountains National Park (BMNP) possesses one of the highest incidences of animal and plant endemism of any terrestrial habitat in the world (Hillman, 1988). In BMNP, there are at least 1321 species of flowering plants, of which 163 are endemic (23 to Bale alone) to Ethiopia. In BMNP Afro-alpine areas of altitude >3400 masl have a vegetation composition of *Erica arborea*, *Helichrysum spp.*, *Alchemilla spp.* and giant Lobelia (*Lobelia rhyncopetalum*). Bale Mountains National Park is the home of diversity and endemism of fauna (Hillman, 1986). The Park supports 68 mammal species (Fishpool and Evans, 2001). The Park is home to the largest populations of both the endemic and endangered Ethiopian wolf (*Canis simensis*) and Mountain Nyala (*Tragelaphus buxtoni*), as well as the endemic Bale monkey (*Chlorocebus djamdjamensis*) and the Giant mole rat (*Tachyoryctes macrocephalus*). Over 170 bird species have been recorded in BMNP to date, from these about 20% of the species are endemic to Ethiopia. Among the endemic birds of Ethiopia, 57% are found in Bale Mountains (Hillman, 1986).

The Mountain Nyala is currently listed as endangered by the World Conservation Union due to reduced populations and continued to decline (IUCN, 2003). Mountain Nyala is known to occur in six localities from the South-eastern highlands, in which the largest area of its habitat (about 75%) lies in the BMNP (Evangelista and Malcolm, 2007). The total population of Mountain Nyala from 1969 to 1975 was reported by Leslie Brown estimated to be between 7,000 and 8,000. Summing the totals for the different parts of the Bale Mountains, a population of between 2,500 and 3,000 seems probable for the areas where Mountain Nyala are currently known to occur (Ethiopian Wildlife and natural history Society, 2011).

The Northern *Juniper-Hagenia* woodlands and Gaysay grasslands harbor the largest population of the Mountain Nyala (*Tragelaphus buxtoni*) with about 1000 to 1300 individuals or approximately two-thirds of the global population (Refera and Bekele, 2004). Apart from Gaysay about 80 to 120 Mountain Nyala occur in the rest of the Bale Mountains National Park, and a few hundred occur in the areas in the vicinity of the national Park (Sillero-Zubiri, 2008).

3.1.6 Crop production and animal husbandry

Like communities in any other areas, the local community in Dinsho district practice agricultural activities. Farmers rely on mixed farming system; crop production was the first while animal husbandry was the second major economic activity by settlers in the area. The major crops growing in the area are barely, wheat, beans, lentils, and different vegetables like potato, garlic, cabbage, and carrot are the most common. Both crop and animal production system are extensive production systems and subsistence production. Historically, people living in Bale Mountain areas were pastoralists. The most animal husbandry reared in the area is bovine and ovine (Barbre, 2013). Sheep and horse are highly dominated domestic animals in the study area.

3.2 Study Design

Two district administrations were purposively selected out of the nine (Geremba-Dima, Ayida, Gofingira, Mio, Dinsho 01, Zallo-Ababo and Kara-Ari) found in the vicinity of the BMNP. The two-selected districts are found in the Northern direction of the Park. Moreover, like other remaining districts found next to the Park territory, the human encroachment and livestock impacts on the habitats of Mountain Nyala was more severe in the selected two districts. The study designed from February 2017 to May 2017. Among others, they are located in Afro-

montane ecological zone that strongly depends on natural resource from the habitats of Mountain Nyala in the National Park. Besides, there was strong community challenge on biodiversity especially for grazing, cultivated land, timber harvesting and settlement that affects natural resource services and also on the habitats of Mountain Nyala.

3.3 Data Collection

3.3.1 Primary data

3.3.1.1 Questionnaires

Semi- structured questionnaires were prepared and given randomly to the selected respondents. The respondents were selected based on experience and long year resident in the area. Only respondents whose age was between 20 and 80 were responded to questionnaires and also gender balance was considered to insure representation of both males and females. The questionnaires were most commonly taken place outside a respondent's house. Care was taken not to introduce bias during questionnaires interpretation. In each representative district, head of the family were selected as respondents due to their acceptable knowledge and information. The semi-structured questionnaires were filled by Afan Oromo; since all the community of both districts are speakers of Afan Oromo language.

The first part of the questionnaires was related to the household characteristic and socioeconomic information of the households. The second part of the questionnaires contained general information in line with human encroachment and livestock impacts on the habitats of Mountain Nyala, use pattern and awareness on protected areas and ecosystem services. Therefore, from the 1309 total household of the two districts 172 total respondents (sample size) selected by using Cochran (1977) formula. The sample size for the study site was based on the following equation.

$$N = \frac{(\frac{Z_{\alpha}}{2})^2 * P * Q}{(W)^2}, \text{ where } n \text{ is the sample size, } \frac{Z_{\alpha}}{2} = 1.96 \text{ is the population size, and}$$

* $P * Q$ = marginal variance in which it is 5%,

W = Researchers willingness to accept margin of error.

$$N = \frac{(1.96)^2 * 0.5 * 0.5}{(0.09)^2}, n_o = 118 \text{ individuals. Then using Cochran (1977) correlation formula.}$$

$N = \frac{no}{1+(no-1)/N}$, for Gojera district, $n = \frac{118}{1+(118-1)/137} = 64$ Individuals and for Hora-Sobba district, $N = \frac{118}{1+(118-1)/1172} = 108$ Individuals were selected. Therefore, 172 households were selected from both districts and from each home hold family head were randomly selected for questionnaires.

For plants affected by settlers were identified by using quadrant methods. A transect walk was taken through the Park with the assistance of key informant to identify the different activities, changes in the area and observed pattern of features within the Park. In the sampled area it was conducted that a 10 m x 10 m quadrat from the beginning of the Park and 2 m x 2 m sample plots were laid across the transect. By systematic sampling from one quadrant six plots and from eight quadrant, 48 plots were selected and a total of 480 m transect was measured. The quadrants were separated by a distance of 500 meters. The plots were laid with the assistance of one local forest resource users in the study area and the plants species that were affected by settlers were identified by the BMNP ecologist expert and by Addis Ababa Herbarium staff.

3.3.1.2 Focus group discussion

Group discussion methods were used as a complement for the questionnaires. Seven pre-designed open-ended questions were used (Appendix II) for gathering information. Information was collected on how local communities perceive natural resource, how they access and use the Park's resources (grass, forest), and the co-existence of Mountain Nyala and communities.

Focus group discussion held in three places. One was in each district's among five people (one male and one female as key informant) from local area who live in the area for long years ago and knew the past and the present features of the area, one natural resource expert, and one Park expert and one district's administration. The second discussion was held at Dinsho woreda with the above five people from each districts', woreda's administration, Park administration, natural resource administration and district's administration. During the time of discussion, the participant genuinely generated valuable information about the major challenges which negatively affected the natural habitats of the Park in general of the Park and the life of Mountain Nyala in particular. The main issue for their discussion was the main factors that challenge habitats of Mountain Nyala in Gojera and Hora-Sobba districts.

