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Deforestation and a Strategy for Rehabilitation in Beles Sub Basin, Ethiopia

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Abstract
Being identified as one of the growth corridors of Ethiopia with untapped common pool resources, the regions' abundant natural resources are not yet adequately utilized in planned, integrated and systematic manner. In connection to this, the country has initiated and implemented large-scale development projects such as the renaissance dam of Ethiopia and the Tana-Beles sugar factory in Beles sub basin region. A study is undertaken on deforestation and its protection strategy in Beles sub basin which focuses on estimating the pattern and magnitude of deforestation and the triggering factors of deforestation. The study uses NDVI data from two periods (2001 and 2012) to analyze the rate of deforestation and the associated biodiversity loss. Key informants interview and focus group discussions were held to generate the required data. Secondary data on ecological and socio-economic issues were obtained from different GIS and Satellite images, which were downscaled using NDVI technique. The result shows that deforestation and the resulting environmental degradation were the major problems in the Beles sub basin of Ethiopia. High population pressure, agricultural land expansion, large-scale investments, uncontrolled wildfire, illegal logging, firewood and charcoal production, and forced villegalization program were found to be the main drivers of deforestation. As a result, environmental consequences such as climate change, massive deforestation in the name of investment and migration of precious animal such as lion, elephant and buffalo to Sudan were few of the overwhelming problems. This may strongly confront the food security, community livelihood and sustainable development of the study area. Therefore, continuous water, land and forest conservation activity by local communities based on the principles of collective actions and Participatory Forest Management (PFM) is recommended as vital development activities. Furthermore, frequent awareness creation on wildfire protection, modern charcoal production, EIA preparation and implementation for large scale agricultural investments, and implementation of voluntary villegalization program is suggested for long run effective use of the Beles basin natural resources.
Keywords:, deforestation, biodiversity loss, NDVI and GIS, Beles Basin, Benishangul Gumuz and Amhara Region, Ethiopia

1. INTRODUCTION

Ethiopia is the second-largest population in Africa, with limited capacity to manage natural resources, and widespread land degradation. The country also faces many serious challenges to conserve its biodiversity and forests. With broad latitudinal and altitudinal ranges, Ethiopia encompasses an extraordinary number of ecological zones, which in turn host rare and endangered species and high rates of endemism (USID, 2008). In combination with its importance as a center of genetic and agricultural diversity, conservation of water, forest and biodiversity is an issue of global importance. Benishangul Gumuz region, which covers the majority parts of beles sub basin area is one of the richest regions in terms of vegetation coverage in the country comprising about 68, 495 ha of forest coverage. Moreover, the region possesses about 2,473, 064 ha of woodland, and 1,422,191 ha of shrub land. Yet the rate of deforestation and forest degradation is alarmingly high due to overexploitation, overgrazing, expansion of cultivation and settlements that are accompanied by excessive deforestations, invasions of alien species and pollution. According to Benishangul-Gumuz Regional Food Security Strategy Report (BGRFSSR) report, degradation of forest resources is increasing at an alarming rate due to various factors such as encroachment, forest fires, absence of secure land use policy, effects of agricultural expansion and intensive resettlement programs (BGRFSSR, 2004). Lack of equitable access to natural resources and, hence, inequitable distribution of their benefits often leads to clandestine encroachment, resource use conflict and misappropriation of these resources (Veerakumaran, 2007). In the same ways, the rich forest resources of Beles basin area in the BGR are being depleted because of several factors. These in turn, hamper the economic growth of the region.

Although there are some cases of improvements in some parts of Amhara region as the result of implementation of participatory forest management (PFM) and basin conservation activities, still massive forest degradation is threatening much of the biodiversity of the Beles basin. Consequently, from time to time, the distribution and population of many mammals and birds is dramatically declining. A study conducted in Benishangul Gumuz region indicated that large scale projects significantly and negatively affect the socio-economic and environment condition of the local people (Semeneh, 2014). As a result, the environmental consequences such as massive deforestation and migration of precious animal such as lion, elephant and buffalo

to Sudan are one of the overwhelming challenges. Though ample theoretical evidence is cited on the economic, social and political causes of biodiversity loss in Tana-Beles basin, there is lack of scientific study on magnitude and pattern of deforestation in Beles basin. If it exists, the available studies are fragmented, meager or even non-existent particularly in BGR parts of the basin.

To reverse the situation, academicians in the field of natural resource economics often suggest cooperative/collective management of forest by local people themselves, while others still recommend privatization and centralized state management. Despite the advantages and disadvantages of the aforementioned development approaches, currently, collective forest management initiatives has been under implementation through PFM strategy adopted in the regions. Hence more scientific research in this area is imperative to validate the effectiveness of such development strategies.

2. Objectives of the Study

This study will have the following interrelated three objectives.

i. Demonstrate the pattern and trends of deforestation in Beles Basin areas of Benishangul Gumuz and Amhara regions.

ii. Identify the main causes of deforestation in the in Beles Basin areas of Benishangul Gumuz and Amhara regions.

iii. Suggest policy option that can reduces deforestation and biodiversity loss in future planning.

