ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

SOCIAL-ECOLGICAL DYNAMICS OF SEASONAL MOVEMENTS AND SETTLEMENTS OF AGRO-PASTORALISTS IN THE AFRO ALPINE ECOSYSTEM OF BALE MOUNTAINS NATIONAL PARK, SOUTH EAST ETHIOPIA

BY

FEDLU ABDELLA

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CENTER FOR ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

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School of Graduate Studies

This is to certify that the thesis entitled “Social-Ecological Dynamics of Seasonal Movements and Settlements of Agro-Pastoralists in the Afro-alpine Ecosystem of Bale Mountains National Park, South East Ethiopia**”** is submitted in partial fulfillment of the requirement for the degree of master of art in Environment and Sustainable Development from Addis Ababa University, and is a record of original research carried out by Fedlu Abdella Shafi, Id.N° GSR/7992/09, under my supervision, and no part of the thesis has been submitted for any other Degree or Diploma. The assistance and help received during the courses of this investigation have been duly acknowledged. Therefore, I recommend it to be accepted as fulfilling the thesis requirement.

Major Advisor _____ Signature _____ Date _____

Addis Ababa University

School of Graduate Studies

This is to certify that the thesis prepared by Fedlu Abdella Shafi, entitled "Social- ecological Dynamics of Seasonal Movements and Settlements of Agro-Pastoralists in the Afro-alpine Ecosystem of Bale Mountains National Park, South East Ethiopia" and submitted in partial fulfillment of the requirement for the degree of master of art in Environment and Sustainable Development complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

The Afro-alpine ecosystem of Bale Mountain National Park (BMNP) is the largest ecosystem in the African continent. Anthropogenic activities have been uncommon element in the Afro-alpine ecosystem until recently. This study examines the social-ecological dynamics of seasonal movements and settlements of agro-pastoralists in the Afro-alpine ecosystem of BMNP. Household survey (321), key informant interviews, focus group discussions and analysis of land use land cover changes (LULCC) were employed to generate relevant data. Descriptive statistics mainly used to analysis the data. The results from LULC changes revealed the decrease and degradation of Afro-alpine vegetation between 1991 and 2018. Human-livestock influxes including domestic dogs have increased in the recent past in the study area. The findings further demonstrated that 71% and 58% of the permanent and seasonal settlers respectively constructed their first hut in the Afro-alpine in the last twenty seven years. The degradation of the Afro-alpine ecosystem and expansion of cultivated land in the Afro-alpine are some of the major social-ecological changes witnessed in the area. Therefore, integrated efforts among the relevant stakeholders including the local community are critical required to work on education, family planning, and management of the ecosystem to minimize *the problems.*

Key words: Afro-alpine, Social-ecological, dynamics, Pastoralist, Ecosystem, Seasonal, Permanent, Settlement

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List of Acronyms and Abbreviations

AAE	Afro-alpine Ecosystem
AA	Afro-alpine
asl	Above sea level
CDV	Canine Distemper Virus
CRC	Convention on the Rights of the Child
ANP	Awash National Park
CSA	Central Statistics Authority
BINDTF	Biodiversity Indicator Task Force
BMNP	Bale Mountains National Park
EPRDF	Ethiopian people's Revolutionary Democratic Front
ERVs	Exceptional Resource Values
EWCA	Ethiopian Wildlife Conservation Authority
EWNHS	Ethiopian Wildlife and Natural History Society
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
GMP	General Management Plan
ha	hectare
HH(s)	House hold (s)
ICF	International Classification of Functioning
IUCN	International Union for Conservation of Nature
KII	Key Informant Interview
LCC(s)	Land Cover Change(s)
LULCC(s)	Land Use Land Cover Change(s)
Mt	Mount
PA(s)	Protected Area(s)
PPS	Probability Proportional to Size
QS	Questionnaire Survey
UNDP	United Nations Development Program
UNESCO	United Nation's Education, Science and Culture Organization
vs.	versus
WWF	World Wildlife Fund

CHAPTER 1: INTRODUCTION

1.1. Background

Ethiopia is a relatively vast country with a land area of 1.12 million square kilometers and wide variety of topography and climate. Altitude ranges from 4620 masl at the top of Mt Ras Dashen to 116 m below sea level in the Danakil depression. The differences in altitude, coupled with topographic variations, have resulted in wide variations in rainfall, humidity and temperature and thus, the country comprises of many ecosystems that range from Afro-alpine at the highest elevations to desert and semi-desert ecosystems at the lowest elevations. As a result, Ethiopia is endowed with a wide variety of fauna and flora and the extreme ranges have resulted in unique and diverse suite of its biological resources. In recognition of these facts, the country established many protected areas which belong to different categories to conserve and manage the resources for proper utilization. National parks, wildlife sanctuaries, reserves, controlled hunting areas, community conservation areas are among the types of protected areas.

However, the rich biodiversity of the country is under serious threat from overexploitation, overgrazing, expansion of cultivation and settlements that are accompanied by excessive deforestations, invasions of alien species and pollution (BINDTF, 2010). Owing to this fact, the system of protected areas (PAs) has been Ethiopia's principal strategy to conserve its biodiversity. However, the protected areas in the country are de facto open access resources areas, with the perception that they exist but only for a tiny patch of land around the head quarter. In short, despite recent gains with seven PAs being legally gazetted, the protected areas are ineffective at reaching their objective of protecting biodiversity, ecosystem services and ecological processes (UNDP, 2016). Thus, PAs are not safe from the influence of local, regional and international socio-ecological dynamics that is as going as they were before.

Environmental change and growing cross-scale anthropogenic influences mean that PAs can no longer be thought of as ecological islands that function independently of the broader social-ecological system in which they are located. For PAs to be resilient (and to contribute to broader social-ecological resilience), they must be able to adapt to changing social and ecological conditions over time in a way that supports the long-term persistence of populations, communities, and ecosystems of conservation concern (Cumming et al., 2015). According to Laverencheko et al. (1998) and Vial et al. (2011) in Demeke Hansilo & Lemma Tiki (2017), natural habitats of Ethiopia have been altered by human settlement/pressures including overgrazing, which affect the wildlife. Majority of livestock production in Ethiopia takes place in afro-alpine grasslands. Livestock is a key livelihood component for the majority of inhabitants of the Bale Eco region and should be central to sustainable land and resource use planning and management in the area (Belete Asefa & Aynalem Teshome, 2017).

The Bale Mountains are the largest remaining alpine habitat on the African continent. They stand out for their many endemic animals, plant species, and high biodiversity value. The proportion of endemic species in the Bale Mountain National Park is so high that with the loss of the Park's natural resources more species would become extinct than in any other area of comparable size worldwide (Wallelign, 2007).

The park has identified various research gaps to be studied by researchers, one of them being the socio-ecological dynamics of seasonal movements and recent settlements in the Afro-alpine ecosystem. The change in the duration of stay of pastoralists in the Afro-alpine and facts behind increasing permanency of settlements needs to be researched to fill the gap.

Therefore, this research was conducted with the intent to assess the socio-ecological dynamics that the Afro-alpine ecosystem has undergone and is in, focusing on seasonal movements and recent settlements of the pastoralist communities into this area of Bale Mountains National Park (BMNP).

1.2. Statement of the Problem

According to BERSMP (2008) The Bale Mountains are relatively untouched with no history of ancient cultivation, land degradation, recurrent drought or chronic food insecurity. But negative human pressures with their adverse effect are rapidly increasing with unregulated exploitation of resources that threatens the sustainability of the environment with no effective land use management plans with confused land use and land ownership rights. According to this same source, rapid immigration with unplanned and unrestricted settlement is a significant and mounting problem both within and outside the National Park. Existing settlements are growing, and new settlements are appearing in previously unsettled and environmentally sensitive areas.

Migration has been used for centuries as a means of adapting to and coping with change, both in Ethiopia and in the Great Lakes region more broadly (Dereje, 2015). It is driven by a number of oftentimes mutually reinforcing factors, including: livelihood strategies, such as mobile pastoralism; the pursuit of economic opportunities; population pressures; environmental and climate stresses; development policies; and political persecution and conflict (Dereje, 2015). According to him, the livelihood and natural resource management strategies that are adopted throughout the migration process can have a range of impacts on ecosystems and the livelihoods they support.

Like most African countries, humans also put pressure on BMNP by various ways such as expansion of settlements, agricultural expansion, and livestock grazing. Livestock rearing and agricultural expansion activities can have a wide negative impact, such as deforestation and loss of wildlife habitat (Demeke et al., 2017). Some of the pressures were there, though not common in some parts of the park and little in magnitude in earlier periods where the park was established in 1971 (Demeke et al., 2017). Thus, in recent years, settlements are also flourishing and they are widening in the Afro-alpine ecosystem and seasonal movements are increasing. The seasonal movements are increasing with a larger herd of livestock than before. Therefore, this study focuses on the social-ecological dynamics of these seasonal immigrants and permanent settlements in the Afro-alpine ecosystem focusing on ongoing social and ecological changes inside and outside it based on sample communities that can represent the phenomena.

1.3. Objectives of the study

1.3.1. General objective

The main objective of the study is to assess the general social- ecological dynamics of seasonal movements and settlements in Afro-alpine ecosystem of Bale Mountains National Park.

1.3.2. Specific objectives

The specific objectives of the study are:

- To assess the ongoing social changes in the Afro-alpine ecosystem,
- To assess the ongoing ecological changes in the Afro-alpine ecosystem,
- To assess the implication of the current social-ecological dynamics in the future management of the park.

1.4. Research questions

- What are the ongoing social changes on the Afro-alpine ecosystem?
- What are the ongoing ecological changes on the Afro-alpine ecosystem?
- What implications do the social ecological dynamics have in the future management of the ecosystem?

1.5. Significance of the study

As this research is focused on the Afro-alpine ecosystem of BMNP which is the largest Afro-alpine ecosystem in Africa it is significant in understanding the underlying social factors that impact ecological functions and structures of the Afro-alpine ecosystem and the ecological factors that impact the human social settings so as to put in place proper management options. It is also significant because it reveals social ecological interactions that have detrimental effect on the future of Afro-alpine ecosystem and the endemic key species of the Ethiopian wolf and its main food Giant mole rat and other ecologically important vegetations and biophysical features. Moreover, the result of this study will give glimpse of ideas for policy makers, planners, conservation practitioners, and researchers to look for better and further perspective on the issues for sustainable conservation and use of valuable resources. It may also help to address community livelihood issues.

1.6. Scope of the study

This study is focusing on the Afro-alpine ecosystem of BMNP. It investigates issues related with changes in the study area. It tries also to see social- ecological changes in the sample villages which have direct and indirect impact on social-ecological conditions in the study area in question, which also represents the villages and districts that have connection in one or other way with the Afro-alpine ecosystem.

1.7 Limitation of the study

The researcher faced challenges in collecting the data due to language barriers in the study area. It was compulsory to work with translators (Amharic-Oromifa) to communicate with the local community due to which the data collection took longer than expected.

CHAPTER 2: LITERATURE REVIEW

2.1 Concepts and definitions

2.1.1 social-ecological dynamics

Halliday & Glaser (2011) stated, “Societal and ecological problems facing the planet are both systemic problems and management problems. They are systemic because they arise from deep-rooted, complex, interrelated processes that operate across and between different scales from global to local. They are management problems because their solution requires a sustained, coordinated and goal-driven response by policy makers: there are no quick fixes’’. Briefly defined, SES research views “ecological, economic, and social systems as interlinked and inseparable social-ecological systems” (Berkes & Folke, 1998; Folke, 2006; Ostrom, 2009; in Balvanera, 2017).

The importance of understanding the central role of socio-ecological dynamics for the appropriate governance of social change has been highlighted by work carried out in governance studies (Michael & Madon, 2017). These demonstrate how addressing issues of system complexity, viz. those socio-ecological systems are not only complex, dynamic and dissipative, but are also adaptive and display uncertain emergent properties, need to be at the core of any attempt aiming to transform persistent societal problems (Michael &Madon, 2017).

Socio- ecological system is a coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner; a system that is defined at several spatial, temporal, and organizational scales, which may be hierarchically linked; a set of critical resources (natural, socioeconomic, and cultural) whose flow and use is regulated by a combination of

ecological and social systems; and a perpetually dynamic, complex system with continuous adaptation (Redman, Grove & Kuby, 2004).

The term “Social dynamics” invariably implies a focus on change over time in a social entity, it is closely related to the term “social change” (https://www.encyclopedia.com). Social-ecological dynamics in this paper is referred in this context.

2.1.2 Agro- pastoralism and pastoralism

Agropastoralism is defined as a way of life or form of social organization based on the growing of crops and raising of livestock as the primary means of economic activity (https://www.merriam-webster.com/dictionary).

pastoralism is defined as social organization based on livestock raising as the primary economic activity(https://www.merriam-webster.com/dictionary).

2.1.3 Driver of change

Driver is defined by Oxford dictionary as a factor which causes a particular phenomenon to happen or develop (https://www.lexion.com). It is also defined as something that makes other things progress, develop, or grow stronger (https://dictionary.cambridge.org).Both definitions goes in line with the context used in this paper.

2.2 Global trends of Protected Areas Management

Biodiversity is under increasing pressure worldwide from increasing human population, global economic and social changes, and climate change and these pressures result from the interaction between the expanding influence of humanity and ecological processes that alter the delivery of ecosystem goods and services (Dudley & Stolton, 2012). Biodiversity conservation in National Parks is affected by various factors associated with the creation and management of the park, the local community neighboring the park, the area where the park is located, the national policy governing the park, and the financial resource base of the park(Muhumuza & Balkwill, 2013). This indicates that future strategies of conserving

biodiversity in parks should focus as much on the socio-economic human dimension of biodiversity conservation as the scientific study of species and habitats in National Parks (Muhumuza & Balkwill, 2013).

Protected areas on land and sea are the cornerstones of international efforts to conserve biodiversity (Leverington, Lemos Costa, Pavese, Lisle & Hockings, 2010). National Parks are the most extensive type of protected areas in Africa and globally (Muhumuza & Balkwill, 2013). National parks are often places where people have previously lived and worked—they have been formed by a combination of natural and human processes that embody an identifiable history of cultural and political values (Dahlberg, Rohde & Sandell, 2010). Conservation of protected areas is primarily about how we perceive such landscapes, how we place differential values on different landscape components, and who gets to decide on these values (Dahlberg, Rohde & Sandell, 2010).

Human pressures on protected areas are continuing to intensify, because of global population growth and associated economic and political changes (Gurung, 2010). Globally, there is a growing trend of biodiversity loss and an increase of species threatened with extinction. For example, of the 44,838 species included in the 2008 IUCN Red list database, about 17,000(38%) were threatened with extinction (Kide ghesho & Msuya, 2012)

Numerous protected areas (PAs) have been created in Africa to safeguard wildlife and other natural resources. However, significant threats from anthropogenic activities and decline of wildlife populations persist, while conservation efforts in most PAs are still minimal (Tranquilli S., Abedi-Lartey M., Abernethy K., Amsini F., Asamoah A, et al.,2014). According to this source, subsistence hunting, commercial hunting and human density are comparatively prevalent human threats in west, central and east Africa respectively; emphasizing human density in and around the PAs was found to be the most prevalent threat in east Africa.

2.3 Management of BMNP

It was first proposed in the late 1960s to protect af-roalpine habitat and populations of the rare and endemic species of the mountain nyala (*Tragelaphus buxtoni*) and the Ethiopian wolf (*Canis simensis*) (BMNP GMP, 2017). According to this source, the importance of the hydrological services that the area provides to south-eastern Ethiopia and parts of Somalia and Kenya have gradually been recognized over subsequent years and their conservation is now a primary purpose of the park. The reality of protected areas in Ethiopia is that all designated areas are settled and or used by local communities (Dereje, Williams & Irwin, 2011). People have lived inside the BMNP since its establishment, albeit insignificantly fewer numbers than there are today (Dereje et al., 2011).

The Derg government adopted strong 'protectionist and exclusion management systems as was being advised to them by external conservation advisors, in parallel with the trends elsewhere in the world (Dereje et al., 2011). Nevertheless, the limited enforcement has primarily occurred in the northern part of the park near the headquarters in Dinsho and in the Gaysay area (Arechiga, 2014). Since its inception, the BMNP management authority has never stretched far beyond the northern parts of the park around the Gaysay Valley. According to Arechiga (2014), attempts to extend this area of influence in the late 1980 have resulted in conflicts with local communities that affect relationships to this day.

In 1986 a General Management Plan (Hillman, 1986) was developed, containing a thorough review of the knowledge of the area and guidelines on how to meet management objectives (Nelson, 2011). According to this source this plan was never implemented due to increasing civil strife as opposition to the Derg government grew.

Since 1991, the effectiveness of protection and management in the area has declined dramatically (Nelson, 2011). In the last decade less than 10% of the park has been patrolled or monitored by park management in any meaningful fashion. The park has undergone

serious deteriorations since 1991. Therefore, according to Nelson (2011), lack of human and financial resources, political interest and technical knowledge has contributed to the decline in management effectiveness and consequent degradation of the BMNP's resources. As a result the BMNP has become an open access resource, with a burgeoning human population through immigration and rapid natural population growth and consequent unsustainable use of the park's natural resources as a result, the unique ecological and hydrological systems of the BMNP are seriously threatened (Nelson, 2011; Dereje et al., 2011).According to Dereje et al. (2011) people have always existed in a context of uncertainty with regard to no legally recognized resource use-rights by the National Park management which is this context of uncertainty (i.e. the non recognition of people's resource use rights, and the lack of Park law enforcement to prohibit non-legitimate resource users) that has led to the de facto open access resource use, and consequent lack of share in any natural resource management responsibility from the local people.

On the other hand, according to Dereje et al. (2011) there are a lot of factors that contributed to poor and ineffective park management the main ones among them being the historically unclear status and definitions of protected area policy and establishment in Ethiopia, Ethiopia's socio-political history, characterized by frequent political and organizational change and thus policy change and the conservation sector's inability to change or adapt to the realities and challenges that face protected areas.

There have been three management plans so far; all of them recognized the threats from human population expansion, settlement and related threats to the park, (BMNP GMP, 1986; BMNP GMP, 2007; BMNP GMP, 2017). Though the management plans have tried to tackle and solve these issues using different approaches they have not addressed them meaningfully to date due to many reasons not mentioned here.