3.3.1.3 Interview

Interviews were administered to the Park's administration with an emphasis on level of human encroachment and livestock grazing on the habitats of Mountain Nyala. Ten pre-designed open-ended questions were used (Appendix III) for -gathering information and any future plans for the management of this problem.

3.3.2 Secondary data

Secondary data were collected from published and unpublished literatures, previous studies done by researchers and books. In addition, the data that have been done in related discipline in the area by relevant bodies such as Frankfurt Zoological Society (FZS), Movement for Ecological Learning Community Action (MELCA) Ethiopia, Ethiopian Wildlife Conservation Authority (EWCA), and park experts, as well as district natural resource expert and district's agricultural office were essential to grasp necessary information.

3.4 Data analysis

Descriptive statistics was employed to analyze data gathered through questionnaire, FGD and interviews. To examine the forest coverage trend, biodiversity and ecosystem changes of the study area; especially, in the areas settlement expanding in the Park, about 5 km outside of the Park (imagined as buffer zone) and about 1-2 km adjacent (boundary) found between Park and selected districts. As well as image, photographs and pictures used and processed with excel. For qualitative data obtained through field visits and interview were analyzed in the form of descriptions. For quantitative data the research used statistics computer software SPSS version 20 was used.

3.5 Ethical Consideration

This study was conducted after obtaining ethical clearance from Ethiopia Wildlife Conservation Authority (EWCA) and 'EWCA Research Ethical Review Committee'. Before conducting the study, the purpose and importance of the study was explained to the Bale Mountain National Park Authority. For the confidentiality and anonymity of the data, the participants' information in questionnaire and interview were secured by using codes and not the respondent's names throughout the study so that, the respondents would not be identifiable.

4 RESULTS

4.1 Background Characteristics of Respondents

From 172 selected sample households, 64 from Gojera district and 108 from Hora-Sobba district were selected by random sampling method. Conducting the distribution of respondents by age group 65% sample households were in adult age group (24-55). Further respondents (60%) had a family size of 3 to 7 and also one house male can have wives from 1 to 5. About 161 (94%) of the respondents settled in the area were indigenous and 11 (6%) settlers came from adjacent districts.

All respondents were dependent on land and animal pastoral to generate income from farming. They settled in the area by their own need, means illegally. Separate land was not allocated for their livestock grazing in the area. According to the respondents, the productivity of the land for the majority of farmers was not sufficient and has no guarantee source of income to supplement their livelihood. Because of such low income, settlers around the Park do not get any incentive from the Park. The educational status of the respondents (Table 1), majority 96 (56%) were not attended any education. The two selected sample district predominantly have member of the family size in between two to seven. With the respect to the selected districts household members Gojera district have the highest family size.

Table 1: Educational status of respondents in study area in the year 2017

No	Educational Status	Respondents from selected districts'	
		Respondents response	%
1	Not attended formal education	96	55.8 %
2	Read and write only	52	30.2 %
3	First cycle (1-4)	15	8.7 %
4	2 nd cycle (5-8)	5	2.9 %
5	9-10	2	1.2 %
6	11-12	-	-
7	College and University	2	1.2 %
	Total	172	100 %

Occupation of the respondents was shown (Table 2) most 151 (88 %) of respondents were farmers. They mainly engaged in subsistence farming and produce cereal crops like barley and vegetables, garlic and potatoes for their house consumption as well as income generating. Large number of farmers in both districts needs more expansion of farm land. The rest are merchants and government workers. Likewise, focus group discussions with household members at two districts raised that farming and rearing animals around the Park area were the dominant economic activity of the residents.

Table 2: Distribution of respondents by occupation in study area in the year 2017

No	Occupation	Respondent's from selected district	
		Respondents response	Percent (%)
1	Farmer	151	87.7 %
2	Merchant	14	8.1 %
3	Government workers	7	4.1 %
4	Total	172	100%

Patterns of land holding system of the respondents in the study areas showed that most of them had land and few were landless (Table 3). From these, 105 (61 %) of the respondents had land size less than 0.5 hectares. On the other hand, about 3% were landless and the rest of the respondents had land. Majority of the respondents depend on animal husbandry to sustain their life.

Table 3: Distribution of respondents by landholding in study area in the year 2017

No	Land size	Respondent from selected districts	
		Respondents response	Percent (%)
1	No land	5	2.9%
2	< 0.25 ha	42	24.4 %
3	0.25-0.5 ha	58	33.7.%
4	0.5-0.75 ha	54	31.3 %
5	0.75 -1 ha	8	4.6 %
6	> 1 ha	5	2.9 %
Total		172	100%

4.1.2 Socio-economic conditions of local community

4.1.2.1 Household's livelihood sources income

According to the sample respondents most 149 (86.6%) of the area were generating income from mixed farming (crop and animal husbandry) leaving no scope for other livelihood options and about 23 (13.4%) respondents additionally depend on fuel wood and timber production (Table 4). The demand of farm land and grazing land for the local community was very high, to fulfill their sustained livelihood.

Table 4: Local people income earning methods in the study area in the year 2017

Items for income generating	Respondent from selected districts	
	Respondents response	Percent (%)
From animal husbandry selling	67	38.9%
Vegetables selling	71	41.3%
Cereals selling	11	6.4%
Timber and poles selling	7	4.1%
Fuel wood selling	16	9.3%
Total	172	100%

4.1.2.2 Dependence of the local people to the BMNP

In the selected study area respondents responded that grazing land, farmland, construction material, and firewood were the basic resources by which their livelihoods concomitant to the Park. The livelihoods of local communities are closely related to the natural resources of BMNP and affect the habitats of Mountain Nyala. The main reason of encroachment inside/territory to the national Park is shortage of land for forage and for farming as well as both factors. About 84 (48.8%) mentioned their coming to the area is for livestock forage, 25 (14.6%) for farming and 37 (21.5%) for both forage and farming, 17 (9.9%) for fuel wood and 11 (6.4%) for timber.

4.1.3 Plant species that are widely affected by the settlers

The Mountain Nyala which is endangered because of human activities in the BMNP is mainly relying on plant species (Table 5). However, these plant species are susceptible to local people need for timber production, firewood, charcoal and dry fencing. This human demand seriously affected the natural habitats of the park in general and the mountain Nyala in particular.

Table 5: Plants species more affected by settlers in the study area in the year 2017

Plant species	Used by local peoples
<i>Hagenia abyssinica</i>	Timber/furniture, for firewood's, for medicinal, ornamental, mulch, carvings / Utensils
<i>Hypericum revolutum</i>	Timber/furniture, for firewood's, for medicinal
<i>Juniperus procera</i>	Timber/furniture, for firewood's uses, Poles / Posts, Flooring
<i>Erica arborea</i>	Timber (local construction) and firewood's uses, charcoal, dry fencing
<i>Olinia rochetiana</i>	Firewood, timber (local house), farm tools, walking sticks, ornamentals, fencing materials, making bee cave

The forest size cover, majority of the respondents of both districts that is 152 (88 %) replied that the size of the forest in the area has been reduced from time to time due to using Park Forest illegally among the local communities. Woody plants in the area were used for different purposes (example *Hagenia abyssinica* for production timber, *Juniperus procera* for production of poles) used for themselves and also sell illegally by local settlers (Plate 1). Since land is scarce with fast growing population number affect the resource of the park and also high demand of the local people towards the acquisition of more land through time.