2. RESEARCH METHODOLOGY

2.1. Location and Description of the Study Areas

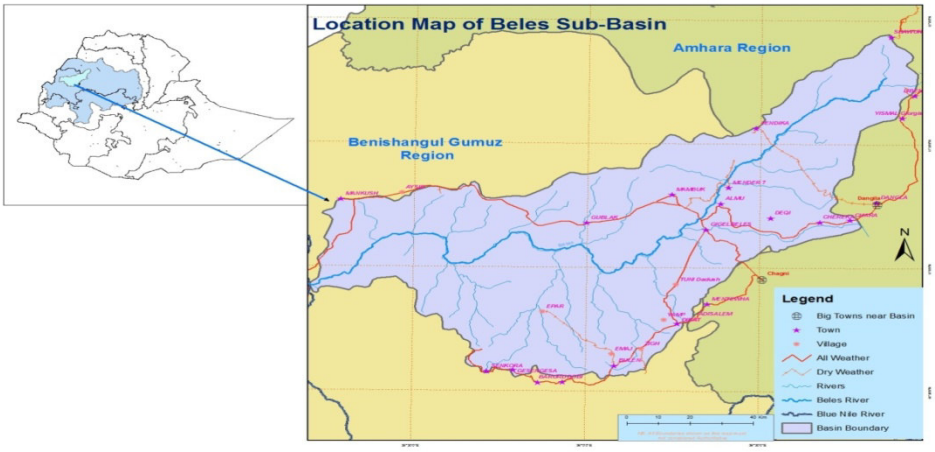
This section will describe location of the study areas and brief research design followed in achieving the research objectives. More specifically, the location and description of BG and Amhara regions, data collection techniques, data type and method of data analysis is briefly described.

2.2.. Location and description of Beles sub basin

The Beles sub basin is part of Abbay River Basin and situated within Metekel zone of Benishangul-Gumuz Regional State (BGRS) and five *woredas* of Amhara National Regional State (ANRS). The sub basin covers an area of 14,209 km2; including the catchments of a number of small rivers (totaling about 650 km2) that drain directly into the Abbay and are strictly not part of the Beles river catchment. The Beles River has two rivers: The major river is called Abate and the other is Gilgel Beles River. Apart from this, many small tributaries drained into the Beles River. To mention some of them: on the right bank of Beles River (Babzenda, Yazbil, Aysika and Gulbak) whereas on the left bank (Bunta, Rapids, Shar, Dukusi, Gorishi and Bajengi).

The highest point in the Sub basin is 2,725 m.a.s.l, at the water divide between the Tana and Beles basins. The mean elevation of the sub basin is 1,190 m.a.s.l and the Beles river joins the Abbay at an elevation of 540 m.a.s.l, near the border with Sudan. The rainfall pattern within the sub basin shows spatial and temporal variation. Despite the variation, the average annual rainfall within the sub basin is about 1,490 mm/year. From the past field data collected, land cover of the sub basin includes 56.37 percent open forest in which the cultivated land may be found, 26.3 percent closed forest and others cover the rest 17.33 percent. It can be concluded that the land cover of the sub basin is predominated by forest. Meanwhile, the Beles sub basin at both lower and upper Beles has a huge potential of irrigable land. According to Nile basin master plan document, 17,232 hector of land are estimated as suitable for irrigation.

Figure 4: Location map of of Beles Sub basin



Source: Google Earth, 2013

2.3. Data Collection Technique and Dataset

As indicated above, the study is conducted in Benishangul-Gumuz and Amhara regions. These regions are selected purposively based on the huge resource endowment and thei are of deforestation as the result of manmade and natural causes. The basin area includes 12 districts (seven districts in BGR and five in Amhara) region. The study utilized both primary and secondary data.

Primary data was collection using various survey techniques. These were Key informant interview, focus group discussion, and field observations. These methods are briefly described as follows. 30 key persons participated in the interview process that comprises the zonal bureau of agriculture heads, NRM experts, *woreda* environmental protection and land administration heads and experts, regional and *woreda* and NRM expert, representative of various institutions at *woreda* and community levels were identified and interviewed. Two step field visits across the basin area was observed and assessed with the help of photographic images. During this time, infrastructure, forest resources, landscapes and the ecosystems of the basin were visited. Specially, the degradation statuses of the forest resources such as forest cover of bamboo forest, landscape and basin woodlands and their status. Moreover, geographic information system (GIS) was used. The study also gathered secondary data from various government reports, unpublished documents, proclamations, and from government and private Medias.

2.4. Methods of Data Analysis

The Normalized Difference Vegetation Index (NDVI) was used to estimate the trend and magnitude of deforestation. NDVI is an index of plant "greenness" or photosynthetic activity used to estimate the status of deforestation. The NDVI is commonly used to assess the situation of green biomass and its interannual changes to draw conclusions about trends in biomass development Gu et al. (2011). NDVI are based on the observation that different surfaces reflect different types of light differently. Photo- synthetically active vegetation, in particular, absorbs most of the red light that hits it while reflecting much of the near infrared light. Vegetation that is dead or stressed reflects more red lights and less near infrared light. Likewise, non-vegetated surfaces have a much more even reflectance across the light spectrum. NDVI is calculated on a per-pixel basis as the normalized difference between the red and near infrared bands from an image:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

where NIR is the near infrared band value for a cell and RED is the red band value for the cell.