2.4 Community-Park relations

Managing protected areas in developing countries presents a number of challenges, particularly reconciling the conservation of biodiversity and ecosystem processes with the livelihoods of resource dependent communities (Nelson, 2011). Nelson (2011) asserts that this is acutely so in Ethiopia, a country with significant challenges of conserving globally unique biodiversity whilst lifting rural communities out of poverty. The reality of protected areas in Ethiopia is that all designated areas are settled and/ or used by local communities (Dereje et al., 2011). Those communities already living in the area were not involved in this decision despite recognition of their mainly negative impact on the land (Worku & Flintan, 2017). During the Derg regime, the Park was at its strongest state owing to the forced removal of settlements and the effective colonization of the mountain landscape **(**Worku et al., 2107). As feelings towards the Park were not favorable, "the local people destroyed all the outposts during government changeover in 1991…after demolishing the outpost, Tamsa'a area was converted into farmland by the local people" (B & M Consultants,2004 in Worku et al.,2017). According to Demeke Datiko and Lemma Tiki (2015) most of the cropland and human settlement expansions in BMNP have been increasing from time to time owing to migration of people from other places for farming and livestock grazing and destroying the natural habitat and associated biodiversity.

Reports regarding BMNP's human and livestock populations asserted that between 1986 and 2007 the resident park populations grew exponentially (Hillman, 1986). The park-wide population boom and the advent of agriculture in Rira village were likely due to a vacuum of enforcement when the Derg was unseated in 1991(Arechiga, 2014).

A survey conducted in 2009 revealed that 1072 and 2034 households seasonally use the Afro-alpine habitat and Harenna forest part of the national Park, respectively, for livestock grazing

(FZS unpublished data in Dereje et al., 2011). The reality in the BMNP is that people live in and around the Park and that these people use the natural resources from within the Park to support their livelihoods (Watson, 2011). Currently they do this both without regulation by the Park Authorities, and also without taking management responsibility. In other words, the resources are used as *de facto* open access resources, and levels of resource mining and degradation are increasing annually (Dereje et al., 2011).

There has been an increase in human habitation within and outside the park over the last thirty years, which has accelerated particularly in the past 10 years (Watson et al., 2011). Consequently, the communities' attitude towards conservation has been eroded because of increased demand on natural resources (Addishiwot Fekdu, Afework Bekele and Demeke Datiko, 2016).

A crucial question in Bale therefore is how to conserve the natural resources and the biotic elements of the environment in the face of intensified human use, given that the livelihoods of thousands of people depends upon them (Flavie v. et al., 2011). Moreover, high interest of local people to utilize the resources and negative attitude towards the conservation areas are major challenges (Addishiwot et al., 2016). The community had complains about park restrictions on grazing of their animals during drought, cutting grass for thatching and as fodder for their livestock and high penalty on them when caught with their cattle grazing in the park (Demeke & Verma, 2013).

According to Addishiwot et al. (2016) the communities also claim that they have the right to utilize the natural resources of their area though it has been tried to address the problems in the latest GMP document worked out to be implemented from 2017- 2027, there is no any improvement in park-community relation to date.

2.5 Pastoralism in and around Bale mountains National Park

Livestock has been an integral part of the Bale Mountains landscape for centuries and until recently the system was extensive allowing free mobility of a small human and livestock Population (Hillman 1986; Solomon et al ND; Watson 2007 in Worku et. al., 2017 **).**

Human population growth bordering protected areas is high and has become a serious threat to the management of wildlife species all over Africa (Newmark et al., 1994 in Demeke**.** et al., 2017). Many protected areas in Ethiopia are becoming isolated and the reasons for the isolation include growing human population in areas adjacent to protected areas and land use change towards agriculture, infrastructure, and settlement in areas that were previously unpopulated (Demeke et al., 2017).

The communities in and around BMNP have traditionally herded cattle, sheep and goats sold for cash, bartered for commodities and generally kept as a saving investment(Vial et al., 2011). Traditionally, the transhumance system of Oromo pastoralists, known as the Godantu system, was a key feature of human use of the Bale Mountains (Chiodi & Pinard, 2011).

As grazing opportunities outside the park have been reduced, pastoralists are putting greater pressure on the park, causing damage to fragile alpine habitats, competition with native wildlife, and potential for disease transfer (Alers et al., 2007).

2.6 Park degradation

The lack of both park management capacity and a clear political directive for 40 years, led to the use of BMNP as an open access resource and the current unsustainable situation, where, unless measure are put in place, the current resource degradation will continue until the resources are destroyed (BMNP GMP, 2017).

The overall land coverage has been changing from time to time due to human activities within the park (Demeke et. al., 2017).

Habitat degradation and erosion caused by livestock overstocking and other factors pose a particular risk to the BMNP watershed (BMNP GMP, 2017). The Bale Mountains have been under increasing pressure from a rapidly growing pastoralist population and their livestock (Vial, Sillero-Zubiri et al., 2011). Settlement appears to have increased in all areas of the park, including remote and inhospitable areas of the Afro-alpine and Harenna forest (Anteneh Belayneh, Temesgen Yohannes and Adefires Worku, 2013). According to Anteneh et al. (2016), fire is also a recurrent phenomenon in the Bale Mountains massif. It is one of the highly threatening parks of the country. The major threats are village expansion, agricultural encroachment, overgrazing, timber and firewood harvesting, and fire (Temesgen, 2015**).**

2.7 Social-ecological conditions in BMNP & the Afro-alpine

Recent demographic pressures have changed the way that people use land, water and forests, and have contributed to a widespread deterioration in the condition and productivity of these resources. In developing countries, population growth, migration, and resettlement are changing how people use land, and where they settle. ….. In addition, destructive land use practices of the past are resulting in present-day reduced productivity of croplands, forests, pastures, and fisheries, and in increased poverty and hunger (Brown et al., 1993).

Most Afro-alpine settlement occurs seasonally and consists only of huts and fenced areas for holding livestock overnight, without any agricultural activities. However, some users are now permanent residents, as the pattern of grazing has changed and is occurring year-round. These permanent residents do include a few families that were present when the BMNP was created. In a 2013 survey, households using the Afro-alpine area of BMNP were recorded from 14 villages (kebeles) of three Districts (Weredas). Over 80% users stated they had farmland and houses outside the park and generally exhibited a polygamous family situation. Within BMNP, 16% used more than one hut. The kebeles with the most Afro-alpine users are from Meskel Darkena, Gojera, Wege Harenna, Geremba dima and Rira (BMNP GMP, 2017).

Traditionally, under the Godantu system, livestock moved into the Afro-alpine in the wetter months, from June to September, when livestock are excluded from lower pastures where agricultural crops are being grown. Thus, although the traditional Godantu system of seasonal livestock movements may have been operational at the point of park establishment, current systems of livestock usage are unsustainable; grazing occurs all year and associated settlement has become more and more permanent (BMNP GMP, 2017).

Increasing population pressure and weak policy implementation and legal enforcement has caused threats for alpine forest ecosystem in Bale eco-region (Adane et al., 2017). The biodiversity and ecological processes of BMNP are being severely impacted by the expansion of human activities in and around the park. Settlement and the unsustainable use of natural resources such as livestock grazing has increased annually to date and are impacting the viability of endangered species as well as the provision of ecosystem services that are critical for humans (BMNP GMP, 2017). In contrast to this, the dynamics of local populations in the Bale Mountains showed that, in the absence of infectious diseases, Ethiopian wolf numbers were relatively stable and resilient to livestock grazing and human disturbance, but disease epizootics severely affected wolves living at high densities in rodent-rich areas (Marino,2003) .

‘‘The BMNP has been under increasing pressure from a rapidly growing human population. The region’s human population increased from an estimated 18,732,525 in 1994 to 27,158,471 in 2007 (CSA of Ethiopia, 2007). This phenomenon was mirrored inside BMNP with a human population increasing from an estimated 2500 total users in 1984; to 7000 in 1992 (OARDB, 2007) and c. 35,000 in 2009 (Frankfurt Zoological Society (FZS), unpublished data). In the Afro-alpine zone of BMNP (>3000 m a.s.l.), the number of households stood at 2872 in 2009 (average household size of six people) including 1072 seasonal households (FZS, unpublished data)’’ in Vial et al. 2010. Ethiopian wolves face

threats that arise from their isolation, small size, and the increasing contact with humans and their domestic dogs.

As the Afro-alpine is the core part of the BMNP, the pressure on the Afro- alpine is at increase. However, there is a gap regarding the trend of human-livestock pressure along with associated factors and the derivers behind.

2.8 Conceptual framework

The framework shows that social changes in the villages surrounding the Afro-alpine progressive shrinkage of farm and grazing lands along with their productivity and their poor management causes degradation of the resources. Livestock population also increases hand in hand with the increase in human population creating imbalance between pasture need and number of livestock on one hand and livelihood needs and human population on the other hand. This necessitates alternative livelihood means for humans and pasture for their livestock. Increase in livestock market price and perception of the community to the Afro-alpine (considering the Afro-alpine as open access regime) pushes the community to search alternative means in the Afro-alpine. The polygamy, poor family planning/ lack to its access and early marriage aggravate the increase in population and their resource needs. Lack of land use policy and poor governance of resources aggravate the degradation of resources. poor governance of resources impact effectiveness of park management and law enforcement and leaves the park resource for free and open access by communities. Problem in land tenure prevents individuals from investing on conservation activities on their land which results in loss of productivity and land degradation. The cumulative effect impacts the park in general and the Afro-alpine ecosystem in particular causing social-ecological changes there in. As a result the permanent and seasonal settlements increase from time to time devastating the ecology. This in turn degrades the ecosystem services provision to the surrounding nearby and far communities.

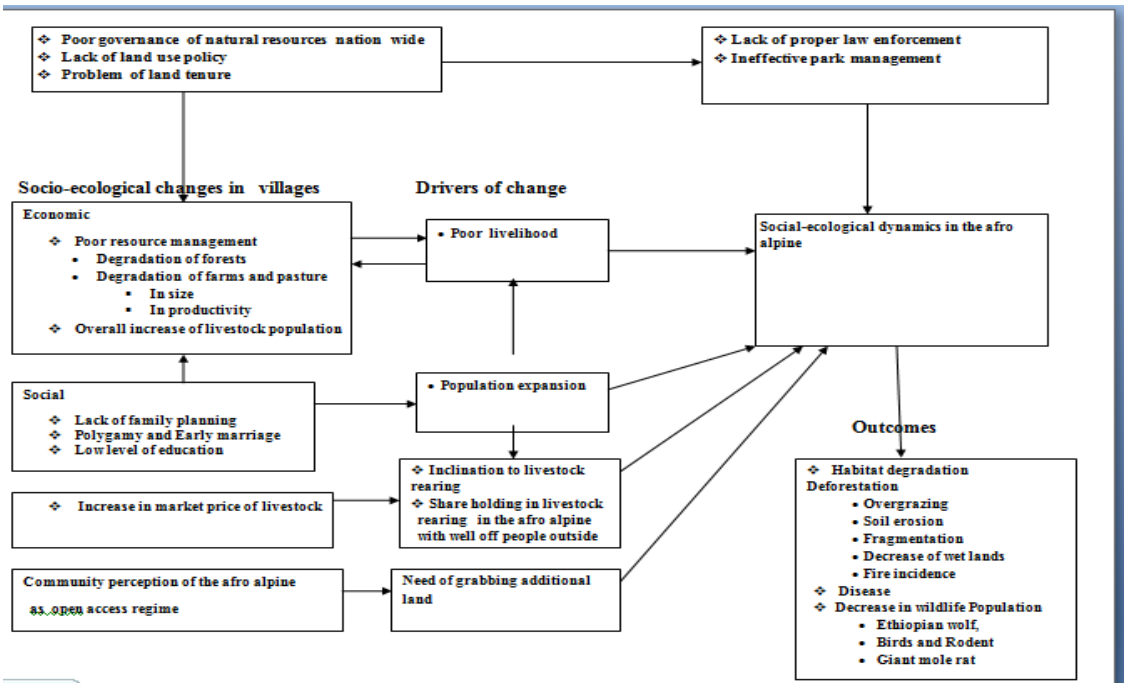

Figure 2.1 Conceptual framework of social- ecological dynamics

CHAPTER 3: MATERIAL AND METHODS

3.1. Description of the Study Area

3.1.1. Bale Mountains National Park

BMNP (6º29' – 7º10'N and 39º28' – 39º57'E) is located 400 km in southeast of Addis Ababa in Oromia National Regional State as cited by Temesgen (2015). The Bale Mountains National Park (BMNP) in the southeast of Ethiopia encompasses approximately 2,150 km^2 of mountains and forest. It was first proposed in the late 1960s to protect Afro-alpine habitat and populations of the rare and endemic species of the mountain nyala (*Tragelaphus buxtoni*) and the Ethiopian wolf (*Canis simensis*). It was established by the Ethiopian Wildlife Conservation Organization in 1971 with the primary objective of conserving the wildlife and other valuable natural resources in the area. The importance of the hydrological services that the area provides to south-eastern Ethiopia and parts of Somalia and Kenya have gradually been recognized over subsequent years and their conservation is now a primary purpose of the park. BMNP was finally formally gazetted by proclamation in 2014 under Council of Ministers Regulation 338/2014. It belongs to the Bale-Arsi massif, which forms the western section of the south-eastern Ethiopian highlands. The local boundary of BMNP lies within five woredas in two Zones: Adaba (west) in West Arsi zone and then in Bale Zone, Dinsho (north), Goba (northeast), Dolomena, Harenna Buluk and Berbere (east). Largest area above 3000m *asl.* in Africa. Tullu Dimtuu, altitude 4377m *asl*., is the highest peak in the Park and one of the highest in Ethiopia (BMNP GMP, 2017).

Based on this Source the park has the following exceptional values:

Exceptional Resource Values (ERVs) are the biophysical features of an area that are considered to be particularly important in maintaining the unique ecological character and

functions of an area and that provide outstanding benefits (social, economic, aesthetic) to local, national and international stakeholders (BMNP GMP, 2017)..

The Bale Mountains National Park is the most important conservation area in Ethiopia (FDRE, 2005 cited in BMNP GMP, 2017). It contains the world's largest Afro-alpine area and encompasses the second largest moist tropical forest in Ethiopia. The Bale Mountains are a centre of endemism, and are the most important area for a number of threatened Ethiopian endemics in all taxa.

The Bale Mountains are also a "Water tower", being the origin of major rivers of regional importance and has dry season water-holding capacity in its swamps and lakes. This hydrological system is of critical importance to up to 20 million downstream users. Bale is also very important from other social and cultural aspects, with local communities partially or totally dependent on many of its natural resources such as grass, non-timber forest products and fuel wood. With its scenery, biological and cultural attractions, the Bale Mountains have great potential for tourism although this is currently largely untapped. The area is thus of critical biodiversity, ecological, cultural and economic importance.

According to BMNP GMP (2017) the park has the following resources:

3.1.1.1 Wildlife

Mammals

The Bale Mountains are a centre of endemism, and a critically important area for a number of threatened Ethiopian endemics. The Afro-alpine area is home to over half the global population of Ethiopian wolves (*Canis simensis*), the rarest canid in the world, and listed as Endangered by the World Conservation Union (IUCN), whereas the northern Juniper-Hagenia woodlands, harbour the largest population of the endemic and similarly endangered

Mountain nyala (*Tragelaphus buxtoni*), estimated to be approximately two-thirds of the global population.

Lions and endangered African wild dogs are still found in Harenna forest, as are giant forest hogs.

Gese grassland at the north of the park comprises almost flat land, with swampy areas. The area is particularly important for mountain nyala, although good populations of other antelope such as Menelik's bushbuck, reedbuck, and grey duiker are found in large numbers on these grasslands,

Migratory and endemic birds

Over 170 species have been recorded in BMNP to date, some 20% of the species recorded for Ethiopia. Of the areas recorded birds, 6% are Ethiopian endemics. 57% of Ethiopia's endemic birds are found in the Bale Mountains, such as Rouget's rail, spot-breasted plover, blue-winged goose, the black headed siskin and white-backed black tit. The area, with its abundant rodent community, is also very important for many internationally rare large eagles, vultures and other raptors. Bale is also the only know breeding site for a number of Eurasian species, such as the golden eagle, the ruddy shell duck and choughs. The park also has breeding populations of another species, the wattled crane, the only known site out with southern Africa. In addition, it is an important over-wintering ground or passage station for migrants from Eurasia, particularly passerines and waterfowl.

Rodent Community

The rodent community, particularly of the Afro-alpine plateau is a keystone ecological species in BMNP. 32 % of the 47 BMNP mammal species are rodents and they are the main natural grazers of the Afro-alpine areas. The impressive giant mole rat is apparently endemic

to the Bale Mountains and lives underground, coming up only to harvest vegetation around the burrow holes in its 200 m^2 territory. Endemic rodents are found throughout BMNP; for example 2 endemic shrews have been identified in the Harenna forest and at least 8 endemic species in the whole park.

3.1.1.2 Vegetation

A total of 1321 species of flowering plants with 163 endemic (23to Bale alone) to Ethiopia are found in BMNP. The highland plateau and slopes of the Bale Mountains, areas over 3,500 m asl, encompass the largest area of Afro-alpine habitat (1,000 km^2 and 17% of the total) on the continent. Overall, due to the extreme climate, plant diversity is low, but the grasses and herbs support an extraordinary high density and diversity of rodents. The soil is constantly turned over by cryoturbation and rodent activity.

A spectacular feature of the southern part of the park is the progression through distinctive altitudinal vegetation zones as the altitude falls from the Afro-alpine plateau at 4000 m to the park boundary at 1500 m, with just 60 km separating the Combretum/Terminalia dry wooded grasslands and the Afro-alpine highlands. At the higher altitudes, giant heather stands of Erica form a unique habitat, whereas bamboo provides an important resource across large areas. Hagenia trees are common on the upper slope, although Juniperus is absent. Below 2,200 m larger tree species such as Podocarpus falcatus appear, many over 30 m in height.

3.1.1.3. Hydrological System

The Bale massif plays a crucial role in climate control in the region, attracting large amounts of orographic rainfall. Rainfall can occur in any month of the year, although peak rainfall occurs between March and October, peaking in August and March. Some 600-1000mm falls annually in the lower altitude areas, and 1000-1400mm in the higher areas. The watershed of

the plateau is characterized by flat, swampy areas and many small shallow lakes that are crucial for flow regulation. Overall a total of 40 rivers rise in BMNP area.