Plate 1: Forestland affected by human settlements around Gojera area
(Photo by Adane Weyessa in the year 2017)

4.1.4 Major factors that affect the habitats of Mountain Nyala

Majority 162 (94%) of respondents enumerated that; the major challenges to the habitats of Mountain Nyala were livestock grazing, agricultural expansion, fire wood collection, cutting living tree, conflict between the Park scout and local communities, human encroachment and human settlement in the area (Table 6). As interview the Park administration the main challenges around the habitats of Mountain Nyala is livestock grazing and human encroachment. For instance, estimation based on responses of Park expert staff also said that, the recent free grazing, expansion of farmland and uncontrolled fire might be the main management problems of the BMNP, which exposes natural resources for severe degradation.

Table 6: Factors that increase the impacts on the habitats of Mountain Nyala in the year 2017

Factors for increase impacts on the habitats of Mountain Nyala	Respondent from selected districts	
	Respondents response	Percent (%)
Grazing of livestock in the Park	61	35.5%
Settlements in the habitats of Mountain Nyala	42	24.4%
Farming in and around the Park	34	19.8%
Construction materials production from the Park	21	12.2%
Firewood collection from the Park	14	8.1%
Total	172	100%

4.1.4.1 Impacts of livestock grazing on Mountain Nyala habitats

Local communities allow their livestock in and around the National Park to meet their grazing needs. As a result, these communities have been benefited from grazing land by admitted their livestock inside the National Park especially during dry season. Both interviews and focus group discussion also point out that the National Park serve as a main feed source to their livestock's especially during dry season where there is a shortage of feed on their farm and communal grazing land. In the adjacent communal areas, the high density of livestock and increasing human populations leads to overgrazing and land degradation, leading to the park to become more attractive for livestock grazing. During data collection the researcher observed that about 93 cattle's, 127 sheep's and 63 horses were grazing in the area of the Park.

In plate 2, respondent households living in two selected district had been more benefited from livestock grazing inside the BMNP during both seasons, compared to the rest district. This is particularly severs in dry seasons due to shortage of water and other resources, and leading to disturbance of the park and its natural resources. Districts are not statistically significant in livestock grazing inside the National Park ($\chi^2 = 1.079$, $df = 1$, $P > 0.05$).



Plate 2: Livestock grazing in the park area from Gojera direction
(Photo by Adane Weyessa in the year 2017)

4.1.4.2 Agricultural activities around the habitats of Mountain Nyala

About 20% of respondent's households had farm land at the border of the National Park. Across the study area, there was a lot of fragmentation of land with most households reporting less than half hector of land. It was not the scope of this study to detail the effects of fragmentation on productivity. About 31% of respondents said, when family size become large, each child inherits just a small portion of the land and may have to delineate by own clearing more land to increase their land holding need.

Most of the respondents reported to have acquired at least one of the parcels of land by inheritance. The result shows that, about 3% and 4% of respondent households across the study area were delineated farmland and home garden by their own clearance, respectively. About 117 (68%) respondents confirmed that having farm land inside the National Park was the primary essential resources by which one of the livelihood benefit of the local community linked to the Bale Mountains National Park. There was statistically significant $\chi^2 = 1.416$, $df = 1$, $P < 0.05$) in farmland holding inside the National Park among the villages.

4.1.4.3 Human settlement into the habitats of Mountain Nyala

Park conserves many of the world's habitats and species, human encroachment is severely degrading and destroying the biodiversity of the area. This has often resulted in the elimination of species, loss of forest lands and resources. As the Park administration explained that currently more 40,000 people live within the park's boundaries, increased pressure on the natural resources of the area and diminishing natural habitats of wild animals. About 12 (80%) in FGD illustrated that in past years the plants species that are found around our area was not seen know. Destruction of wildlife habitats has remained the leading threat to biodiversity. Majority 141 (82%) stated that destruction, takes different forms such as degradation, fragmentation, and changing of the features of the forest cover the area (Fig. 5). As interview with the Park manager, seasonal and permanent encroachments were occurred in the Park. In Gojera forest and other areas on the Park boundary, land has been cleared for agriculture, principally garlic and barley production and also livestock grazing were high during dry season. In these areas activities like cutting living trees for (timber, poles making), fuel wood collection, and clearing of forests for slash and burn cultivation and illegal commercial logging were principally encountered.



A

B

Figure 5: Settlement (A) and farming (B) in the BMNP area from Adeley direction

(Photo: by Adane Weyessa in the year 2017)

4.1.4.4 Impacts of Human population around the habitats of Mountain Nyala

Many of the people living near the park rely on livestock for their livelihood and have become dependent on the grazing lands within the Park since traditional grazing lands outside the Park have been converted to cultivated croplands. Human population growth migrations of people into the area contributed to the high human population density around protected or natural resource. Conferring to the household information on the study area, the number of wives for a man ranged from 1-5. About 22% had one wife, 44 % had two wives, 27% had three, 6 % had four and 2 % had five wives (Appendix I). A man with three wives is expected to have an average of 3 to 7 children per wife.

According to Dinsho woreda Agricultural office, the human population in the study area increased to 1309 in 2017 and increased pressure around the BMNP has resulted in high environmental degradation and loss of habitat for the Mountain Nyala. The number of people living in and border of the Park increased by 3.74% compared to the 2012 population estimation within five years (Dinsho Woreda Agricultural Office).

4.1.4.5 Impacts of construction materials around the habitats of Mountain Nyala

Most 96% respondent households living across the study area were constructing their house using locally available materials, for instance, poles for wall, timber (for doors, windows, tables), for making bee hive (Plate 3) and grass touching houses. From personal observation of total selected households about 5% of respondent got benefit from selling timber and poles to Dinsho town and other areas from the National Park which the Mountain Nyala harbors. Commercial forestry illegal in areas with critical to Mountain Nyala habitat is generally conducted at a small scale, but have severe cumulatively. Some old-growth timber is harvested illegally by commercial enterprises, which transport large quantities of wood to saw mills where it is processed into various wood products.



Plate 3: Plant species *Olinia rochetiana* affected by settlers for making beehive at Gojera (Photo by Adane Weyessa in the year 2017)

4.1.4.6 Firewood collection around the habitats of Mountain Nyala

The firewood collectors collect firewood from the park. The member's adult women and girls collect the firewood for the family per day or for selling. So, the utilization of wood by the rural human population also significantly increases to the degradation of Mountain Nyala habitat. Majority 159 (92%) of respondents were gain firewood from their nearby Park. In most cases, it is collected for use by individual households, but also collected for charcoal and sold to Dinsho town.