The biophysical interpretation of NDVI is the fraction of absorbed photosynthetically active radiation. Water typically has an NDVI value less than 0, bare soils values are between 0 and 0.1 and vegetation values are over 0.1. The disadvantage of this approach is that the determination of whether vegetation degradation is climate or human induced is not indicated. This is because many factors affect NDVI values like plant photosynthetic activity, total plant cover, biomass, plant and soil moisture, and plant stress. Because of this, NDVI is correlated with many ecosystem attributes that are of interest to researchers and managers (*e.g.,* net primary productivity, canopy cover, bare ground cover). Although NDVI is affected by soil background, atmospheric scattering, and is relatively insensitive to high biomass levels, it provides sufficient stability to capture seasonal and inter-annual changes in vegetation status (Vrielinge et al, 2002). Because it is a ratio of two bands, NDVI helps compensate for differences both in illumination within an image due to slope and aspect, and differences between images due things like time of day or season when the images were acquired. Thus, vegetation indices like NDVI make it possible to compare images over time to look for ecologically significant changes. Vegetation indices like NDVI, however, are not a panacea for rangeland assessment and monitoring.

The output of NDVI is a new image file/layer. Theoretically, values of NDVI can range from -1.0 to +1.0, but values less than zero typically do not have any ecological meaning, so the range of the index is truncated to 0.0 to +1.0. Higher values signify a larger difference between the red and near infrared and low NDVI values mean there is little difference between the red and NIR signals. This happens when there is little photosynthetic activity, or when there is just very little NIR light reflectance (*i.e.,* water reflects very little NIR light). Although NDVI is affected by soil background, atmospheric scattering, and is relatively insensitive to high biomass levels, it provides sufficient stability to capture seasonal and inter-annual changes in vegetation status (Huete et al. 2002).

2.5. Empirical study on Deforestation using NDVI Approach

Vast numbers of researches related to deforestation have been conducted using NDVI approach. For example, *Kumar et al., (2013)* applied Advanced Very High Resolution Radiometer (AVHRR) Normalized Difference Vegetation Index (NDVI) to estimate forest coverage and amount of deforestation in India. Using time resinous analysis 1981–2001 period Julien *et al.* (2009) has used NDVI to detect changes in the Iberian land cover in Valencia, Spain. Social and land-use/land-cover change data was modeled to assess drivers of smallholder deforestation in Belize. The predicted rate of total deforestation between 1989 and 2004 was found to be 30 percent.

NDVI and rainfall estimates data from the National Oceanic and Atmospheric Administration (NOAA) satellites were used to investigate the spatio-tempotal pattern of precipitation and the response of vegetation to precipitation in Ethiopia (Getahun, 2008). Land use and land cover changes that occurred from 1984 to 2009 in the Fincha'a Sugar Estate, Blue Nile Basin of western Ethiopia, were estimated using a geographic information system (GIS) and a remote sensing approach (Getahun et al., 20014). According to this study the natural forest cover declined from 17.25 percent in 1984 to 10.16 percent in 2005 and 8.70 percent in 2009. The total natural forest cleared between 1984 and 2009 amounts to 3186 hector, which was equivalent to 50 percent of the forest cover that existed in 1984. The pattern and magnitude of deforestation that occurred from 1972 to 2000 in the south central Rift Valley of Ethiopia were analyzed using similar techniques (Gessesse and J. Kleman, 2007). The results show that natural forest cover declined from 16 percent in 1972 to 2.8 percent in 2000. Their estimate indicated that total natural forest cleared between 1972 and 2000 amounted to 40,324 ha, corresponding to an annual loss of 1440 hector. Other others such as Getachew *et al.,* 2011; Yitea *et al.,* 2012; Francesco *et al.,* 2009) have used NDVI to estimate deforestation, desertification and land use land cover in various parts of Ethiopia. Hence this paper has also followed the same approach.

3. RESULTS AND DISCUSSION

This section presents two main findings of NDVI data and secondary data collected from various sources. The first section focuses on estimation of deforestation in the study area. Then analysis on the driving forces of deforestation in Beles sub basin followed.

3.1. Land use system in Beles sub basin region

From field observation and secondary data collected from different sources, land cover of the study area was found to be 56.37 percent open forest in which the cultivated land was 26.3 percent, the remaining are closed forest 17.33 percent. The result implied that the land cover of the region is still predominated by (mainly bamboo) but in a declining sate. This figure was also cited in most past studies. For example, qualitative study conducted by Habtamu et al (2012) indicated similar finding. From my field observation and KIIs, economically important tree species such as incense tree and the lowland bamboo are highly threatened by human intervention. On the other hand, the regenerating capacities of these types of tree species are generally very low; once removed, it will be difficult to bring them back. In terms of the types of forest, grassland was found to be the dominant forest type which covers about half of the total forest while state farm are the least existed in the basin region.

