Journal of Biodiversity & Endangered Species

Garedew et al., J Biodivers Endanger Species
2018, 6:3
DOI: 10.4172/2332-2543.1000221

Research Article Open Access

Survey of Charcoal Production and its Impact on Plant Diversity and Conservation Challenges in Abeshige District, Gurage Zone, Ethiopia

Belachew Garedew* **and Legesse Simon**

Department of Biology, Natural and Computational Sciences, Wolkite University, Wolkite, Ethiopia

***Corresponding Author:** Belachew Garedew, Department of Biology, Natural and Computational Sciences, Wolkite University, Wolkite, Ethiopia, E-mail: belachewgar@gmail.com

Received date: September 05, 2018; **Accepted date:** September 31, 2018; **Published date:** October 15, 2018

Copyright: © 2018 Garedew B, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Charcoal is the principal energy producing fuel commonly used in urban and institution households for cooking and heating whereas rural settlements is commonly used firewood. This paper aims to explore charcoal production and its impact on plants diversity and conservation challenges around Wolkite Town, Gurage zone. A combination of qualitative and quantitative methodological approaches was used in data collection and analysis. These methods include: questionnaire, interview, observation and market survey. The findings show that charcoal and wood fuel is the means of revenue for the people leading to desertification due to the source of domestic fire in use. Also another mean of domestic fuel such as kerosene, electricity, coal and gas are not made available at affordable rates and therefore does not encourage the use of continuous and constant supply. Acacia species and Combretum species were the most preferred species due to the quality of charcoal (moisture content, volatile matter, ash content and duration time) and wood fuel products it produces. The result of investigation revealed that the plant diversity in the study area was tremendously being depleted.

Keywords: Abeshige district; Charcoal; Consumer; Plant diversity; Producer

Introduction

Most parts of Sub-Saharan Africa, households both rural and urban are largely dependent on fuelwood (charcoal and firewood) for their energy needs [1-3]. In Sub-Saharan Africa, firewood and charcoal contribute more than 80% to the total domestic energy requirements [2,3]. This traditional energy represents about an annual average consumption of 419,964 tons per year on national level [4]. This incessant growing request for traditional energy is ensured by national production. Unfortunately, this important consumption of charcoal had enormous consequences on the ecosystems since the methods used by the producers and the consumption modes of charcoal by households still remain archaic. Indeed, the production yield is about 15% to 20% i.e. 150 kg to 200 kg of wood produced per ton of woody material and during the cooking with charcoal; the loss in energy is about 8% to 13% [5]. Deforestation of forest resource is one of the major environmental issues not only in directly affected countries and locations, but also from global perspective, the degree of international attention to deforestation is commensurate with the role of forests in the global, national and local ecosystems. Tropical forests are declining rapidly owing to forest degradation through fuelwood collection, charcoal production and logging and other factors such as conversion to arable land [6]. Over the course of the last 30 years, assessments of fuelwood consumption, both firewood and charcoal, in developing countries have changed substantially [7-10]. Ethiopia is one of the most severely deforested countries in sub- Saharan African countries, particularly in forest degradation which resulted in soil erosion and degradation of agricultural land. The decline in overall stability and productivity of the country's natural resource is the result of complex and interrelated series of processes that were triggered by the loss of forest cover in critical watershed [11]. Even though, the charcoal is of good quality when part of the wood used is fresh, the excessive exploitation of the forestry resources for energy purposes puts an important pressure on the ecosystems and leads consequently to serious harmful effects on the environment and the biodiversity preservation. The loss of forest resource can lead to diminished income, and food-generating capacity for forest dependent communities, higher rates of soil and siltation of waterways, loss of species and genetic diversity and an increase in carbon emission, which, contribute to global warming [12,13]. The impact of population growth on forest degradation and forest resource consumption is direct since energy needs and other forest product services are essentially proportional to population size. The demand for forest product and services has increased in response to increase in population [14-16]. To cover energy needs, most households in Ethiopia resort to freely gathered biomass fuels. More than 85% of Ethiopian population lives in rural areas. The vast majority of the rural and urban populations are dependent on the traditional fuels of wood, cow dung and crop. Generally there is little study done in Ethiopia on conversion of agro-wastes into charcoal and effect of wood charcoal on human health and pollution impact as well as biodiversity [17]. More over the increment of needs for food and other agricultural products also leads to the clearance of forest resources. In such cases it is necessary to increase the output of lands under cultivation or to increase the cultivated area.

The Objective of the study was to assess the charcoal production and its impact on plants diversity and conservation challenges in Abeshige district, Gurage zone, Ethiopia.

Significance of study

Wisely use of forest resources in any area, especially in rural part of the study area have paramount importance for the improvement of carrying capacity of the environment which helps to raise the living condition of the on-site inhabitants and off-site inhabitants and also

contribute the county's economic advancement. Charcoal is viewed as an advanced fuel in because of its clean-burning nature and the fact that it can be stored for long periods of time without degradation. Thus, in addition to showing how the society may able to use charcoal and manage the existing forest, the researcher believes that the result of this study:

- Enriches the knowledge on forest use pattern and forest deforestation practices prevalent in the study area
- Provides the basis for planning and forest management in the district and serves the officials and concerned body as a supplement to their knowledge
- May add to the existing literature and may serve as an additional source of reference
- Gives bases for others researchers who want to make further investigation in the area and may be used as stepping stones
- Lastly, it enables the concerned body to take measure and fight the problem in time. No matter how the problem might be perceived locally, the result of this may hold true for other similar regions in the country

Material and Methods

Description of the study area

Geographical location and population size of study area: The study was conducted on charcoal production and its impact on plant diversity town Abeshige Districts in Gurage zone SNNP of Ethiopia. Wolkite town is situated at distance of 337 km from Hawassa (capital city of southern nations, nationalities and people region) and 158 km away from south west of Addis Ababa. The geographical location of the town is approximately 8˚ 33' N latitude and 37˚ 59' longitude E. The study area is located 5 km away from south of Wolkite Town. Due to expanding of urban centers, the study area has a tendency to be included with urban area. It forms the southern extension of the Shewan plateau, located about 160kms south of Addis Ababa and lies between $7^0 46^1$and $8^0 27^1$N latitude and $37^0 28^1$and $38^0 18^1$ E longitude. The area is characterized by hills, gorges, steep slopes and average elevation ranges from 1710-1950 meters above sea level. The mean annual temperature of the zone ranges between 13 ˚C -30˚C and annual average temperature of the town is 32 ˚C. The area is experiencing a bimodal rainfall pattern with the main rainy season (meher) is from June to August. The six largest ethnic groups reported in the Gurage zone are Gurage people (82%), the Mareqo or Lilibido (4.28%), the Amhara (3.36%), the Kebena (3.34%), the Silte people (2.71%), and Oromo (1.69%); all other ethnic groups made up 2.62% of the population. According to Guraghe zone Rural and Agricultural Development Office (2014) report, the soil types of the study area are divided into four. These are black soil (Vertisol) which covered the majority of the area, brownish soil (Cambisol), grayish soil (Aerosol) and reddish soil (Nitosols). Farmers also involved in some types of seasonal non-farm activities. Farming is mainly dependent on rain fed and traditional farming system. According to zonal report, Perennial crops such as enset, chat and cereals, such as teff and maize are the most commonly cultivated. Enset is the most important crops in the study area as a staple food. Others fruits like; mango, orange, banana and avocado and also vegetable are some of the major important household's income sources in the study area.