4.1.5 Perception of local people towards the habitats of Mountain Nyala

Responses from respondents were ranged from less aware toward the Park to views of general support, especially issue related with the benefit from the National park resources. Therefore, the awareness of local community living in and territory of the Bale Mountains National Park was varied. Similarly, about 45 (26.2 %) of them have received no financial benefits from park as an incentive or the limited livelihood opportunities to enhance their income.

During focus group discussion, the most (65%) commonly reported disadvantages of the Park were crop raiding by wild animals. For instance, respondent households living in Hora-Sobba district mostly complained on the negative impacts of the Park related with crop raiding by wild

animals. Most 95 (55%) households living in Hora-Sobba district were not satisfied with Park management approach. These districts' households were worse to felt the advantage of the Park, compared to Gojera district. Respondent households living in Gojera district had significantly perceived the possible means of job opportunity like renting of horses for tourist and as employment in scout as an advantage of the Park, compared to Hora-Sobba district.

About 127 (74%) have positive perception and 45 (26%) respondents around the territory of the Mountain Nyala habitats justified that till we didn't get any benefit from this park; the income get from visitors were used by federal government. Therefore, these issue must be changed; we must be benefited some percent of the Park income or they support in another infrastructures like road construction, clean water supply, school materials (example, chairs , desk and so on) and fuel consume stove and other materials must be supported by the Park managers.

4.1.6 The conflict between the Park scout and the local communities

The natural resources of the study area are mainly controlled by the government as a National Park and local community around the area. The Park had a variety of natural resources (wildlife, vegetation, land form topography, spring water and surface water) as a tourist attraction and the community uses the Park resource as the source of animal feed, farming land, pastoral land, and fuel wood resource.

The use of the term conflict in the context of this study refers to land use conflict in the study area between the government and the local community, which reflects ongoing compaction over access to farmland, grazing, house building materials and other range resources. The respondents 97 (56 %) responded that there was conflict between the Park scout and the farmers during the dry season. The cause for the conflict between were shortage of grazing land and inadequate area for settlement and farm land, demand for house building materials, demand for firewood, fodder and owner ship of territory (Fig. 6).

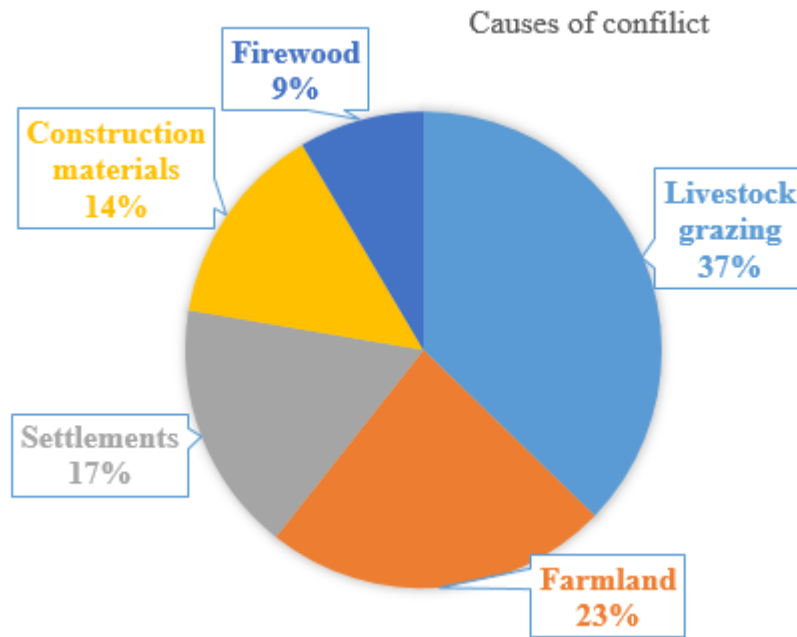


Figure 6: Causes of conflict between the Park and the local communities in the year 2017

4.1.7 Knowledge of the local community towards the demarcated boundary of the Park

According to the respondents about 71 % of respondents who lived within the study knew the legal boundary of the Park and legal boundary demarcations done in 2015 but till now it was not implemented especially at Gojera district. The perception of local community living surrounding the protected areas is vital to conserve its resource sustainably. For instance, during FGD and data collection process most (69%) local residents were familiar with the existence of the Park and had better perception toward it. On the contrary, few respondents have developed wrong perceptions toward the Park and were pose challenges in implementing the Park demarcation strategy.

4.2 Plant Species Recorded in the Area that are Affected by Settlers

Two randomly transects were laid in Gaysay grassland area in North-south direction, in Adelay woodland area, three transect lines in North-west direction and in Gojera, three transect lines were laid along South-west direction with a minimum distance of 1500 m in between them. As one moves away from the center of Gaysay grassland area in East-west direction, the vegetation structure gets shorter, more uniform and less diverse. When all vegetation types were observed, level of browsing was higher at the edges than inside the Park area. The species dominant within the Park, *Artemesia afra*, *Helichrysum splendidum*, grasses and sedges in the marshy areas were

virtually absent around the border and outside the Park area (Table 6). On the contrary, species such as *Foeniculum vulgare* and *Kniphofia foliosa*, which were relatively absent inside the Park area of Gaysay, were dominant towards the edges of the Park and outside. In Gojera, plant species such as *Euphorbia dumalis* and *Solanum giganteum* were more common.

Table 6: Plants Species distribution at study area in the year 2017

Plant species name	Border area of the Park		Inside area of the Park	
	Frequency	%	Frequency	%
<i>Artemesia afra</i>	5	1.2%	62	10.9%
<i>Helichrysum splendidum</i>	7	1.6%	69	12.2%
<i>Juniperus procera</i>	49	11.5%	71	12.6%
<i>Euphorbia dumalis</i>	37	8.7%	45	7.9%
<i>Rosa abyssinica</i>	29	6.8%	38	6.7%
<i>Solanum giganteum</i>	42	9.8%	51	9.9%
<i>Hypericum revolutum</i>	24	5.6%	47	9%
<i>Hagenia abyssinica</i>	34	7.9%	63	11.1%
<i>Maytenus senegalensis</i>	14	3.3%	34	6%
<i>Kniphofia foliosa</i>	78	16.6%	9	1.6%
<i>Foeniculum vulgare</i>	89	18.2%	28	4.9%
<i>Erica arborea</i>	19	4.4%	35	6.2%
<i>Olinia rochetiana</i>	-	-	13	2.3%
Total	427	100%	565	100%

4.2.1 Plant species distribution in the border areas of the Park

From the result presented in the border area, the area around the buffer had 13 species with a total of 427 tree, shrub and grass species within the plots. The dominant species was *Foeniculum vulgare* which constituted about 89 (18%) of the total trees in the area. This was followed by *Kniphofia foliosa* which occupied about 78 (17%) of the total species in the plots. *Artemesia afra* was the least consisting about 1%.