Table 1: Land use type and area covered by forest

Land Use	Area (Sq.km)	Area covered (%)
Grass land	6,028.88	49.24
Cultivation	3,571.07	29.17
Shrub land	2,320.05	18.95
Woodland	266. 90	2.18
State farms	56.45	0.46

Source: Ministry of water resource, 2013

However, compared to other regions, due to poor infrastructure and little population density, the rate of deforestation becomes generally low in tower parts of the basin. The evidences indicated that population density in the Guba *woreda* is quite low. In contrast, there is high forest cover compared with the highly populated areas of Alefa and North and South Achefer in the upper parts of basin area. The indigenous types *Wanza /cordia Africans, yehager-grer/Acacia spp/, Zigba /podocarpus graciolaris/, Sholla /Ficus sycomorus/, Woira/Olea african/, Zenbaba/palm tree, Kerer/Aningeria altissian, Kerkeha/Bamboo, "Dokuma/Syzygium*/are being endangered due to charcoal making and other sources of livelihoods in the basin area, especially in the lower parts of the basin. Deforestation and the land degradation have brought losses of different types of small and big wildlife. Just to mention a few: Hart Beast, Bead-Buck, Water-Buck, Bush-Buck, Bush-Duiker, Wild-pig, Ape, Globes, Fox, Giraffe, Wild cat, Porcupine, Crocodile, Warthog, Guinness hen, Birds, Warthog, Fish, Guinean fowls, Hyena, Lion, buffalo, and Monkey live in the in the region. Since the major parts of the basin forest resource are cover by bamboo, the following has estimated the rate of bamboo deforestation.

3.2. Estimation of the rate Bamboo Deforestation in Beles sub basin

Table 2 represents the mean annual forest coverage and patterns for bamboo deforestation (from 2006 to 2012). Quantitative analysis of changes in bamboo forest coverage between these time periods depicted a general decline in bamboo forest coverage. However, bamboo coverage seems to improve since in the years 2011 and 2012. The decline in forest coverage was the replica of decline in the calculated values of NDVI. For the first five years the value of NDVI and the corresponding bamboo forest has sharply declined. Increase in the value of NDVI up to (0.55) in 2011 and 2012 years revealed recovery in bamboo forest coverage in the study area. The result shows that in 2006, the bamboo coverage was estimated to be 1,056,187 hector while in the year 2012 it falls to 556, 715 hector, indicating 499,472 hector decline of bamboo forest within seven years. Moreover, the data revealed high rate and low of bamboo deforestation in the year 2008. Table 2: Estimated annual rate of

deforestation in Beles sub basin (2006-2012)

Year	Forest Area (Ha)	Amount deforested (ha)
2006	1,056,187	-
2007	980,080	(-)76107
2008	887,101	(-)92979
2009	420,044	(-)467057
2010	435,816	(-)15772
2011	509,051	(+) 73 635
2012	556,715	(+) 47664

Source: Downscaled NDVI data, 2014

Woreda level NDVI analyses illustrate the amount total forest areas cleared in the study area. High rate of deforestation was observed in South Achefer (69.16 percent) and the least being in Mandura *woreda* 21.47 percent. In terms of total forest area cleared Dangur *woreda* was found to be very high, with the total area of 125, 400 hectors within the six years time period. The data indicates that the upper parts of the basin areas, which mainly fall in Amhara region was the most degraded area as compared to the lower parts of the basin areas. As indicated, the lower parts of the basin which covers Benishangul Gumuz region was covered with dense forest. The high rate of deforestation and land degradation could be due to the high population pressure in the upper parts of the basin areas.

Table2: Change in forest coverage between (2006 -2012)

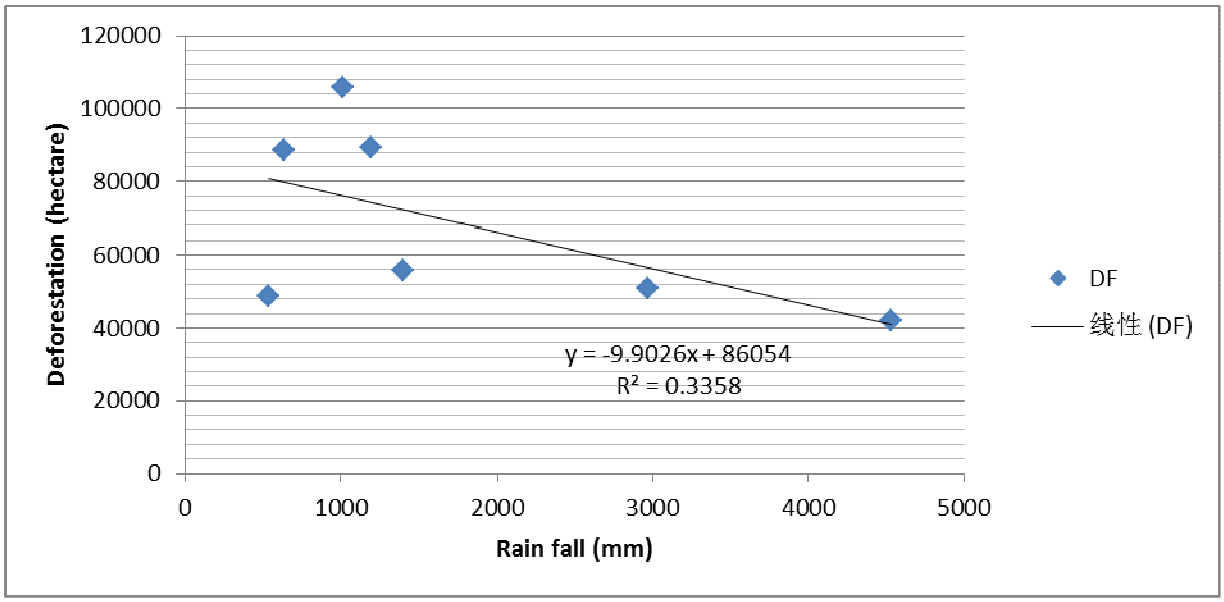
Woreda	Change in forest (loss)	Percentage change
Alefa	26,849.83	40.24
Bulen	39,523.53	27.22
Dangla	13,220.04	45.72
Dangur	125,349.55	49.14
Dibatie	14,966.90	34.39
Mandura	13,960.48	12.47
S.Achefer	32,816.46	69.16
Pawe	25,246.75	41.44
Jawi	47,366.41	52.81
Wombera	70,377.48	31.84
N.Achefer	12,515.54	32.24
Guba	77,278.64	67.52

