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Full Length Research Paper

Impact of Human Activities on Ground Water Forests of Arba Minch: A Case Study from Ethiopia

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ABSTRACT

The availability and quality of clean water in many regions of the world is increasingly threatened by human induced changes. In this regard, the relationship between forests and water is a critical issue that must be accorded high priority. A study was made for three consecutive months (December 2007, January and February, 2008) in the Arba Minch Ground Water forest which is the best component of Nech Sar National Park, to determine the impact of human activities on the forest and associated natural resources within the Nech Sar National Park. Five check points namely '*Green land', 'Moter sefer', 'Dorze Sefer', 'Konter sefer*' and '*Kulfo Bridge'* were identified for the data collection and five technicians were assigned to record the people who were entering and coming out from the park including the different products they have collected from the surrounding forest. The result showed that for only 21 days, 3078 people have entered the forest to collect different forest products. The effect of the product collection on the flow of springs and ground water was also observed. The result also indicated, on average 147 people have entered to the park per day to collect different forest products. The highest number was observed for people who were collecting fuel wood amounting 58% were women followed by grass collectors (10%), split wood collectors (3%), pole collectors (5%), fruit collectors (5%) and 19 % were observed coming out with no products. With regard to the type of sites, higher human pressure was recorded and significant differences ($P<0.05$) was observed at Moter Sefer and Konter Sefer. Therefore the park managers and the wildlife scouts of Nech Sar National Park should design better patrolling activities to conserve the forest, fauna and the forty springs.

Key words: *Arba Minch, Forest Product, Ground water forest, Human activity, Check points, National Park.*

INTRODUCTION

The availability and quality of clean water in many regions of the world is associated with the existence of the forest resources. However, the quality of clean water is increasingly threatened by human induced changes such as overuse, misuse, pollution and degradation of the surrounding forest resources. In this regard, the interaction of forests and water is a critical issue that must be accorded high priority (USDA, 2000; Hofer, 2007; Daive and Fahey, 2005; Hamilton, 2008; Blumenfeld, *et al*. 2009). The Arba Minch forest is the best component of Nech Sar National Park and is unique in its vegetation formation from which the miracle forty springs emanate. Currently, this forest is under great threats from the surrounding community particularly from Arba Minch Town. With increasing human population, demand for fuel and other forest products is also progressively increasing (Bolton, 1969; White, 1983; Kirubel Tesfaye, 1985; Duckworth *et al*, 1993; Mateos Ersedo, 2003; Demeke Datiko *et al.*, 2007).

Recent studies showed that the population size of Arba-Minch town has greatly increased from 2,830 in 1966 to 72,507 in 2005 (Elias, 2003; CSA, 2005). At present the rapid population growth of Arba-Minch is related to immigration of people from Gamo highlands, Wolaita and Gofa. This

dramatic increase of population coupled with the higher demand of fuel wood and construction materials create huge pressure on the Arba Minch ground water forests and Kulfo riverine forests. Along with the fast population growth and the development of Arba-Minch town there is a high demand for fuelwood and timber production by the urban dwellers and big institutions. For all these institutions the only source of heat and light energy for almost every household in Arba-Minch town and for villagers who live near the forest is the Arba-Minch forest. It is also used for construction of farm implements, fences, furniture and houses, serve as a source of food, feed and bee fodder, and provide other environmental and social services to the community (Duckworth, *et. al*, 1993; Lemlem Aregu & Fasil Demeke, 2006). Like in many other developing world water related climate change is also experienced in the form of more severe and more frequent droughts and floods (Laurance, W.F., 2004; Pearson and Dawson, 2005; UN-water, 2008).

This research study aims to assess the human impact and pressure on the Arba Minch forest and its effect on the associated natural resources which may used to call urgent actions from the concerned stakeholders and institutions.

MATERIALS AND METHODS

Description of the Study area

The study was conducted in Arba Minch forest which is located in Southern Ethiopia near Arba Minch town, 510 km south of Addis Ababa. (Fig. 1). Arba Minch forest covers about 2120 ha. Area. Geographically, it extends between $05^0$59`-$06^0$30`N latitude and $37^0$32`-$37^0$48`E longitude. The Kulfo riverine forest is located along the strip of Kulfo River and runs from Arba Minch town to Lake Chamo Bordering the ground forests in the east.

The climate of the study area is characterized by a relatively hot climatic condition with low and unevenly distributed rainfall pattern. The average annual rainfall of the woreda ranges between 750 to 1100 mm.

Data collection method

This study was conducted for three consecutive months (December 2007, January and February, 2008 for 07 days in a month) to have a comparable data and to determine the impact of human activity on the park, five check points of Nech Sar National Park with Arba Minch forest, viz., *Green land', 'Moter sefer', 'Dorze Sefer', 'Konter sefer' and 'Kulfo Bridge'* were selected (Figure 2).