4.2.2 Plants species distribution in the inner Park area

As we moves to the inner of the park area was dominated by *Juniperus procera* which occupies about 79 (14%) of the total species just as what was obtainable in the middle area. Comparing the Biodiversity across the Park, the numbers of species generally increase inwards. However, the outer part on the edge of the Park is dominated by shrubs colonizers, while at the middle and inner part of Adelay area was dominated by *Juniperus procera* and *Helichrysum splendidum* which is the primary species. As one move away from the edge of Park to inside, the vegetation structure gets longer, more diverse and plant species are more diverse. Shrubs and grasses are dominant at border of the Park but trees are higher as one move from the territory of the Park to the center of the Park reversely. From personal observation in the inner part of the Park around Hora-Sobba area the plants species like *Hageneia abbyssinica* were affected by settlers for production of timber (Plate 4).



Plate 4: Plant species, *Hageneia abbyssinica* affected by settlers around Adelay area (Photo: by Adane Weyessa in the year 2017)

4.3 Focus Group Discussion on the Impacts on the habitats of Mountain Nyala

In this discussion the participants were included from 5 to 15, most 13 (89%) of the participants in the FGD were satisfied with the existence of the Park. But they considered the Park as a

limiting factor not to improve their livelihood. Participants in discussion confirmed that limited access to the resources of the Park, caused forced relocation and a means of income generating for very few people, particularly of Gojera district. The restriction of the Park for grazing livestock was the reason for low quality of their livestock. Majority (92%) selected participants stated that they were using the habitat for grazing and wild plants for construction materials, timber and firewood, but the land was used for animals that have little benefit. Few (8%) participants in discussion had negative attitudes towards the Park not for crop raiding and livestock depredations by wildlife, rather for restricting access of resources. Settlers still use the resources such as firewood, construction materials, and grasses and pasture even though they know it illegally.

About (27%) feel that the resources still belong to them; because they said “our grandfather’s land” and we do not want anyone to restrict the use of such resources. They feel that small area was enough for the existing wildlife and some part of conservation area should be returned for them. They also rose that the Park management team allow them to use resources like pasture, firewood and access to grazing without restriction especially during dry season at some area of the Park. They stressed that if government wants to conserve Mountain Nyala; they should participate us in conservation and solve our problems. About (20%) felt bad because some local people were allowed to live inside the Park and others were tried to forcefully dislocate from the same area. Such unfair measures and lack of uniformity disappointed them. In addition, corrupt discriminate practices by some scout members to have access to the resources have frustrated them and Park demarcation plan was not implemented, especially at Gojera district; because they do not participate local people. About (73%) participants in discussion undermined the human and livestock population growth. Majority 12 (80%) participants raised that assistance in improving their household economies would increase their willingness to support conservation activities.

5 DISCUSSION

The local people of the woreda were mainly agro-pastoralists and led their livelihood by rearing cattle and plough farm. They farm livestock and produced different varieties of cereal crops to feed their large sized families. Most respondents possessed land less than a hectare and largely rely on the income acquired from rearing cattle and land. Surprisingly, others even have no land. The product obtained from this plots of land is inadequate and enabled the majority of the local communities to led hand to mouth life. This situation enforced the local people to get benefits in illegal ways from the nearby national Park. According to the respondents, productivity of the land for the majority of farmers is less than sufficient and has no guarantee source of income to supplement their livelihood. Since their land is found next to the Park and even inside the Park's territory, the natural habitats are not escape from inhuman activities. The shortage of the land and its urgent demand resulted for human settlement inside the Park.

Most respondents 87% from both districts' explained that land which was previously covered by forest has been reduced from time to time due to human action. This was due to the local people settled in the area use the natural resource of the Park and degraded it. The researcher finding was correlates with the work of Teshome *et al.* (2011) confirmed that between the years 1973 to 2000 on the average about 1.6 km² of forest was lost annually while the figure goes up sharply with in period 2000 to 2005, 15 km² on Simien Mountains. Similarly, the plant specious that harbor for endemic Mountain Nyala commonly affected by the local people for the purpose of farming, timber production and poles making. This caused the Mountain Nyala to be disappeared from the nearby territory of the Park. Moreover, the local communities of the two districts also moved with their herds of cattle to the Park territory. Although there is restriction on the behalf of the government towards illegal grazing in the protected areas of Ethiopia, this issue is a common phenomenon in the BMNP. The researcher finding agrees with the studies of Temesgen (2015) who confirmed the association with settlement and agricultural expansion demand for timber and wood in BMNP has increased both locally and commercially.

Formal education did play a significant role in predicting attitude towards wildlife and its conservation around study area. In the study area most of households who attained secondary education showed lower negative attitudes than households with elementary school and no formal education groups, as they might be familiar with conservation concepts. The researcher

finding was similar to the work of Tewodros and Afework (2014), those households with low formal education were observed to have fewer attitudes to wildlife conservation, while those with better educational status showed positive attitudes. The researcher finding was correlates with the idea of Yihew (2017), it is noticeable that formal education helps to better improve the perception and understanding of households to conservation benefits than the non-educated groups. Hence they developed negative attitudes towards its existence.

Education work is an important function of the Park staff, and is proving successful in explaining the role of the Park in the conservation of the environment and natural resources, especially water catchment and forests. Most studies indicate the positive association between education and perception of the community towards protected area. Kugonza *et al.* (2009) in their study in Uganda discovered strong positive and significant correlation between education and natural resource management. The role of education is immense in people understanding towards global issues. Likewise, people who have educational access may play a significant role in managing and conserving the surrounding environment. However, contrary to this, the majority (56%) of respondents were not attended any class. As most study shows education is expected to be negatively correlated with BMNP income since better educated households have access to a wider range of income opportunities. Godoy and Contreras (2001), observed that a similar situation in a study of people's attitudes towards the wildlife in Kosi Tappu Wildlife Reserve in Nepal. The study revealed that those respondents with higher household literacy rates had positive attitude about wildlife in the reserve. Their illiteracy highly affected their attitudes to the conservation of the Park's ecosystem.

The fact that resources are scarce where as human need is unlimited. Therefore conflict over resources is imminent to happen. Protected areas have huge resources which support and sustained the life of many biotic and abiotic habitats. However, these resources are susceptible to serious problems because of the interference of local communities. Likewise, there was disagreement between the Park scout and the local people over the usage of the Park resources. Increasing population and illegal activity to access resources from the Park were the main factor that instigated conflict. Majority (95%) respondents responded that the conflict has been induced due to shortage of grazing land, human settlement and desire for more farmland.

Livestock grazing is a longstanding issue in most of protected areas and National Parks. The numbers of people and livestock has been increased dramatically around the BMNP since its inauguration in 1970. This animal needs an area that is not occupied with human and livestock. Evangelista (2007) also reported that Mountain Nyala are confined in the steep woodland areas which are unsuitable for human settlement and crop cultivation in the Arsi and the Bale Mountains. These support the notion that Mountain Nyala avoid areas dominated or over-utilized by humans and livestock. Thus, the impact of livestock and human activity is manifold, affecting range quality for Mountain Nyala and reducing the potential for ecotourism by reducing the quality of wildlife viewing. Stephens *et al.* (2001) also noted that the high number of livestock has negative impact on the Bale Mountains National Park in terms of tourist attraction. The questionnaire and focus group discussion survey showed that there is a huge livestock impact on the habitat of the BMNP. As some informal interview made explained, punishment rate were decided by community when their cattle enter into the habitats of Mountain Nyala but, they had been complaining the increased punishment per cattle. The researcher finding was the same as the work of Anteneh *et al.* (2014), who done research on Natural resource use conflict in Bale Mountains National Park in 2012 to 2013.