Source: computed from NDVI data, 2014

Natural factor such as disasters and weather viabilities are reported as the major contributor of deforestation all over the world (REDD+ policy document, 2010). In light of this, the influence of temperature and rainfall viabilities on bamboo depletion was assessed. Pair-wise correlation between bamboo deforestation and temperature shows strong positive and significant associations (r=0.79). An inverse relationship between deforestation and temperature was a study by study in China (GAO and Liu, 2011). On the other hand, negative and weak correlation between bamboo deforestation and rainfall was observed with correlation coefficient of (r=-0.47). This result is in line with the findings of Yitea (2012) in Goajam, Ethiopia. His analyses show strong positive correlation between the values of NDVI and rainfall in most years of considerations. He also identified that temperature and the rainfall are positively correlated, which implies that a decrease/increase in temperature could improvement in rainfall distribution (r=0.43).

In using NDVI as a method of data analysis, rainfall data are widely used variable than temperature data. Hence, metrological rainfall data collected from the study *woredas* shows persistent variability in rainfall distribution over five years time periods, and its effect was found to be significant on bamboo deforestation. Figure 2 below illustrates the simple regression results between bamboo deforestation and amounts of rain fall; in the study area. From the correlation analysis, it can be known that deforestation consistently varied with fluctuation of rainfall distributions. The simple OLs result depicts that keeping other explanatory variables constant, an increase in rainfall (mm) causes an increases in forest cover, by about 10 hectare.

Figure--- Linear fit for annual rainfall and deforestation in the period 2006–2012.



Source: GIS and Methodological Data, 2013

4. Drivers of Deforestation and Forest Degradation

This section critically assesses the main drivers of deforestation and subsequent biodiversity loss in the basin areas. There are several causes of deforestation in beles basin area. However, in this study only few causes of deforestation are reported.

4.1. Clearance of forest for cropland expansion

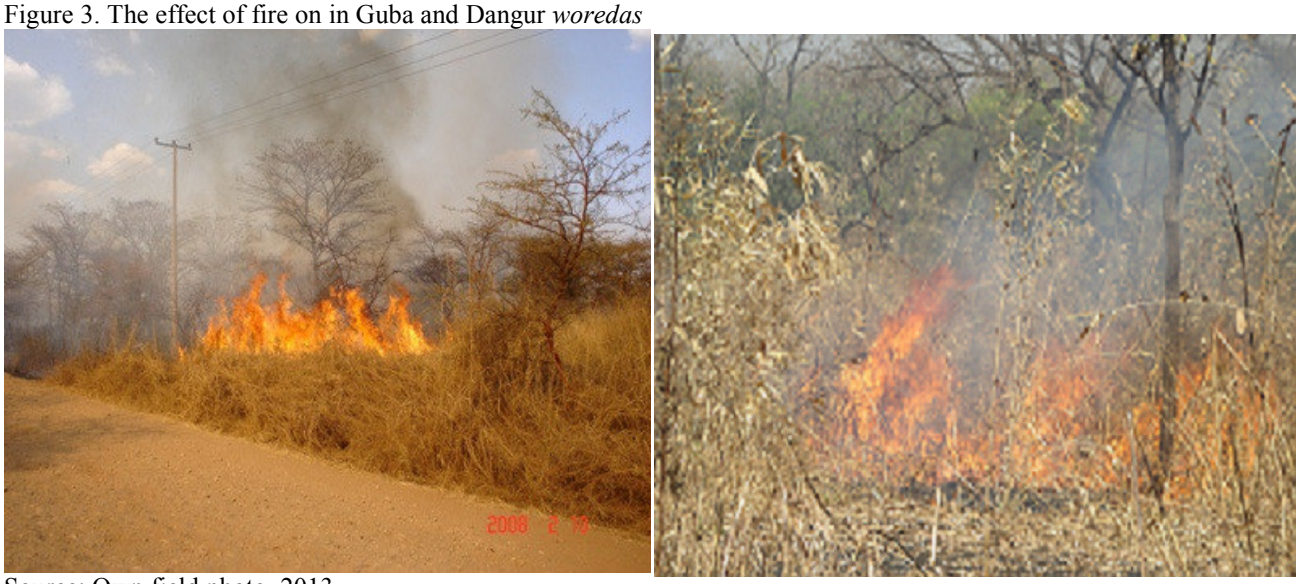
Forest ecosystems often serve two contradictory roles. On the one hand, they offer essential, ecological, social and economic services and benefits. On the other hand, ecosystems are considered as reserves, hence taken as opportunities for development through other economic sectors such as agriculture and agri-investment (Mulugeta and Bekabil, 2011). Similarly, a major concern in the beles basin *woredas* today is found as the alarming deforestation of natural forests and woodlands for agricultural land expansion. In fact, from the results of field data, this variable is the most important direct driver of deforestation in the basin region. The reason for the high rate of clearance and conversion to cropland is the fact that the economy of the study area largely depend on agriculture, which accounts for 93.2% of employment for the economically active population. Furthermore, the high rate of migration from different regions of Ethiopia in search of cropland instigated high rate of conversion of forest woodlands to croplands.