Selection of specific study area: The reconnaissance survey was conducted Abeshige Districts in 2010 E.C, to select study villages and conduct charcoal production survey. The study area of edigetber and selamber kebele was selected purposively. These kebele were selected because of high demand for fuelwood and charcoal coupled with population growth has accelerated serious land degradation problem in those kebele. Its selection was the researcher experience about the area, which was important to know and prioritize the serious problems in the study area. During the survey charcoal production site was selected from study area purposefully (by non-probability sampling technique).

Sample size and sampling method

The size of sample was determined depending on the available time and resource. Not necessary on the whole total population as study unite it takes time and cost. Charcoal producers were selected from selected study area by using some sampling method such as purposeful sampling strategies and quota sampling strategies (total sample size fifty seven). In sample survey sample determination is important. To determine the sample size of informants those participate in the study area, a quota sampling and purposive sampling techniques were employed. The sample size was determined by using the following formula which used to determine the size of informants.

Where; n=the sample size, z=standard error related with the chosen confidence interval (1.96 for a 95% confidence interval), e=marginal error, p=estimate proportion in the population.

From 384 informants calculated. Because of lack of time and budget 15% (57 informants) were used.

Purposeful sampling strategies were conducted to select informant based on their knowledge on charcoal production. Purposive sampling is used for selecting informants which who consider as representative of the population on the study area. Purposeful sampling strategies are typically used when focusing on a limited number of informants, whom you select strategically so that in their in-depth information was give insight into an issue about which little is known. Quota sampling strategies were made to give proportion of informant (for producer, merchant, users and agriculture office) and then according to quota informants were selected from each by using systematic sampling technique. Therefore, the number of informants (producer=25, merchants =10, users=20 and agricultural office 1 for zone and 1 for district).

Methods of data collection

Surveys were conducted with charcoal producers from study area. The data was collected through Semi-structured questionnaires and oral interviews were held with charcoal producers. Woody species used in making charcoal and the preferred species were identified and their availability is systematically recorded. Data relatives to the quantity of charcoal produced were collected in the forest checkpoints.

Semi-structured interview: Semi-structured interview was conducted face to face selected producers who have a deep knowledge about charcoal production. Interview is asked on a check list of question prepared by English language then translated to local language (Guragagna).

Field observation: Field observation was conducted in the study site by walking with producers where the charcoal production takes place. The purpose of observation is to check the availability, distribution, location and type of plant species in study area by capturing photo by using digital camera.

Market survey: Market survey was conducted in one open market found in Wolkite town the capital city of Gurage zone, to check for availability of marketable charcoal. Data was gathered through observation and interaction with producer and consumer of charcoal. Data on charcoal consumption in the study areas were obtained through structured and semi-structured interviews. A limited number of informants were randomly interviewed and questionnaires were used to administer their responses. A random survey regarding charcoal price were conducted mainly through the collection and selling centers along Wolkite town. A further survey of charcoal prices were conducted in Wolkite town where areas covering those selling bags (sacks) weighing. Charcoal selling sites were located at both the source in the rural areas from where charcoal production takes place and along the road as well as at various localities in the urban area.

Data analysis

The collected data was analyzed in terms of figure, graphical, table, etc. using Excel spread sheet. Preference ranking were calculated for evaluating the degree of preference or level importance of certain selected plant of charcoal production by using fifty seven selected key producers and consumers are invited to rank certain marketable plant species that are used for income generation . The value is coded as zero to five (0=not used, 1=least used, 2=less used, 3=good, 4=very good and 5=excellent). The ranking was five for the preferred marketable plant species and one is least preferred marketable plant species.

Results and Discussion

Socio-demographic characteristics of respondents/ informants

A total 55 respondents were used for this study. During the research 20 producers were interviewed of which 18 constituting 90% were male and the remaining 2 representing 10% were also females. On other hand 25 consumers were interviewed. Out of this number 25 females representing 100% were females. Finally 10 traders were interviewed. Out of this number 8(80%) were females and remaining 2(20%) were male (Table 1). Regarding the religious 30 representing 54.54% were Orthodox Christian, 20 constituting 36.36 were Muslims and 5 representing 9.09% were protestant Christian (Table 1). With regarding educational status out of total 55 respondents 41 (74.54%) of them were illiterate, 8 (14.54%) were grade 1-6, 4 (7.27%) were grade 7-8 and 2 (3.63%) were above grade 12 (Table 1). Regarding the marital status; according to field survey, all respondents were married. With regarding age distribution of respondents 35(63.63%) were in the age group 31-45 year followed by who's in the age group of 46-60 years 20(36.36%) (Table 1). Regarding family size of household; family size was one of the factor that affect land holding size and agriculture expansion of the farm household. According to field survey, about 20(36.36%) of the sampled house holdhad family size of 5-8 members and 30(54.54%) of them had 3-4 members. Only 5(9.09%) of the sampled household had the members up to 2 members (Table 1).

Demographic character of sample household		Frequency	Percent (%)	Demographic character of sample household		Frequency	Percent (%)
Sex	Producer	20	100%	Sex	Producer	-18	-3700%
	Male	18	90%		Male	-16.2	-3330%
	Female	2	10%		Female	-1.8	-370%
	Total	20	100%		Total	-18	-3700%
	Consumers	25	100%		Consumers	-23	-4700%
	Female	25	100%		Female	-23	-4700%
	Traders	10	100%		Traders	-8	-1700%
	Male	2	20%		Male	-1.6	-340%
	Female	8	80%		Female	-6.4	-1360%
Age	31-45	35	63.63%	Age	31-46	-33.7274	-6809.11%
	46-60	20	36.37%		46-61	-19.2726	-3890.89%
Religion	Orthodox Christian	30	54.54%	Religion	Orthodox Christian	-28.9092	-5836.38%
	Muslims	20	36.36%		Muslims	-19.2728	-3890.92%
	Protestant Christian	5	9.09%		Protestant Christian	-4.8182	-972.73%
Educational Status	Illiterate	41	74.54%	Educational Status	Illiterate	-39.5092	-7976.38%
	Grade 1-6	8	14.54%		Grade 1-7	-7.7092	-1556.38%
	Grade 7-8	4	7.27%		Grade 7-9	-3.8546	-778.19%
	Above grade 12	2	3.63%		Above grade 13	-1.9274	-389.11%

Family Size	Less than 2 members	5	9.09%	Family Size	Less than 2 members	-4.8182	-972.73%
	3-4 members	30	54.54%		3-4 members	-28.9092	-5836.38%
	5-8 members	20	36.36%		5-8 members	-19.2728	-3890.92%

Table1: Socio-demographic characteristics of respondents.

