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WOODY SPECIES COMPOSITION OF DILFAQAR REGIONAL PARK AND ITS SOCIOECONOMIC IMPORTANCE

BY

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DEDICATION

This work is dedicated for the memory of my family: my mother w/o Jebene Negeri, my sisters w/o Toleshe Mekonnen, w/o Shitaye Mekonnen and my brother Olkeba Tuge. Especial dedication is to my sister s/r Beshatu Mekonnen who was in reality my sister but all for me (she acted as my sister, brother, daughter mother, father councilor and friend). She was the main initiator for me to start my graduate studies and always wishes the best for me but not chanceful to see my successes. So I pray to the almighty God for granting eternal peace & rest to the soul of my departed family. The paper is also dedicated to my children's: Merga Dereje, Geleta Dereje and Abdissa Dereje who suffered a lot of hardship in the absence of me.

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ACRONYM

ASDA	Association for Sustainable Development Alternatives
DBH	Diameter at Breast Height
CSA	Central Statistic Authority
EARO	Ethiopian Agricultural Research Organization
EGS	Ethiopian Geological Society
EMA	Ethiopian Mapping Agency
EPA	Environmental Protection Authority
EWCO	Ethiopian Wild life Conservation Organization
EWNHS	Ethiopian Wildlife and Natural History Society
FGD	Focus Group Discussion
FAO	Food and Agricultural Organization
FWCDA	Forestry and Wildlife Conservation and Development Authority
GPS	Geographical Positioning Systems
IUCN	International union for the Conservation of Na
MOA	Ministry of Agriculture
NMSA	National Metrological Services Agency
NRCDMD	Natural Resources Conservation and Development Main Department
OBPED	Oromia Bureau of Planning and Economic Development
ONRDEPB	Oromia Natural Resources Development and Environmental Protection Bureau
PC-ORD	Software package for community analysis
PRA	Participatory Rural Appraisal
RPSUD	Research program for sustainable Use of Dry land Biodiversity
SAREC	Swedish Agency for Research and Cooperation with Developing Countries
SIDA	Swedish International Development Agency
UNEP	United Nations Environmental Program
WCMC	World Conservation Monitoring Center

ABSTRACT

This Study was conducted in Dilfaqar Regional Park which is found in Doddota-Sire District, Arsi zone, Oromia Regional State with the aims to identify, describe the vegetation type, species diversity, as well as the importance and impacts of socio-economic activities of the local people. Collection of vegetation data was made using systematic sampling methods, laying four transects and 41 plots. Plant specimens collected from field were identified at the National Herbarium of Addis Ababa University. Socio–economic data was collected through formal and informal discussion based on PRA techniques and semi-structured questionnaires. Vegetation data were analyzed using PC-ORD computer software, whereas socio-economic data were analyzed using descriptive statistics. The vegetation in the study area was sparsely distributed, and only 39 woody species representing 24 families were recorded. The most dominant species of the vegetation in Dilfaqar Regional Park were acacia species; as a result vegetation of the study area can be categorized under White (1983) as Somalia Massai Center of Endemism. Classification of the vegetation data resulted in four plant communities. The density of woody species was 1734ha^{-1}. Beside this, the Shannon diversity index value was 2.877 and the evenness value was 0.785. Currently Dilfaqar is recognized as one of the Regional Parks within Oromia Regional State, where many numbers of wild animal made the enclosed area their habitat and rejuvenization of flora observed. About 95% of the interviewed member of the local communities had positive attitude toward enclosure of the area as park. But, some landless householder consider enclosure of Dilfaqar as Regional park as the reason for the limited access for grazing and farm land. More over the elder member of the local community were highly aware of the relationship between rehabilitation of forest and climatic change such as intensity of rain. The visibility of wildlife and interest of the local people due to grass for house covering they obtain, will ascertain the survival of the park. Since the area is highly degraded for along period of time as a result the conservation activities of Dilfaqar Regional Park should involve the collaboration of government, non governmental organizations as well as the local communities to enhance eco-tourism, rehabilitation and sustainable utilization of the resources in the study area.

1 INTRODUCTION

Varied topography, the Rift Valley and the surrounding lowlands have given Ethiopia a wide spectrum of habitats and a large number of endemic plants and animal species (EFAP, 1994; Demel Teketay, 1999; Zerihun Woldu, 1999). According to FAO (2000) classification, Ethiopia is one of the thirty-six dry land developing countries in the world. The dry lands (including the arid, semi-arid and dry sub-humid areas) account for about 70 % of the total landmass, and 46% of the total arable land. Arid areas are characterized by mean annual rainfall of between 100 - 800 mm, mean annual temperature of 21-27.5°C and mean annual potential evapotranspiration of between 1700 - 2600 mm. The semi-arid zones of the country have mean annual rainfall of between 300 – 800 mm, mean annual evapotranspiration of 1600 - 2100 mm and mean annual temperature of between 16-27°C. The dry sub-humid zones of the country are characterized by mean annual temperature of between 16-28° C and mean annual rainfall ranging between 700 - 1000 mm. Areas of the Oromia Region falling in this dry sub-humid zone include some parts of Bale, Arsi and Wollega (EPA, 2000).

The biggest challenge in the dry lands of Ethiopia is environmental degradation aggravated by poverty, which in turn accelerates the environmental degradation process itself. Earlier estimates indicated that 1.5 - 2.0 billion tons of soil is lost annually because of erosion (Chadhokar, 1988). The annual rate of deforestation in Ethiopia ranges from 100,000 to 200,000 hectares (FAO, 1988). It has been accelerating in recent years for different subsistence and local economic activities, like agriculture, fuel wood and incidence of uncontrolled forest fires.

Ethiopian wildlife conservation organization (EWCO) categorizes protected area of Ethiopia into four, namely national parks, sanctuaries, game reserves and controlled hunting areas. Management input towards protected areas was restricted to national parks and sanctuaries due to limited resources to manage the remaining once. Totally there was no management practice that exerted towards game reserves and controlled hunting areas. As a result considerable portion of habitats of wildlife converted in to agricultural and other types of land use which threatened the survival of wildlife. In Ethiopia there are nine national parks of which only two are legally gazetted, namely the Awash and the Semen Mountains. There are also fifty-eight national forest

1priority areas, eight wildlife reserves, four sanctuaries; eighteen controlled hunting areas and seven world heritage convention, (Appendix -1) which are considered as protected areas. The data do not include sites protected under local law (Michael, 2001).

The establishment of Oromia natural resources development and environmental protection bureau (ONRDEPB) with the duties and responsibilities given to it according to proclamation number 41/1993 and consecutive transfer of wildlife from EWCO to ONRDEPB facilitated and widened the possibility of identifying possible area to be included in protected areas in the region. Based on this ONRDEPB identified Dilfaqar site which is found in Arsi zone, to be protected as one of Regional Park. The site was first enclosed for preservation in 1975 encompassing only 20 hectares of land and resettling about 20 households from the central part of the initial enclosure.

Currently Dilfaqar is recognized by Oromia region as "Regional park'' and the protected area is estimated to have 2500ha. In addition to the rejuvenization of the natural flora, the area becomes habitat for many numbers of wild animals. According to a wildlife census conducted in Feb 1995, major wild animals inhabiting the park include greater kudu, lesser kudu, silver-backed jackals, spotted hyenas, warthog, Abyssinian hare, anubis baboon, civet leopard, bushbuck, a number of rodents, porcupines and over a hundred of birds (Abdurrahman Kubssa, 1995).