BMNP is the source of water for five major rivers (the Wabe-Shebelle, Web, Welmel, Ganale, and Dumal) on which an estimated 12 million people depend. The Afro-alpine wetlands and the Harenna forest hold the water, releasing it year round to the arid and semi-arid areas of south-eastern and southern Ethiopia, including the Ogaden and Somali agricultural belt

The alpine lakes and mountain streams are a key feature of BMNP and, as well as providing vital habitat and ecosystem services, are an attractive scenic feature in their own right. Access is good to small lakes on the Sanetti Plateau and these draw birdwatchers and other tourists.

This study covers the Afro-alpine ecosystem of BMNP with areas above 3200 masl. The Afro-alpine ecosystem of the BMNP is surrounded by three districts, namely Dinsho, Goba and Adaba with a total number of 14 villages (Kebeles).

3.1.2. The Afro-alpine of the Bale Mountains

They represent the largest continuous area (over 1,000 km2) of Afro-alpine habitat in Africa (Yalden, 1983). The Bale Afro-alpine lies in the 1,000–1,400 mm annual rainfall zone. The climate of the Afro-alpine belt is influenced by desiccating north-easterly winds and orographic rains, showing a marked seasonality. Over 2/3 of the annual rainfall occurs between April-September (the wet season). The dry season, from October to March, is characterized by extremely cold nights and warm days (Hillman, 1986; Miehe & Miehe, 1994). The Afro-alpine belt is characterized by sparse, short vegetation adapted to low rainfall, heavy frosts and desiccating winds during the dry season. Ecosystem engineers, such as the giant molerat (TM, *Tachyoryctes macrocephalus*), and cryoturbation keep the

vegetation in permanent pioneer stages, dominated by short forbs and grasses (such as Alchemilla species (A. abyssinica, A. rothii, A. cyclophylla), Polygonum plebejum, Trifolium acaule, Anthemis tigrensis and Poa muhavurensis) and dotted with Helichrysum shrubs (H. citrispinum, H. cymosum, H. gofense, H. slendidum) and Artemesia afra (Miehe & Miehe, 1994).

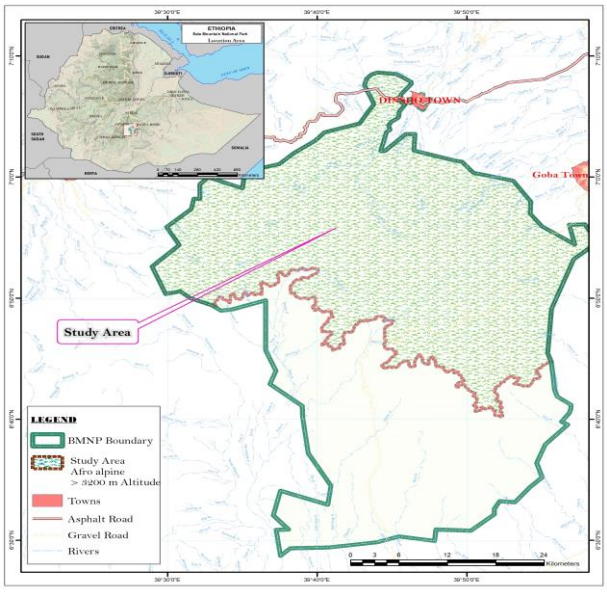

Figure 3.1 Location map of the study Area

3.2. Research Design

Quantitative data were collected using structured questionnaires. The quantitative data were collected from randomly selected respondents residing in the three sample villages. The qualitative data were collected through interviews from selected Key informants from EWCA, EWCP, BMNP and the three sample villages through Open ended guiding questions. Focus group discussions were done with selected community groups of various ages in sample villages using open ended guiding questions.

Direct ground observations were made in the three sample villages and in representative sites in the Afro-alpine (Web valley and Sanetti plateau) using checklists. Pictures were taken when necessary during the observations to supplement data collected through questionnaires, KIIs and FGDs. Satellite images were also employed to collect and analyze land use land cover changes both in the study areas.

3.3. Sampling techniques and sample size

3.3.1. Sampling techniques

Purposive sampling was employed to select the three sample villages from three districts (Goba, Dinsho and Adaba Dodola) based on representativeness, accessibility and security on the basis of prior survey with key informants (park officials) and secondary data. The sample villages were selected purposively to represent both the three districts which are surrounding the Afro-alpine and those villages inside and outside the park. Based on village offices' data around 1651 households (HHs) are living in these villages. These villages are Rira (from Goba district), Geremba dima (from Dinsho district) and Qoma Witincho (from Adaba Dodola district). Then the number of HHs for questionnaire survey for each village was determined based on their proportional size from the total number of HHs. The respondent HHs in each village were selected through first come type of random sampling technique.

3.3.2. Sample size

The total household number (total population) size in the three target villages is 1651. Sample size was determined from each village using probability proportional to size (PPS) method to make equal representation of households in each village based on (Yemane, 1967 in Israel, 1992).

The sample size (number of respondent households for each village) was calculated using the following scientific formula:

n= N/1+N (level of significance in units) ² with 5% level of significance (Yemane, 1967)

Where n=sample size, N=population size, level of significance in units (5%=0.05). Accordingly, n= 1651/1+1651 (0.05) ² = 321. Therefore, the sample size is 321 HHs. All in all questionnaire survey was conducted for 321 HHs in the three target villages.

3.4. Data collection methods and tools

The study implemented both primary and secondary data collection tools. Three types of data collection methods were utilized: survey (individual questionnaire), contact (key informant interviews and focus group discussions) and observation methods. Land sat satellite images from free sources had been utilized to get land use and land cover changes of the surrounding villages and land cover change of the Afro-alpine to strengthen data from ground observations and other tools. Ten ground points were taken from each main land use and land covers to utilize them in supervised classification o f satellite images. Review of data from secondary sources was also done. Generally, the following tools had been utilized in the data collection.

3.4.1. Questionnaire Survey

Structured survey methods had been utilized using questionnaires to collect data from individual targeted respondents.

The structured questionnaires were used to collect social, economic and ecological data in the area related to the socio-ecological dynamics of the area (Annex 1). All in all 321 questionnaires had been utilized. The questionnaires were prepared in English and finally translated into Amharic to facilitate easy interactions. Pre-testing of questionnaires was made before handed over to data collectors to collect data and questions found unnecessary were omitted and others found crucial also included in the questionnaire. The pre-test was also

important to know what the researcher means regarding each question in the questionnaire. Translators were also used to facilitate easy translation to Afan Oromo to gather reliable data on the issues mentioned. In areas where data collectors used were given short training on the questionnaire and in some cases orientation had been provided and close follow up and timely adjustments were made where there happened misinterpretations of the questions to gather best quality data.

3.4.2. Key informant interview

In the case of interviews, a one to one interview had been made using designed interview guides (Annex 2) with key informants who have a special knowledge about the area and historical events that has occurred in the research issue and the study area in question. This was done absolutely by the researcher. Key informants were drawn from the three target villages mentioned above, from BMNP, from EWCA and EWCP (NGO working on conservation of Ethiopian wolf in the Afro-alpine of BMNP for above twenty years financed by Oxford University).

Three community members from each sample village (a total of nine) that have close contact with and knowledge about the Afro-alpine participated as key informants. Three experts from both community and ecology case teams were included, and one community warden (a total of four) was made to participate from BMNP. One monitoring expert who has worked closely with the Afro-alpine ecosystem and the endemic Ethiopian wolf for more than twenty years, another expert working on community awareness for more than sixteen years and one veterinarian working as veterinarian on domestic dog and Ethiopian wolf disease control and vaccination for more than ten years (a total of three) were interviewed from EWCP. One expert from EWCA who has extensive knowledge and experience of more than two decades

on birds was interviewed about Afro-alpine birds in BMNP. All in all, data was gathered from sixteen key informants.

3.4.3. Focus group discussion

Focus group discussions were arranged with the community members, leaders and elders of the surrounding community who are knowledgeable in the area of study and the site. In the village level a total of 7 to10 people were drawn from each target villages. The discussions were held in each village. Open-ended general questions on the research issue were prepared to dig out relevant information from the discussants. The discussion was made using Afan Oromo and translations were made to Amharic to communicate easily (Annex 3).

3.4.4. Ground Observations

Data were also collected through observations of geo-physical features, flora, fauna and social status of the study area using checklists and camera. Photos were taken to show the existing condition on the Afro-alpine .This had been done with the assistance of a guide working on community awareness in the Afro-alpine for EWCP. The ground observations and random interviews were made in the Web valley and Sanetti plateau, which are main part of the Afro-alpine ecosystem in different localities. The observations included the pattern of settlements, livestock density and type, biophysical conditions like status of grasslands, wetlands, shrubs and bushes etc. A checklist was employed for field observations (Annex 4).

3.4.5. Satellite image

To strengthen data obtained from direct observations, household questionnaires, key informant interviews and focus group discussions on ecological changes, land use / land cover changes using land sat 8 free satellite images had been utilized. Land use / land cover change for the three surrounding sample villages had been worked out to compare the changes that had undergone through 45 years so that it can be possible to infer the impacts of

these changes in the Afro-alpine ecosystem of BMNP. The images were taken for years 1973, 1991 and 2018. The intention is to compare land use/land cover changes in the three consecutive regimes to see the changes in the three governance periods. The first two years (1973 and 1991) were selected, because they were years these regimes almost lost their political power and the periods mark shift of governance that helps to show what was there in both and what changes had occurred. The last shows the degree of change in very recent years after EPRDF has taken over the power. All in all the three maps show the trend of the LULCC in the sample villages and LCC in the Afro-alpine ecosystem in terms of degradation and habitat quality and ultimately shows the trend of ecological changes. The intention is to compare changes in the villages and their effect on the Afro-alpine.

3.4.5.1 Data sources

To meet the objectives of the study, two major data sources of remote sensing and a field data had been collected. Remote sensing data had been used to produce land cover information and to analyze conversion observed over the period of 45 years (1973 – 2018). Therefore satellite imageries cloud-free Land sat multispectral scanner (MSS), Thematic Mapper (TM) and Thematic Mapper plus (ETM^{+}) image for the year 1973,1991 and 2018 with bands 4,3,2 and Landsat8 6,5,4 (2018) (http://www.usgs.gov/) for the month January had been used because this month is better for observing land cover conversion than the other months because during January the land cover is clearly observed whereas during the autumn season the crop and grass have almost the same spectral reflectance. Land cover changes of 1973 (during the last year of Hailesellassie regime), 1991 (downfall fall of the Derg regime) and 2018 (current period) had been taken to see land use/ land cover changes on the three sample villages and only land cover changes for the Afro-alpine ecosystem of BMNP had been assessed to compare changes and infer their reflection on the Afro-alpine ecosystem of the BMNP. Therefore MSS, TM and ETM^{+} images, with a spatial resolution of 60 after it

resample to 30m, 30 m and 30m resolution of ETM^+ after resample to 15m resolution using panchromatic band were used.

The source of the remotely sensed data was of the United States Geological Survey (USGS). Images of same month were selected to minimize classification inaccuracy but in cases where cloud cover occurs nearest months had been selected as there is no that much difference unless there occurs huge natural or manmade catastrophe during the period.

Sample field observations had been carried out in the three sample villages and in Sanetti and web valley to collect ground truthing samples based on the land cover types and for each land cover type 30 random points were taken. Hence, TM and ETM^+ image had been classified into different land cover types. Moreover over all accuracy assessment and KAPP statistics based on land cover image and ground control points (GCPs) for the supervised classification accuracy assessment had been performed.

Land cover types are classified into cultivated land (farm land), water bodies, grass lands bare lands, Erica vegetation, swamp grass land, bush/shrub land, forest land, Helichrysum dominated vegetation and Artemisia dominated vegetation. Water bodies represent any type of surface water, grass lands represent open grass lands and herbs, bush/shrub land represents dominant vegetation lower than 1m, with a canopy cover below 50% but higher than 5% and dominant vegetation lower than 3m but higher than 1m with a canopy cover above 15%, or dominant vegetation below 1m with a canopy cover above 50%, forest land covers any patches of forest with a canopy cover over 50% found in the periphery of the villages, in gorges and communal lands in the form of remnant natural forest.

3.4.5.2 Data analysis of images

A. Pre - Image classification

Following the acquisition of remotely sensed data, the images were stacked so that different combinations of Red, Green and Blue (RGB) can be shown in the ERDAS interface. The atmospheric and geometric correction of the Preprocessing of satellite images that is important to improve the quality of the images which helps to image classification and change detection processes was made. Besides, to improve the visualization of the image for the prospected classification different false color composite were produced in addition to the true color composite. The application of each color composite for different land cover features identification and training site selection for supervised classification was used. Pre-field image processing was done using a combination of bands 6, 5, and 4 and bands 4, 3 and 2 in RGB transformation for Landsat 8 and Landsat 2 and 5, respectively. In this study a combination of bands 4, 3 and 2 for Landsat 2 MSS and 5 TM and bands 6, 5 and 4 for Landsat 8 in RGB transformation had been used, Since this combination is commonly used for land cover mapping study. Because, vegetation cover reflects more at infrared region than visible band (Netsanet, 2007). Pre-image classification process had been done using ERDAS Imagine 9.2 software within interpreter main icon utilities with layer stacked function. Then from the stacked satellite image the image of study area was extracted by clipping the AOI layer of my study area in ERDAS imagine 9.2 software.

B. Image Classification

Digital image classification is defined as the process of sorting all the possible image pixels into a finite number of classes or categories of data (Golmehr, 2009). Within the scope of this research proposal, it had been defined as the extraction of different classes of land cover categories from raw remotely sensed data. There are two methods to classify pixels into different categories: supervised and unsupervised classifications.

Supervised classification is a procedure for identifying spectrally similar areas on an image by identifying 'training' sites of known targets and then extrapolating those spectral signatures to other areas of unknown targets (Ekwal , 2011). Supervised classification relies on the previous knowledge of the location and identity of land cover types that are in the image. This was achieved through field visits of the study area (Ekwal , 2011). The resulting products of classification were used to assess spatial patterns of land cover converse on for the study area.

Maximum likelihood supervised classification will be employed to establish the land-cover classes from Landsat imagery of 2018. Maximum likelihood method assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class (Ekwal, 2011). Prior to carrying out supervised classification, field survey had been conducted using Global Positioning System (GPS) to collect GPS points for training site collection and for signature generation. A clear and existing land cover type that represents each type of land cover were selected as training sites and ten times for each land cover GPS points were collected for training area selection. Furthermore, unsupervised classification was employed for the1973 and 1991 Landsat TM and ETM^{+} imageries in order to define the land cover classes. The imageries were checked against the ground truth land cover of the study area during the reference periods (1973, 1991 & 2018) to sharpen the classification and to validate the interpretation approach. Finally, different land cover classes were identified using ERDAS Imagine 9.2 software.

C. Post classification

Post classification is among the most widely applied techniques for land conversion detection purpose. Since in post classification change detection approach two images from different dates are classified and labeled. The post classification is performed from visual and digital interpretations of the satellite imagery based on this different land cover categories had been

distinguished. The LC classes are Artemesia dominated vegetation, Helichrysum dominated vegetation, Swamp grass land, cultivation land, grass land, Erica vegetation, water body and bare land for the Afro-alpine ecosystem and forest land, bush/shrub land, erica vegetation, cultivated land, grass land, swamp grass land Helichrysum dominated vegetation, Artemisia dominated vegetation and water body for sample villages. Based on the visual interpretation of satellite imagery and field observation land cover classification had been done. Some literatures had been also referred to assist the classification process.

D. Accuracy Analysis

During classification to what extent the produced classification is compatible with what actually exists in reality is fundamental and was incorporated as part of the Classification process. The accuracy procedures involved the production of references or facts from the field that evaluated the produced classification. These references are produced from maps, aerial photos or visits to the field with help of GPS system and this had been represented by points or area. This comparison produces an error matrix that will be the basis for the accuracy verification process (Abiy, 2010). He also suggested that, for classifications that have few classes, less than ten 50 – 60 reference points for the accuracy production should be used. These points' proportion may be differentiated due to the volume of area occupied by a certain class.

In addition to the producer and user accuracy indices, there are other indices produced from the error matrix that involve more complex mathematical operations such as probabilities.

One of these indices is called Kappa Statistic and it enables a generalization of information that allows us to compare classifications produced from different images. Kappa statistics is one of the most common means of expressing classification accuracy .The minimum level of accuracy in the identification of land cover categories from remote sensor data should be at least 80 % (Abiy, 2010)

3.5. Data analysis

Both quantitative and qualitative data analysis techniques had been employed. In the case of quantitative data collection, data on marital status, main livelihoods, family size, land holding size (both farm & grazing land), household educational level, etc were collected.Quantitative data analysis was made using SPSS data analysis software package version 20 and presented using descriptive statistics. These include percentages, graphs, proportions and averages.

Text explanations and descriptions are also used in the case of qualitative data analysis. In this case, the data gathered through key informant interviews and focus group discussions through writing from speeches or taped were transcribed and sorted into categories and finally quoted directly or paraphrased.

Direct observations made during field survey in Sanetti Plateau and Web Valley were done to count sample settlements, observe conditions of wetlands, condition of livestock and dogs, degradation of vegetation etc along with photographing them. Camera was used to take pictures of settlements, condition of grass, wetlands and Erica vegetation. Haphazard interviews were also made using checklist adapted from EWCP to know about fuel wood, fencing materials, condition of wetlands and wildlife habitats etc. and these were also transcribed and sorted to support the data from QSs, KIIs and FGDs

Land use / land cover changes were analyzed for 1973, 1991 and 2018 using free satellite images of the same season simply to show what changes have undergone in the sample villages and what changes had been reflected on the Afro-alpine ecosystem.

The LC conversion had been analyzed using Arc GIS 10 and ERDAS IMAGINE 9.2 software. Therefore the acquired multi-temporal images were processed following standard image processing procedures that comprise image enhancement, rectification and

classification. This allowed the extraction of information on LC conditions and quantification of conversion and its rate over the past 45 years using multi temporal analysis.

The land cover map for the three period series of images had been analyzed based on LC types. The changes over 45 years' analysis and rate of change for each LC type had been calculated. In the mean time, the rate of LC conversion for the three periods: for the period 1973 – 1991 and 1991 – 2018 had been computed using the following simple formula (Amanuel & Mulugeta, 2014)

$$r = (Q2-Q1)/t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, r = rate of change

Q2 = recent year land use/ land cover in ha

Q1 = initial year land cover in ha

t = interval year between initial and recent year

Chapter 4: Results and discussion

4.1 Results

4.1.1 Afro-alpine ecosystem and socio economic conditions

4.1.1.1 Permanent and seasonal Settlements

The results clearly revealed that there are three categories of respondents in relation to the Afro-alpine ecosystem. There are permanent settlers, seasonal settlers and people who do not use the Afro-alpine ecosystem. Table 4.1 below shows the status and the purpose of settlement in the Afro-alpine among respondents.