Overview of plant distribution

Sources of household income: Farmers in the study area pursue mixed agriculture. Both crop farming and rearing of livestock were the dominant sources of household income. The occupational characteristics of a given society in one way or other determine the way that society interacts with their immediate environment. Thus it was found important to dig out information about the occupational characteristics of each sampled group. Accordingly, agriculture within the area is the main means of living. Agriculture makes about 73.21 % of the whole economic activities. The major types of income from agriculture are cereal crops 96.49%, firewood and charcoal production 79.65%, animal production 67.4%, vegetable 36.14%, spice products 21.05% (Figure 1). Production and trade occupies special charcoal about 79.65% which is the second choices for household uses. No matter how the rural peoples seem to be engaged in different activities they all do cultivate their land and produce crops. That is, almost all are agrarian even if they give attention to different income generating activities. Absences of alternative means of livelihood enforce the respondents to highly dependent on agricultural activities. In the study area, family size in household is increasing from time to time, as a result farm land owned by heads of household fragmented among the family members. Since there is no other alternatives economic activity, the only chance they have is to increase additional agricultural land at the expenses of vegetation. Some respondents says that, lack of other diverse nature of economic activities in their local area enforce us to produce charcoal and other forest product

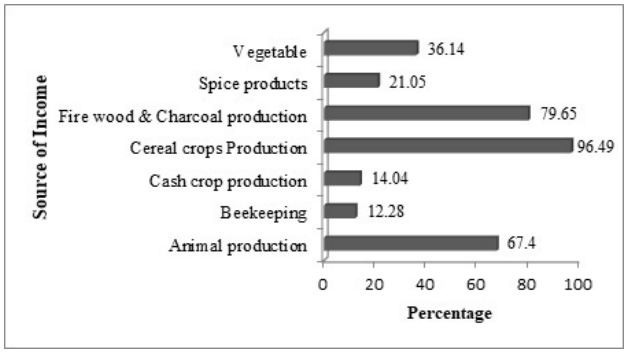

Figure 1: Sources of income for the sample informants.

Forest status in study area: According to the information from key informants, about 2% forests cover of the study area before 20 years ago. But today there was only 0.5% forests coverage, the remaining about 1.5% was deforested. Causes mentioned for forest depletions were expansions of agriculture, wood collection, settlements and urbanization. It was obvious that forests in the world had undisputed and vital role in sustaining nature and human environments. However, according to one of the producer perceived that the last two decades in the study area forests resource have been depleted for satisfying different needs of the communities. He/she added also that because of lack of alternatives for local communities, which being devastated their highly dependency on forests and its products. Among the producers, one of the producers in the study area said that expanding agricultural activities and charcoal production activities were the only options sustaining our life. According to the respondent, instead of using the land for forests, it was better for us to use for agriculture, because different agricultural products take few time to get the outcomes but, in case of forests it takes long time to get its outcomes. He/she also added regarding income generation, agricultural products took the highest contribution than forest products for local communities livelihood.

Perception and adoption of people for plant diversity

According to local source, forests used to support the livelihood of most rural communities. The farmers used to get different functions and services from the forest such as fire wood, herbal medicine, beekeeping, house construction materials, food, etc. However, decrease in forest area coverage in the study area was indicated as indicators of decrease in functions and services of forests. One of the producer said that the last few decades forests were depleted and even currently the local communities supplying forest products in the market as income generation. He also said that although forests were being used as income generation, but the communities were not in the condition that conserving forests resource rather than depleting and changing its area to agriculture. The producers in the study area perceived that forests were being depleted intentionally or unintentionally. He said that, forests depleted intentionally because of lack of alternatives for income generation for the communities' livelihood, to ensure their way of life, there should be immediate income sources to do so, forests are being exploited and its products are supplied to the market. The interviewee also added, forests were being exploited inadvertently because of lack of awareness creation for the local communities concerning protection of forests and other natural resources.

Importance of forest to local users

Interviewees proved to be very knowledgeable about the surrounding forest. People seemed genuinely concerned about the state of the environment surrounding their village and the overall state of the environment in the region. When asked about the importance of the forest, all of the respondents emphasized the importance of the forest in everyday life. All participants strongly expressed that the forest is an important component of their livelihoods. Based on this, the respondents had knowledge as tree if importance for prevention of soil erosion (26.77%) and followed by production of charcoal (23.62$) and construction purposes (20.47%) (Figure 2).

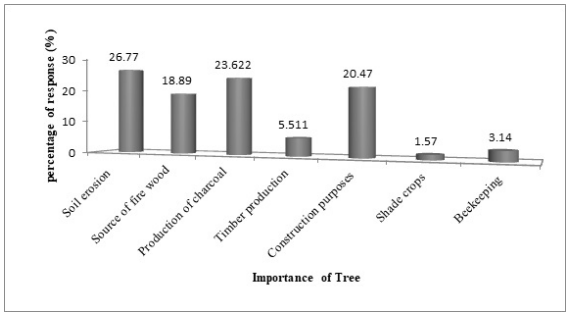

Figure 2: Some of the importance of tree.

The forest is used for fuelwood for local consumption, the collection of non-timber forest products such as fruits and honey along with bark and sap for medical uses, grazing of livestock, timber and grass to make roofs, timber and charcoal. Statements similar to this were heard in all villages regardless of the type of management around the village: Many of our activities are done in the bush. We need the bush even more when there is a poor rainy season. If we have short rains we must try to make money from the bush. We cut deadwood and make charcoal. We do this only out of need. It is not only us rural people who depend on the bush, town dwellers need it too. They buy the deadwood and charcoal and use them for cooking. Gas is too expensive so they too are forced to buy from us. If the rains are good, then we do not have to go to the bush as much, but only if the rainy season is good and we have enough harvest to feed our families. Since we live here, we have nothing but the bush. Some respondents emphasized they use the forest out of necessity. Interviewees described the necessity to make some money so they can by cereal crops, vegetable or other food to survive. If given the choice, they would much prefer not to make the daily trips to the forest to collect forest products. In many cases people expressed that the forest was used like a bank, although, generally more like a bank that only supplied money and received no reinvestment. If the agricultural yield is sufficient then they will not have to enter the forest to make charcoal or extract deadwood or timber for sale.