The zero state basin documents of BESBO highlighted that Beles basin is blessed with different natural resources (Forest, water, aquatic, and wild animals). The area occupies attractive natural beauties and historical sites. Its rolling mountains, breath taking landscapes, agreeable climates, endemic wildlife, diverse cultural heritages, hospitable people, and artifacts could make the nation an alluring destination. As per the findings of this study, the most direct household level consequences of deforestation in the basin include reduced wild fruits, reduced wood products and reduced wildlife products. However, it is commonly argued that forest area of the basin has been declining from time to time (BESBO, 2012). In consequence, economically important trees like Etan and Mucha are highly over-utilized.

4.2. Unregulated forest fire

Fire is being used widely as site clearance technology in the region. Unbodtly, this has been one of the major degrading agent in the basin areas. In the area, fire is caused by several factors that include: i) wild honey hunting; ii) site clearance for shifting cultivation and cropland preparation; iii) road clearance for gum and incense tapping; defense agains wild animals, and iv) trophy hunting. As there is no or weak systematic burning and fire control mechanism, fires consum huge areas of land including unintended areas. Conseqently, fire has been consuming a huge areas of natural land every year. On average, 1 percent of all forests were reported to be significantly affected each year by forest fires (FAO, 2011). However, the area of forest affected by fires was severely underreported, with information missing from the study areas. According to the valuable evidence in the study site local Communities basically ignite fires deliberately in order to hunt wild animals, to harvest honey, and to collect wood. Previously, forest areas were also set fire for charcoal production. Enforcing mechanism to prevent such problem was challenging even today it is still difficult due to the difficulty of identifying who starts a fire. The main consequences of fire and the subsequent deforestation were habitat destruction and decline of water availability. As it can be seen from the following picture below people intentionally set fire in Dangur woreda affecting the ecosystem and economically important three. Specifically, the lowland bamboo is one of the highly victimized economic trees in the basin.

Figure 3. The effect of fire on in Guba and Dangur *woredas*



Source: Own field photo, 2013

4.3. Unsustainable wood harvest for fuel and Constraction

Wood is the main source of energy and construction materials in BG region. However, the wood harvest for construction, fuel wood, and other sources of energy is often unregulated owing to lack of formal or informal regulatory system, hence more or less open access harvesting takes place where households or individuals harvest and use wood products and materials often extravagantly. Similar to the effect of fire, the bamboo forest is particularly the major victim of the unsustainable harvest since it is the most widely used species as a construction material.

Data obtained from BGR agricultural and rural development office revealed that a huge number of woods are being consumed by wonbera woreda. From the total 316,785 wood consumed in metekel zone as the source of energy, about 68, 353 wood is consumed by 8701 rural families and 672 urban families per annum. Dibate is the second largest worked in terms of wood consumption. A total of 59,831 woods are being consumed annually which is equivalent to 239472 ha of forest land. Pawi, Dangur, Bulen and Mangura woredas consume about 56,474woods, 50,831woods, 31,974woods, and Mangura 35,664 woods respectively. Guba district is the least consumer of fuel energy. Only 2,692 rural families and 271 urban families depend on wood as the sources of fuel energy which is equivalent to 40,5396 ha of forest coverage.

Table 7: Total annual wood consumption by their residence in the basin areas of BGR

Woredas	Rural Families	Urban Families	Area (Ha)	Total wood
Bulen	4,165	898	287756	31,974
Dengur	6,868	1,068	865252	50,831
Dibate	9,413	886	239472	59,874
Guba	2,292	271	405396	13,615
Mandura	5,259	488	102312	35,664
Pawe	9,502	1,982	62,796	56,474
Wenbera	8,701	672	734,436	68,353
Subtotal	**46,201**	**6,265**	**2,697,420**	**316,785**

4.4. Large scale investment

The government report revealed that in Benishangul-Gumuz region about 691,984 hectors of agricultural land has been transferred to the Federal land bank to undertake large scale agricultural investment. Some researchers in Ethiopia associate the situation with the so called “global land grabbing” (Dessalegn, 2011). Land grabbing is the rush for commercial land in Africa and elsewhere by private and sovereign investors for the production and export of food crops as well as bio-fuels, in which the land deals involved stand to benefit the investors at the expense of host countries and their populations.