Table 4.1 Proportion of Type of respondents' relation and purpose of settlements in the Afro-alpine across sample villages

Type of settlement	Purpose settlement	Villages			Frequency (percent)
		Geremba dima (n= 98)	Koma witincho (n=135)	Rira (n=88)	
Permanent	Farming	1	0	0	1(0.3)
Seasonal	Grazing	65	37	1	103(32.1)
Permanent	Grazing	8	35	63	106(33.0)
None users	-	24	63	24	111(34.6)

Source: Author's Research survey, 2018

There are people who are living there year round and others who come with their livestock during wet season of the year and go back to their original village after some stay (seasonal settlers/ Godantu in the local language Afan Oromo). The main reason of settlements (both permanent and seasonal) is in search of grazing land. Around 65.1% (around two-third) of the respondents use the Afro-alpine for this purpose (Tab1). The relationship between sample villages and the Afro-alpine is statistically significant (c^2= 135.26, df =6 and P= 0.00 < 0.05). In addition to this, key informants also mentioned that well off individuals in nearby towns and

villages outside the AAE buy and give sheep and goat to the communities settled in the Afro-alpine in mutual share agreement to benefit from the reproduction or fattening which is a recent trend (5-8years). According to key informants and focus group discussants, people are also focusing in livestock rearing than crops owing to lesser labor requirement, higher market demand and higher price than crops and open access along with suitability of the Afro-alpine for cattle rearing. On top of this, progressive decrease of productivity and shrinkage of farm sizes are pushing the community to shift from farming to livestock rearing. According to key informants and focus group discussants population of sheep and goats are highly increasing from time to time. The reasons given for this by them are shorter reproduction time, easier management, less vulnerability to droughts, more demand in markets and less risk of loss of sheep and goats than cattle (due to death).

Following settlements there are increasing number of construction of huts in the AAE. Among 107 permanent settlers, 106 (99%) have huts in the Afro-alpine, where as 89 (86.4%) have huts among 103 seasonal settlers ($t=13.43$, $df=209$ and $P=0.00 < 0.05$) (Annex 5).Individuals without huts live with other relatives during their stay there. Those settlers in the Afro-alpine do not always own a single hut, part of them own more huts. In the case of this study, for instance 68 (34.9%) respondents own two and more huts out of the total 195 respondents that own huts in the AAE (Annex 6). Total huts belonging to 195 respondents amount 290.

Settlers in the Afro-alpine formed many patches of villages having mainly permanent huts used for living. For the case of this study, Permanent huts are huts used for more than a year, both permanent and seasonal settlers use them, and temporary huts are those huts used only for a year. It is so defined by the author, because seasonal pastoralists construct the huts to use it every year when they come to the area (Annex 7).

During ground observations it was also possible to count 205 permanent huts used for seasonal and permanent settlement in only five settlement villages near to each other (Wella, Sodota, Horogoba, Bisile and Guracha) following hill bottoms near a plain called “Kotera Meda’’ in a small area in the Web Valley. Few of settlements in Web Valley and Sanetti Plateau are shown in Annex 8.

According to key informants working for the Park as ecologists there are three mosques in Web Valley alone, in area locally called "kotera". The researcher was also able to observe one newly built mosque in Web Valley and well established grave yard (Annex 9).

All in all 192 (98.5%) out of 195 respondents constructed their huts using Dung, wood and grass; while 3 (1.5%) constructed their huts using wood and grass only (Annex 10).

Among 195 respondents that have huts in the AAE 131 (67.2%) fully used Erica species for construction. Altogether, 175 (89.8%) respondents use Erica and Erica in combination with other species. Only 20 (10.3%) used species like Hagenia, Juniperus, and hypericum and arundinaria altogether. There is high pressure in this highly ecologically important Afro-alpine woody species (Annex 11). Construction wood is fully obtained from the park (both from the Afro-alpine and outside the AA inside the park).

Besides using the Erica for construction of huts, it was also observed during the field observation that they use it for fencing their compounds, though they are also using stones too (Annex 12). According to KIs and informal interviews with residents in Web valley the reason they started to use stones has also connection with constantly declining of the Erica and getting farer from their homes.

Out of the total respondents that have huts in the Afro-alpine, 195 (100 %) of them are using wood from the natural forest in the park for construction (both in the AAE and inside the park). 195 (100%) respondents use the grass at the Afro-alpine as their source of thatching

grass found in wetlands for their huts especially a grass known as “suqiye” in Afan Oromo which is these days near extinction due to over exploitation and livestock pressure. The researcher was able to see the dead butt of the grass in the wetlands of web valley (Annex 13). The decrease of this grass was also mentioned by respondents during questionnaire survey, key informant interviews and focus group discussions. The reason was mentioned to be year round grazing pressure and consumption for hut making inside and outside the Afro-alpine within and outside the park. The trend of hut construction went on increasing through past years. 8%,21% and71% respondents out of 210 were constructed by permanent settlers for the years shown in the figure below and 7%, 35% and 58% were constructed by seasonal settlers as shown(significant with x^2=22.93 df=2 and p<0.05=0.03)

Most of the respondents' first hut construction was done in the last twenty seven years, especially after 2005 national election (Figure 4.1 and Annex 14)

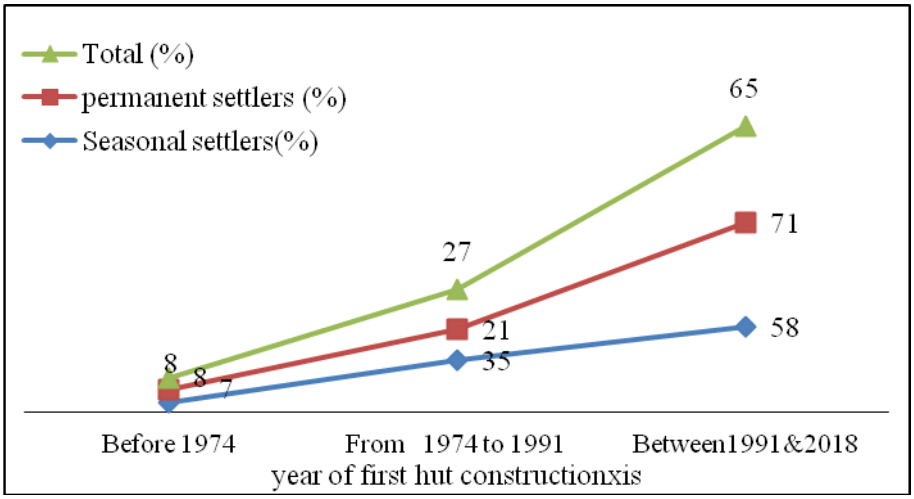

Figure 4.1: Trends of first hut construction by permanent & seasonal settlers in the Afro-alpine (Source: Author's Research survey, 2018.)

It was also confirmed by key informants and group discussants from the three villages that there were settlements during Hailesselassie regime but they were very few in number owning large number of livestock per household 300-500/HH. They also mentioned that the

weather condition during that time was not as conducive as today's. One key informant from Rira expressed the condition by saying “today you can walk in the Afro-alpine wearing a T-shirt because the weather condition has changed radically as compared to that of old days.” Due to this and many other reasons like low level of law enforcement, population increase, shrinking of size and productivity of cultivation land, market changes livestock and crops); these days there are a lot of people from far and near villages living in the Afro-alpine ecosystem (FGDs and KIs).

Around 75 (70.7%) out of 106 permanent respondents constructed their huts after 1991 which is the highest (Figure 4.1) of all the three periods.

Out of the total 210 respondents that are permanent and seasonal setters in the AAE 165(78.6%) use wood for house hold fuel consumption, while 42 (20%) of the respondents use both wood and animal dung and 3(1.4%) use animal dung only (Annex 15). During field visit in web valley it was observed that people making animal dung for fuel. The interview with KIs and FGDs revealed the main reason for that is these days the Erica is getting far from settlements due to unsustainable utilization and fire incidences. In the same locality in the web valley it was also observed that Artemesia afra species cleared through uprooting and left on the ground to dry for fuel which has unpleasant smell when burning and which was not used as fuel wood previously (Annex 16). It was also possible to see uprooted Erica buts laid on rocks to dry for the purpose of fuel wood (Annex 16).The source of fuel wood is totally (100%) from the natural vegetation; from the park & Afro-alpine (Annex 17) and around 182 (87.9%) of the respondents out of 207 that use wood for fuel in the Afro-alpine were found to use Erica species. 21(10.2%) use Erica in combination with other tree species like Hypercum, Hagenia, and Juniperus procera Annex 18).

According to key informants in BMNP & EWCP high amount of Erica is extracted from the surrounding of Sanetti plateau to Goba town for fuel wood. The researcher was also able to witness this situation during data collection travelling to Rira along Goba- Dolo Mena road. A lot of horses and donkeys loaded with Erica fuel wood were travelling to Goba town in a weekly market day. There is also extraction of Erica fuel wood from web valley for sale at Dinsho market.

4.1.1.2 Trend of Human and Livestock influx into the Afro-alpine

Data collected through questionnaires, key informant interviews, focus group discussions, observations and secondary data clearly revealed that human settlements are increasing in the Afro-alpine. Key informants from the park and EWCP witnessed that people come and settle in the Afro-alpine due to their relation with those already settled inside or upon marrying a girl from them. Table 4.3 below depicts the facts about the influx gathered through questionnaire survey in the sample villages.

Table 4.2 Status of Human and livestock influx to the Afro-alpine in the last 30 years

Responses	Response across sample villages			Total frequency(percent) (n= 210)
	Geremaba Dima (n=74)	Koma witincho (n=72)	Rira (n=64)	
Increasing	66	70	50	186(88.6)
Decreasing	5	1	1	7(3.3)
Same	1	1	9	11(5.2)
No idea	2	0	4	6(2.9)

Source: Author's Research survey

88.6 %, 7%,11% and 6% of the respondents that are seasonally and permanently living in the Afro-alpine believe that the human and accompanied livestock influx both in the form of permanent settlement and seasonal grazing have been increasing, decreasing same and no idea in their order (Table 4.2). The influx is significant($x^2=23.75$ df =6,$p=.00< 0.05$) This was also

confirmed through key informant interviews and focus group discussions in all three sample villages as well as interviews with permanent settlers in the Afro-alpine habitat in Web valley and Sanetti plateau during ground observation. According to key informants and focus group discussants, they pointed out that there were settlements even during Hailesellasie regime (before 1974), but they were very few (4-7 households / sample villages) with large number of cattle owned per household (up 300 to 500 per household). But these days the number of livestock is not more than 50-100 per household.

As per the household respondents, the main reasons mentioned for an increase influx of human-livestock population are attributed to increase in family size (59.6%) and shortage of grazing land (23.7%) in their permanent locality outside the Afro-alpine ecosystem (Annex19). According to group discussants in Rira village during Hailesellasie regime family size was very few, but today a house head may have 10 -20 children.

Natural increase in human population in the surrounding nearby and far villages also supports the reasons given for the increase of human and livestock influx that pose burden on the park in general and the Afro-alpine in particular (Annex 20). According to key informants and group discussants, people from the surrounding districts and villages also take their livestock to Horas (ponds of mineral water) in the Afro-alpine throughout the year in varying intervals so that their livestock drink the mineral water. The interval depends on the distance between the villages and the "Horas" and personal decision. They believe livestock that drinks mineral water from "Horas" reproduce in short intervals, fatten well, host no internal parasite and become milky. Pastoralists that take their livestock to these "Horas" (mineral water) stay there from a week to a couple of weeks. It was also possible to understand that there are seasonal pastoralist movements within the Afro-alpine by the permanent settlers depending on pasture availability and of suitability for living because some localities are not suitable for living

during certain months of the year. The permanent pastoralists change place at least three times per year at an interval of at most four months.

Majority of people that settle in or seasonally come to the Afro-alpine ecosystem are from three districts, Dinsho, Goba and Adaba Dodola. But there are also that come from Assasa and other non bordering districts too (Annex 21).

4.1.1.3 Status of seasonal movements to and duration of stay at the Afro-alpine

The majority of the seasonal pastoralist movements start on May though there are movements beginning from April that continues until July. Majority of the respondents that are seasonal comers used to and still start movement to the AAE on May (just before the onset of the long rainy season). Regarding their duration of stay for these two villages has also no significant change (Annex 22). Regarding starting month of yearly seasonal movements during past years 7(6.8%), 74 (71.8%), 10(9.7%), 11(10.7%) and 1(1%) responded that they are coming on April, May, June, July and August in their order, whereas 7(6.8%), 74(71.8%), 10(9.7%)and 12(11.7%) responded to start movement on April, May, June and July in their order these days. This is the case for the two sample villages (Geremba dima and Koma witincho). Therefore, this reveals that there is no significant change on this regard through years in these villages

In the case of Rira village there is totally no respondent reported seasonal movement these days except a single respondent which is negligible, they totally stay in the Afro-alpine throughout the year though seasonal movement was very common during Derg regime. This fact was also proven by KIIs and FGDs. During those old days they used to stay at the Afro-alpine from February to September /early October and they used to stay in their village (Rira) from September/ early October to end of January/start of February (Annex 23). Therefore, there is a complete shift from seasonal settlement to permanent settlement in this case of Rira.

4.1.1.4 Domestic dogs and the Afro-alpine ecosystem

About 77.3 % of the respondents own dogs. Only 73 (22.7%) of the respondents don't have dogs (Annex 24) .The average number of dogs owned by household is around 2.

According to key informants and focus group discussants, the number of dogs is increasing from year to year in the Afro-alpine. .According to informants from the park and EWCP, the presence of dogs in the Afro-alpine is a threat to survival of the Ethiopian wolf in particular and healthy of ecological pattern in general, because they serve as disease transmission medium (Rabies & CDV). The major causes for decrease of Ethiopian wolf population are these diseases, which are wholly transmitted from domestic dogs. Diseases are transmitted through contacts between the infected dogs and non-infected wolves because of multiple reasons like territorial defense by wolves, probable food competition (during feeding on rodents, hares and hyraxes) or sometimes during matting (hybridization). According to a Veterinarian working in many settlers inside the Afro-alpine ecosystem , unwillingness to vaccinate their dogs because of misunderstanding that the dogs become weak and inactive, though there have been improvements through past years owing to extensive awareness creation and practical demonstrations to refute the misconception. On top of this, people living beyond vaccination radius villages bring new unvaccinated dogs with them every year as new arrivals to the area which makes vaccination more costly and difficult. There are also dogs which are free roaming in the AAE in the Ethiopian wolf territories. This was observed in Sanetti plateau and Web valley during ground observation. An ecologist from BMNP stated as "any threat to the Ethiopian wolf is a threat to the Afro-alpine ecosystem". All in all 84.5%,84.1% and 64% of seasonal settlers, permanent settlers and non users of the Afro-alpine own dogs where as 15.5%,15.6% and 36% are without dogs are in the same order. (Highly significant with x^2=51.27,df= 15 and p=0.00<0.05).

Table 4.3 Respondents status of domestic dogs' ownership in the Afro-alpine

No. of dogs owned	No. of respondents			Percent
	Seasonal settlers (n=103)	Permanent Settlers (n=107)	With no link to AAE (n=111)	
Five	3	0	2	2
Four	11	8	0	6
Three	17	17	7	13
Two	33	37	28	31
One	23	28	34	26
None	16	17	40	23
Percent (own)	84.5	84.1	64	100
Percent (none)	15.5	15.9	36	

Source: Author's Research survey, 2018

4.1.2 Ecological changes in the Afro-alpine ecosystem

4.1.2.1 Land use/land cover change in the Afro-alpine ecosystem

There are seven major land use land cover types identified in the AAE (Table 4.5). The proportional cover of Erica vegetation decreased from 40438 (33.8%) in 1973 to 32216 (27%) in 1991 and to 13081 (10.3%) in 2018 and bare land increased from almost none in 1973 to 0.6% in 1991 and further increased to 6.1% in 2018 (Table 4.4 and Figure 4.2).