Vegetation of Ethiopia have been described by various scientists such as Pichi Sermolli (1957), Ratray (1960) and White (1983) have made considerable contribution towards the understanding of the vegetation of the country. Recent studies made by Sebsebe Demissew (1980), Ensermu Kelbessa *et al.*, (1992), Tamirat Bekele (1993), Tesfaye Hawas *et al.*, (2001), Kumilachew Yeshitila & Tamirat Bekele (2002) are some of the vegetation surveys made in different parts of the country.

Despite its ecological and socio- economic importance, no attempt was made to investigate the floristic composition and the socio-economic importance of Dilfaqar Regional Park.

2. OBJECTIVES OF THE STUDY

2.1 General Objective

The main objective of this study is to assess the woody species composition of Dilfaqar Regional Park and its socio-economic importance.

*2.*2 Specific Objectives

The specific objectives of this study are:

1. To assess the woody species composition, and population structure of Dilfaqar Regional Park.
2. To investigate plant communities of the study area
3. To give baseline information about the socio-economic importance of the area to the local community and impacts of human use, and to recommend possible solutions

2.3 Research questions

1. What are woody species composition diversity and vegetation structure of the study area?
2. What are the plant communities occurring in Dilfaqar Regional Park?
3. What are socio-economic importance and/or impacts of the study site for the local people?
4. What are the impacts of local people on sustainability of the resources of the park?

3 LITERATURE REVIEW

3.1 Vegetation Ecology and Floristic composition

Vegetation covering an area has a definite structure and composition developed as a result of long term interaction with biotic and a biotic factors, and any change in the status of these factors disturbs the floristic composition of the environment. Persistent disturbance caused by biotic exploitation triggers change that finally results in the decline of the quality vegetation and reduction in the diversity and abundance of indigenous plant species and majority of fauna. Functionally, vegetation is an organized and an integrated whole than the individual species and possess properties which is not necessarily found in the species themselves (Greig-Smith 1964, 1983). This shows that vegetation is a holistic system by itself and it is the most obvious feature of earth's surface that forms the immediate environment of human being and his domestic animals.

The study of floristic composition enables us to build a mental picture of an area under investigation and also permit the comparison as well as the ultimate classification of different units of vegetation (Kershaw, 1973). Shimwell (1984) pointed out that vegetation analysis has five main objectives, which enable us to understand:

- The plant communities of an area
- The relationship that exists within communities
- How plant communities related to the environment and express their environment
- How the individual plant species are distributed within these communities
- How the communities develop and function as organized living system

For along time it was believed by some ecologists like Clements (1916), Braun-Banquet (1932) and Odum (1971), that vegetation is composed of certain distinct and fairly discrete plant communities. This view regards communities as having a degree of internal organization which jointly modifies the environment with sharp delimitation from other communities (Odum, 1971).

The community concepts on the other hand as considered by Ramensky (1924), Gleason (1926), Curtis & McIntosch (1951) and Whitaker (1967), regard species individuality and community continuity.

Vegetation involves many species and environmental factors with complex relationships. Multivariate technique is employed to study the complex nature of the plant communities, with the general objectives of summarizing large complex data set obtained from community samples aiding in the interpretation of the data and the generation of the hypothesis about the community structure and variation (Lambert and Dale 1964; Greig-Smith 1983). These Multivariate methods have shown an enormous increase in development and application since the last few decades. Among this multivariate methods employed to study the complex nature of communities ordination and classification are the two main basic strategies.

3.2 Species Environmental Analysis

Ordination is a technique used to order a group of objects along a given gradients .The usual objective of ordination in ecological work is to generate hypothesis about the relationship between the species composition at a site and the underlying environmental factors (Digby and Kempton, 1996).Ordination summarizes the patterns of species and samples along environmental variables by collapsing the data in to a single graph so that similar species or samples are close together. Digby and Kempton (1996) provided a detail of Direct Gradient Analysis.

3.3 Community Classification and Indicator Species

Classification has been widely used in the past as a necessary tool to produce some order in to a collection of facts and enable one to communicate description and ideas on the relationships about the type of vegetation recorded and make comparisons with similar or dissimilar samples from elsewhere (Duffey, 1974). Cluster analysis is the general term applied to many techniques used to build classification. The concept of classification in ecological works aims at grouping individual stands or species in to homogenous categories based on their similarity with one another. The stands that is similar with one another form one class, which is separated from other such classes that also consists of similar stands. The properties common to a group of similar

stands are then abstracted to serve as adscription of that class. Therefore, the abstracted class properties may be compared to the average or mean of a set of various values when combined with a measure of range (Greig-Smith, 1980). For practical and scientific validity, the abstracted class features should adequately describe the individual members of each class (Greig–Smith, 1964; Mueller-Dombosis and Ellenberg, 1974; Digdy and Kempton, 1994) .This technique is primarily qualitative. However, since this makes it too broad or too narrow for practical purpose, it is necessary to consider the quantity of more prominent species (Greig-Smith, 1964). This means that it provides a useful summary when complemented by an ordination (Orloci, 1967; Whitaker, 1972; Digby and Kempton, 1994).

Indicator species are species whose status provides information on the overall condition of the ecosystem and gives information about other species in the ecosystems. They reflect the quality and changes in the environmental condition as well as other aspects of the community composition. Moreover, their presence or absence or their relative wellbeing in a given environment is indicative of its ecosystem (UNEP, 1995).

3.4 Plant diversity

Biological diversity is defined as the total variability of all living organisms and the ecological complexes in which they occur often shortened to “Biodiversity”. “Species diversity” refers to the number of species found within a given area. “Genetic diversity” refers to the variety of genes within a particular species variety or breed (WRI-IUCN- UNEP, 1992; IPGRI, 1993 ‘’ Plant diversity’’ refers totality and variability of all plants and their ecosystems.

The diversity of higher plant species increases as one move from the pole to the equator. According to Groombrige (1992), 40-100 tree species may occur in one hectare of tropical moist forest in Latin America, compared to 10-30 per hectare in Northeastern America. The estimated number of Angiosperm species in the world and Ethiopia is 250,000 and 6000-7000 respectively. However, due to biotic and/or a biotic factors species and ecosystems are being lost (Tsidel, 1991). The recognition of this loss at a global level has led scientists and concerned groups to draw up world conservation strategy and the Convention on Biological Diversity held at the Earth

Summit in Rio de Janeiro, Brazil in June, 1992. At the national level, Biodiversity Institute and National Conservation Strategy have been established. In addition, various government, non-governmental organization and Peasants Associations are involved in conservation practices (UNEP, 1995).

Diversity in ecological research could refer to species diversity, habitat diversity or genetic diversity indicating variability between species, habitat and individuals respectively (Spellberg, 1994). Species diversity could be viewed from different approaches in terms of alpha (α), Beta (β) and gamma (γ) diversity (Rosenzweig, 1995). Alpha diversity refers to the diversity of species within particular habitat or community. Beta diversity is a measure of the rate and the extent of changes in species along gradient from one habitat to another. It is diversity between habitats that measures the turnover rate. Gamma diversity on the other hand is the diversity of species in comparable habitat along geographical gradients and is independent of the two.

Diversity indices are simple mathematical expressions that summarize a lot of data recorded in one or sets of figures. Among the different coefficients widely used to compute diversity of a community are species richness, evenness and heterogeneity (Krebs, 1989). Species richness is the simplest concept of species diversity implying the number of species in a community. Heterogeneity is the measure of the probability of which two individuals randomly picked from a community belong to a different group or species (Hulbert, 1978). Evenness is the measure of equitability. It attempts to quantify the unequal representation of species in a community against a hypothetical community in which all species are equally common (Lioyd and Ghelardi, 1964).