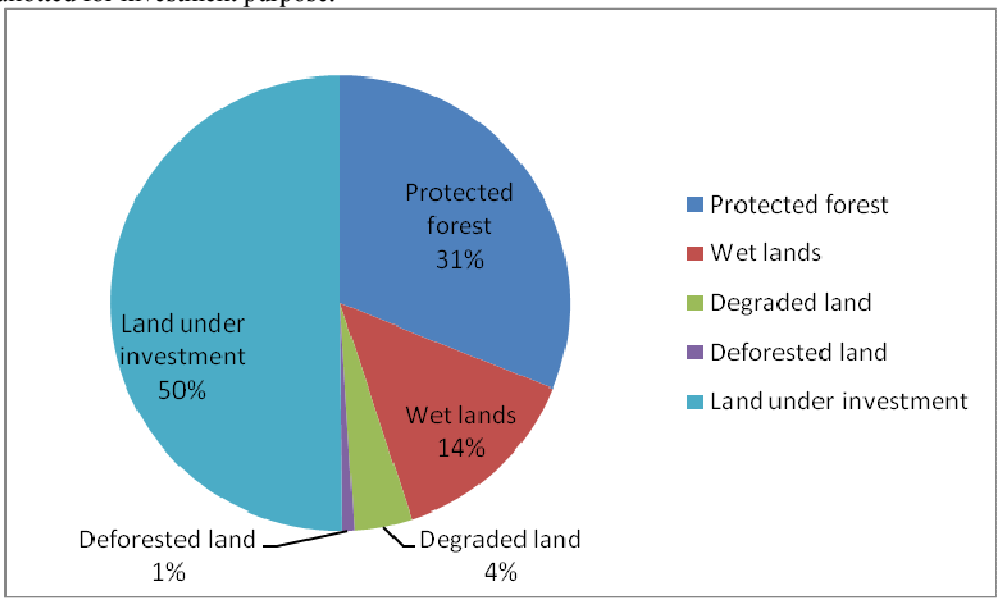
According to Tsegaye (2013) in BGR a substantial amount of land has been transferred to domestic and foreign investors without mapping of existing land uses. Moreover, his study identifies that the land transferring process lacks genuine participation of local communities and authorities. In consequence, these the dispossession and displacement of communities from their villages and destruction of the natural environment threatened the livelihoods of the local people. A study conducted in BGR by Maru (2012) suggests that there is weak linkage, monitoring and support from federal, regional and district levels in relation to large scale

agricultural investment activities. Moreover, weak capacity of domestic investors has accelerated degradation of forest resources, and threatened livelihood security of rural community. During my preliminary filed survey in the region it has been realized that different large-scale development projects have been undertaken by private investors with the view of promoting regional development. However, these large-scale development projects are perceived as a threat by the local communities and causes of investor-farmers conflict.

Figure 3: Environmental Effect of Large Scale Investment in Dangur Woreda

Source: Own data, 2013

In connection with rich version land and suitable for land for private and public investment, Massive large scale investment has been undertaking in the region. During the discussion with the residents of Dangur woreda large scale investors are engaged in destructing economically important tree species and transport it to Amhara region. When the local people and *kebele* leaders request the project owners to pay attention to environmental issues, the investors often fail to do so. Secondary data and some KII revealed that50 percent of the basin's virgin land is allotted for investment purpose.



Source: computed from secondary data

4.5. High population growth

Population growth, although debatable, is one of the root drivers of degradation under poorer economy that heavily depends on natural resources extraction for survival. In all districts of the basin, population is growing due to the characteristic high fertility rate. One of the reasons for this is the prevalence of the practice of polygamy. In this regard, projected regional demographic parameters suggest that even more serious pressure on natural resources is yet to come (RCS, 1997). The high young population in the region as well as in the Beles basin may imply a high pressure on the future livelihood of generation. In general, as population grows, pressure on forest and other natural resources also build. Demand for cropland will increase to feed more mouths, wood demand will increase to provide more energy and shelter. In general, deforestation has risen as population figures continue their inexorable increase. These could be attributed to the cutting of trees in the forests for

various uses such as firewood, timber production and clearing for agricultural purposes. These decreases could be linked to changes in climate change, and the effects of in-migration and population growth.

4.6. Weak institutions

Leftwich and Sen (2010) indicated that institutions are the formal and informal *'rules of the game'* that shape, but do not determine, human behavior in economic, social and political life. They are understood as "sets of rules that allow a plurality of persons to coordinate their behavior and to routinely solve typical problems that arise in social interaction" (Vanberg, 2001). The regional state does not have regional formal institution like forest policy and accompanying acts or legal instruments so far. In fact there is land administration policy but these do not explicitly look in to the forestry condition of the region. The land administration policy states that land is government property, but when government could not quickly put in place regal instruments and its enforcing institutions, the resources, as usually the case, fall into the state of open access resulting over utilization of the resources.