Table 4.4 Land use/ land cover change statistics of the Afro-alpine ecosystem

Land use class	1973		1991		2018	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Water body	939.7	0.8	671.6	0.6	372.0	0.3
Helichrysum dominated vegetation	36848.0	30.8	50400.0	42.2	38663.4	32.4
Erica vegetation	40438.1	33.8	32216.4	27	13081.4	10.9
Artemesia dominated vegetation	38350.1	32.2	34473.7	28.8	57245.2	47.9
Swamp grass land	2900.5	2.4	979.5	0.8	-	-
Bare land	-	-	735.2	0.6	7263.2	6.1
Cultivated land	-	-	-	-	2851.2	2.4
Total	119476.4	100	119476.4	100	119476.4	100

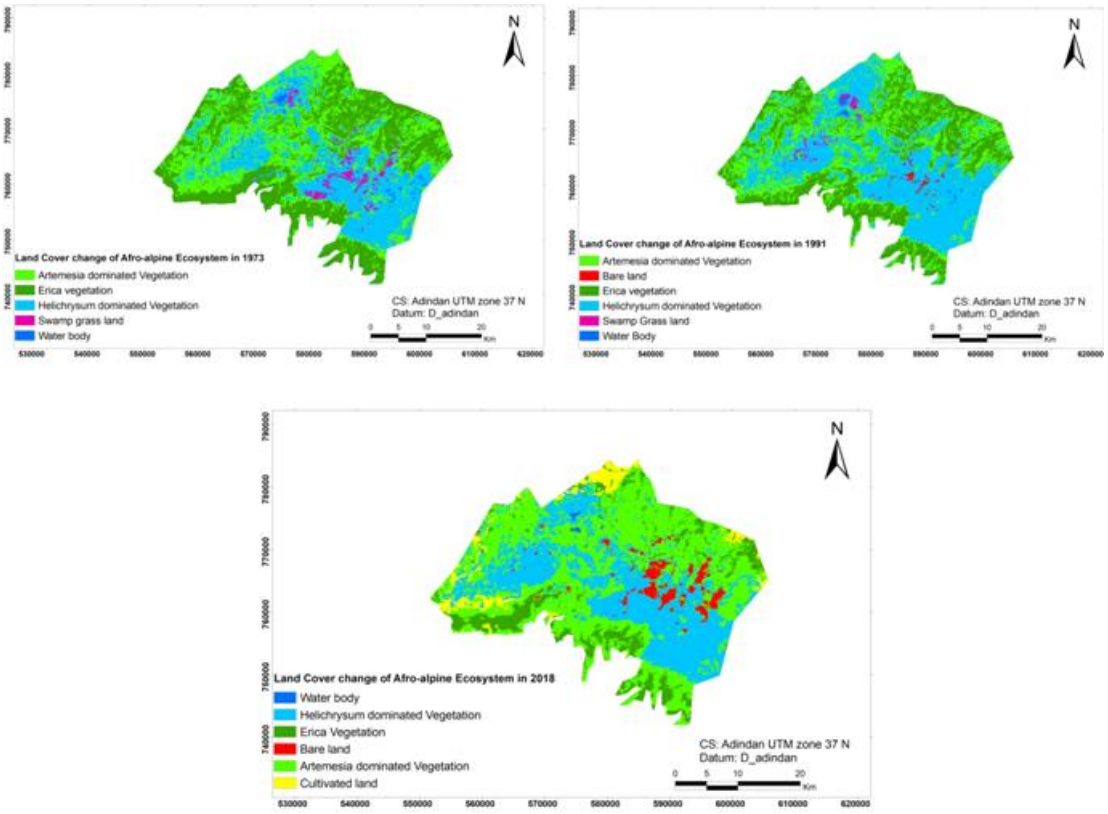

Figure 4.2: Land use/ land cover change maps of the Afro-alpine ecosystem

Table 4.5 Changes of land cover types through years 1973 to 2018

Land use classes	1973-1991		1991-2018		1973-2018	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Water body	-268.1	-0.2	-299.6	-0.3	-567.7	-0.5
Helichrysum dominated vegetation	13552	11.4	-11736.6	-9.8	1815.4	1.6
Erica vegetation	-8221.7	-6.8	-19135	-16.1	-27356.7	-22.9
Artemesia dominated vegetation	-3876.4	-3.4	22772.2	19.1	18895.1	15.7
Swamp grass land	-1921	-1.6	-979.5	-0.8	-2900.5	-2.4
Bare land	-	-	6528	5.5	7263.2	6.1
Cultivated land	-	-	-	-	2851.2	2.4

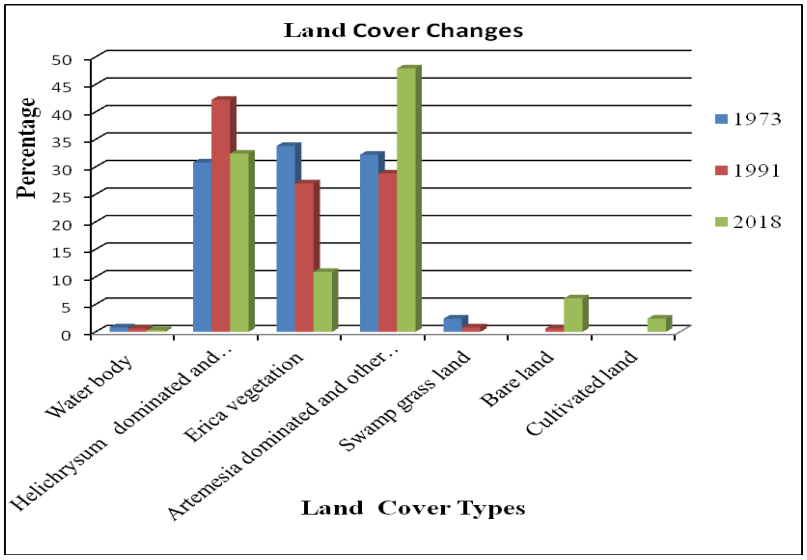

Figure 4.3**:** Graphical representation of land cover changes in the Afro-alpine ecosystem

4.1.2.2 Abundances of wildlife in the Afro-alpine in the last 30 years

The respondents were asked about which wild animal/ wildlife was abundant during their first arrival to the AAE regardless of when they first come to the area. This was simply asked which wild animal was easily seen in the area without much search due to abundance. Among 210 seasonal and permanent settlers 172 (81.9%) responded that Ethiopian wolf and Giant mole rat to be abundant at their first arrival (Table 4.6). the respondents have significant difference ($t=50.65$, $df=209$ and $p=0.01<0.05$)

Table 4.6 Respondents' view on wildlife abundance (representative wild animals in the AAE) in the last 10 years

Type of wild animal	No. of respondents	
	Frequency	Percent
Ethiopian wolf	36	17.1
Giant mole rat	2	1.0
Both	172	81.9
I don't know	-	-
Total	210	100

Source: Author's Research survey, 2018

4.1.2.2.1 Population trend of Ethiopian wolf and Giant mole rat

Respondents were also asked about the trend of their population over the last 10 years to compare population trend of both animals which are ecologically interconnected. Among 208 respondents responded for change of Ethiopian wolf population, 142 (68.3%) believe the population of Ethiopian wolf has been decreasing and among 174 responded for change of Giant mole rat 118 (68.7%) believe that it has been decreasing (Table 4.7).

A key informant from EWCP who have been working closely on the Ethiopian wolf also expressed his frustration as "everything in the Afro-alpine ecosystem has decreased except the rocks in the last two decades."

	No. of respondents		
	Frequency	**Percent**	**p-value**
Ethiopian wolf population			
Increasing	53	25.5	P= 0.00<0.05
Decreasing	142	68.3	
No change	3	1.4	
I don't know	10	4.8	
Total	208	100.0	
Giant more rat population			
Increasing	44	25.3	p< 0.00<0.05
Decreasing	118	67.8	
No change	3	1.7	
I don't know	9	5.2	
Total	174	100	

Table 4.7 Respondents' view of Ethiopian wolf and Giant mole rat abundance in the Afro-alpine ecosystem in the last 10 years

Source: Author's Research survey, 2018

Those believing the populations have been decreasing gave reason of recurrent diseases due to increased number of settlement along with livestock grazing in the Afro-alpine which are accompanied by dogs which come from areas out of vaccination radius that bring "dog

diseases” (Technically speaking, they mean diseases like rabies and Canine distemper virus) (Table 4.8).

Table 4.8 Respondents' reasons for the decline of the Ethiopian wolf

Reasons of decline	Frequency	Percent	Cumulative Percent
Increase of grazing pressure	16	11.3	11.3
Increase of settlement pressure	8	5.6	16.9
Both	71	50.0	66.9
Disease	16	11.3	78.2
Increase of grazing, settlement pressure & disease	22	15.5	93.7
Other reason	4	2.8	96.5
I don’t know	5	3.5	100
Total	142	100.0	

Source: Author's Research survey, 2018

4.1.2.2.2 Status of Afro-alpine birds

According to a key informant at EWCA mainly working on birds and their habitat, wetlands and lakes in the Bale Afro-alpine has been declining along with its bird population over the last twenty years. ,. Birds of prey were common before 8-10 years in November and December, but these days they are not common as they were during past; Mountain and long legged buzzard, Golden eagle and Eastern imperial eagle as examples. The probable cause might be related with the food chain as they are feeding on small birds and rodents in the Afro-alpine. The population of Wattled Crane which was common in wetlands of the Afro-alpine has extremely decreased these days.

4.1.2.3 Fire incidences

Among 132 respondents who witnessed Erica fire 106(80 %), 9(7%), 8(6%) and 9 (7%) responded that Erica fire incidence was increasing, decreasing, no change and no idea in these order. Regarding the reason, 88 (66.7%) pointed out that the cause for the fire was burning for facilitating new sprouts so that the communities get palatable Erica leaves for their livestock. Around 23 (17.4%) gives non intentional fire during honey harvesting as the cause of the fire

(Annex 25). According to KIs the fire most of the time starts in the Erica outside the Afro-alpine and goes on to the Afro-alpine that also burns the rodents. There were also recurrent fire occurrences during the last twenty seven years (especially in the last fifteen years) which is clearly mentioned through individual questionnaires which was the result of high human influx as permanent or seasonal settlers during the period than the Derg regime.

4.1.2.4 Status of Afro-alpine lakes and wetlands

Out of 321 total respondents, 210 have link with the AAE either in seasonal grazing or permanent settlement. Out of these 210, 197 (93.8%) believe that there are changes in lakes in the AAE. Whereas 5(2.4%) and 8(3.8%) do not believe that there are changes and have no idea respectively. According to the respondents who are familiar with the Afro-alpine 193 (98.0%) out of 197 who believe that there are changes revealed that the lakes had decreased both in surface area and depth (Annex 26). In any case there are changes in the lakes because it was also confirmed during KIIs and FGDs. It was also able to see the decrease during ground observations in Sannetti plateau as the water receded much from its original position.

Major reasons for the decrease according to the respondents account 160 (81.2%) for shortage of rainfall, 25 (12.7%) for grazing and settlement pressure (Annex 27). The main reason given is rainfall shortage though altogether human related reasons account around 16%. Here it is worth mentioning that regarding the wetlands almost all KIs and FGDs believe that in addition to shortage of rainfall wetlands (swampy grass lands) have decreased a lot and many dried up due to increase of livestock that graze on the wetlands, both in wet and dry seasons, especially during the dry season as there is no better grazing ground than the wetlands.

4.1.3 Threats to wild animals

4.1.3.1 Human population

As it is evident from questionnaire survey (Table 4.2) human population in the Afro-alpine is increasing due to the human influx from within and around the park outside the Afro-alpine

ecosystem and natural human growth from permanent settlers resulting in additional resource interest (KIIs and FGDs). The average family size per household of the respondents is close to 9.4 and there is a prevalence of polygamy (43.3% and 35.2% in the Afro-alpine and overall rate respectively).

4.1.3.2 Overgrazing

Questionnaire survey (Table 4.2), KIIs and FGDs revealed that livestock influx is increasing with human influx especially during the wet season where land outside the Afro-alpine is occupied with crops. The wetlands are severely used as grazing ground, especially during the dry season as there is no better pasture than them during this time.

4.1.3.3 Deforestation

Deforestation is a severe problem especial in Erica vegetation due to various human needs like hut construction, fencing and fuel wood for growing population. This was evident from land cover change of Erica from LULC change analysis (Tables 4.4 and 4.5). This has its own influence in changing the ecology of the Afro-alpine in degrading habitat of wild animals like hares and hyraxes that are used as food source for Ethiopian wolf during the wet season (KIIs from the park ecologists). It also deprives wild animals like leopard and Serval cat of their habitat.

4.1.3.4 Habitat fragmentation

Habitat fragmentation is one of threats for Ethiopian wolves and other wild animals due to flourishing patches of new villages and related human activities in web valley and Sanetti plateau in the Afro-alpine ecosystem.

4.1.4 Drivers of change

4.1.4.1 Decline in size and productivity of farm and grazing land

An average farm land holding size of the respondents is 2.71 ha /household. The minimum farm land holding is 0, whereas the maximum is 16 ha which is recorded in Rira village. It is

worth noting that this village is wholly situated in the national park and the other two (i.e., Koma witincho and Geremba dima) have little part of them in the park. The average land holding of the villages are 1.5, 2.4 and 4.9 ha in their order. Regarding size of agricultural plots an elder in Koma witincho expressed the situation he said "Fallowing has become history in our village due to shortage of land". According to FGDs and KIs in the sample villages agricultural land productivity/hectare decreased a lot through past years. A Key informant in Geremba dima, for instance, expressed the seriousness of the issue by saying "some years back crop yield / hectare without any fertilizer was higher than that of these days even with a fertilizer".

Table 4.9 Farm size of respondents

Number	Size in hectare	Number of respondents	percent	Cumulative	p-value
1.	0	45	14.0	14	P= 0.00<0.05
2.	0.1 - 1	71	22.1	36.1	
3.	1.1 - 2	68	21.2	57.3	
4.	2.1 -3	44	13.7	71	
5.	3.1 - 4	41	12.8	83.8	
6.	4.1 - 5	17	5.3	89.1	
7.	more than 5	35	10.9	100	
Total		321	100.0		

Source: Author's Research survey, 2018

4.1.4.2 Land use /land cover change of sample villages

The major land use land cover changes in the villages include increase in the proportion of cultivation land from1.9% in 1973 to 13.1% in1991 and further increase to 16.3% in 2018 and decrease of grass land from 22.3% in 1973 to18.7% in 1991 and further decrease to 11.2% in 2018 (Figure 4.4 and Table 4.10).

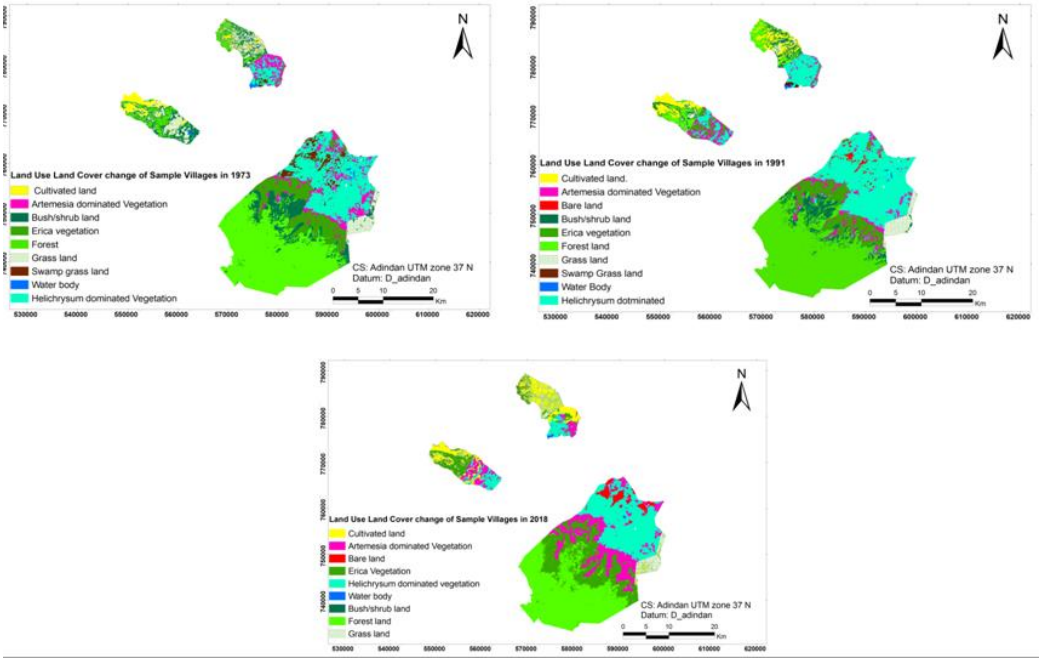

Figure 4.4: Land use/ land cover change maps of the sample villages

The following table shows the absolute and proportional land use/land cover changes.

Table 4.10 land use/ land cover change statistics of the sample villages

S.n.	Land use/land cover classes	Year and size					
		1973 Area (ha)	%	1991 Area (ha)	%	2018 Area (ha)	%
1	Bush/shrub land	9629.2	11.5	8167.5	9.8	23900.4	28.6
2	Grass land	18653.5	22.3	15653.5	18.7	9330.6	11.2
3	Cultivated land	1560.2	1.9	10,924.4	13.1	13575.3	16.3
4	Water body	506.1	0.6	186.6	0.2	0.9	Neg
5	Forest land	30526.9	36.6	31254.2	37.5	22975.8	27.5
6	Helichrysum dominated vegetation	10571.9	12.7	15139.9	18.1	8154.7	9.8
7	Artemisia dominated vegetation	1991.8	2.4	1027.2	1.2	5548.9	6.6
8	Erica vegetation	8039.9	9.6	1004.9	1.2	0.8	Neg
9	Swamp grass land	2007.9	2.4	129.2	0.2	-	-
Total		83487.4	100	83487.4		83487.4	100

4.1.4.3 Social conditions in the Afro-alpine and the villages

4.1.4.3.1 Marriage type

All in all the degree of polygamy is 43.3% among those respondents which are permanent and seasonal settlers in the AAE and 19.8% among those respondents who are not using AAE (Figure 4.5). (x^2=14.98 df=1 and p=.00<0.05)

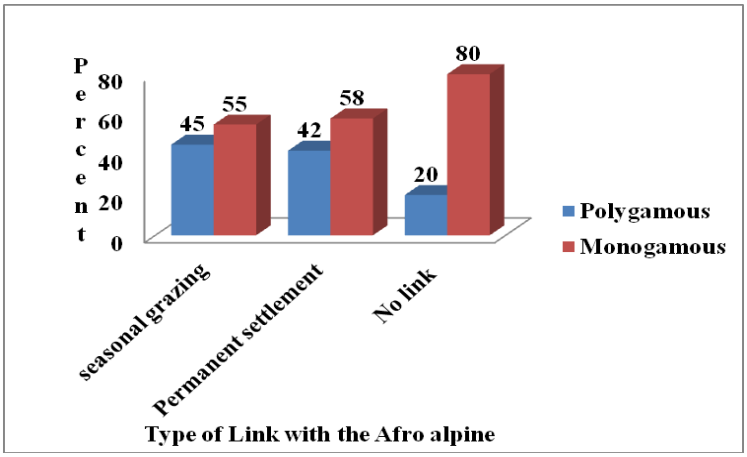

Figure 4.5**:** Marriage type vs. permanent settlement, seasonal grazing and absence of link with the Afro-alpine (Source: Author's Research survey, 2018)

It is worth mentioning that polygamy has a sort of link with age. As the age increases polygamy also increases.