Assessments of plant diversity have been frequently used to judge the success of conservation efforts (Hall and Willig, 1994) besides being a criterion for the identification of potential conservation sites. Therefore, it is important to assess the floristic composition and dynamics of the forest communities after protected area establishments in order to comprehend the conservation efforts made so far (Geilbach, 1975; Margules and Usher, 1981; Baskin, 1994).

3. 5 Frequency and important value index

Frequency is defined as the proportion of sample quadrates in which individuals of a species are recorded. Frequency measures reveal the uniformity of the distribution of the species in the study area, which again tell about the habitat preference of the species (Silvertown and Doust, 1993 cited in Abeje Eshete *et al.,* 2005). In other words, it gives an approximate indication of the homogeneity of the stand under consideration (Kent and Coker, 1992).

The important value index (IVI) permits a comparison of species in a given forest type and depict the sociological structure of a population in its totality in the community. It often reflects the extent of the dominance, occurrence and abundance of a given species in relation to other associated species in an area (Kent and Coker, 1992; Kindeya G/Hiwot, 2003; Simon Shibru and Girma Balcha, 2004). It is also important to compare the ecological significance of a given species. Therefore, it is a good index for summarizing vegetation characteristics and ranking species for management and conservation practices.

3.6 Plant population structure

Population structure is defined as the distribution of individuals of each species in arbitrarily diameter-height size classes to provide the over all regeneration profile of the study species (Peters, 1996; Simon Shibru and Girma Balacha, 2004). Information on population structure of a tree species indicates the history of the past disturbance to that species and the environment and hence, used to forcast the future trend of the population of that particular species (Peters, 1996).

Population structure is extremely useful tool for orienting management activities and, perhaps most important for assessing both the potential of a given resources and the impact of resource extraction (Peters, 1996). Analyses of population structure has then some thing to do with the future management of the key and untapped resources of the dryland of Ethiopia. Information on populaton structure help to respect the healthy regeneration of the species under utilization (Kindeya G/Hiwot, 2003).

The population structure of a given species can be roughly grouped in to three types. Type I, II and III. Type I, shows the case in which diameter/height size class distribution of the species displays a greater number of smaller trees than big trees and almost constant reduction in number from one size class to the next (Peters, 1996; Simon Shibru and Girma Balcha, 2004; Abeje Eshete *et al.*, 2005). Such a pattern skewed to a reversed J-shape distribution in a forest are considered to have a favorable status of regeneration and recruitment and hence, stable and healthy population (Kindeya G/Hiwot, 2003). Type II, is characteristic of species that show discontinuous, irregular and/or periodic recruitment. In this type, the frequency exhibited, for instance, in diameter/height size class causes discontinuities in the structure of the population as the established seedlings and saplings grow in to larger size classes. Type III, reflects a species whose regeneration is severely limited for some reasons (Peters, 19996). Hence, knowledge about the category in which our study species fall is important issue before planning to utilize the resources.

3.7 Ecological services of plants

Natural biological communities play important ecological roles in producing and sustaining habitable environments. No organisms can exist alone but all depend on multitude interactions among themselves and within the environment. In these interactions plant play the greatest roles: soil formation, nutrient recycling, solar energy absorption and management of biological and hydrological cycles all depend to a significant extent on plants, animals and microbes (Cunningham and Saigo, 1995). This process mainly takes place in undisturbed areas (in areas where interference of man is very low). In wild areas there is self-sustenance and maintain ecological processes. Hence ecologically, plants represent a library of information (Cunningham and Saigo, 1995).

3.8 Vegetation of Ethiopia and human impacts

Studies on floristic composition of some parts of Ethiopia have been made taking different factors into consideration, altitude and climate being the most important. Some of these are Russ (1945); Breitenbach (1961,1963); Beal (1968); Sebsebe Demissew (1980); Friis *et al.* (1982);

Hailu sharew (1982); Zerihun Woldu (1980,1985); Tewelde Berhan G/Egzabiher (1986); Lissanework Nigatu (1987); Zerihun Woldu *et al.* (1989); Zerihun Woldu & Mesfin Tadesse (1990); Tamirat Bekele (1994); Minasse Gashaw & Masresha Fetene (1996). The contribution made by these authors towards the understanding of the vegetation of Ethiopia is of paramount significance. Although much effort has been made on the study and description of floristic composition of the country, no previous research on the floristic composition of the study site has been made.

According to Taylor (1984), who emphasized on the contribution of anthropogenic factors, forests are considered to be large complex environment that can be destroyed irreversibly and altered and prevented from reestablishment for an extended time by human being mainly by burning forest for the purpose of obtaining areas for hunting and later cattle raising and crop production. Ethiopia is agricultural country with about 85% of the population mainly depending on it. Agriculture occurs throughout the highland of the country with the highest production being in the central and north western areas. According to the Natural conservation Strategy (1990), high forest was reported to cover 16% of the country in the early 1950s, 3.6% in the early 1980s and only 2.7% by 1989. Breitenbach (1962) stated that the Ethiopian highlands were covered by vast forests in ancient times. Therefore, one can deduce the forest cover of Ethiopia in the past was much larger than the present (Teshome Soromsa, 1997).

According to Tigist Wodimu (2003), prolonged drought, over population, overstocking, cropping encroachments and soil erosion are characteristics threats to the Ethiopian flora. Deterioration of biodiversity and invasion of undesirable woody species into grasslands are known to be the major constraints to the management of biological resource of Ethiopian dry land areas (EARO, 1999).

3.9 Protected areas

Global biodiversity strategy (UNEP, 1995) defines a protected area as a legally established land or water area under either public or private ownership that is regulated and managed to achieve specific conservation goal. Total protected area (TPA) is generally considered to include IUCN categories I-VI. These categories and corresponding management objectives are defined as follows (IUCN, 1994).

Category I. Strict Nature Reserve/Wilderness area: to protect nature and maintain natural processes in undisturbed state in order to have a representative examples of the natural environment for scientific study environmental monitoring ,education and maintenance of genetic resources in a dynamic and evolutionary state. There are two sub categories

IA: includes protected areas managed mainly for scientific research and monitoring

IB: includes protected areas managed mainly for Wilderness protection, subsistence and recreation.

Category I. National Park**:** to protect outstanding natural and scenic areas of national or international significance for scientific, educational and recreational use where extraction of the resource is not allowed..

Category III. National Monument/Natural Land mark: to protect and preserve nationally significant natural features because of their special interest or unique characteristics. These are relatively small areas focused on the protection of specific features

Category IV. Habitat/ Species Management: to assure the natural conditions necessary to protect nationally significant species, biotic communities or physical features of the environment where these may require specific human manipulation for there perpetuation .controlled harvesting of some resources may be permitted

Category V. Protected Landscape and Seascapes: to maintain nationally significant natural landscapes that are characteristic of the harmonious interaction of man and land while providing opportunities for public enjoyment through recreation and tourism .These are mixed cultural/natural landscapes of high scenic value where traditional land use are maintained.

Category VI. Managed Resource Protected area: this is a new category designed to include areas that ensure long-term protection and maintenance of biodiversity while providing a sustainable flow of natural products and services to meet community needs.