Plants preferred for charcoal production: During a survey in the main charcoal production basin Abeshige districts found that the production is focused on 15 plant species classified as the species of the first choice or species of category 1 among which *Acacia abyssinica*, *Acacia nilotica*, *Combertum molle*, *Acacia tortilis*, etc. are by far the most exploited species which provide the best wood for charcoal production. It is one of these species used in Togo and described as one of the preferred or category 1 species [10]. The interest shown in these species is related to the quality of their charcoal, which is highly valued by the consumers in the cities. Due to a lack of adequate policy in reforestation in Abeshige districts, these species are overexploited and many of them become rare. The charcoal producers are of the view that highly valued species (*Acacia abyssinica* and *Combertum molle*), are no more available. Apart from these first choice species, others are increasingly being exploited because of their availability. These species exploited by default or species of category or alternative species. They are 7 of number, *Eucalyptus camaldulensis*, *Eucalyptus glubules*, *Juniperus procera*, *Croton macrostachyus*, *Olea weliwitshi* etc. Some of these species are forest species and others occur in the savannas or woodlands [18]. The use of these species of the second category, mainly those used in reforestation. The choice of the resource is not only related to the energy quality but also to the availability. Therefore 16 woody species are popularly used for charcoal production.

Trends of charcoal production

Major source of energy: Almost 52.08% of the 25 producer interviewed in study area acknowledged having bought fire wood for heating. In the absence of the fire wood, up to 14.58% of those use charcoal; 8.33 % use of crop residue and 25% use dry dung.

Source of energy	Frequency	Percent's (%)
Charcoal	7	14.58
Firewood	25	52.08
Crop residue	4	8.33
Dry dung	12	25
Total	48	

Table 2: Frequency of producer use of the charcoal in household energy.

Almost 58.33% of the 20 consumer interviewed in Wolkite acknowledged having bought charcoal for heating. However, the frequency of use charcoal depends to the economic level of the household. In the absence of the charcoal, up to14.58% of those use firewood; 27.08 % the use of electricity (Table 2). In all case, the level of wood and charcoal consumption, despite the use of other energy sources, remains high and gives a dominant character to wood and charcoal as a source of energy in households. It is important to raise awareness of the alternative use of wood and charcoal; gas and petrol, crop residue, dry dung which would reduce wood and charcoal consumption. Equally the study in Malawi [19] shows that, larger cities consume about 6.08 million standard bags of charcoal per year. CHAPOSA reported that in Lusaka (Zambia), 65% of the households used charcoal as the only energy source while the rest of the households used charcoal in combination with firewood (23%), kerosene (17%) and electricity (1%) [20]. As for Dar es Salaam, 86% of the households used charcoal as their first choice fuel for cooking. But most of the households (88%) combine two or more types of fuels [21]. Contrary to this in developed countries (Western Europe and North America) there is decrease in per capita household wood (charcoal / firewood) consumption due to increase in use of fossils fuel (Table 3) [22,23].

Energy demand for household or domestic consumption	**Frequency**	**Percent's (%)**
Charcoal	28	58.33
Firewood	7	14.58
Electricity	13	27.08
Total	48	

Table 3: Frequency of consumer use of the charcoal household energy.

Major source of charcoal: The major sources of charcoal in study area some producers 53.01% from natural forest, 15.66% from shrub land, 13.25% from home garden, 9.63% from plantation forest and 6.02% from closure area (Figure 3).

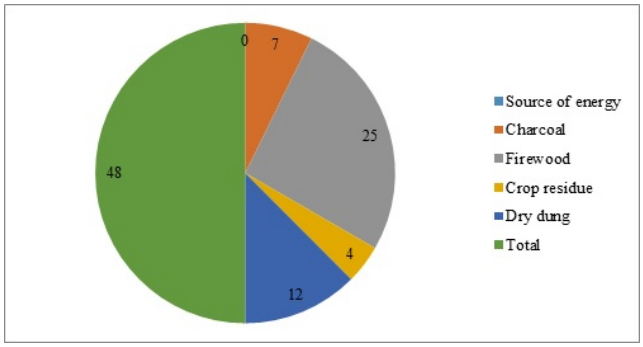

Figure 3: Major source of charcoal.

Similarly, studies by WRI indicated that two thirds of wood fuel (charcoal) worldwide comes from non-forest sources that includes alternative sources for collecting fuelwood from logging, home garden and from agro-industry plantations [24].

Species selected for charcoal production: A total of 17 species belongs to 13 genera and 11 families were identified which used to produce charcoal and other energy sources (Table 4). Acacia species and Combretum were the richest. The most used species to produce charcoal were Acacia abyssinica (60%) and followed by Acacia nilotica (32.72%), Acacia seyal and Combretum molle. However, Tchobsala quoted Combretum molle (Combretaceae), Eucalyptus camaldulensis and Acacia tortilis as the most used species to produce charcoal in the moist savannahs of Adamawa in Cameroon [11]. The surveys done by Mapongmetsem shown Acacia abyssinica was most used species to produce charcoal in Adamawa [25]. The choice of species to produce charcoal can be depended on two factors. The first factor is the availability of plant materials. Some species are very less used or not frequently used because there are few individuals of these species in the zone. The second factor to choice species for producing charcoal is based on the quality of the wood. Three important elements have repercussion on the quality of charcoal: the plant species, rate of humidity and rate of lignin. The hard wood produces more charcoal compared with light wood [26]. The excessive exploitation of charcoal and firewood causes desertification that it begins with deforestation leading to a sharp decline of the floristic composition. It is a source of degradation of the plant resources richness. This degradation concerns the irreversible extinction of biodiversity and the decline of reproduction potential of ligneous resources, pasturage, and soil fertility. It is important to integrate the wild species that are exploited to produce charcoal into the reforestation plans, especially multi-purpose species that are already considered to be endangered locally.