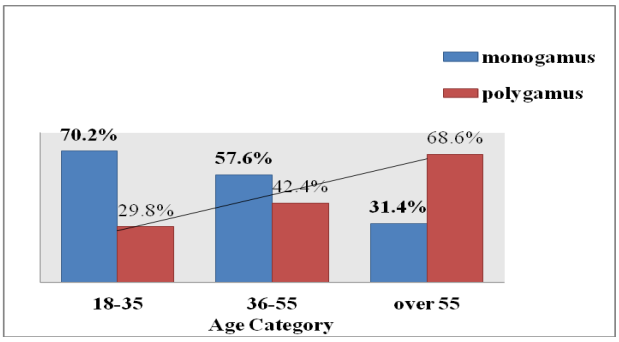

Figure 4.6: Age vs. Marriage type relationships among seasonal and permanent settlers in the Afro-alpine. (Source: Author's Research survey, 2018)

4.1.4.3.2 Educational status

The educational status of the respondents varies from illiterate to diploma and first degree level. All in all majority of respondents in the study area are dropouts from grade one to grade six across all age categories (Figure4.7). The difference is very significant(t=25.05 df=320 p< 0.05=0.01)

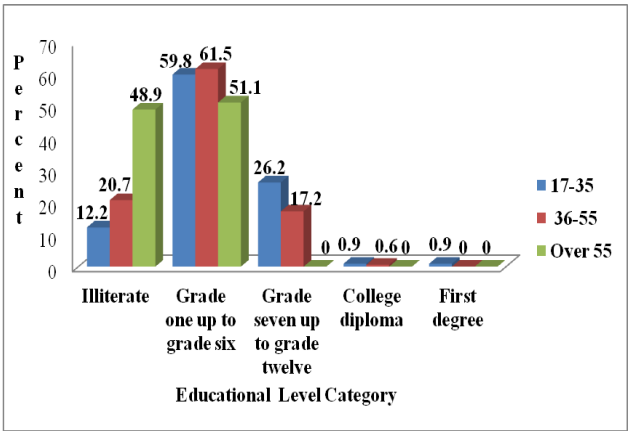

Figure 4. 7**:** Age vs. Educational level of respondents (Source: Author's Research survey, 2018

4.2 Discussion

4.2.1 Afro-alpine ecosystem and socio-economic conditions

4.2.1.1 Permanent and seasonal settlements

Considering initial construction of huts as one of indicators of trend of settlement and seasonal movements, this study revealed that the trend of construction went on increasing through past years, the highest construction being after 1991, the highest construction of first huts being in the last twenty seven years. Comparing only the most recent two regimes, EPRDF and Derg, the increase in permanent settlers in the last twenty-seven years is more than two fold of the Derg time for somehow equal period. This confirms the increment of permanent and seasonal settlers during this period. This finding agrees with the statement that many people returned to the Park following the fall of the Derg in 1991 and the disintegration of controls, although the eviction of some communities was attempted again in 1999 (Flintan, 2000; Malcolm & Evangelista, 2005 in Worku et al., 2017). In Ethiopia during the Derg regime (1974-1991) any settlements in protected areas were forcefully removed and so there were few if any people living in the BMNP'' (Teshome et al., 2011).This was also so in other protected areas like ANP where herders were evicted forcefully. Therefore, this situation can also be taken as indicator for the influence of governance in natural resource conservation in relation to the two regimes and the effect of non-participatory management during the Derg regime at the same time. This agrees with Demeke et al. (2015) who stated that before the establishment of BMNP, human population density and its impacts on the biodiversity was not that much significant in the AAE and in the area. This might be attributed to minimum human and accompanied livestock population and non conducive weather condition and roads in the Afro-alpine during that time.

4.2.1.2. Trend of Human and Livestock influx in the Afro-alpine ecosystem

Majority of permanently and seasonally settled respondents in the Afro-alpine believe that the human and livestock influx has increased and still increasing. The major reasons given were increase in family size and shortage of grazing land outside the AAE. According to BMNP GMP (2017) settlement and the unsustainable uses of natural resources has increased annually to date and are impacting the viability of endangered species as well as the provision of ecosystem services that are critical for humans. As of 2017, more than 965 households have been living permanently in BMNP along with some 750,000 head of livestock in the Afro-alpine area. Ineffective management of the park since 1991, the residents have expanded their agricultural land, and practiced unregulated seasonal livestock grazing and forest coffee management - more or less unabated and as they please (Dereje et al.,2011). This explicitly indicates the impact of human activities that posed negative effects on the Afro-alpine ecosystem.

Human activity can affect wildlife population in the area in three ways. First direct alteration of natural habitats (Zelalem et al., 2012); and changes in soil compaction in turn can result in vegetation changes (Keesing, 1998; Mwendera et al.1997; Hoffmann et al., 2003; in Teshome et al., 2011). Livestock population negatively affect the most flagship wild animals like rodents by increasing their predation risk (through removing vegetation cover), by reducing the soil suitability for maintaining burrow systems (through trampling) or, less likely, by competing for food resources (Vial, 2010).

Livestock grazing in the area was the major problem encountered affecting the rodent population (Addishiwot et al., 2016). Livestock grazing has profound impacts on the Afro-alpine ecosystem from consuming vegetation to physically altering the soil (Addishiwot et al., 2016). Grazing by livestock can also modify the micro-topography of an area (Nash et al., 2000, in Vial et al., 2011) thereby affecting water redistribution (for example through a

reduction in the infiltrability of the soil or an increase in surface run-off) or the establishment of plants. Such processes have been observed on other heavily grazed Ethiopian rangelands (Taddese et al., 2002; Tefera et al., 2007 in Vial et al., 2011), and may represent another threat to the endemic fossorial rodent populations in Bale.

4.2.1.3. Domestic dogs and the Afro-alpine ecosystem

The results depict that the permanent and seasonal settlers own dogs more than those respondents who are not using the Afro-alpine completely. The reason for owning dogs are mainly to guard their livestock against predators like hyenas and hence the number of dogs in the Afro-alpine has drastically increased with increase in human settlements and livestock number. In any case, this posed a great danger on the survival of the endemic Ethiopian wolf because domestic dogs are carriers of the prevalent diseases that cause mass death of the wolves. "The endangered Ethiopian wolves (*Canis simensis*) are restricted to the Afro-alpine areas of Ethiopia and live in small populations. Together with habitat loss, diseases transmitted by domestic dogs pose the major threat to their survival (CludioSillero-Zubiri et al., 2015). According to Perry et al. (2018) “Dogs used the same areas as wolves, foraged throughout wolf habitat, and aggressively interacted with wolves in their territories. Wolves were actively displaced from foraging grounds by dogs, with dogs chasing wolves both while foraging alone or when moving with livestock.” Ethiopian wolves are extremely territorial and living in groups called packs when any dog/s or wolf/wolves comes to their territory they fight the incoming group. Studies of scent-marking behavior and inter pack aggression in Ethiopian wolf packs provided detailed evidence of territoriality (Sillero-Zubiri & Macdonald, 1998).

4.2.2 Ecological changes in the Afro-alpine ecosystem

4.2.2.1 Land use/land cover change of the Afro-alpine ecosystem

The research revealed that there have been progressive land use/land cover changes since 1973 in the area. The land cover of the Afro-alpine was not that much disturbed and degraded owing to low human population density during that period. This agrees with Demeke et al.(2015) who stated that before the establishment of BMNP, human population density and its impacts on the biodiversity of the area was not that much significant. The main indicator of human impact in the Afro-alpine and sub-Afro-alpine is vegetation cover change in Erica species which commonly used for construction, fencing and fuel wood for local community. Through years from 1973 to 2018, the highest reduction of the Erica vegetation occurred in the last twenty seven years (in EPRDF regime) (Table 4.7 and Figure 4.2). This indicates how severe the degradation was in recent years which have excellent implications on increase in permanent and temporary settlements in the Afro-alpine owing to poor law enforcement and ineffective park management in this period, though there was also decrease during the Derg. This is in confirmative with Worku et al. (2017) who stated ‘‘During the Derg state authority over the Park was at its strongest resulting in the forced removal of settlements and the effective colonization of the mountain landscape.”). The extent of bare land also increased by tenfold from 1991 to 2018. Cultivated land was totally a phenomenon of the last twenty seven years which directly indicates recent escalating human encroachments. These are ample evidences that show recent drastic social changes in one hand and ecological changes caused by social changes on the other hand in the Afro-alpine along with impacts of governance and policy on conservation. The Derg regime was following strict prohibitions of humans and livestock in protected areas, whereas the EPRDF is very reluctant on this matter. According to Worku et al.(2017), over the next decade and a half (i.e. 1991 to 2005) management of the Park has lacked consistency though there have been several further attempts to evict villages, though not

necessarily well-enforced resulting in a return of many villagers once the controls have weakened. In Ethiopia during the Derg regime (1974-1991) any settlements in protected areas were forcefully removed and so there were few if any people living in the BMNP (Teshome et al., 2011).

Importantly, overgrazing in Afro-alpine ecosystem enhances soil erosion (Kirkpatrick et al., 2002). This in turn has impact on the Ethiopian wolf, because rodents are the main feeds of it. A study in Netherlands' De Hoge Veluwe national park (Smit et al., 2001) stated that large herbivores can have significant effects on vegetation dynamics not only via direct plant consumption but also through indirect effects by reducing the habitat quality of small rodent habitats. Therefore, all this indicates the ecological changes that had occurred through years caused by humans badly affecting the survival of wildlife in the Afro-alpine ecosystem.

4.2.2.2 Abundances of wildlife in the Afro-alpine ecosystem

4.2.2.2.1 Population trend of Ethiopian wolf and Giant mole rat

Though there are other wild animals in the Afro-alpine, Ethiopian wolf and its favorite food Giant mole rat (both endemic to Ethiopia) are typically common wild animals that can represent the Afro-alpine ecosystem. They can be also taken as indicators of changes. Accordingly, from the results above (Table 4.7) majority of the respondents witnessed that both have undergone tremendous decrease in population through years. Thus, according to the respondents who are permanent and seasonal settlers in the AAE, increase in settlement accompanied by increase in grazing pressure are the main reasons for the decline of the Ethiopian wolf; of course these may include space competition that prohibits free movement for feeding and reproduction of Ethiopian wolves and their main food sources (rodents). Disease was mentioned as the second factor for the decline while it can be considered that these three anthropogenic reasons are interlinked with each other. The increase in settlement or seasonal movement is positively correlated with increase of human and livestock influx (Table

4.2) which is also interlinked with increase in number of dogs (Table 4.3). Transmission of Rabies and CDV is facilitated by domestic dogs as they are main carriers of these diseases. These diseases are known to be the main causes of death and decrease of wolf population. EWCP (2017) report, states that the bottom line is that the rapidly increasing human and dog populations in Bale over the past decades have made the task of eradicating rabies through dog vaccinations alone impossible. As human settlement increases due to both internal population growth in the AAE and external human influx, the habitat gets reduced, fragmented and degraded at the same time. This has great negative impact both on the reproduction of wolves and their main food (giant mole rats) and other rodents. This also goes with the study of the International Union for Conservation of Nature and Natural resources (WWF, 2017) which states that around 85% of threatened mammals are at risk due to habitat loss with about 2,000 mammals around the globe are affected by it. These results confirm the general hypothesis that large herbivores reduce the habitat quality of small rodents and thereby cause a decrease in small rodent density (Geier and Best, 1980; Putman, 1986; Keesing, 1998 in Smit et. al., 2001). Habitat quality also decreases due to trampling and overgrazing because of compaction which has a direct effect on soil structure which is very important for the life of rodents which serve as their home and food depot.

4.2.2.3. Erica Fire incidences

Majority of the respondents witnessed that there had been recurrent fire incidences in the Erica direct contact with the Afro-alpine ecosystem as most of respondents mentioned the reason for the fire was to encourage sprouting of new leaves for livestock because seasonal movements are not confined to the Afro-alpine part of the park, but also areas bordering and not bordering it in the national park. This result also agrees with that of Vial (2010) indicating farmers set fires to improve forage quality among other reasons and the fire burns very large area of the forest and the Afro-alpine. Fire has many adverse impacts on ecology of an area. Death and

migration of the mammals and birds; more impact on bird population as they inhabit more the Erica shrub and hence their eggs and chicken are more vulnerable, increasing runoff and a decrease in water percolation that will have a severe impact on the rivers (Anteneh et al., 2013). Fire also deprives wild animals like hares; hyraxes and leopard off their habitat in the Afro-alpine, which the former two serve as wet season food source for the Ethiopian wolf (see result section).

4.2.2.4 Status of Afro-alpine lakes and wetlands

Most respondents acknowledged changes in the Afro-alpine lakes; both in depth and surface area. The main reason given for this by the respondents is shortage of rainfall. According to key informants the duration of rainfall decreased by half in recent years, formerly it was raining for around eight months but now only for around four months per year. The rainfall duration of the past, described by KIs and FGDs also agrees with the description of Hillman (1986) who stated "The rainfall of the park area was characterized as one eight months rainy season, followed by a four months dry season, with the rainfall well distributed throughout the wet season" . But regarding the wetlands these respondents believe, in addition to shortage of rainfall, that wetlands have decreased a lot and many dried up due to increase of livestock grazing on them throughout the year. The wetlands are the main grazing grounds during the dry season (ground observation and KIIs). This also agrees with Getnet (2017) that stated wet lands are often a last destination for pastoralists during the dry season in most parts of Ethiopia.

4.2.3. Drivers of change

4.2.3.1 Decline of farm and grazing land in size and productivity

From the results on livelihood, it was also evident that about 97% of the respondents depend on farming and cattle rearing as main livelihood (Annex 28).The land size/HH (from questionnaire survey) and productivity of land (from KII & FGD, for both farm and private grazing land) for which the livelihoods of communities depend on in sample villages have been getting lower and

being shrunk from time to time posing great danger on the Afro-alpine ecosystem than any other natural resources as communities consider the Afro-alpine as ideal and open access resource for cattle rearing. They gave reasons like degradation of the soil in Geremaba dima and Koma witincho villages along with continuous farming without fallowing due to shortage of land. This research also showed that the average family sizes for Rira, Geremba dima and Koma witicho are 9.1, 9.9 and 9.3 respectively that ultimately results in human population increase (Annex 29). This agrees with the statement the increase in livestock using the park is a direct result of human population increase, poor land planning outside the park (BMNP GMP, 2017). The researcher was able to observe no soil conservation practices in Geremaba dima and Koma witincho villages, despite the need owing to the hilly nature of the land. This might be related with ownership insecurities emanated from the land tenure systems of successive governments as Kassa (2003) stated ‘‘as state ownership of land and the latent fear of future redistribution have created a sense of uncertainty, which in turn is translated in reluctance to invest in long-term land improvement measures’’. Afar National Regional State Rural Land Use and Administration Policy (2008) also mentions lack of clear laws of rights to transfer, rent and use prohibited holders of land to invest their resources and labor in perennial crops and engage in soil and water conservation activities.. Israel Petros (2016) Also described Local people are highly dependent on agriculture and domestication of livestock for their livelihood as a threat for conservation of BMNP biological resources.

There is shortage of grazing land in sample villages, especially during the rainy season where their private land is completely occupied by crops. Observations in Arsi Mountains National Park also showed that the high number of livestock during the wet season is due to the decrease in available grazing land in the lower elevations that are instead covered with crops (Zerihun Girma, Chuyong G. and Yosef Mamo,2018).

4.2.3.2 Land use /land cover change of sample villages

The land use/land cover change of the sample villages revealed that the forest cover has shown an increase from 1973-1991, though it is minimal, and a decrease from 1991 to 2018 (Figure 4.17 and Table 4.29). The increase during the former period might be either due to the greening program that had been carried out during the period and/or the strict natural resource conservation policy that was followed by the Derg regime. The decrease in the last twenty seven years most probably might be due to lack of attention to natural resources,

Poor governance of natural resources, reluctance in natural resource developments, population increase and its related multiple negative impacts during this period. Erica showed continuous decrease from 1973 to 2018. The LULCC further showed a slight decrease of bush/shrub from 1973 to 1991 and high increase from 1991 and 2018. The highest expansion of bush/shrub lands during those years indicates succession of forest land by bush/shrub lands after degradation/deforestation of forests due to human pressure. The minimum decline from 1973 to 1991 can be attributed to minimum level of tree cutting.

The finding of this research also shows the size and proportion of grass lands decreased tremendously through the last forty five years, again the highest change occurring after 1991. The reasons most probably may be need of additional farmlands. The reverse happened in the case of cultivated lands which increased in size during the same period, again the highest increment happening after 1991. The expansion of cultivated lands at the cost of grass lands and forest lands throughout the periods has direct implication of the population growth in need of mainly additional farmlands besides other needs like fire wood, construction wood and so on. Destruction of natural forest is still visible in sample villages. For instance the communities in Geremba dima and Koma witincho in sample villages outside the AAE mainly use Juniperus procera (natural and indigenous) for fuel wood and construction from the constantly shrinking

little remnant communal natural forests though in the later case those who are at the periphery of the park also use Erica, hypericum and other naturally grown tree species too. No or little man made plantations, like eucalyptus, are there in all sample villages (ground observation). Therefore, almost all families are wholly dependent on natural forests and the major woody species used as fuel wood in sample villages; especially in Geremab dima & Koma witincho are Juniperus procera (29.9%) and Erica Arborea (28%) (Annex7.25). The case of Rira is completely exceptional in many regards, because it is entirely located at the heart of the National Park. It is situated in the Harenna forest where Hagenia, hypericum, Erica and other natural tree species are there. Therefore, most of the degradations have occurred after 1991, which is mostly part of the EPRDF regime.

All of the socio ecological changes that had occurred in the villages have direct implication on the Afro-alpine ecosystem. It is quite easy to see that the population growth is the pushing factor that intensified the need of cultivation land, the degradation of forests and grass lands in the villages (from LULCC of sample villages) which have inculcated need of alternative livelihood resources and has posed burden on the nearby resources, the BMNP in general and the Afro-alpine in particular

4.2.3.3 Social conditions in the Afro-alpine and the villages

4.2.3.3.1 Marriage type

The results on type of marriage also showed that those respondents who settle permanently or seasonally in the Afro-alpine ecosystem are more polygamous than those that have no link with it. This might be seen from two angles; either the open access to the Afro-alpine (low level of law enforcement) encouraged polygamy or polygamy forced access to it to support extended family size. To make it more clear, in some cases people may get married with more than a wife to use ‘open resource regimes’ like that of the Afro-alpine ecosystem in our case or where

polygamy is naturally encouraged by societies like in Bale area the family size may compel them to use such areas to support the extended family size or both. This indicates that there is a positive relation between polygamy and utilization of the Afro-alpine. Polygamy has also another consequence in such a way that it invites more settlers to come to the AAE through blood relations from outside the area (as it was made evident by key informants from the park and EWCP) and it has high contribution to extended family size inside and around the Afro-alpine . Further research is important to identify the cause-effect relation between the polygamy & access to the Afro-alpine.

4.2.3.3.2 Educational status

Findings on educational status depict that majority of the respondents 191 (59.5%) out of 321 are dropouts from up to grade six. Altogether 81.3% are illiterates and dropouts from classes up to grade six. This indicates that most of the respondents are not well educated.. Shows the dependency of large community members on natural resources agricultural to make living.. This agrees with Demeke et al. (2017) who asserted that there was low level of formal education in the area due to tradition of pastoralist societies who do not encourage their children to attend schools instead many of them remain caring or shepherding of livestock. Unless the youth are getting educated, they follow the footstep of their predecessors in terms of livelihood, at least.. This further poses a big threat on future of the Afro-alpine ecosystem because they continue to be dependent on the Afro-alpine and develop negative attitude to the conservation. Demeke et al.