3.10 Socio-economic importance of Ethiopian protected areas

In Ethiopia there are nine national parks, of which only two are legally gazetted namely, Awash and Semen Mountain National Park. There are also fifty-eight national forest priority areas, eight wild life reserves, four sanctuaries; eighteen controlled hunting areas and seven world heritage conventions, which are considered as protected areas (Appendix 1). The data do not include sites protected under local law (Michael, 2001, 1995)

Protected areas have hardly been managed in Ethiopia due to population pressure (Hurni *et al.*, 1987; Shibru Tedla, 1995; Feyera Senbeta and Fekadu Tefera, 2001). Often the decisions made on the protected areas do not take due consideration of the interests of stakeholders, especially communities who are dependent on the local resources. As a result, uncontrolled expansion of agriculture and grazing coupled with illegal harvesting of the forest and other products have been threatening the function of the protected area systems in many parts of the country (Chaffey, 1980; Shibru Tedla, 1995; Feyera Senbeta and Fekadu Tefera, 2001). In this regard, lack of integration of the local people living around the conservation areas in the conservation efforts, and absence of law enforcement system are the major constraints to the overall conservation effort in Ethiopia.

Even though, a number of national, international and non-governmental organizations involved in the conservation, management and development of protected areas like IUCN and WWF, there are a number of constraints to protected areas management. The Natural Resources Conservation and Development Main Department (NRCDMD) were in need of a strong and properly trained staff for the overall planning, monitoring, evaluation and coordination of management activities at the national level. Resources have been directed to the development of national parks and sanctuaries, which, in practice, are treated almost equally, since sanctuaries are set up to conserve threatened wildlife tax on and the production of harvestable animals is not permitted. While still more or less recognized, wildlife reserves and controlled hunting areas exist on paper only (Abdurrahman Kubssa, 1995)

Gambella National Park has virtually ceased to exist as a conservation area, Yabello Sanctuary has been taken over for a livestock project, and Bale Mountains National Park has suffered from uncoordinated development in and near its boundaries. Further, Semen Mountains National Park is listed as threatened by the IUCN Commission on National Parks and Protected Areas (Abdurrahman Kubssa, 1995).

3.11 Historical Development of Dilfaqar Regional Park

The area adjacent to Dhera town which was hilly and undulating terrain were devoid of vegetation. Dust and rock from the bare hills used to affect the town. In most places, particularly at three sites, erosion and gully formation became serious problems. Farm lands have reduced in size due to erosion. Productivity of the area has declined. The situation had worried the administrators and people in Forestry and Wildlife Conservation and Development Authority (FWCDA). Realizing the seriousness of the issue, in order to rehabilitate the degraded area, small portion of todays Regional Park was decided to be closed in July 1975 by ONRDEPB. The area included Marabe and Dilfaqar hills as well as the land between the hills. The area was completely closed from human activity. Residents of 21 houses of the area were shifted to a place known as Haroressa. The closed area has shown improvement in terms of vegetation cover as well as wildlife. Acacia species regenerated and different species of wild mammals increased in the closed area (Abdurrahman Kubssa, 1995).

Currently Dilfaqar is recognized as a Regional park, with estimated area of 2500 ha. Besides the rejuvenization of the natural flora in the park, quite a number of wild animals have made the enclosed area their habitat. According to a wild life census conducted in February 1995 there were 23 species of mammals and 105 species of birds were recorded in the park (Appendix 6). The major species of mammals include greater kudu, lesser kudu, Klipspringer, Caracal and stripped Hyena. The other species include Silver backed Jackal, Grey duiker, etc. In addition to these there are a number of rodents, porcupines and some species of water fowls .Most of the species were widely distributed all over the park. In spite of this fact, more exhaustive census is required since it could be plausibly assumed that both the species as well as population size of each species have significantly increased during the last ten years and seasonal movement of the mammals also a research gap to be studied in the future (Abdurrahman Kubssa, 1995).

4. MATERIALS AND METHODS

4.1 Description of the Study Area

4.1.1 Location

Dilfaqar Regional Park is located in Doddota-Sire district in the north eastern part of Arsi zone, Oromia Regional State. It is close to Dhera town, the capital of the district. The geographic location of the centre of the study area is at 8^0 16'N longitude and 39^0 20'E latitude. It is about 125 km south from Addis Ababa and 25 km south from Adama town and 50 km north from Asela town the capital city of Arsi zone. The Great Rift Valley in which the study area lies includes part of Arsi zone (EMA, 1988). Doddota- Sire is a district with an area of 1139.27km^2 and shares boundary lines with East Shoa in the north, North West and North East, Hetossa and Tana districts in the South, East Shoa and Ziway- Dugda in the North West and Teju in the East (Oromia Bureau of Planning and Economic Development, 2000). The total area of Dilfaqar Regional Park is about 2500 hectares.