No.	Scientific name	Family name	Habit	Vernacular name	Frequency	Percent (%)	Rank
1.	Acacia abyssinica	Fabaceae	T	Girar/wachu (Amh)	33	60	1st
2.	Acacia nilotica	Fabaceae	T	Girar (Amh)	18	32.72	2rd
3.	Acacia seyal	Fabaceae	T	Dodot (Or)	16	29.09	3th
4.	Acacia tortilis	Fabaceae	T	Dedecha (Or)	13	23.64	4th
5.	Allophylus abyssinicus	Sapindaceae	T	Embus (Am)	5	9.09	8th
6.	Cardia africana	Boraginaceae	T	Wanza (Amh)	1	1.82	15th
7.	Combretum molle	Cuperssaceae	T	Rukesa(Or)	10	18.18	6th
8.	Croton macrostachyus	Euphorbiaceae	T	Bissana(Amh)	1	1.82	15th
9.	Dichrostachus cinerea	Fabaceae	T	Dare (Amh)	3	5.45	12th
10.	Eucalyptus camaldulensis	Myrtaceae	T	Key bahir zaf (Amh)	11	20	5th
11.	Eucalyptus glubules	Myrtaceae	T	Nech bahir zaf (Amh)	5	9.09	8th
12.	Junipeus procera	Cuperssaceae	T	Habesh tid (Amh)	3	5.45	12th
13.	Nuxia congesta	Loganiaceae	T	Chocho (Amh)	4	7.27	11th
14.	Olea welwitshii	Oleaceae	T	Woyra mesal (Amh)	5	9.09	8th
15.	Osyris quadripartita	Santalaceae	T	Keret (Am)	9	16.36	7th
16.	Terminalia browin	Combretaceae	T	Abalo (Amh)	1	1.82	15th
17.	Ziziphus spina	Rhammaceae	T	Kurkura (Or)	3	5.45	12th

Table 4: List of plant species used for charcoal production in study area.

Reasons for charcoal production: Major reasons people produce charcoal from different plants in their locality was for domestic use (56.66%), market to generate money (43.33%). The subsequent factors account for the high patronage of charcoal production in the study area for different purposes as private level. Higher income generated from charcoal production for: Food and other household goods

43.24%, Schooling 35.13%, Housing 10.81% Health/medicine 6.75% and Transporting 4.5% (Figure 4).

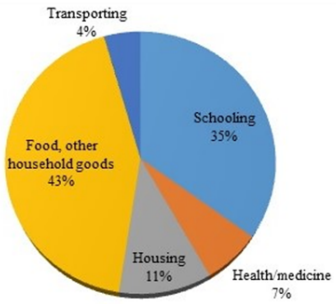

Figure 4: Reasons that shows why people involve in the charcoal production.

The income earned by individual producers in the course of production is a major influential factor of steadiness of the activity. As rural livelihoods are intricately linked to the natural environment, making the charcoal problem a delicate one to solve. The high incidence of poverty and food insecurity in the community is as a result of the single rainfall regime which supports one season rain fed agriculture. Commercial charcoal production is thus a significant source of livelihood providing incomes to support households especially during the long dry seasons [27]. Producers of charcoal also aim at profit in profit maximization. The price of charcoal was higher in especially the rainy season and hence a motivating factor for an individual producer to produce more. Producers engage in other activities such as farming, trading among others but the charcoal production is seen as the fastest way to income generation especially during the rainy seasons when prices of charcoal and wood fuel are higher.

Parts of tree used for charcoal production: Based on intensive information collected from informants of the district, different parts of plants used for preparing of charcoal. Therefore, they used mostly root and stem (100%) and followed by stems (67.27) and roots (58.18%) (Figure 5). But the rest part of the plants had insignificant uses for charcoal production. These parts of the plant prepared primarily from tree growth form only.

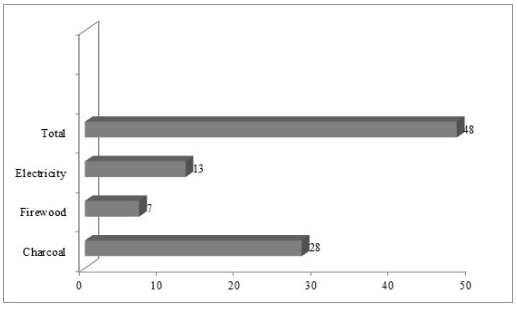

Figure 5: Parts of tree used for charcoal production.

Charcoal production Techniques: Charcoal is a very important energy source for households. Charcoal production is an important economic activity in most rural areas of developing countries, and an important source of energy in developing countries [28,29]. Charcoal is a black, porous material, containing 85% to 98% carbon, derived from wood or woody biomass. *Acacia abyssinica* is the most appreciated species for charcoal burning throughout the study areas. The Common harvesting methods observed at the time of the study were either to set fire at the base of the tree or cut it at 40 cm above the ground level. These types of harvesting trees for charcoal will never make possible for trees to regenerate again. Thirteen charcoal producers who were inquired why they preferred live trees responded that they have no other alternative as deadwood is almost completely exploited. Charcoal is produced in a three step process. First select trees are cut. Second, the cut wood is stacked into a kiln and covered with a layer of grass and sand. Finally, the kiln is lit and left to burn slowly for up to three weeks. At this point the charcoal is ready to be collected into bags and sold either to charcoal merchants or individually along the roadside. With regard to charcoal production technology, two types of kilns were observed across the study area. The pit/trench kiln is practiced in mountain areas where the surface mound kiln is not in use due to in availability of enough soil to cover it, whereas in valleys, surface mound kiln is used. Despite, variations in sizes of the pit kilns, the average one is 1.3 meter deep, 1.70 m wide and 2.60 meter long. Before woods are stacked into the pits, they are cut into stumps of about 1m long to avoid open spaces for air penetration. Woods are arranged horizontally leaving open spaces in the center of the pit. This space is filled with a combustible material from Forbes species to make fire spread effectively down to the pit during the burning process. The average production of a medium kiln is 10 sacks each time. Many charcoal producers prefer to use the same sizes of the pit kilns to average 1.80 wide and 2.75 meter after the kiln is prepared, during subsequent periods of charcoal production, the charcoal producers must only do a quick tilling of the soil in order for it to be ready for a new kiln to be constructed in the same location [30]. To produce this quantity one needs 2 or 3 days to dig the pit, one day for arranging the wood, one day for burning and one for cooling. The other kiln is surface mound type, designed as Gurage traditional house with strong pole erected at the center (1.50 m high) to hold it from the ground. Other woods of lengths 1m are positioned around the center pole. It is then buried with sand and iron sheets, and finally set to fire from the top. Both kilns need to be closely supervised during the carbonation process to prevent the charcoal to burn into ashes. The study observed that the respondents commented that lack of modern tools and the use of traditional method of charcoal making results into shortage of production charcoal average 10.5sacks per month (127.75 sacks per year) and shortage in the market. The study by Girard observed the same that traditional methods of charcoal production that are still persist today in many developing countries, are often produce very low yields with low quality of charcoal product because it is difficult to maintain uniform carbonization [2].