The study by Teketay and Limenih (2005) revealed that forest grazing and browsing are the major sources of food for the vast population of livestock in Ethiopia. The impact is more severe during the dry season where wild animals are under pressure due to the shortage of enough pasture. During this season, the larger quantity of cattle was released to the Park's territory. The existence of larger number of livestock in the national Park means, the loss of the Park's rich resources. From personal observation more domestic animals are grazing inside and at the territory of the national Park and in these areas no Mountain Nyalas were existed. The work of Gandiwa (2011) on livestock and encroachments were also illustrated that further negatively influence of some wildlife habitats and ecological processes.

The increase of livestock number has been creating competition of resources between wild and domestic animals for food. Such competitions negatively affected resources in the Park and finally result is overgrazing. The researcher finding was contradict to the work of (Almaz, 2009) intensive livestock grazing may improve forage condition for wildlife by stimulating nutritious re-growth. In addition, proximity to livestock and herders might help protect wild herbivores from predators. But,

as a result of competition of resources an endemic animal Mountain Nyala and other resources are exposed to dangerous situation.

The need for acquiring more farm land by the local communities has a great impact on the ecosystem of BMNP. About 50% of respondents replied that the households have land around the Park territories in both districts. Due to the practice of inheritance whereby the father allocates land among all children, there is no enough land that inherited to all of his children and the young children try to hold land from their area that are not occupied by others. When family sizes become increases, each child inherits just a small portion of the land and may have to delineate by own clearance more land to increase their land holding need. Tesfaye (1997) also illustrated that the Ethiopian rural poor depend on natural resources such as land resources in reposes of their basic needs. Nowadays land has been fragmented because it is inherited among all children within a family. Most respondents stated that they acquired land through inheritance.

The BMNP is one of the conservation areas in which human interference usually affected. It is continuously under threat from growing human population. Since the time of its establishment, the number of people who reside inside the Park territory has been increased tremendously. For example, during field observation, habitats which are adjacent to human settlement were less used by Mountain Nyala, largely due to high disturbances by human and livestock. As illustrated by Tadesse and Feyera (2008), immigration from other parts of the country and the polygamous marriage system had contributed to high rate of population growth in and around the Park. A man may have as many as five wives and from single women he may get greater than two children. Therefore, to feed his large sized family he has relay on the Park resources. So, as the human encroachment to the habitats of the animal, it leaves the area that occupied by human being to higher elevations that were not interfered by humans. The finding of the researcher was similar to the work of Evangelista and Swartzinskion profile of the Mountain Nyala (*Tragelaphus buxtoni*) in 2005 to 2006, as Ethiopia's population and demand for cultivated lands expand; Mountain Nyala populations have become increasingly fragmented and isolated to small patches of habitat at high elevations. The fragmentation of Mountain Nyala populations not only confines them to small areas but also deteriorates genetic viability. Increasing settlement and more intensive exploitation of resources by humans in the past have resulted in the degradation of natural environment (Temesgen 2015).

As human population increase and use protected area illegally, there is no free space for their survival species and then given raised to in the eradication of the larger species, particularly the large mammals. Generally, the growing number of human population within and surrounding the Park areas and unrestricted demand facilitated degradation of the habitats which the Mountain Nyala mainly depend on. The further increase in human populations will undoubtedly lead to the expansion of agriculture into areas currently unused. The researcher finding is agree with the work of Tewodros and Afework (2014) on Abijata-Shalla Lakes National Park in 2011 to 2013 illustrated the main cause of interference by the local community in the Park is due to population growth.

Although the BMNP is home to a great variety of habitats, it does not safe from damage from human interventions. The local people put pretext for being intervened against the Park's resources. According to the respondents, the local people believed that the existence of the Park benefited nothing; these were might due to unaware about use of natural resource. However in this study area, large wild animals (especially Mountain Nyala) came at night in the proximity of livestock for several reasons; to escape from predator and gain warm air from cattle or settlers . One elder man in the discussion at Hora-Sobba district described that; "The occurrence of all problems in the Park are not because of the local communities dislike the Park'', but the high demand of the local communities to improve their socioeconomic conditions. Even the local communities have shown their support for the Park in occasions the Park had faced problems, example fire outbreak. The local people desire the safe existence of the Park and their contribution to preserve the Park is increasing from time to time. But, they strongly protested the flow of income from the national Park to the central government and the punishment for their cattle when entered to the Park.

Since the time of the establishment of the Park in 1970, the boundary of the Park had not been well demarcated from the adjoining local people. This was an important factor which created a good opportunity for the local people to use the Park's resources. However, the government attempted to address this problem by identifying the Park's boundary. The issue of boundary demarcation was finally resolved in 2015. The Park was legally gazette on 2nd February, 2015 (BMNP Wikipedia.html). Except few, the majority of the respondents had known the Park's boundary. Nevertheless, the inhabitants have not been stopped their intervention against the Park's resources.

It is evident that the Park area bounded by farmland and livestock were undergone changes in species. For instance plant species around border of the park like *Artemesia afra* and *Helichrysum splendidum* were less in number and other shrubs like *Foeniculum vulgare* dominate the outer zone of the Park because of they were not grazed by livestock. The researcher's finding was associated with the Yosef *et al.* (2011), sites where human and livestock interferences are more prevalent, the vegetation types and composition showed considerable changes from more diverse and suitable to less diverse and unpalatable types. The important food sources for Nyala such as *Hypericum revolutum* and *Artemesia afra* have almost been eradicated. The finding of the researcher was similar to the work of Yosef and Bekele in 2003 to 2005 illustrate that; widespread growth of plants such as *Euphorbia dumalis*, and *Solanum giganteum* in and around Dinsho is an evidence of negative effects of human and livestock encroachments into the habitat quality. These species were largely unpalatable by Mountain Nyala. These species are known to be associated with human presence or interferences and often occur in abandoned farmlands. Thus a reduction on primary tree species can occur. The researcher's finding was correlated with Mugisha (2002) on land change and plant species affected. Tree species existing at edges of the forest normally faced degradation and are decimated to lesser and isolated species especially close to agro-ecosystems.