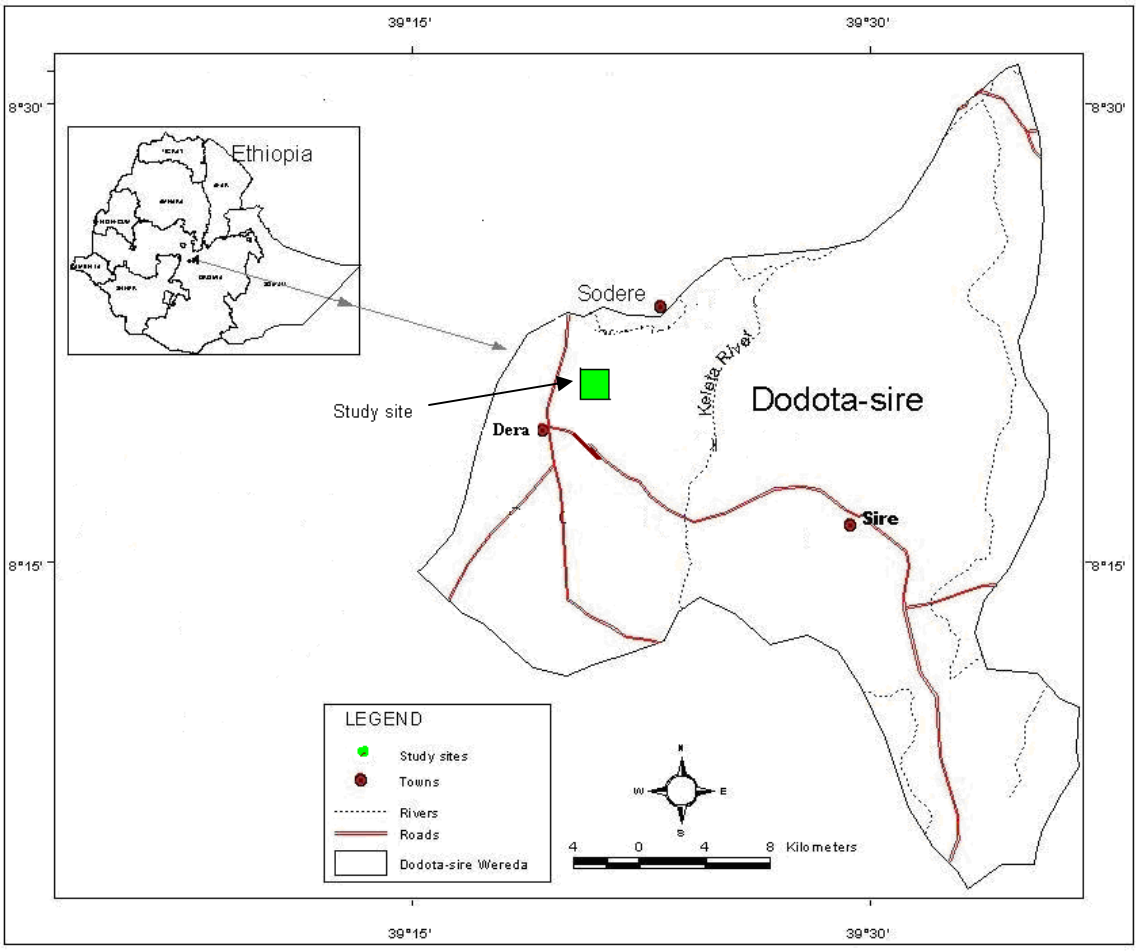


Figure 1: Map of the study area with location of study site

4.1.2 Topography

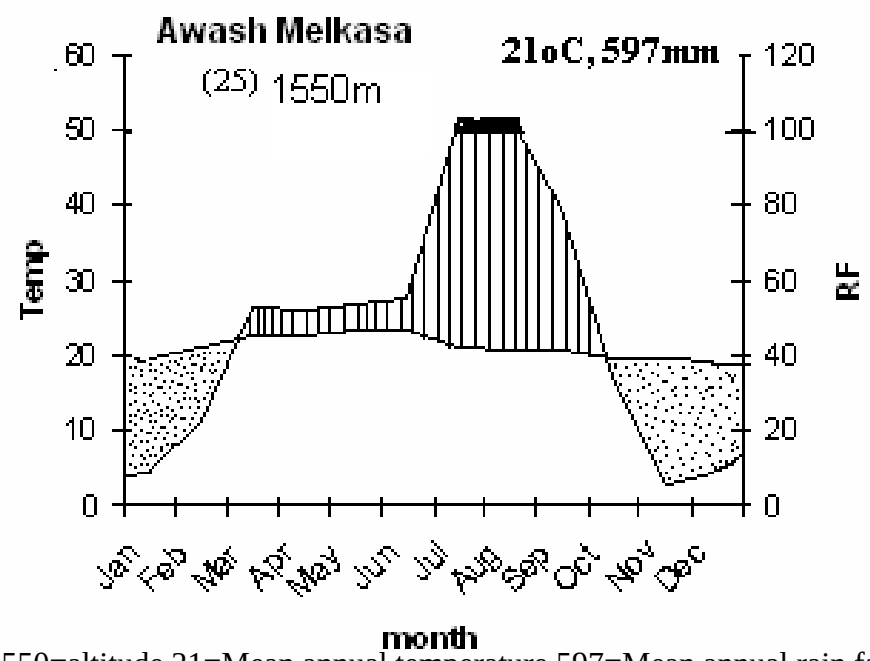
Topographically the district is located with in the Rift Valley. The altitude of the district ranges from 1400-2500m with undulating plains, hills, mountains and degraded land area decreasing in elevation from south to north (Abdurrahman Kubssa, 1995). The elevation of Dhera town is 1700m a.s.l. But the elevation of study area (Dilfaqar) covers from 1440-1835m a.s.l.

4.1.3 Geology and soil

The geology and soil of the study area are very much related to the formation of the Great Rift Valley. Hills broken, terrains and shallow valleys are the result of past volcanic activity. More recent vulcanization is associated with the development of the rift valley, activity being concentrated within this structure and along the edge of the adjoining plateau (Ethiopian Mapping Authority, 1988). The major soil types of the district are Cambisols (45%), Litosols (35%) and Adosol (20%) (Oromia Bureau of Planning and Economic Development, 2000). Moreover, soil of the Dilfaqar Regional Park was classified as Luvic phaeozemes which have an argillic B horizon. As most of them are sodic, their agricultural value is limited (Ethiopian Mapping Authority, 1988). In general, fertility of the soil varies in relation to depth. Soil of the study site is very erodable with gullies forming rapidly removing vegetation cover along tracks and between the hills on the steeper slopes (Abdurrahman Kubssa, 1995).

4.1.4 Climate

About 61%, 24.5% and 14.5% of areas of district are classified as 'Kola', 'Weina dega' and 'Dega' respectively (Oromia Bureau of Planning and Economic Development, 2000).Since there is no metrological station in Dhera town, the following climatic data (Fig 2) were taken from Awash-Melkasa station, which is the nearest meteorology station to the study area. Based on 25 years climatic data obtained (1980-2005) except 1992, during which there was no record both for temperature and rainfall. The mean monthly rainfall at this station was 48mm with minimum in November (6mm) and maximum in July (102mm). The mean annual rainfall in the study area was 597mm with mean minimum in 1991 (57mm) and maximum in 1998 (873mm). There is slight variation in mean temperature throughout the year. The mean annual temperature was 21^0C, with mean minimum in 1988 (15^0C) and maximum in 2001 (23^0C).



Key: 25=year, 1550=altitude,21=Mean annual temperature,597=Mean annual rain fall.

Figure 2: Climatic diagram of Awash Melkasa station following Walter (1985).

4.1.5 Population and land use

The people of 'Doddota-Sire' district are settled farmers growing mainly the annual food crops such as teff, maize, and sorghum in integration with cattle rearing. According to CSA (1998), the total population of the district was 125974. Out of this, 63939 are male and 62035 are female. Based on the data obtained from the Woreda Agricultural Office, about 60% of the total area of the district is usable; where 48.26%, 3.76%, 5.67% and 1.86% are cultivated, pasture land, natural vegetation, and village respectively.

4.1.6 Vegetation

As it is described in Zerihun Woldu (1999), the vegetation of Ethiopia is extremely complex. The complexity arises from the great variation of altitude implying equally great spatial differences in moisture regimes as well as temperature within very short horizontal distances.

According to White (1983), classification of African and Madagascar vegetation, the vegetation of the study area falls into Somalia-Massai regional Centre of Endemism category that is characterized by having a flora dominated by acacia woodland.

4.2 Vegetation data collection

A reconnaissance survey was conducted in October 2005 to collect base line information, observe vegetation distribution and determine number of transect lines to be laid. The method of vegetation sampling was based on Braun Banquet as described by Muller-Dombosis and Ellen berg (1974). The approach has been used successfully in African vegetation. Zerihun Woldu (1980 and 1985), Tamirat Bekele (1994), and Scholder (1999), in Ethiopia can be sited as an examples.

Data on vegetation were collected using systematic sampling techniques in which four transect lines were laid along south-north direction using compass. This is to include as much vegetation as possible that can represent the vegetation of the study area. Along each transect, sample plots of 20m x 20m ($400m^2$) were taken at a distance of 300m from each other. The distance between each transect line was 1000m. Plant species in each plot was counted and recorded at individual level, and voucher specimens were collected following standard taxonomic method (Bridson and Forman, 1992). Woody plants taller than 1.5 m in the plot were identified and their diameter at breast height (DBH) was measured if greater or equal to 2.5 cm and the number of individuals was recorded. The collected specimens were identified and authenticated by comparing with already identified specimens and referring published flora books at the National Herbarium of Addis Ababa University. Tree height and DBH measurements were taken using sunto clinometer and calibrated bamboo stick, and caliper respectively.

4 3 Socio-economic data collection

Socio-economic data about the importance and impacts of the study area was collected by using Participatory rural appraisal (PRA) and semi-structured interview (Martin, 1995). Concerning the case of PRA, systematically selected Peasant Associations (PA) and Dhera town were used to collect the necessary information. From the selected PA and Dhera town, key informants were identified purposively. Where as, in the case of semi-structured interview, respondents were selected randomly from the residents. A total of 20 key informants were selected using purposive sampling method from the population for PRA discussion. 50 interviewees of whom 20 (40%) were female, were selected and responded for the semi-structured interview.

4.4 Data Analysis

A number of indices of diversity have been devised, each of which seeks to express the diversity of a sample or quadrate by a single number. Of the various indices, the most frequently used is the simple totaling of species numbers to give species richness (Magurran, 1988). ,In spite of the indices that combine species richness with relative abundance, probably the most widely used is the Shannon Index (H'), which makes the assumption that a) individuals are randomly sampled from an infinitely large population and b) assumes that all the species from a community are included in the sample and calculated according to Kent and Coker (1992). The value of Shannon diversity index usually found to fall between 1.5 -3.5 rarely surpasses 4.5 (Magurran, 1988).