Quality of charcoal: Charcoal will go further if it is used efficiently and if its quality is optimum for the particular end use. Charcoal quality can be specified and measured in various ways which are usually derived from the end use requirements; some of these ways are moisture content, volatile matter, ash content and duration time. The least demanding market for charcoal quality wise the domestic one. According to majority consumer said that the weight of the charcoal is also a determinant of its quality. Quite often, good charcoals are usually heavy, while the bad ones are likely to be very light; in addition to this some producer said that, Charcoal of satisfactory market quality can be made in kilns of any size or type when suitable coaling temperature and time conditions are present. The reasons are that

performance cannot be measured easily; the power of consumer as individuals to specify and obtain good quality is minimal. Similarly good stocks for hardwood charcoal contain considerable low moisture contents, low ash contents and very minimum volatile matter contents. Another good quality of hardwood charcoal is to be in good sizes usually between 20 mm -120 mm and relatively high carbon contents to suit any usage [31].

Charcoal Marketing: Most charcoal coming to towns is produced, transported and retailed illegally (Figure 6). But, these acts are very much tolerated, or there is no public body to enforce the rules. The main actors directly involved along the charcoal marketing chains include producers, distributor's transporters, wholesalers, retailers and consumers. In Wolkite, the charcoal transported to the town through the few gates is delivered to distributors stationed at different corners of the town. Small retailers buy charcoal from distributers; producers are also engaged in retailing charcoal. As the charcoal commodity is moved from the point of production through markets to consumers, it incurs various costs: production, transportation, taxation and other informal costs. Thus, it is problematic to accurately present the cost-benefit distribution of the business along its chain. What is obvious at this point is that the current charcoal production system does not take the tree resource into account. This is mainly because charcoal makers produce charcoal from state or communal forest resources free of charge.

Figure 6: Ready markets for charcoal and transportation of charcoal.

Impacts of Charcoal Production: During the study, the team placed more emphasis on the practice about the negative impact of charcoal production on the fragile ecosystem as woodland resources are currently experiencing an extensive degradation, through charcoal production, building materials, and overgrazing. In addition to cutting trees for charcoal production, forbs and herbs are also collected and used as easily combustible materials during kilning [32,33]. The surface mound kilns, also damage the top soil, through digging and burning during the production cycle. Moreover the area where surface mound kilns are erected/ established will not be re-vegetated even if rain drenches.

Health effects of charcoal production and use: The main activities in charcoal production which contribute to health complaints among producers are kiln building which causes physical injuries and strain and kiln tending during carbonization, kiln breaking and charcoal bagging that cause burns, respiratory difficulties and poisoning as result to heat, smoke, gases and dust that a regenerated through these activities. The health problems associated with cutting and kiln buildings are injuries and muscular strain while those associated with carbonization and kiln breakings are burns, respiratory impairment and accidents. A single study performed in one charcoal production area north of Lusaka indicated that the ten most prevalent complaints among charcoal producers [34]. Charcoal is used for cooking. Women who do most of the cooking are subjected to the highest health risks associated with urban charcoal burning. Poisoning, respiratory impairment and burns are the common health risks caused by gases, smoke and heat generated during charcoal burning. During burning of charcoal for cooking and space heating, smoke, heat, gases and ash are generated which may cause burns, respiratory impairment and poisoning. Generally, urban women who use electricity for cooking enjoy a higher social status than those that cook with charcoal. The main differences being that electricity users have larger houses and better sanitation. However, in spite of these differences the health status of electricity users was only marginally better than that of charcoal user. WHO standards on respire able particulates include sulphur dioxide concentration which was not measured in this study [35]. But it is apparent that exposure to respire able suspended particulates among charcoal users is not a significant health problem.

Plant diversity/Biodiversity: Harvesting of wood for the production of charcoal does significantly change the structure and species composition of the forest. Species diversity was significantly lower in harvested than undisturbed plots. Only common species are regenerating at rates to rates capable of replacing the existing population. Uncommon species, specifically large hard wood and fruit trees lack sufficient numbers of seedlings and saplings to replace current populations. Local people interviewed described changes that have been occurring in the forest in recent memory. In some people's opinions the forest, or bush, had changed to such a degree that it could no longer be called by the same name. A forest full of wildlife and diverse tree species was gone, replaced by a space without animals, few large or fruiting trees and only a handful of dominant tree species. Many believed that the harvesting of wood for charcoal production was part of this change. Charcoal workers cut the forest, and even though the forest regrows, they still negatively altered the landscape by cutting trees. Forest structure and tree species composition and richness will be less in areas of charcoal production when compared to areas of no production [36].

Loss of vegetative cover

The economic and agricultural activities undertaken by residents of Abeshige is a major determining factor of the nature and density of the vegetation. Natural and most importantly human activities course destruction to the environment there by reducing the ambient nature of the bio-physical environment from the study conducted, it was revealed that charcoal and wood fuel activities contribute to the loss of the vegetative cover in the community the frequent felling of trees for charcoal and firewood coupled with farming activities leads to the depletion of valuable tree species. Extraction wood for charcoal has biological impacts such as reduced faunal abundance [32,33] and biodiversity [37]. Additionally, in extreme cases such changes are expected to culminate in changes in weather patterns and, in drier regions, desertification [37]. In the literature researchers observed that the harvesters of the trees cut about 40cm above the ground level such as axes, cutlasses at times chain saws with the hope of enabling the forest to rejuvenate; but it was found that trees cut in the community could not rejuvenate. This means that the situation applies to Wolkite

community; Out of the 20 producers interviewed 98.43% did not replace trees cut whilst 1.57% did. The situation if continued, could lead to the extinction of the tree. Apart from the loss of foods and livelihoods as a result of the cutting of the economic important trees, medicine, feed for animals building materials tree are also lost [38-40].

Loss of soil fertility: All of the charcoal producers use the earth mould method which inflicts the damage to the vegetation. In the process of the production, the grasses are lost, the heat from the earth mould kill off micro bacterial organisms in the soil rendering the soil infertile for a long time. The process often causes bush fires which has implications for the sustenance of flora and fauna in the community [41-43]. Fuelwood extraction has been cited in increasing soil erosion reducing soil moisture content and decreasing soil fertility as nutrient leaching is increased while vegetative recycling of subsoil nutrients [32,33].