The utilization of wood by the rural human population also significantly contributes to the degradation of Mountain Nyala habitat. Wood comprises 93% of Ethiopia's biomass fuel consumption (MoWR, 2001). In most cases, it is collected for use by individual households, but also collected for charcoal and sold within the community or to travelers passing through. Besides the need for collection of firewood and construction materials were also threats that exacerbated the habitats and life of Mountain Nyala. From the FGD and interview with Park authority, it is observed that the Park was threatened by illegal encroachment, bush burning, farming, poaching and other human activities. The introduction of exotic species, over-harvesting of biodiversity resources, homogenization of species in agriculture, high energy consumption such as fuel wood, and the drive habitat loss for Mountain Nyala and other species extinction worldwide, the study by Hens and Boon (2003) causes of Biodiversity Loss: a Human Ecological Analysis. During FGD the local community, NGOs and Park management agreed that the current Park-people relation is poor and to reverse the current trend, supported idea of awareness should be created for local community. Likewise, to create good relationship between local community and conservation agencies, creating awareness of community.

6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

A serious problem which has a huge impact on the ecosystem Mountain Nyala is livestock grazing. Our country Ethiopia proceeds in terms of livestock population from Africa. Therefore, the country's protected areas do not escape from the influence of livestock. The existences of livestock in the protected areas put pressure on the life of wild animals since the natural habitat they live in have been destructed by interventions; suggesting that the area may have reached its carrying capacity in terms of livestock. In Gojera and Hora-Sobba districts livestock grazing is a threat to the natural habitats of the area in general and wildlife in particular. The territories of the Park in two districts were vulnerable to habitat loss because of livestock interference.

The vegetation type and their composition showed considerable changes from more diverse and suitable to less diverse and unpalatable types. This created a difficulty condition for Mountain Nyala to get food easily since its important source of food has almost been eradicated. Widespread growth of plants such as *Euphorbia dumalis*, *Foeniculum vulgare* and *Solanum giganteum* in and around Park is an evidence of negative effects of human and livestock encroachments on the habitat of Mountain Nyala. These species were largely avoided by Nyala as feed. These species are known to be associated with human presence.

Moreover, the expansion of agricultural land for the purpose of possession of more farm land also another urgent problem which affected the habitats of Mountain Nyala. The attitude of people toward a protected area is influenced by the benefits which they acquire from it, land holdings, lower frequency of visits by Park officials and increasing distance from the Park and by the negative consequences of its conservation status.

6.2 Recommendations

The researcher has looked forward to recommendations based on the findings of the study. The researcher could possibly show the solution to human encroachment and livestock impact on the habitats of Mountain Nyala and the extent by which different concerned bodies have been took successive steps. Therefore, based on the findings of the study the following recommendations are made to reduce the extent of human encroachment and livestock impact on the habitats of Mountain Nyala.

- Creating awareness among the society concerning the economic benefit of endemic Mountain Nyala species so as to restrict their livestock's and prevents from degradation of wildlife corroder and natural recourses at large.
- The BMNP authority in collaboration with Conservationist which works in the area should teach the impact of climate change due to environmental degradation because of human action to the local people who live in and surrounding the park territory.
- The local people of Gojera and Hora-Sobba districts should consider the Park's habitats of Mountain Nyala and ecosystem as their own property and protect from degradation.
- The Dinsho woreda administration, the Park authority and NGO which work on natural resource of the area should work hard cooperatively with the local people of Gojera and Hora-Sobba districts to change their attitudes with regards to conservation of biodiversity.
- The problems of human interventions in the natural habitats of the BMNP in general and in the selected districts in particular are addressed if conservationist, stakeholders, regional government involvement are actively engaged in the management of the Park.
- The Park authority and non-governmental organization working in the area plan and implement for making infrastructures and firewood consuming for the local peoples surrounding the Park areas.

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8 APPENDICES

Appendix I

Questionnaires used for data collection

Adama Science and Technology University

School of Applied Natural Science

Department of Biology

Dear respondent, the purpose of this questionnaire is to collect data on human encroachment and livestock impacts on habitats of mountain Nyala (*Tragelaphus buxtoni*) in Bale national park, Oromia regional state. Respondents selected randomly from the area fill out this questionnaire. Since the quality and success of this study depends on the information you supply, you are kindly requested to provide your genuine response. Right at the outset, I would like to assure you that your response will be used only for research purposes and will be kept confidential.

Direction for enumerator: Circle one for close ended questions and write responses on the space provided for open ended questions. There is no need to write your name.

Your district _____

I. General Demographic Information

1. Gender of the respondent: 1. Male 2. Female
2. Age of the respondent: 1. 18-25 2. 26--40 3. 41-60 4.>60
3. Marital status of the respondent: 1. Monogamy 2. Polygamy 3. Divorced 4.Widowed
5. Single
4. Family size including adults and children in heads: Male____, Female____, Total_____
5. Respondent's educational level 1. Not read and write 2. Read and write3. Primary school 4. Secondary school 5. College and university
6. For how long have you been living in/nearby the national Park?A.1-5 years B.6-10 years C.11-15 years D.16-20 years D.> 20 years
7. Why did you decide to live in/nearby the National Park? 1. Close to nice resource 2. Lack of land in other places 3. Cultural reasons 4.Presence of endemic wildlife 5. Place where I born and my family live

II. Livelihood Information

1. What is your **main** source of income? 1. Crop selling 2. Vegetables selling 3.creals selling 4.feul wood

selling 5. Poles and timber selling

2. Did your household engaged crops production? 1. Yes 2. No
3. What was the primary purpose of your household engaged in crops production?
A. Home consumption B. For market
4. Does your household own livestock? A. Yes B. No
5. Does your livestock allocate grazing area A. Yes B. No
6. What is the cause of livestock related problem -----

III. Local community perceived benefits from Bale Mountains National Park

1. Does your household benefited from the **BMNP**? A. Yes B. No
2. What are the benefit get from the park? -----

3. What are the main challenges to the habitats of Mountain Nyala in your area? -----

4. Do you have farm land inside/border of the park? A. Inside B. Border C. Outside
5. How many hectares of land do you have now?
A. 0 – 1 B. 1- 2.5 C. 2.5- 3 D. 3.5- 4.5. E. 4.5-5.5 F. 5.5-6 G.> 6
6. What is the type of material that you/your family get from the park? -----

7. Does the size of forest in the park increase, decrease, or remains the same over time?
A. Increase B. Decrease C. No change D. Do not know
8. If your answer to question 6 above is **decrease/increase**, what are the reasons for the decrease?
No. Reasons for the decrease of forest land size
8.1. _____
8.2. _____
9. Do you know the park has legal boundary? A. Yes B. No
10. What types of plant are widely cut by the settlers and for what purpose?

No.	Types of plant are widely cut	Purpose
9.1	_____	_____
9.2	_____	_____
- 10 Is there settlers and park management disagreement in this area? A. Yes B. No
11. In question 10 if you say yes, what are the causes for the disagreement?
No. Major reasons for disagreement
a. _____
b. _____
12. What solution you are given to reduce this problem? -----

Appendix II

Focus group discussion (FGD) with local peoples

1. Who owns and uses the area before humans settled to national park? And in what condition?
2. Do you think park management plan is being implemented effectively? In which way?
3. Do you think the presence of the park close to your area benefited the community?
4. Are you comfortable by law of park management plan? Is there treating to the park from the surrounding community?
5. Which local community groups more depend on the park for their economic benefits?
6. Does the park face any challenges from outside? If yes, what are there?
7. How do you accommodate the interest of different group around the park? For example fuel wood seller, searching for grazing, farmland, and timber production?