The last week of each month was selected randomly and the same procedure was employed for the entire study period as similar study by Shiferaw Alem *et al*., 2010 has got significant results. Five wildlife technicians, one to each check point were assigned to record the information on the forest resource collection from the Arba Minch ground water forests and the assessment was done without actual contact to the illegal intruders to the park. To that end, both people entering to and coming out from the park were recorded including the forest products which they have collected from the forest area. The result from this information was summarized and was compared with the regular patrol data of similar week done in Arba Minch forest by the regular patrol activity of the park management.

Group discussion and interview were also made with the Nech Sar National Park scouts who has long experience in the park, with Park warden and the surrounding community to collect information on the stream flow status of forty springs and to see whether there is an effect on the stream flow as the forests disturbed by anthropogenic factors.

Data was analyzed using one-way analysis of variance (ANOVA) and Tukey's test (95% confidence interval). All statistical analyses were performed with SPSS version 12 for windows (SPSS, 2002) and MS Excel.

RESULTS AND DISCUSSION

Effect of human pressure from Arba Minch town

The results revealed that for the entire study period 3078 people have entered the forest to collect different forest products. This result also indicates, on average 147 people has entered the park per day. From the total people entering to the forest the highest number was observed for male (53%) and 47% were female. Among these the highest number was observed for people who were collecting fuelwood amounting 58%, followed by grass collectors (10%), split wood collectors (3%), pole collectors (5%), fruit collectors (5%) and 19 % were coming out with no products from the forest. The result indicated the record which is done only for day time monitoring from 6:00 am – 6:00 pm.

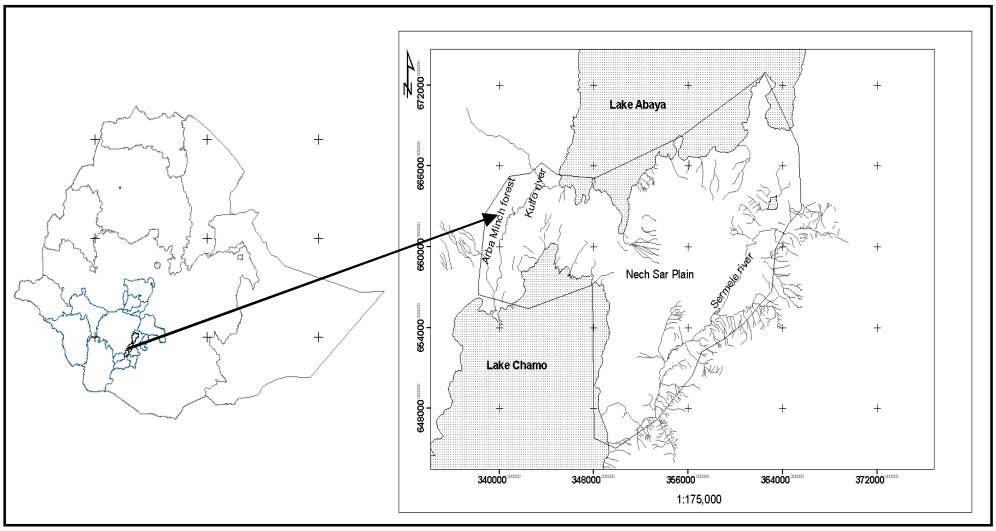

Figure 1. Map of Study area

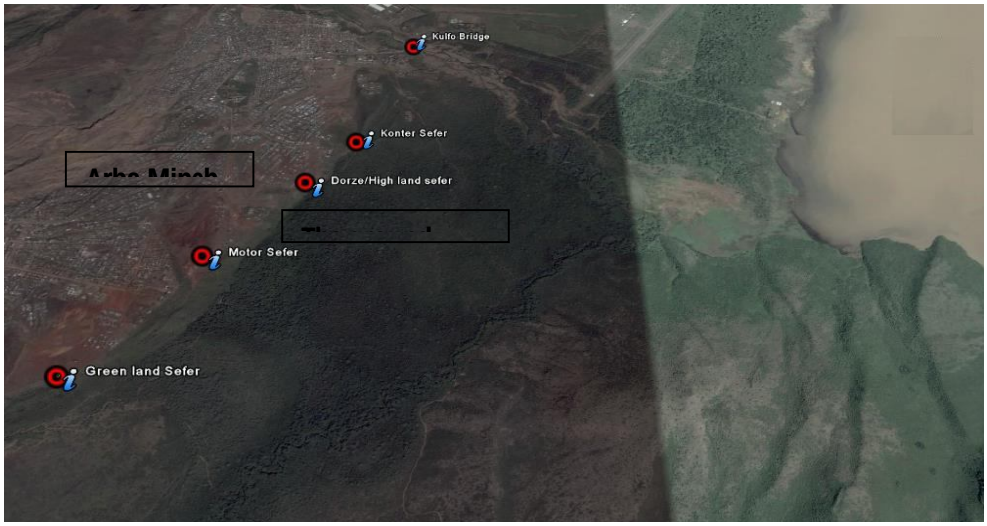

Figure 2. Sample check points on Google earth digital image.