Drying up of water bodies: Trees in the catchment area of the streams fell for charcoal and wood fuel activities expose the water bodies to direct sun shine. As a result there is a reduction in the volumes of the streams which are already seasoning. This eventually leads them to drying up hence affecting aquatic eco-system, domestic consumption and the prospects of setting up an irrigational facility. This supported the literature that harvesting of trees for solid fuel also destroy the eco-system and the habitats of animal species which exposes water bodies to the risk of drying up which is gradually affecting the rainfall pattern and climatic conditions of the country [44-47]. Fuelwood extraction has been associated with more extensive effects including reservoir siltation, flooding, and water shortages due to shifting ground water regimes [32,33].

Plant conservation challenges

Local knowledge played important role on conservation of natural resources including forests not only in the study area but also around the world. During interviews of respondents were asked if their saw and willingness on the communities to carry on with the protection and conservation of natural resource including forests, and in light of this, whether they say any potential for a community-based collective action in the study area. Majority of the producers argued that most households in the study area had no a tradition of plantation of trees [48]. Only a few respondents believed that community would be willing to take up the task of conservation, which was not at all surprising considering the very small size of the tree plantation in the study area [49,50]. Most of the factors identified by the majority of the producers as the cause of community unwilling to carry on conservation were: lack of the flow of tangible benefits to farmers, the ambiguous nature of their ownership, and the ordinary farmers understanding that the conservation of tree plantation was not his business unless he was paid to do so and etc. These were some of the factors which led for the local communities unwilling to carry on the tasks of conservational activities in the study area. There was no way that people would be interested in working for the common welfare, regarding tree plantations, without food payment. According to some informants, people have never been and are still not interested in working on community activities without payment. One of the key informants in the study area perceived that it was better to emphasize a change in work style, in addition to the need to individualizing planting of tree plantation. Another informant, made a strong emphasize for individualizing tree plantation that means, when it was a matter of ownership by one or two people, then the owner can himself protect the trees. Some of the informants said that most of the farmers in the study area highly depend on land and forests resources. Because their livelihood was based from mixed agriculture in majority and also use of forest products (special charcoal) as income generation. One of the interview said that protection of forest in the study area has not employed by the majority of the communities rather some of them who has awareness and access of training concerning on conservation of forest was made good decision for enhancing environmental stability. From the above key-informants perception, it was possible to say that local community played important roles for protection of natural resources particularly forests [51,52].

Current management practice

The charcoal production has brighter days ahead to damage more the natural ecosystems and contributes more to the loss of the biodiversity because of the failure of the forestry policy. This authors show that there is a very significant decoupling between the policies and laws enforcement by the officials in charge of the protection and management of the environment. The direct consequence of this situation is the anarchical trees logging by the farmers for firewood and charcoal supply [53]. According to data from zonal and woreda sector, Ethiopia has formulate some relevant policies such as Environmental protection policy, Biodiversity conservation research policy and federal forest policy. Further regional states have issued their own provision to fill existing gap in forestry sector. All these regional legal documents in one ways or the other supportive the conservation, development and sustainable use of forest resources. However, even if these guide lines are formulated the producers are not adapted to actual realities in terms of protection and regulation of forest products movements; more over the producers concerned at first place by the protection of the ecosystem are not aware of any laws. According to Gurage Zone Rural and Agricultural Development Office [38] the action to be taken to reduce forest resource degradation are building institutional capacity; need to capacitate human, the material and the financial resources of the responsible institutions, implementation of community based forest management programs and introduce alternative energy sources. According to Gurage Zone Rural and Agricultural Development Office he said that experienced tree growing in some closure area to rehabilitate degraded land and to control soil erosion problems". Some of the tree species are Acacia dicurrence, Acacia saligna, Gravillia robusta and other grass species such as Elephant grass and Desho grass. According to Gurage Zone Rural and Agricultural Development Office, all communities (Mother, Father, children, government merchants, private organization and Students) have responsible to manage forests surrounding them. Cutting of any live tree, inside or outside demarcated forest parks and within Rural Community forests, is illegal and people wishing to produce charcoal must first obtain a permit from the Forest Service [54].

Conclusion and Recommendations

The aim of this study looked at the charcoal production and its impact on plant diversity and conservation challenges in and around Wolkite. A combination of qualitative and quantitative methodological approaches was used in data collection and analysis. These methods include: questionnaire and interview. Conclusively, the study showed that the districts environmental resources are becoming over exhausted specifically the vegetation. Wood, flowers, herbs, grasses, stems, roots, leaves as well as fruits are on the degeneration due to non-replacement of trees. The used plants species to produce charcoal

are numerous and various. They are quoted multipurpose because they can be used for other need as medicinal, timber, fruit or essential oils and exudates. The choice of species to produce charcoal can be depended on two factors.

The first factor is the availability of plant materials in the area. The second factor to choice species for producing charcoal is based on the quality of the wood. The person involved in charcoal can be divided into three categories: producers, consumer and trader. Due to the over extraction of vegetative resource without replacement, the existence of imbalance to the extent that even if this resource is left unharnessed to regenerate, it would take many years for it to reproduce and for an environmental balance to be achieved. The environmental degradation concerns the irreversible extinction of biodiversity and the decline of reproduction potential of ligneous resources, pasturage, and soil fertility. It is important to integrate the wild species that are exploited to produce charcoal into the reforestation plans, especially multi-purpose species that are already considered to be endangered locally. The result of investigation revealed that the plant diversity in the study area was progressively being depleted. While the majority of the communities, entirely depends for their daily livelihood on the local environmental resources. Thus, conservation and sustainable utilization of these resources are crucial. Therefore, in order to alleviate the challenges, it may better to take the following measures:

- The government should create job opportunities for the communities in order to reduce their dependency on forests resource
- Forests resource should be managed by the stakeholders, in order to ensure environmental sustainability
- Promoting environmental education and awareness
- The local community should have a habit of planting various trees species on sustainable way
- Natural resources including forests should be considered in its utilization and management by governments and private owners
- Facilitate the expansion of alternative energy sources, training, and fuel saving technology diffusion in order to reduce dependency on fuelwood and charcoal
- The local knowledge should be supported by scientific knowledge in order to fill their gab concerning environmental protection
- Capacity building should be given for the local community concerning on environmental conservation