(2017) stated that “educated respondents supported protected areas more than those with no formal education; conservation may be quite difficult in the future in areas like BMNP where people are more illiterate. Support for conservation was positively correlated with the level of education of the respondents.”

On the other hand uneducated people have less chance to use family planning. This goes with CSA &ICF (2016) findings which state that with modern contraceptive use among currently married women increases with education from 31% for women with no education to 51% for women with secondary education or higher. According to this source again (CSA &ICF, 2016) teenage childbearing decreases with increasing education. The percentage of teenagers who have begun childbearing rises from 3% among those with more than a secondary education to 12% among those with a primary education and 28% among those with no education.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

There is high degradation of natural resources including farm and grazing lands due to poor land and resource management along with progressive fragmentation and decline in productivity through years with unplanned and unregulated high family size in the sample villages. Consequently, seasonal movements to and permanency in the Afro-alpine have increased in recent years (particularly after 1991). Landless youths in the sample villages are viewing the Afro-alpine as alternative livelihood means. Increasing number of youths born in the Afro-alpine is also main source of increase of population and permanent settlement in the afro- alpine.

As most of new constructions made after 1991, children born there in this period could not get access to schools as there is no school in the Afro-alpine though most of the youth in the sample villages are also illiterates and drop outs from elementary schools. Seasonal and permanents settlers are more polygamous than those which are not using the Afro-alpine.

Seasonal and permanent settlers own more dogs than others who are not using the Afro- alpine that posed danger on the endemic Ethiopian wolf population which has not been increasing markedly through past years; rather it has been fluctuating with sharp decreases with the recurrent occurrence of the prevalent diseases transmitted from dogs.

There is increasing tendency to cattle rearing, increasing share holding of cattle rearing (Particularly goat and sheep) between the permanent settlers in the Afro-alpine and the well off people in surrounding villages and towns mainly owing to escalating market prices, easy access to the Afro-alpine due to poor law enforcement, low labor requirement.

Change in governance and attention to conservation of protected areas from the Derg to EPRDF, with the former being stricter with strong law enforcement and attention to

conservation than the latter with very reluctant approach to conservation and weak law enforcement, also impacted the Afro-alpine.

From the land use land cover changes in the sample villages, huge increase in cultivation land and major decrease in grass lands and the forest are implications of high increase in population.

Owing to these social changes there are new phenomena of recent emerging farming practices (particularly after 1991), decline of vegetation (especially the Erica), frequent fire incidences caused by pastoralists and overgrazing with its adverse effects, decline of water bodies and wet lands (swamp grass) and increase of bare lands on the Afro- alpine ecosystem.

By and large, the social-ecological changes that occurred in the Afro-alpine are mainly mirror reflections of social-ecological changes in the sample villages. Changes in market prices of livestock and poor governance/ineffective park management also contributed to this end.

5.2 Recommendations

Based on the findings from land use/land cover changes, questionnaire survey, key informant interviews, observations and secondary data the following recommendations are forwarded:

- It is important to clearly identify those people who have land and property outside the park carefully and draw a road map to support and establish them on strong livelihood basis outside the Afro-alpine (resettlement), because it is evident from this research that the livelihood and family size of most households is not balanced. This can be achieved by introducing quality livestock breeds, improving forage quality, implement soil and water conservation practices in villages outside, and improved crops to enhance the agricultural sector as the productivity of farm and pasturelands is very poor and the livestock are of local origin with poor quality.

- Working on awareness creation on importance of education and improve access to schools in the surrounding villages should be done in collaboration with the education sector as most of the respondents are dropouts at elementary level. Strategic youth employment opportunities should be given due emphasis and thought over critically.

- Awareness creation on family planning should be one part of the conservation as high family size is prevalent. This should be done in collaboration with concerned health institutions and other stakeholders at village and district level.

- Special attention should be given to this ecosystem. Strong law enforcement and patrolling is fundamental as the Afro-alpine ecosystem is very fragile in nature and as it is a home for the endangered endemic Ethiopian wolf, Giant mole rats and other avian species which are highly important in tourism market in addition to serving as source of water for downstream people. The ever increasing new constructions and settlements should be immediately halted until long lasting solutions can be implemented regarding the already established settlements because the settlements are cause of most dangers like decrease in Erica & other vegetation cover.

- To accomplish all the above duties, integration among agriculture, education, health, administration and wildlife sectors at all levels along with the local community in planning, implementing, monitoring and evaluation is imperative. It is also crucial to create awareness among the community about the ecosystem hand in hand with improving their livelihood basis through creating benefit sharing and income generating schemes, otherwise the degradation of the Afro-alpine ecosystem is very disastrous for the surrounding community and the ecosystem in question in many respects.

- The issue of domestic dogs in the Afro–alpine should be given due attention to completely deter dog presence in the Afro-alpine , as they are carriers of fatal wolf diseases and vaccinating new dogs yearly during seasonal movements may be costly and not be feasible in the nation's capacity and not advisable in wildlife conservation.

- Habitat protection should be given highest priority than anything else. Otherwise, it is like treating symptoms rather than the main disease. To do so, a systematic resettlement of permanent settlers outside or regulated co-existence should be thought over in discussion with all stakeholders. Search for solutions and planning should also include the local community, districts and other key stakeholders for long lasting solutions.

- New policies should be designed to entertain new socio-ecological changes to answer community needs in such a way that can benefit the local community in one or another way so that they feel sense of ownership to the wildlife and the ecosystem. Policies on land use and land tenure at national level are also important.

- EWCA and the park management should be long sighted to see the ongoing socio-ecological changes mentioned above with their fatal effect on future of the Afro-alpine and the ineffective park management that could not accommodate the subsequent social- ecological changes.

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Annexes

Annex 1. Individual questionnaire

This questionnaire is prepared to collect data on socio-ecological dynamics of the Afro-alpine ecosystem of Bale Mountains National Park. All the information gathered in this questionnaire are solely meant for academic purpose and are fully confidential. I thank you in advance for your voluntariness to be one of the respondents.

General

Interviewer's name…… Date of interview……

Respondent's code number……. District ……

Village……..

Part1. Basic information

A. Basic information of the respondent

Age (write age)						
Gender(tick)						
Male				Female		
Marital status(tick)						
Married		Single		Widowed		Divorced
Type of Marriage(tick)						
one	two	Three	four	five	six	above six
Year of Marriage (write in Ethiopian calendar)						
first	second	third	fourth	Fifth	Six	above six
Livelihood(write the type)						
main				additional		
Level of education(write grade)						

B. House holds information of the respondent

Items		Gender		Total household size (excluding the respondent)
		Male	**Female**	
Age category	0-15			
	16-35			
	36-60			
	Over 60			
Educational status	Illiterate			
	Kindergarten-grade 6			
	grade 7-10			
	Preparatory			
	University/ college level			
	Graduate			
Occupational status				
Formal	Employed (other than farming and cattle rearing)			
	Agriculture (farming and cattle rearing			
	Farming only			
	Cattle rearing only			
Informal	Day laborer			
	Carpenter/ Mansion			

Part 2.Socio economic information

A. Permanent residence locality

1. Land holding size (hectare)……

2. Type of domestic animals (fill in number)

cattle…… sheep and goats …… donkeys ……horse…….
mules…….. Dogs…… chickens…….
beehives……..

3. Respondent's main livelihood

A. Agriculture B. cattle rearing C. farming D. employed

4. Additional livelihoods for income generation

A. honey collection B. poultry C. fuel wood selling D. all E. no other livelihood

5. If the answer for question number 5 is C, from where do you get the fuel wood?

A. natural forest B. own plot C. market

6. If the answer for question number 5 is A, Mention the locality……

7. Where do you get fire wood for household consumption in your permanent locality outside the Afro-alpine ? (note: locally Afro-alpine is referred as Sanetti, Kotera/ Chelelaka)

A. from natural forest B. from own land C. purchase D. other, specify……

8. Which tree/shrub species mainly do you use for fire wood in your permanent locality outside the Afro-alpine ?

A. Hagenia (Kosso) B. Erica (Asta) C. Hypericum species (Amja) D.all E. other, Specify……

9. Do you go to the Afro-alpine ?

A. Yes B. No

10. If your answer to question number 1 is yes, what is the principal reason of your going to the Afro-alpine area?

A. Search of land for agriculture B. search of grass for livestock C. search of land for settlement D. all E. other reasons, State the reason…….
…….……
……

11.If your answer for question number 2 is B do you take all of your livestock with you?

A. yes B. no

12.If your answer in question number 2 is D or any combination of the listed reasons rank them according to their importance.

1st…….. 2nd …….3rd ……

13. Do you go along with your all family?

A. yes B. no

14. How many hours does it take from your permanent village to the Afro-alpine area you go?

A. 1 B. 2 C. 3 D. 4 E. 5 F.6 G. more than 6, Specify in hours…….

15. When did you start to go to the Afro-alpine for the first time?

A. During the derg regime (before 1983 E.C.)
B. In 1983 E.C.
C. between1983 E.C.- 1997 E.C.
D. In 1997 E.C.
E. After 1997 E.C.
F. If not mentioned here, state when it was……

16. Which month of the year you used to start moving to the Afro-alpine area when you first move to it?

A. May B. June C. July D. August E. September F. if other, state……..

17. For how long you used to stay when you first went to Afro-alpine ?

A. one month B. two months C. Three months D. Four months E. Year round

F.If not mentioned, how many months ……

18. What was the reason you preferred to stay at the Afro-alpine (kotera, chelelaka/saneeti during the mentioned months of the year? Because:

A. Land occupied by crops in our permanent village B. no grass in our permanent Village C. better grass D. better for living E. No reason

19. Which month of the year do you start to move to the Afro-alpine these days (recent years)?

A. May B. June C. July D. August E. September F. if other, state……..

20. For how long do you stay at the Afro-alpine these days (recent years)?

A. One month B. two months C. Three months D. Four months E. Year round

F.If not mentioned, how many months ……

21. If your answer for question number 20 is different from that of question 17 , what do you think is the reason?

A. shift of start of rain B. if others, State ……

22. If the duration of stay in the Afro-alpine increased these days (recent years) than previously, what do you think is the reason for this?

A. need of additional income due to increase of house hold size

B. owning additional livestock size per house hold

C. improvement of weather condition at the Afro-alpine .

D. cultivation of previous grazing lands in our village to meet additional needs

E. All

F. if a combination of any, write the letters from the choice…….

23. If your answer for question 14 is B, What do you think is the reason?

A. Increase of price of livestock in the market B. Increasing suitability of Afro-alpine for livestock rearing C. cultural change in owning more livestock D. Change of lifestyle from farming to pastoralism E. open access of land F. If any other reason or combination of the listed reasons, please mention them.

……

……

…….

24. What type of fuel do you use for household consumption when you are at the Afro-alpine ?

A. fire wood B. dung C. crop residue D. all E. A and B F. please mention, if there is another combination from the above listed……..

25. If the answer for question number 16 is A, where do you collect it from?

A. from natural forest B. from own land at Senate C. from market D. from our permanent village E. another source, specify the source and the locality…….……

26. If your answer for question number 16 is A which tree/shrub species mainly use for fire wood when you are at Sanetti?

A. Hagenia (Kosso) B. Erica (Asta) C.Hypericum (Amja) D. all E. other, state the species…….

……..……

……

…….

27. What is the source of water for household human consumption?

A. From rivers at Senate B. outside Senate area C. other sources, mention by locality and

Type of source……..

28. What is the source of water for your livestock?

A. From rivers at Senate B. outside Senate area C. other sources, mention by locality and type of source……..

29. Do you have hut/huts at Afro-alpine?

A. Yes B. No

30. What is the status of the hut/huts?

A. Temporary (for a single year or movable) B .permanent (used for more than one year)

31. How many huts do you have there?

A. 1 B. 2 C.3 D.4 E. if more than 4, state the number……

32. When did you first construct a hut?

A. from 2005- 2018

B. from1991-2004

C. from1974-1990

D. before 1974

33. What was your reason for the construction?

A. increase of duration of stay B. ensure land ownership C. both D. other, specify the reasons……

34. What are the materials used?

A. mud, wood and grass B. wood and grass C. other, Specify the materials……...

…….……

35. Where is the source of the wood?

A. natural forest B. own land in our permanent village C. Market, name the market……

36. What is the species of the tree used for construction?

A. Hagenia B. Erica C. other, state the species……

37. How about the source of thatching grass?

A. Natural forest B. own land in our permanent village C. Market, state name of the Market……..

38. How do you compare the number of people coming to senate through past years during the last 30 years or from the time of your first arrival?

A. Increasing B. deceasing c. same D. I don't have any idea.

39. If increasing, what do you think is the reason?

A. Shortage of grazing land B. Increase of livestock number per household C. increase of household number D. open access of land for grazing

40. Are there people who came to settle in/around around BMNP through government strategy?

A. yes B. no C. no idea

41. If yes, when?

A. During Derg regime B. between 1983 E.C. to 1997 national election C. after the 1997 E.C. national election D. if not mentioned in the above list, mention the year…….

42. Can you mention where they made to settle (name of village/ locality)?

.....

43. Do they come to the Afro-alpine?

A. Yes B. no C. no idea

44. Do you remember years when fire destroyed the Erica forest?

A. Yes B. No

List the years……..

45. How is the Recurrence of fire?

A. Increasing B. Decreasing C.No change D. No idea

46. What do you think are the causes?

A. Deliberate clearing for farming
B. Deliberate clearing to facilitate growth of grass
C. Accidental fire during honey collection
D. Natural fire
E. Other, specify……..

47. Which wild mammal was common and abundant in number in the Afro-alpine when you first come or in the last 30 years?

A. Ethiopian wolf B. Giant Mole rat C. Both D. other, Specify……

48. If your answer for question 46 is A, How do you see the change in population?

A. increasing B. decreasing C. same D. no idea

49. If your answer for question 46 is B, How do you see the change in population?

A. increasing B. decreasing C. same D. no idea

50. I f your answer for question number 47and 48 is B, What do you think are the reasons?

A. Increased grazing B. Increased settlement C. Disease D. all E. A and B

F. If any other reason or combination from the above listed, mention …….

……

51. Is there any grass species you know that disappeared from this area since your first arrival to the Afro-alpine ?

A. Yes B. no C. no idea

52. If yes, can you mention the name/s in your local language?.....

53. If your answer for question number 51 is yes, What do you think is the reason?.....

A. livestock dung B. through humans C. flood D. No idea

E. If any other reason out of the list or combination of them, please mention them

……

54. Is there any new grass, herb or shrub that appeared after your first arrival?

A. Yes B. no C. no idea

55. If your answer for question number 53 is yes, Can you mention the name/s of grass, shrub or herb species in your local language?.....

56. If your answer for question number 9 is yes, what do you think is the reason?.....

A. human settlement & grazing pressure B. weather change C. no idea

E. If any other reason out of the list or combination of them, please mention them

……..

57. Are there disappeared bird species you witnessed?

A. yes B. no C. no idea

58. If your answer for question number 56 is yes, can you mention the name/s of bird species in your local language?

.....

59. If your answer for question number 56 is yes, what do you think is the reason?.....

A. drying up of wetlands due to grazing pressure B. human pressure increase

C. weather change D. no idea E. If any other reason out of the list or combination of them, please mention the ……

60. Do you see any change in the Afro-alpine lakes?

A. yes B. no C. no idea

61. If your answer for question number 59 is yes, what are the changes you witnessed through past years ?

A. Decrease in size (area) B. decrease in depth C. decrease in quality D. all

E.A and B F. mention any combination from the list, any……

THANK YOU.

Annex 2. Key Informant Interview guiding questions

1. When did you first know the Afro-alpine ecosystem of BMNP?
2. What changes do you observe through years in respect to social, cultural, economic and ecological aspects in the area?
   In relation to:
   - human influx & settlement,
   - livestock influx in number and type
   - change of human culture in relation to wildlife and their habitat particularly in the AAE,
   - change in population status of Ethiopian wolf, Giant mole rat and bird diversity,
   - Change in quantity &quality of grass species, wetlands & lakes,
   - Occurrence of wildlife disease & fire along with their causes and effects etc.
   - Land use - land cover change
3. How do you see the duration of stay during seasonal movements of humans with their livestock to AAE and condition of human settlement?
4. Is there any Change through years?
   - During the Derg regime
   - Between 1983- 1997 E.C.
   - After 1997 E.C. – 2000 E.C.
   - During the last 10 years
5. Major social changes
   - During the Derg regime
   - Between 1983- 1997 E.C.
   - After 1997 E.C. – 2000 E.C.
   - During the last 10 years
6. Major ecological changes?
   - During the Derg regime
   - Between 1983- 1997 E.C.
   - After 1997 E.C. – 2000 E.C.
   - During the last 10 years
7. Can you estimate total number of domestic animal at a peak seasonal movement at Senate at a time these days?
   - Cattle…….
   - Sheep…….
   - Goat……...
   - Donkey……..
   - Mule……..
   - Horse…….
   - Dog……

8. General comments

Annex 3. Focus Group Discussion guiding questions

1. Can you compare the change in fauna and flora of the Afro-alpine ecosystem through years (during Derg, between 1983- 1997 E.C., 1997- now)

- Trend of population number: decrease /increase – main causes and effects
  - Ethiopian wolf
  - Giant mole rat
  - Bird species
  - Grass species (names)
- Trend of population diversity: decrease, increase, remain same or extinction- main causes and effects
  - Bird species
  - Grass species
- Condition of invasive species – causes and effects
  - Grass species
  - Bush
- Physical environment- level of degradation – causes and effects
  - Afro-alpine grass land
  - Wetlands
  - Lakes
  - Erica forest

2. Occurrence of fire and causes and effects in AAE including trends through years (if possible starting from Hailesselassie regime to date)
3. Occurrence of wildlife diseases and causes and effects in AAE including trends through years
   (If possible starting from Hailesselassie regime to date)
4. Can you compare the social changes in regard to human-livestock seasonal movements and settlement in the Afro-alpine ecosystem through years (during Derg, between 1983-1997 E.C., 1997- 2000 E. C.,2001- now) – causes and effects

- Trend of …., Causes (economic, cultural, market, settlement etc) and effect on
  - Livestock population
  - Human population
  - Settlement
- Changes:- causes and effects
  - In start of seasonal movements
  - Duration of stay

5. Trend on Average farm land holding size, Average household size, average livestock size, farm and grazing land productivity (cattle, shoats, sheep and goat), condition of grazing land etc.
6. Trend of life style in relation to farming, livestock etc.
7. Any new trend in connection with the Afro-alpine.