Thank you very much for your cooperation in giving your ideas!

Appendix III

Questions used for interviews with the district land experts and for park managers and experts

Adama Science and Technology University

School of Applied Natural Science

Department of Biology

Dear respondent, the purpose of this interview is to collect data on human encroachment and livestock impacts on habitats of mountain Nyala (*Tragelaphus buxtoni*) in Bale national park, Oromia regional state. Respondents selected randomly from the area fill out this interview. Since the quality and success of this study depends on the information you supply, you are kindly requested to provide your genuine response. Right at the outset, I would like to assure you that your response will be used only for research purposes and will be kept confidential.

1. Is there human encroachment to the habitats of Mountain Nyala in BMNP?
2. Is farming land increase or decrease for last ten years in the area?
3. If you said decrease or increase what was the reason?
4. Is the plant species covering the Mountain Nyala habitats increase or decrease?
5. If you said decrease, what are the factors to decrease plant species covering the habitats of Mountain Nyala.
6. Is human population in the area decrease or increase?
7. If you said increase or decrease what is the reason behind?
8. Does grazing of livestock take place in the habits of Mountain Nyala in the area?
9. Do you have any idea to add or question to rise?
10. What is your suggestion to reduce this problem?

Appendix IV

Afan Oromo translated questionnaire

Gaafilee hawaasa naannawa Paarkii jiraniin guttaman

Univarsitii Saayinsii fi Teekinoolojii Adamaa

Kabajamoo deebii kennitoota, sababin gaafilee kunniin itti dhiyaataniif miidhaa ilmi namaa fi beeyiladoonni iddoo jireenya Gadamsa Badda (*Tragelaphus buxtoni*) Paarkii Gaarreen Baalee irra geessisaa jiraniif odeeffannoo sassabuuf waan ta'eef deebii keessan haala gaafatamitaniin akka deebifitan kabajaan isiin gaafaadha.

Maqaa barreessun barbaachisaa miti. Ganda _____

I. Oddeeffannoo dimshaashaa

1. Saala A. Dhiira B. Dubartii
2. Umrii keessan A. 18-25 ☐ B. 26-40 C. 41-60 D. >60
3. Haadha/abbaa manaa meeqa qabduu? dhiiraaf/ A. Tokko B. baay'ee C. Kan hike D. Hinfuune
4. Gaaffii 3 jalatti eeyyee yoo jette dhiiraaf A. 1 ☐ B. 2 ☐ C. 3 ☐ D. 4 ☐ E. 5 ☐ F. >5 ☐
5. Baay'ina maatii fi ijjoolee qabdan A. Dhiira _____ B. Shamara _____
6. Haala barumsaa A. Hin baranne B. dubbisuu fi barreessuu C. kutaa 1-4 D. 5-8 E. 9-10 F. Kollejii fi yuniivarsiitii
7. Waggaameeqa as jiraattan? A. Waggaa 1-5 B. Waggaa 6-10 C. Waggaa 11-20 D. >20
8. Maaliif as jiraachuu filattan? 1. Qabeenya uummamaa kanatti siquuf 2. Iddoo birootii lafa dhabineeti 3. Aadaa keenya waan ta'eef 4. Iddoo dhaloota matii keenyaati

II. Haala galii jireenya ilaalchisee

1. Bu'urri galii keessanii maali fa'a? 1. gurgurtaa loonii 2. Kuduraa irraa 3. Gurgurtaa midhaanii 4. Gurgurtaa qorarii 5. 'Xawulaa fi kanchii' irraa
2. Galii qonna/horsiisa lonii irra argatan maal gootu?
3. Loon keessan iddoo oolan kophaatii qabuu? A. Eeyyee B. Lakkii
4. Yoo lakki jette rakkoon loon keessan iddoo oolaniin walqabatee jiru maali? -----

III. Gaafii Gadamsa baddaan fi Parkii walqabte

1. Maatiin keessan Parkii kannarraa fayyadameera? 1. Eeyyee 2. Lakki
2. Argamin lafa qonnaa keessan Paarkii garamiin? 1. Keessa 2. Cinaa 3. Fagaatee
3. Rakkowwan ijoo bakka jireenya Gadamsa Badda irrati dhibba fidan maal fa'a jettu? -----

4. Lafa qonnaa heekitaara meeqa qabdu?
1. Hinqabu 2. < 0.25 3. 0.25 - 0.5 4. 0.5 - 0.75 5. 0.75 - 1 6. > 1
5. Paarkii kanarraa wanti isiin argattan maal fa'a? -----

6. Mukkeen akkamituu naannoo kanatt ibaay'innaan ciraamanii fi maaliif ciraaman? -----

7. Wantoonni iddoo jireenya Gadamisa Badda irratti dhiibbaa geessan jiraa? A. Eeyyee B. lakki
8. Jira yoo jette maal fa'a jettu? -----

9. Bosonni Parkii kanaa kan durii irra dablee moo/hirate jettu? A. Dabalee jira B.hira'atee jira
C. Jijjirama hin qabu
10. Dabale / hir'ate yoo jettan sababin isaa maali jettu? -----

11. Hawaasaa fi warra Paarkii jiddu waldhabiiin jiraa? A. Eeyyee B. Lakkii
12. Yoo jira jettan sababni isaa maali jettu? -----

13. Paarkiiin kun daangeffama isaa beekituu? A. E eyyee B. Lakkii
14. Wanti isiin dhiibba iddoo Gadamisa Badda irra geessisan kanneeniif fala ta'a jettan maali?

Galatoomaa!!

Appendix V

Data gathering sheet for plant species affected by settlers around Gojera and Hora-Sobba districts

Study site _____ Date _____ collected by _____

Transect location _____ Number of quadrant _____ Quadrant size _____

Plant species	Number plots																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Appendix VI

Plants species recorded in the study area

No	Scientific names	Family name	Habits of the plants
1	<i>Artemesia afra</i>	Asteraceae	Shrubs
2	<i>Helichrysum splendidum</i>	Asteraceae	Herbs
3	<i>Juniperus procera</i>	Cupressaceae	Tree
4	<i>Euphorbia dumalis</i>	Euphorbiaceae	Shrubs
5	<i>Rosa abyssinica</i>	Rosaceae	Climbers
6	<i>Solanum giganteum</i>	Asteraceae	Shrubs
7	<i>Hypericum revolutum</i>	Hypericaceae	Tree
8	<i>Hagenia abyssinica</i>	Rosaceae	Tree
9	<i>Maytenus senegalensis</i>	Celastraceae	Tree
10	<i>Kniphofia foliosa</i>	Asphodelaceae	Herbs
11	<i>Foeniculum vulgare</i>	Apiaceae	Herbs
12	<i>Erica arborea</i>	Ericaceae	Small tree
13	<i>Olinia rochetiana</i>	Oliniaceae	Tree