The women were more concentrated in collecting fuelwood, whereas the male population was involved in collecting grass, pole and split wood. This result is supported by other studies that forest dependence among rural and peri-urban communities is high with women particularly conspicuous in their roles as firewood sellers in and around most towns and cities (Abebe, *et.al,* 2009). With regard to the type of sites, higher human pressure was recorded at Moter Sefer and Konter Sefer as they are far from the main road. Forest is the main source of income and energy for many developing countries and collecting forest products is a daily livelihood activity for many citizens. In Uganda the subsistence forest users derive 40% of their income from the forest. In Ethiopia, people living around the forest area are involving in the collection of Non-Timber Forest Products and support their livelihood with the income from forest resources. For instance, the local communities around Menagesha suba Forest drive 27.4% of their annual income from NTFPs of Menagesha Suba Forest. (Aryal, 2002; Aramde Fetene, 2006). Likewise, people in Arbaminch town also obtain significant share of their annual income from Arbaminch forest. However, the utilization in Arbaminch forest is different in that not only the forest is depleted but also the wild animals and the hydrological regime are equally affected.

Human activity also analyzed from geo-referenced regular patrol data from the park scouts for equivalent days (seven days per month for three consecutive months) and exactly at the same weeks of the months when purposive monitoring activity was conducted. The result form this data indicates that only 131 people were recorded for 21 days which is by far less than the purposive monitoring. Hence, a significant difference was detected from the two monitoring data which is a good indicator for the managers to change patrolling strategies to secure the park resources from an increased human pressure.

Within the 21 days, scouts covered 1848 km. patrol in the park. However, patrolling the park in this manner is only important to collect up-to-date biophysical information, but it is less effective in controlling poaching and illegal harvesting activities. This incidence was detected under the management of African Parks Conservation which has been engaging with full capacity of financial and human resources. Unless urgent action is taken by the government, following the withdrawal of African Parks from the Management of Nech Sar National Park, the problem will persist progressively and we will be losing our unique resources (the Arba Minch ground water forests and the forty springs) which are closely coexisting The statistical test also confirmed that human pressure on the forest with respect to check points, showed significance difference ($P<0.001$) (Table 1).

The check point to the forest locally called 'Motor Sefer' showed a big difference among others. This might be because the area is easily accessible to enter to the park and patrolling activity in this particular site might be poor in relation to other sites. Therefore, urgent action should be taken in this area by designing appropriate patrolling mechanisms and deploying sufficient and strong manpower to secure the forest from radical loss. The result from the comparison of three months did not show significant difference for many human activities of Arba Minch forest (Table 2). However, for some human activities like fuel wood collection significant difference was observed ($p<0.05$). The highest number of fuel wood collectors was observed in December and January which can be attributed to the demand of high fuelwood for the celebration of Holey days like Ethiopia Epiphany.

Impact of forest disturbance on the stream flow

The result from the group discussion showed that the stream flow from the forest is decreasing. Although, there is no quantitative data to describe the extent of the impact of forest disturbance on the forty springs, the information from the park scouts and the Warden of Nech Sar National Park clearly indicates the temporal variability of stream flow during wet and dry season. In fact, in the earlier times, the forty springs were providing constant water supply to the lake Chamo unlike the present fluctuation of stream flow between the dry and wet season. This is an important indicator that deforestation in the ground forests resulted in the reduction of water flow. Several studies have shown strong relationship between vegetation and the hydrological cycle in that vegetation has a direct influence on controlling erosion, water quality, nutrients, watershed protection, and water production (Cheng, 1989; Kassa Tadele and Gerd, 2007). Vegetation removal leads to several changes, including a decrease in photosynthetic rates and evapotranspiration where the decrease in evapotranspiration has an impact on precipitation, thus impacting stream flow and hydrological response (Wright et al., 1990; Cornish, 1993).