4.7. Lacke of commitment on rehabilitation of degraded forest lands and tree plantation

Side by side with improving the management of natural forest, rehabilitation of degraded lands through soil and water conservation, tree planting, area exclosure and other relevant techniques is an important action to contribute to improved natural resources management in the region. Tree planting, except for fruit trees, is not practiced by the community in the region. So far there is little motivation from the regional government to boost their endeavour for rehabilitation and tree planting, due to the relatively large coverage of the landmass by natural vegetation. However, by planting trees on degrading lands, further pressure on the natural vegetation can significantly be reduced. Therefore, tree planting need to be considered seriously as strategy to reduce pressure on natural resources base.

5. RECOMMENDATIONS

Based on the findings of collected data and field observations the following key recommendations are suggested for effective use of the basin resource.

5.1. Implementation of Intensive Agricultural Production System

Since shifting cultivation is the most important means of agriculture production in Beles basin, it must have created stiff competition over the natural resource use. Thus sustainable and intensive crop production system coupled with improved agricultural inputs such as irrigation and fertilizer will reduce encroachment of the local people into forest illegally. These will improve livelihood of the people in the basin in general and overall rural development strategy of the region. However, such a shift may be challenging. Hence, a strong capacity building is needed for farmers, extension agents and experts in the region in order to equip them with sustainable crop production intensification techniques.

5.2. Regulating Large Scale Agricultural Investment

To attain the Five Year Growth and Transformation Plan of 2010/11-2014/15, Ethiopia launched massive development projects with the intention of overthrowing poverty and ensuring sustainable economic growth in the country. However, this goal is achieved if and only if their environmental impact appropriately analyzed. In Benishangul Gumuz Region, assessments of large scale investments such as agricultural farming have adverse environment impact due to absence of EIA preparation and implementation. Therefore, there must be EIA regulation and strict implementation based on the recommendation of professionals. This will have the chance to reduce the potential negative impact of investment on environment and biodiversity loss.

5.3. Promoting Participatory Forest Management

Participatory Forest Management (PFM)) is a forest management system that is introduced as a complementary mechanism which safeguards forests, while respecting traditional users and including them in the processis a mechanism to protect forests and enhance the livelihoods of communities who use and benefit from them in the process. It regulates access and avoids unsustainable harvest for wood products as well as open access for cropland encroachments. This strategy appears the most effective to the degradation and deforestation problems observed in the region in general and in the basin areas in particular. Therefore, the regional State needs to develop an enabling forest policy and other informal forest product use rules.

5.4. Controlling Forest Fire

The people in NGR particularly the Gumuz societies culturally practice shifting cultivation in which fire is an essential tool to clear forest. It is related with their day to livelihood activities. Therefore this study recommends that fire control strategy or regulation is needed. However, it is difficult to change the deep rooted cultural practice of the Gumuz and other native ethnic peoples of the region. Hence, continuous training is needed on fire ecology and control mechanisms by government bodies through its agricultural development agents.

5.5. Establish National /Regional Forest Protected Areas

Protected forest and park areas with restricted access for local communities have often been introduced as a solution to tackle deforestation and its effects. Despite huge potential for establishment of national/regional parks, in this regard, little has been achieved by the regional government or local government. Therefore, national or

regional level parks shall be established. For instance, in Dangur woredas of Abby Dar kebele Alatish Parks of Mahara region will be used as the best experiences

5.6. Focus on Bamboo Development

BGR took the first place in bamboo potential in Africa comprising 56 percent of the country's bamboo forest area (Demissew *et al*., 2011). Nevertheless, massive bamboo deforestation has been taking place in many parts of the country. Moreover, mass flowering coupled with unsafe harvest of this forest threaded the bamboo forest in the region. Despite the importance of such a non-timber forest products (NTFP) in sustaining livelihood and poverty smoothening in rural communities, they are highly depleted and poorly conserved in Ethiopia in general and Benishangul-Gumuz region in particular. Hence, quick action should be taken in restocking and planting of bamboo seedling where bamboo is flowering by the government and other stakeholders such as INBAR as they have rich experiences on bamboo forest management.

5.7. Promote Alternative Energy Source

Provision of alternative energy sources such as power saving stoves to the farmers increases efficient and sustainable use of forest resources. Moreover the region has sunshine to supply solar energy in the future. In response to this INBR has started supplying energy and power saving Briskets for local farmers. Hence, as a long-term strategy of the region and the basin woredas must plan in supplying energy saving alternative sources of energy. This may reduce amount of wood harvest, hence degradation in the future.

5.8. Improving Formal and Informal Institutions

Institutions are crucial in managing natural resources in effective, efficient and sustainable ways. Formal institutions such as policies, proclamations, guidelines and regulations and other legal frameworks are essential in regulating unsustainable natural resource uses. In the presence of such formal rules of the games with proper enforcement mechanisms, sustainable NRM can significantly be improved. To achieve this and for future effective use of natural resources establishment of regional forest policy by the concerned bodies is vital for efficient use of the region's natural resources.

5.9. Control Population Growth

The impact of high Population growth is debatable issue in the country and elsewhere in Africa. In sub Saharan countries where there is high dependent and unproductive population it creates pressure on growth and development. As it has been said there is high population growth in the basin region owing to high fertility rate. High population in rural setting indicates intensive resource use and increase the conversion of forest land for agricultural purpose. Hence regulating population growth using the use of family planning is recommended for the future.

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