The Shannon diversity index is calculated from the formula:

$$\mathbf{H'} = -\sum_{i=1}^{s} Pi \ln Pi$$

Where: H' = Shannon-Wiener Diversity Index; Σ = Summation symbol; pi = the proportion of individuals or the abundance of i^{th} species expressed as a proportional of total cover in the sample and ln = log $base_s$ (natural logarithms).

Equitability or evenness index was calculated from the ratio of observed diversity to maximum diversity using the equation.

$$\mathbf{E = H'/ln\ (S) = H'/Hmax}$$

Where: E = Evenness; H' = Shannon-Wiener Diversity Index; Hmax = lnS; S = total number of species in the sample. The value of evenness index falls between 0 and 1. The higher the value of evenness index, the more even the species is in their distribution within the given area.

Species richness is a count of the number of species in a quadrate, area or community, or expressed as number of species per unit area.

Basal area is the cross-sectional area of tree stems at diameter at breast height. Generally it is a measure of dominance where the term "dominance" refers to the degree of coverage of a species as an expression of the space it occupies and calculated by using the following formula.

$$\mathbf{BA = \Pi\ d^2/4}$$

Where BA = Basal area in m^2 per hectare

d= diameter at breast height

Π = 3.14

Population structure**,** (which is the distribution of individual of each species in arbitrarily defined diameter and height classes) was determined to provide the regeneration profile of each species. This was done by employing the total number of individual that were grouped into different arbitrary diameter and height classes, then population structure was constructed using descriptive and simple statistical calculation for both diameter and height class distribution of each species This procedure has been used by (Mekuria Argaw et al., 1999; Tadesse W/Mariam, 2003).

Important Value Index (IVI) of a species used to express the relative dominance of the species in the community was calculated from the sum of relative dominance, relative density and relative frequency as recommended by Kent and Coker (1992).

Hence Important value index = Relative Density + Relative Dominance + Relative Frequency where:

$$\text{Relative density} = \frac{Total\ No.\ of\ individual\ species\ A}{Total\ No.\ of\ individuals\ of\ all\ species} \text{ X } 100$$

$$\text{Relative frequency} = \frac{\text{Re}lative\ frequency\ of\ Species\ A}{Frequency\ of\ all\ species} \text{ X } 100$$

$$\text{Relative dominance} = \frac{Domiance\ of\ species\ A}{Doinance\ of\ all\ Species} \text{ X } 100$$

A Cluster analysis helps to group together a set of observations (here plots or vegetation samples) based on their attributes or floristic similarities (Kent and Coker, 1992). To this effect, a hierarchical cluster analysis was performed by using PC-ORD for windows version 4.20 (McCune and Mefford, 1999). The identified groups were tested for the hypothesis of no difference between groups using the multi-response permutation procedure (MRPP). From the output, the test statistic ***T*** describes the separation between the groups. The agreement statistic A describes within group homogeneity, compared to the random expectation and falls between 0 and 1. When all items within groups are identical, A =1 and 0 if the groups are heterogeneous. In community ecology, A value are commonly below 0.1 and greater0.3 is high (McCune and Grace, 2002). Moreover, descriptive statistics was used to analyze socio-economic data.

5. RESULTS AND DISCUSSION

5.1 Floristic Composition

A total of 39 woody species were identified in Dilfaqar Regional Park that belongs to tree and shrubs. The 39 species were found in 24 families (Appendix 3). The three woody species rich families are Fabaceae (four genera, and nine species) followed by Capparidaceae (3 genera, 3 species) and Anacardiaceae (2 genera, 3 species). The three species rich families (Fabaceae, Capparidaceae and Anacardiaceae) constitute 36% of the total woody species in the study area. There were about 15 families with only one species, which showed the area is under rehabilitation after severe degradation. The Shannon diversity index of the woody species showed that the index value was 2.877 and evenness value of 0.785. The density of woody species of the study area was found to be 1734 ha^{-1}. This value is greater than the mean density of trees and shrubs in the Dida Hara and Web sites of Borana lowland (1274 ha^{-1}) obtained by Gemedo Dalle *et al*. (2005). Enclosure of the study area as a Regional park have great contribution for rehabilitation of vegetation ,Because illegal cutting of tree by local people for different activities like fuel wood, construction and impacts of domestic animals such as goat sheep and others have minimized greatly after enclosure of the area.

5.2 Importance value index

Important value index IVI is a good index for summarizing vegetation characteristics, ranking species management and conservation practices. It reflects the degree of dominancy and abundance of a given species in relation to the other species in the area (Kent and coker,1992). The result of Importance Value Index (IVI) which is calculated from relative density, relative basal area (relative dominance) and relative frequency, of woody species is shown in Table 1.

. **Table 1:** Relative frequency, relative density, relative basal area, important value index and density per hectare of woody species of the study area

	Scientific name	RF	RD	RBA	IVI	D/ha
1	*Acacia oerfota*	1.6	2.7	0.8	5.2	47.0
2	*Sacrostemma viminale.*	0.3	0.0	0.0	0.3	0.6
3	*Leucas abyssinica*	2.7	5.6	0.0	8.4	97.6
4	*Eucalyptus globulus*	0.3	1.5	1.2	3.0	26.2
5	*Balanithes aegypitca*	7.3	4.9	16.0	28.1	84.1
6	*Croton dichogamous*	3.5	7.9	1.4	12.8	137.2
7	*Pappea capensis*	0.5	0.1	0.0	0.7	2.4
8	*Jasminium grandiflorum* `	0.3	0.0	0.2	0.5	0.6
9	*Calupurnea aurea*	0.3	0.0	0.2	0.5	0.6
10	*Ocimium lamiifolium*	0.5	0.6	0.0	1.2	11.0
11	*Acacia etbaica*	8.4	15.0	9.7	33.1	261.0
12	*Commiphora rostrata*	0.8	0.2	0.0	1.0	3.0
13	*Capparis fascicularis*	5.1	1.5	1.9	8.6	25.6
14	*Grewia bicolor*	1.1	0.3	0.0	1.4	4.9
15	*Rhus retinorrhoea*	0.5	0.1	0.0	0.6	1.2
16	*Cadaba farinosa*	3.5	1.7	4.9	10.0	28.7
17	*Solanum incanum*	0.8	1.1	0.0	1.9	18.9
18	*Solanum somalensis*	0.3	0.1	0.0	0.3	1.2
19	*Dodonea angustifolia*	1.4	5.3	0.1	6.8	92.1
20	*Dichrostachys cineera*	7.0	4.3	4.6	15.9	75
21	*Osyris weightiana*	2.7	0.6	0.1	3.4	10.4
22	*Maytenus senegalensis*	3.0	0.7	0.3	4.0	12.8
23	*Acacia tortilis*	7.3	6.7	26.4	40.4	115.9
24	*Cordia ovalis*	2.4	0.6	0.4	3.5	11.0
25	*Eculea schimperi*	2.2	0.9	0.5	3.6	16.5
26	*Acokanthera schimperi*	1.6	1.6	0.1	3.3	109.1
27	*Vernonia natalensis*	1.6	6.3	0.1	8.1	1.2
28	*Fleuggea virosa*	0.3	0.1	0.0	0.3	25.6
29	*Myrsine africana*	1.9	1.5	0.1	3.5	3.7
30	*Maerua angolensis*	1.4	0.2	2.6	4.2	28.0
31	*Grewia tenax*	4.9	2.9	1.1	8.9	50
32	*Acacia nilotica*	10.3	15.2	18.9	44.4	264.0
33	*Ziziphus mucoronata*	1.6	0.2	2.6	4.4	3.7
34	*Acacia Senegal*	5.7	4.5	3.5	13.7	78.0
35	*Asparagus africanus*	0.5	0.6	0.0	1.1	10.4
36	*Schinus mollie*	0.3	0.1	0.1	0.4	1.8
37	*Ehretia cymosa*	0.3	0.0	0.1	0.4	0.6
38	*Premna resinosa*	0.3	0.1	0.0	0.4	1.2
39	*Rhus natalensis*	5.7	4.1	2.0	11.8	71.3