References

1. Ribot JC (1995) From exclusion to participation-turning senegal forestry policy around. World Development 23: 1587-1599.
2. Girard P (2002) Charcoal production and use in Africa: What future? Unasylva 211: 30-34.
3. Post J, Snel M (2003) The impact of decentralized forest management on charcoal production practices in eastern senegal. 34: 85-98.
4. Fontodji KJ (2007) Impact of charcoal production on biodiversity in togo. 217-230.
5. Thiam TA (1991) Etude de marché des produitsforestiersligneux au Togo 225.
6. FAO (2002) Global forest resources assessment. Food and Agriculture Organization of the United Nations, Rome.
7. De Montalembert M, Clement J (1983) Fuelwood supplies in the developing countries. FAO forestry paper 42.
8. O keefe PR (1985) Fuelwood in kenya crisis and opportunity. Ambio 14: 220-224.
9. Arnold, Person R (2003) Reassessing the fuelwood situation in developing countries. International Forestry Review 5: 379-383.
10. Leach G, Mearns R (1988) Beyond the wood fuel crisis: people, land and trees in Africa London: Earthscan Publications.
11. Kokou K, Nuto K (2009) Assessment of charcoal production and impact of environmental policies in limited forest resources countries: The case of Togo, West Africa. Discovery and Innovation.
12. Tchobsala (2011) Impact of logging on natural vegetation in the peri-urban area of Ngaoundere (Adamaoua). Thesis of Doctarat / PhD. University of Yaounde I 204.
13. Amede T, Belachew T, Geta E (2001) Reversing the degradation of arable land in Ethiopian highlands. Managing African Soils No. 23. London: IIED.
14. FAO (2003) Forestry outlook study for Africa. African development bank, European commission and the food and agriculture organization of the united nations, Rome.
15. FAO (2005) Global forest resources assessment. FAO Forestry Rome.
16. FAO (2008) State of the world's forests. Food and Agriculture Organization of the United Nations, Rome.
17. Bongers F, Tennigkeit T (2010) Degraded forests in eastern Africa: Management and restoration.
18. Abbiw DK (1990) Useful plants of Ghana. Kew: Intermediate Technology Publications.
19. Kambewa P, Mataya B, Sichinga K, Johnson T (2007) A study of charcoal consumption, trade and production in Malawi.
20. Chaposa (2002) Charcoal potential in Southern Africa. INCO_DEV: International cooperation with developing countries.
21. Ishengoma RC, Ngaga YM (2000) Wood fuel consumption in urban areas of Tanzania. Consultant report ministry of natural resources and tourism.
22. FAO (2013) Global forest products facts and figures.
23. FAO (1986) Highlands reclamation study ethiopia final report. Rome, Italy.
24. World Resources Institute (2000) People and ecosystems. The fraying web of life: United Nations Development Programme, United Nations Environment Programme, World Bank and World Resources Institute.
25. Mapongmetsem PM, Akagou Zedong CH (1997) Situation of firewood in the humid savannahs of Adamaoua. 42: 29-33.
26. Sponsel F, Leslie E, Headland TN, Bailey RC (1996) Anthropological perspectives on the causes, consequences and solutions of deforestation. In: tropical deforestation: the human dimensions. Columbia University Press, New York.
27. Arnold JEM (2006) Wood fuels, livelihoods, and policy interventions: Changing perspectives-elsevier publishing ltd: global rights department, London.
28. FAO (2000) The challenge of rural energy and poverty in developing countries", World Energy Council/Food and Agriculture Organization of the United Nations, London.
29. Stassen HE (2002) Nuevas tecnologias de produccion de carbon vegetal. Unasylva 211: 34-35.
30. Bah A (2007) Interview with charcoal producer. Tambacounda, Senegal.
31. NNPC (2007) Nigeria on the march to bio-fuels, news flash from corporate headquarters OECD/AfDB, "African Economic Outlook: 2003/2004"; office of the special adviser to the president on energy (OSAPE), Draft of the national oil and gas policy.
32. Ogunkunle ATJ, Oladele FA (2004) Ethnobotanical study of fuelwood and timberwood consumption and replenishment in Ogbomoso, Oyo State, Nigeria. Environmental Monitorinand Assessment 91: 223-236.
33. Oguntunde PG, Abiodun BJ, Ajayi AE, Nick van de Giesen (2008) Effects of charcoal production on soil physical properties in Ghana. Journal of plant nutrition and soil science 171: 591-596.
34. Ellegard A (1992) Health effects of charcoal production from earth kilnsi in chisamaba area, Zambia. Stockholm Environment Institute.

35. WHO (1988) Seed and seedling ecology of Brachystegias piciformis a predominant tree component in miombo woodlands in south central Africa. Forest Ecology and Management 25: 195-210.
36. Bensel T (2008) Fuelwood, deforestation, and land degradation: 10 years of evidence from Cebu Province, The Philippines. Land Degradation and Development 19: 587-605.
37. Anderson D (1986) Declining tree stocks in african countries. World Development 14: 853-863.
38. Gurage zone rural and agricultural development office (2014). Annual report.
39. Abebe N, Endalkachew K (2011) Effect of charcoal production on soil properties in Southern Ethiopia.
40. Araya A, Yissehak D (2012) Sustainable household energy for addis ababa ethiopia, consilience. The Journal of Sustainable Development 8: 1-11.
41. African renewable energy access program (AREAP) (2011). Wood-based biomass energy development for Sub-Saharan Africa: issues and approaches. Washington.
42. Vos J, Vis M (2010) Making charcoal production in Sub-Sahara Africa sustainable. Biomass Technology Group (BTG).
43. Brewer W, Cypher A, Gress J, Neir S, Petitpren L (2010) Investigation of charcoal production methods for sajalices, Panama.
44. Chidumayo E, Emmanuel CM (2010) Dry forests and woodlands in Sub-Saharan Africa.
45. CHF International (2006) Grassroots conflict assessment in the somali region. Ethiopia.
46. FAO (2000) "The challenge of rural energy and poverty in developing countries", World Energy Council/ London.
47. Bailis R, Pennise D, Kammen DM, Kituyi E (2004) Impacts of greenhouse gas and particulate emissions from woodfuel production and end-use in Sub-Saharan Africa.
48. Malimbwi RE, Mugasha AG (2001) Inventory report of Kitulangalo forest reserve, Morogoro, Tanzania. Forest and Beekeeping Division, Dar es Salaam 43.
49. Retrieved (December 2012) at: http://www.ethiodemographyandhealth.org/Ethiopian_Demography AynalemAdugna.pdf Bailis R, Pennise, Ezzati M, Kammen D, and Kituyi E (2004).
50. Tappan GG, Sall EC, Wood MC (2004) Ecoregions and land cover trends in Senegal. Journal of Arid Environments 59: 427-462.
51. United States Environmental Protection Agency (EPA) (1995) Emission Factor Documentation for AP-42: Section 10.7 Charcoal. EPA.
52. Williams M (2006) Deforesting the earth: from prehistory to global crisis: an abridgment. Chicago: The university of Chicago press.
53. Bogale W (2009) Preparation of charcoal using agricultural wastes. Ethiopian Journal of Education and Science 5: 79-91.
54. Paper presented at annual conference of the association for tropical biology and conservation and society for conservation biology Arusha, Tanzania (2012) Christian Science Monitor.