The impact does not stop only by reducing the stream flow, but also has resulted in the disturbance of the downstream resources. As the vegetation is disturbed, the incoming rain fall cause erosion where the water move in the surface layer rather than percolating to the soil to increase the ground water storage. Because of this reason, the flora and

Table 1. Comparison of Human activity in Arba Minch forest along different entrance gates to the forest

Human activities	Observation sites					
	Green land	Motor Sefer	Dorze sefer	Konter Sefer	Kulfo bridge	Sig.
Total human entering in to the park	21.19±2.54[b]	53±4.15[a]	28.05±4.03[b]	27.57[b]	21.47±4.25[b]	***
Total male entering in to the park	11.84±1.64[b]	29±2.31[a]	17.67±3.47[b]	14.38±2.61[b]	9.89±2.13[b]	***
Total female coming out from the park	10.38±1.54[b]	25.3±2.57[a]	11.32±1.39[b]	13.19±1.26[b]	12.22±2.53[b]	***
Total human coming out from the park	32.52±3.62[a]	45±6.95[a]	20.89±2.58[b]	22.76±2.36[b]	16.39±2.09[b]	***
Total male coming out from the park	20.55±2.43[a]	23.57±3.83[a]	10.05±1.74[b]	12.05±1.61[b]	8.2±1.19[b]	***
Total female coming out from the park	12.95±1.66[b]	21.43±3.5[a]	10.84±1.99[b]	10.71±1.73[b]	9.56±1.72[b]	**
Fuel wood collectors	16.38±1.85[b]	25.71±4.13[a]	14.53±2.51[b]	16.71±2.15[b]	15±1.84[b]	**
Split wood collectors	14.5±10.5	5.29±2.08	3.5±1.5	1.00±0.00	1.00±0.00	ns
Pole collectors	2.25±0.62[b]	7.07±1.38[a]	3.00±0.58[b]	3.33±0.65[b]	3.33±0.65[b]	*
Grass collectors	14.42±2.56[a]	4.00±2.52[b]	2.71±0.47[b]	4.2±1.11[b]	4.00±2.00[b]	*
Fish collectors	2.5±1.5[b]	7.5±5.5[a]	1.6±0.16[b]	2.33±0.42[b]	1.67±0.33[b]	*
Fruit collectors	4.00±2.00[b]	3.25±1.10[b]	13.75±3.15[a]	12.5±5.19[a]	2.00±00[b]	*
Human coming out from the park with no products	4.75±0.95a	25.44±5.32b	3.75±0.95a	2.75±0.48a	10.00±00a	*

*Tukey HSD, ab= means across the rows followed by the same letter of superscript do not differ significantly (p > 0.05), SE = standard error, *** = p<0.001, ** = p<0.01, * = p<0.05 and ns = non significant.*

Table 2. Comparison (mean±SE) Human activity in Arba Minch forest for three months

	Months			
	December	January	February	Sig.
Total human entering in to the park	29.94±2.89	28.03±4.00	33.61±3.26	ns
Total male entering in to the park	13.30±1.62[b]	16.16±2.79[b]	20.79±2.06[a]	*
Total female coming out from the park	16.42±1.47	13.03±2.56	10.22±1.02	ns
Total human coming out from the park	29.70±2.64	29.29±5.00	24.78±2.16	ns
Total male coming out from the park	14.60±1.83	16.26±2.69	15.03±1.70	ns
Total female coming out from the park	16.42±1.47a	13.03±2.56b	10.22±1.02b	*
Fuel wood collectors	22.54±2.04[b]	17.20±2.61[b]	13.59±1.28[a]	*
Split wood collectors	8.5±3.86	9.5±3.86	2.83±0.60	ns
Pole collectors	4.71±1.21	5.36±1.13	2.5±0.76	ns
Grass collectors	9.08±2.41	7.57±2.91	10.19±2.96	ns
Fish collectors	3.00±1.00	2.00±0.33	2.58±0.96	ns
Human coming out from the park with no items	5.75±1.49[a]	21.9±5.66[b]	4.71±1.21[a]	*

** = p<0.05 and ns = non significant.*

fauna in the lake Chamo and the surrounding areas will be affected from pollution and extreme flooding during the rainy season. Haigh et al. (1990*)* supported this idea in that as deforestation increases, flooding becomes more serious because of the increased volume of water in the environment, because of the increased frequency and volume of surface runoff and because of the rising levels of affected river beds.

CONCLUSION

It is found that the Arba Minch Forest is the main source of fuelwood for Arba Minch town and the impact of human pressure on the Arba Minch forest is high which poses serious threat to many springs

emanating from the ground. Even though the forest is the best components of Nech Sar National Park, an increasing demand of forest products from the surrounding community resulted in a big problem for the ecosystem Management. If the current scenario continues, the local community would lose any benefit that it might obtain from the park resources and the associated wild life would be in a great risk. The forty springs discharged from this forest which is the major tributaries of Lake Chamo and the sources of Arba Minch town water supply are in danger of water flow variability. Hence, the destruction of the forest affects not only the wild animals existing in the ground water forests but also the downstream resources, the Crocodile, Hippopotamus and fishery resources in the Lake Chamo. With this fast rate of deforestation, the environment will reach to the point where it can't support the community, the wild animals and as a result Arba Minch town will be bounded to face some serious problems in their livelihood. Therefore, an integrated forest and wildlife management with the involvement of all stakeholders may be use as a strategy to conserve the forest and associated resources in a sustainable way.

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