Key: RF-Relative Frequency**; RD-**Relative Density; **RBA-**Relative Basal Area and **D/Ha-**Density per hectare**.**

The result of the index showed that *Acacia nilotica* (44.4), *Acacia tortilis* (40.4), *Acacia etbaica* (33.1) and *Balanithes aegypitca* (28.1) were woody plant species with highest importance value index. *Acacia tortilis* (26.4), *Acacia nilotica* (18.9), *Balanithes aegypitca* (16) and *Acacia etbaica* (9.7) were species with the highest relative basal area. On the other hand, *Acacia nilotica* (15.2), *Acacia etbaica* (15) and *Croton dichogamous* (7.9) were species with the highest relative density and *Acacia nilotica* (10.3), *Acacia etbaica* (8.4), *Balanithes aegypitca* (7.5), *Acacia tortilis* (7.3) and *Dichrostachys cineera* (7) were species with highest relative frequency in Difaqar Regional Park. The most abundant species in this study is *A. nilotica* (264/ha) followed by *A.etbaica* (261/ha) (Table 1). The current study is in agreement with what has been found by Kindeya G/Hiwot (2003) in dry forests of Tigray where he has obtained a density of 288/ha for *A. etbaica* was the most abundant species.

5.3 Cluster analysis of vegetation data

The woody species collected from the study area were 39 in number, they were identified, in the National Herbarium of Addis Ababa university and used for vegetation classification. Four clusters were recognized from the hierarchical cluster analysis (classification) (Fig. 3) with 25% information remaining. Two plots (4 and 11) were outliers and were excluded from analysis. The test whether the identified clusters were different or not was based on the MRPP technique and the ecological interpretation of the groups. The test statistic ***T*** value for the four clusters was -14.007 ($p<0.001$) and the agreement statistic ***A*** was 0.1602. From the result the null hypothesis of no difference among the clusters can be rejected. The four clusters occupy different regions of space, as shown by the strong chance correction within the group (A) and test statistic (T). Based on the present analysis, four plant communities for the study area were considered optimal.

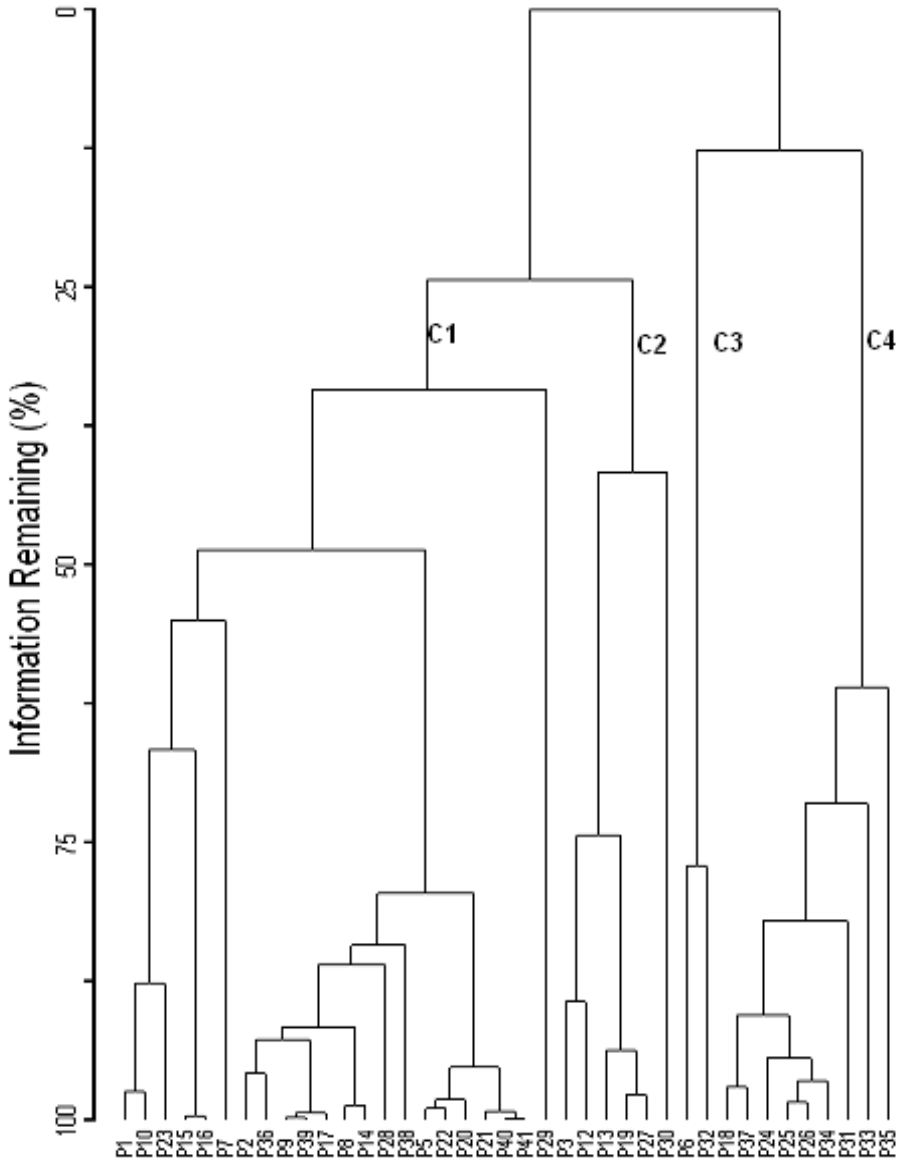


Figure 3: Dendrogram of the cluster analysis results of species abundance of 39 woody species found in 39 plots in Dilfaqar Regional Park**.**

The level of grouping was based on 25% information remaining. The plot Vs species and the arrangement of the plots along the dendrogram from left to right are as follows:

C1:1, 10, 23, 15, 16, 7, 2, 36, 9, 39, 17, 8, 14, 28, 38, 5, 22, 20, 21, 40, 41, 29;

C2: 3, 12, 13, 19, 27, 30; **C3**: 6, 32; **C4**: 18, 37, 24, 25, 26, 34, 31, 33, 36.

*5.*4 Plant community types

In classification of vegetation, classifying communities by considering the dominant species as representative species of that particular community is one of the widely used approaches (Odum, 1971; Ricklefts, 1990; Andreucii *et al*., 2000). The indicator species for each community is shown in Table 2. A species with a significant indicator value at $p<0.05$ is considered as an indicator species of that particular plant community. The cluster analysis of the quantitative vegetation data has resulted in four major Plant communities (Fig. 3). These are described below. Plant community refers to population of several plant species in a given area which are living together and interacting. Every plant community has its own characteristics and has usually one, two or three dominant species Therefore; the four plant communities obtained in this analysis were named after one or two of the dominant indicator species.