8. General comments

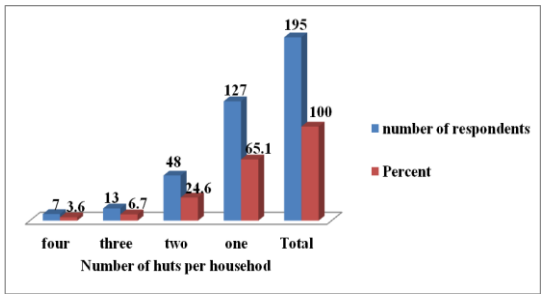
Annex 4.Field observation checklist

1. Condition of Vegetation and soil
    - Erica, Artemesia, wetland (swamp) grass degradation
    - Soil degradation
    - Utilization of resources (grasses, wetlands, Erica and others)
2. Condition of settlements & related issues
    - Village composition of permanent settlements
    - Construction materials
    - Fencing
    - fuelwood
3. Condition of livestock
    - Goats and sheep
    - Cattle
    - Horses, donkey & mule
    - Dogs and diseases
4. Condition of horas and related issues
5. Human-wildlife conflicts

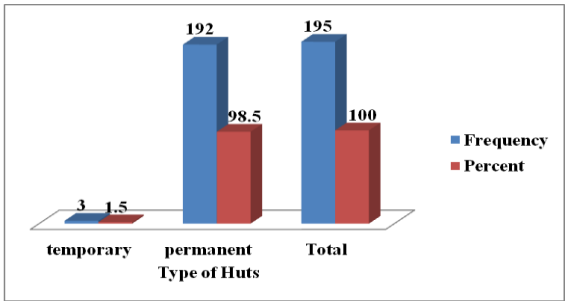
Annex 5. Ownership of Huts at the Afro-alpine

Own/not	frequency	Percent
Own	195	92.9
Not own	15	7.1
Total	210	100.0

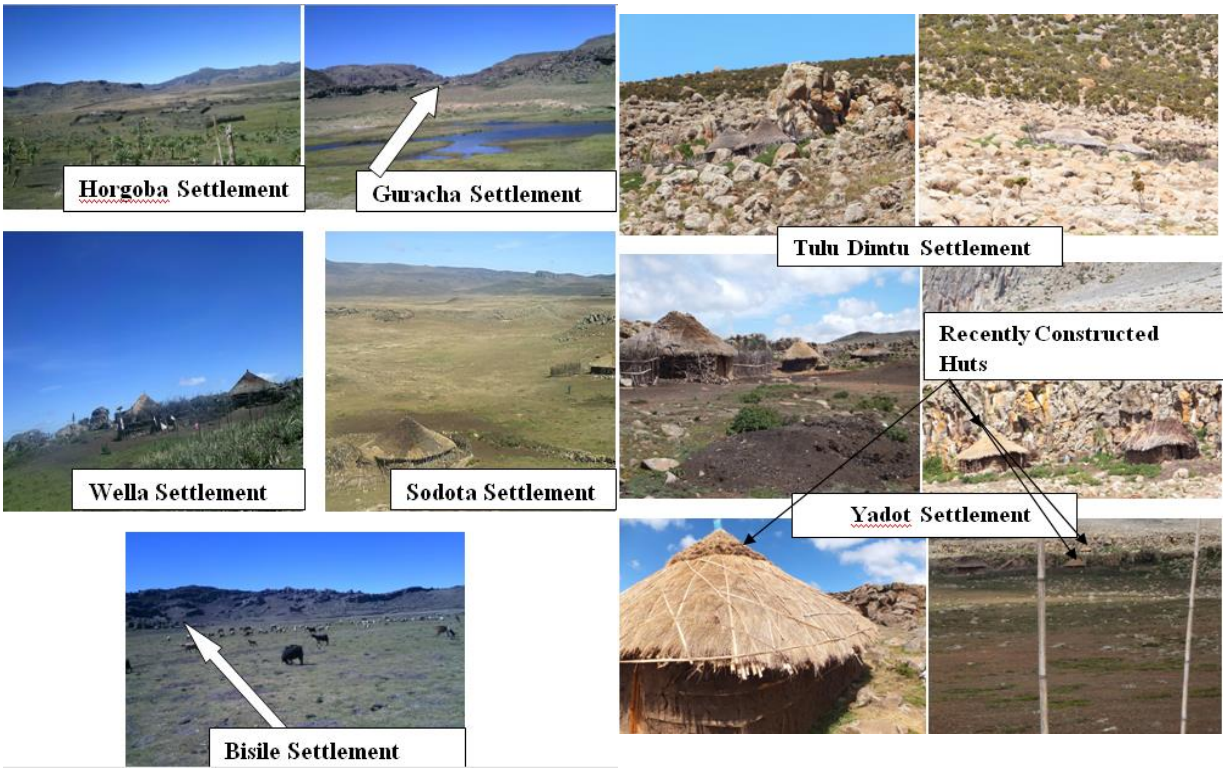
Annex 6. Number of huts owned per household



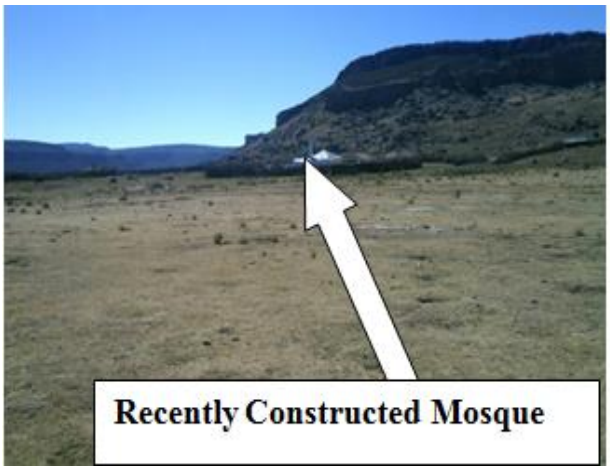
Annex 7.Type of huts in the Afro-alpine



Annex 8.Few of settlement villages in Web Valley (Left) and Sanetti Plateau (Right)



Annex 9. Recently built mosque in Horgoba village and already established graveyard in Sodota Village (Web Valley)



Annex 10. Construction materials for huts

Construction materials	Frequency	Percent
Dung, wood & grass	192	98.5
Wood & grass	3	1.5
Total	195	100.0

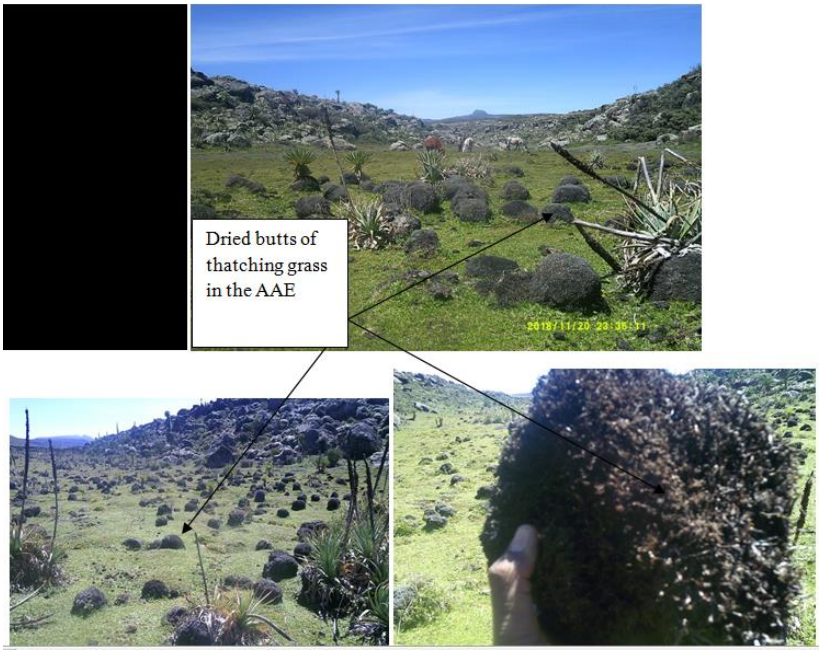
Annex 11. Type of wood species used for construction of huts in the Afro-alpine

species	Number of respondents	percent	cummulative
Erica	131	67.2	67.2
Erica & Juniperus	13	6.7	73.9
Erica & Hypercum	13	6.7	80.6
Erica & Arundinaria	2	1.0	81.6
Erica, Juniperus and Hypercum	2	1.0	82.6

Erica, Hypercum and Hagenia	13	6.7	89.3
Erica,Hypercum, Hagenia & Arundinaria	1	0.5	89.8
Juniperus	6	3.1	92.9
Hypericum	4	2.0	94.9
Arundinaria	5	2.6	97.5
Hagenia	1	0.5	98
Hypercum & Arundinaria	4	2.0	100
Total	195	100.0	

Annex 12. Erica and stone fences in Web Valley

Annex.13 Dead stump of thatching grass ("Suquye" in afan Oromo) in Tiliti wetland (Web valley)



Annex 14.Years of Respondents' first hut construction in the Afro-alpine

Years of first hut construction in the AAE	Link with the AAE		Total	Percent	Cumulative percent
	Seasonal settlers	permanent settlers			
Between 2005&2018	36	56	92	47.2	53.3
Between1991&2004	16	19	35	17.9	71.2
Between 1974 &1990	31	22	53	27.2	98.4
Before 1974	6	9	15	7.7	100
Total	89	106	195	100	

Annex 15. Type of fuel at the Afro-alpine

Type of household fuel	Frequency	Percent	Cumulative Percent
wood	165	78.6	78.6
dung	3	1.4	80
both fuel wood & dung	42	20	100
Total	210	100.0	

Annex 16 Artemesia afra species cleared for fuel (left), uprooted old Erica buts laid on rock to dry (middle) and remnant Erica in Wella Village (right) -Web Valley

Annex17. Source of fuel wood at the Afro-alpine

Source	Frequency	Percent
natural forest inside and near the AAE	207	100
purchase	-	-
From own land in permanent village outside	-	-
Other sources	-	-
Total	207	100.0

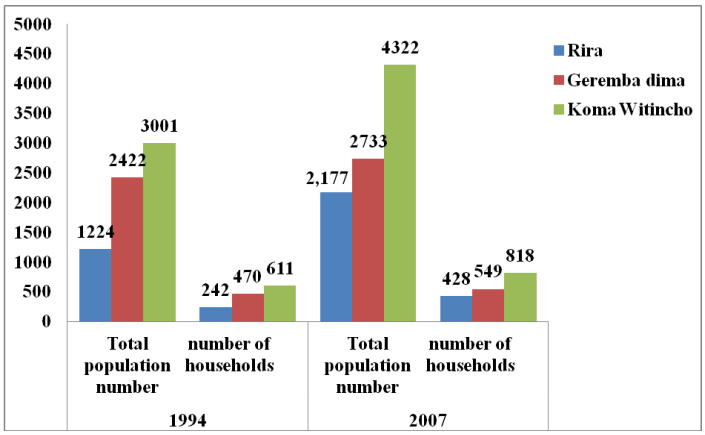
Annex18. Species of fuel wood at the Afro-alpine

Type of wood species	Frequency	Percent	Cumulative Percent
Erica	182	87.9	87.9
Erica Hagenia, &Hypercum	10	4.8	92.7
Erica and Juniperus	1	0.5	93.2
Erica & Hagenia	3	1.4	94.6
Erica & Hypercum	7	3.5	98.1
Juniperus	3	1.4	99.5
Hagenia	1	0.5	100.0
Total	207	100.0	

Annex 19. Reasons for increase in human and livestock influx into the Afro -alpine

Reasons	Frequency	percent	cumulative
Increase in family size	111	59.7	59.7
Shortage of grazing land in permanent localities (villages) outside the Afro-alpine	49	26.3	86
Both shortage of grazing land in our locality & increase in family size	12	6.5	92.5
Increase of livestock number per household	8	4.3	96.8
Open access of Afro-alpine	5	2.7	99.5
Both shortage of grazing land & increase in livestock number /household	1	0.5	100.0
Total	186	100	

Annex 20. Population growth of sample Villages (1994-2007)



Annex 21. List of districts and villages that bring livestock to the Afro-alpine

Some of villages using the Afro-alpine	Source Districts	Type of settlement	Source of information
Geremba dima, Meskel Darkina, Hora Soba, Gojera, Ayda Kara Ari, Tula Kara, Gofin Gira, Meo	Dinsho	Permanent/Temporary	FGDs, KIIs & observation
Hako Kara,Sole Tulu, Gededo, Abamo,Wege Harena,Lencha, Bucha Raya, Koma witinchoArsi,Lita	Adaba	Permanent/Temporary	FGDs, KIIs & observation
Shedem,Fasil angeso, Rira	Goba	Permanent/Temporary	FGDs, KIIs & observation
Not mentioned	Asasa		FGDs, KIIs & observation
Not mentioned	Dollo Mena		FGDs, KIIs & observation
Not mentioned	Meda Welabu		FGDs, KIIs & observation

Annex22. Starting month of seasonal movements to the Afro-alpine during their first arrival and these days.

month of coming to the Afro-alpine before	Frequency	Percent	Cumulative Percent
April	7	6.8	6.8
May	74	71.8	78.6
June	10	9.7	88.3
July	11	10.7	99
August	1	1	100
Total	103	100	
Months of coming to the Afro-alpine these days	**Frequency**	**Percent**	**Cumulative Percent**
April	7	6.8	6.8
May	74	71.8	78.6
June	10	9.7	88.3
July	12	11.7	100
August	-	-	-
Total	103	100	

Annex 23. Duration of stay of pastoralists at the afro alpne during seasonal movements at their first arrival and these days

Duration of stay at first arrival			
Duration in months	Frequency	Percent	Cumulative Percent
One month	2	1.9	1.9
Two months	1	1.0	2.9
Three months	4	3.9	6.8
Four months	28	27.2	34
Five months	19	18.4	52.4
Six months	33	32.0	84.4
Seven months	15	14.6	99.0
Eight months	1	1.0	100.0
Total	103	100	
Duration of stay these days			
Duration in months	Frequency	Percent	Cumulative Percent
one month	2	1.9	1.9
two months	1	1.0	2.9
three months	4	3.9	6.8
four months	28	27.2	34.0
five months	18	17.5	51.5
six months	34	33.0	84.5
seven months	15	14.5	99.0
eight months	1	1.0	100
Total	103	100	

Annex 24. Dogs owned by respondents

Number of dogs	Number of respondents	Percent	Cumulative percent
Five	5	1.6	1.6
Four	19	5.9	7.5
Three	41	12.8	20.3
Two	98	30.5	50.8
One	85	26.5	77.3
None	73	22.7	100
Total	321	100	

Annex 25. Incidence, trend & reasons for fire on the Erica forest in the Afro-alpine

Did you witness fire in the Erica forest	Frequency	Percent
yes	132	62.3
no	80	37.7
Total	212	100
Recurrence of fire	Frequency	Percent
Increasing	106	80
Decreasing	9	7
No change	8	6
No idea	9	7
Total	132	100
Reasons of fire	**Frequency**	**Percent**
Burning for new sprouts	88	66.7
Honey harvesting	23	17.4
Other manmade reasons (cigarettes, careless handling of fire)	16	12.1
To avoid predators	-	-
Both new sprouts & avoid predators	-	-
No idea	5	3.8
Total	132	100

Annex 26. Changes and their type in the Afro-alpine lakes

Are there changes in lakes?	Frequency	Percent	Cumulative percent
yes	197	93.8	
no	5	2.4	
no idea	8	3.8	
Total	210	100.0	
Changes	Frequency	Percent	Cumulative Percent
Change in area	4	2.0	2
Change in depth	-	-	2
Both in area and depth	193	98.0	100
Total	197	100.0	100

Annex 27. Reasons for the changes of lakes in the Afro-alpine

Reasons	Frequency	Percent	Cumulative Percent
Grazing pressure	6	3.1	3.1
Settlement pressure	1	0.5	3.6
Shortage of rain	160	81.2	84.8
All	1	0.5	85.3
Grazing pressure & settlement pressure	25	12.7	98.0
No idea	4	2.0	100
Total	197	100.0	

Annex 28. Comparison of mean family size of monogamous & polygamous households

Marriage type	Number of HHs	Total number of family members	Mean family size
Monogamous	208	1538	7.4
Polygamous	113	1486	13.2
Total	321	3024	9.4

Annex 29. Age Categories vs. mean family size

Age category	Number cof HHs	Percent of HHs	Total family size (number)	Percent proportion of HH members	Mean family size
17-35	107	33.3	646	21.4	6
36-55	169	52.6	1729	57.2	10.2
Above 55	45	14.0	649	21.4	14.4
Total	321	100	3024	100	9.4

Annex 30. Private grazing land vs. Permanent & Seasonal Settlers in the Afro-alpine

Size of Private grazing land (ha)	Seasonal Settlers	Percent	Permanent Settlers	percent
0	59	57.3	43	40.6
0.01 -0.5	11	10.7	15	14. 2
0.51 - 1	17	16.5	20	18.9
1.01 -1.5	8	7.8	5	4.7
1.51 - 2	7	6.8	11	10.3
2.01 & above	1	0.9	12	11.3
Total	103	100	106	100

Annex 31. Source and species of fuel wood in permanent resident villages outside the AA

Source	Frequency	Percent	Cumulative Percent
Natural forest	308	96.0	
Private land	2	0.6	
Purchase	9	2.8	
Natural forest &purchase	2	0.6	
Total	321	100	
Species	**Frequency**	**Percent**	**Cumulative Percent**
Hagenia	1	.3	.3
Erica	90	28.0	28.3
Hypericum	6	1.9	30.2
Juniperus	96	29.9	60.1
Erica &juniperus	17	5.3	65.4
Erica & hypercum	5	1.6	67.0
Erica,hypercum & juniperus	10	3.1	70.1
Erica,hypercum,hagenia & juniperus	6	1.9	72.0
Hypercum & juniperus	6	1.9	73.8
Eucalyptus	1	.3	74.1
Hagenia,erica &hypercum	63	19.6	93.8
Hagenia & hpericum	7	2.2	96.0
Eucalyptus	1	.3	96.3
Olea & junperus	3	.9	97.2
Hagenia,hypercum & juniperus	4	1.2	98.4
Hagenia & juniperus	4	1.2	99.7
Hagenia, erica &juniperus	1	.3	100.0
Total	321	100.0	

Annex 32. Total and average family size in sample villages

Sample villages	Number of HHs	Total family size	Mean family size
Geremba dima	98	968	9.9
Koma witincho	135	1256	9.3
Rira	88	800	9.1