C1*: Acacia oerfata-Acacia tortolis-Solanum incanum* community:

This community has no indicator species, since the p-value for all species are above 0.05 but the community is named after A.oerfota, A.tortilis and Solanum incanum. The common woody species in this community includes *Rhus retinorrhoea, Premna resinosa, Eucalyptus globulus, Jasminium grandiflorum, Calupurnea aurea, Solanum somalensis, Fleuggea virosa, Schinus mollie and Sacrostemma viminale.* Most of the species in the community are distributed through out the study area. *Eucalyptus globulus* and *Schinus mollie* are the two species in the community planted by the local people. The community occurs at an elevation between 1592m and 1815m a.s.l. and found at hillsides and undulating terrain. Furthermore, this community consists of 22 two plots and 12 woody species.

C2: *Acacia etbaica - Leucas abyssinica* community:

The common woody species in the community includes *Acacia nilotica, Dichrostachys cineera, Ehretia cymosa, Pappea capensis, Osyris weightiana, Cadaba farinosa*, *Balanithes aegypitca* and *Acokanthera schimperi*. Most of the species are trees which occupy the upper canopy layer in the study area. The community occurs at an elevation between 1694 m and 1764 m a.s.l. and found on flat terrains with rock outcrop. It has 6 plots and 10 woody species

C3: ***Vernonia natalensis- Eculea schimperi-Rhus natalensis*** **community:**

Although this community has many potential indicator species of a significant value such as *Myrsine africana* and *Maerua angolensis (Table 2),* the values for *Vernonia natalensis, Euclea schimperi* and *Rhus natalensis* is more highly significant that the former mentioned species. Therefore, the naming of this community follows the latter species. The common woody species in this community includes *Capparis fascicularis, Maytenus senegalensis, Ziziphus mucoronata, Acacia Senegal, Grewia tenax* and *Dodonea angustifolia.* The community occurs at an elevation between 1678m and 1762m a.s.l. and most of its species occur around river banks with slightly undulating rocky terrain. Although the area is sloppy, the community is high in density because the area has little interferences of human activity such as grazing by domestic cattle. Moreover, this community has 2 plots and 11 woody species.

C4: Croton dichogamous **community**:

The common woody species in this community are *Ocimium lamiifolium Commiphora rostrata, Grewia bicolor, Cordia ovalis* and *Asparagus africanus.* The community occurs at an elevation between 1658m and 1720m a.s.l and found at the periphery of the study area where the terrain is sloppy, undulating and rocky. Furthermore, this community has 9 plots and 6 woody species.

Table 2: Synoptic table for the result of indicator species analyses: Species are listed by group affinity. Bold values indicate significant indicator value (p<0.05) in each group

Scientific name	**Community type and size with mean abundance value**						
	C1	**C2**	**C3**	**C4**	Group	Value (IV)	p-value
	22	**6**	**2**	**9**			
Acacia oerfota	3.5	0.0	0.0	0.0	**1**	27.3	0.251
Solanium incanum	1.4	0.0	0.0	0.0	**1**	13.6	0.486
Acacia tortilis	6.1	1.2	2.0	4.9	**1**	31.3	0.492
Acacia oerfota	0.1	0.0	0.0	0.0	1	9.1	0.739
Solanium somalensis	0.0	0.0	0.0	0.0	1	4.5	1
Acacia tortilis	2.0	0.0	0.0	0.0	1	4.5	1
Jasmium grandiflorum	0.0	0.0	0.0	0.0	1	4.5	1
Calpurnia aurea	0.0	0.0	0.0	0.0	1	4.5	1
Solanum somalensis	0.1	0.0	0.0	0.0	1	4.5	1
Flueggea virosa	0.1	0.0	0.0	0.0	1	4.5	1
Schinus molle	0.1	0.0	0.0	0.0	1	4.5	1
Premna resinosa	0.1	0.0	0.0	0.0	1	4.5	1
Acacia etbaica	6.3	20.2	7.0	8.6	**2**	53.7	**0.016**
Leucas abyssinica	1.8	13.7	0.0	0.0	**2**	58.8	**0.025**
Acacia nilotica	10.0	15.7	6.0	9.7	2	37.4	0.141
Dichrostachys cinera	2.4	7.5	5.0	2.0	2	42.7	0.164
Ehertia cymosa	0.0	0.2	0.0	0.0	2	16.7	0.208
Pappea capensis	0.1	0.2	0.0	0.0	2	9.2	0.512
Osyris wightiana	0.4	0.3	0.5	0.0	2	17.7	0.562
Cadaba farinosa	0.4	2.2	0.5	0.4	2	19.5	0.617
Balanites aegyptica	2.5	6.2	4.0	4.7	2	26.9	0.673
Ackocanthara schimperi	0.9	1.7	0.0	1.9	2	6.3	0.992
Vernonia natalensis	0.2	0.8	40.0	0.4	**3**	96.4	**0.002**
Eculea schmperi	0.3	0.7	5.5	0.6	**3**	78.1	**0.008**
Rhus natalensis	1.9	3.8	12.5	2.2	**3**	59.8	**0.033**
Maerua angolensis	0.1	0.0	1.0	0.1	**3**	41.6	**0.038**
Myrsine africana	0.5	0.0	12.5	0.3	**3**	45.6	**0.045**
Ziziphus mucuronata	0.0	0.3	0.5	0.2	3	26.8	0.255
Maytenus senegalensis	1.9	1.0	4.5	6.0	3	34	0.381
Acacia senegal	0.7	0.5	1.0	0.2	3	22.3	0.406
Grewia tenax	1.9	1.0	4.0	2.8	3	20.6	0.731
Doddonea angustifolia	1.9	0.2	0.5	0.0	3	9.9	0.806
Capparis fasicularis	0.8	1.2	2.0	1.3	3	18.2	0.889
Croton dichogamous	0.5	4.2	6.5	22.0	**4**	74.3	**0.002**
Commiphora rostrata	0.0	0.2	0.0	0.4	4	16.2	0.317

Grewia bicolor	0.1	0.5	0.0	0.6	4	17.8	0.436
Ocimium lamiifolium	0.3	0.0	0.0	1.2	4	8.8	0.838
Asparagus africanus	0.4	0.0	0.0	1.0	4	8.1	0.876
Cordia ovalis	0.3	0.7	0.5	0.8	4	11.7	0.924

5.5 Woody species density

The density of woody species for all community types were shown below in figure 4

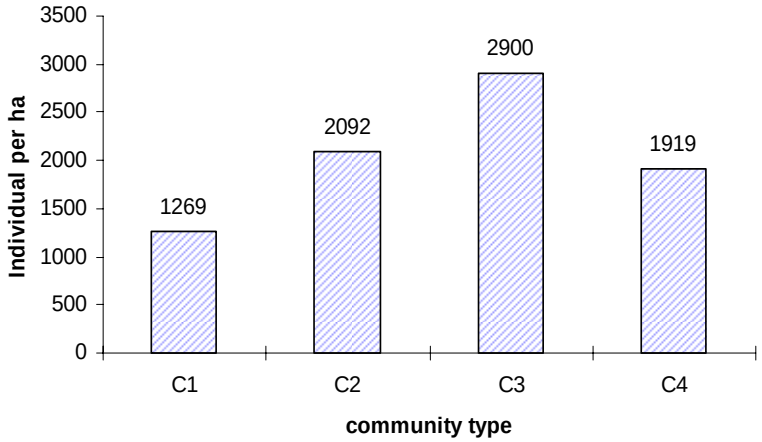


Figure 4 : Density of woody species diversity per hectare across community type

The density of woody species was highest in community type three (2900/ha) and followed by community type two (2092/ha) and the least abundant community was community type one (1269/ha) (Fig 4). There was strong difference between the abundances of the community types ($p<0.o1$)

The density woody species in the study sites along mean altitudes of the community were shown below in Figure 5 by arranging the communities in increasing order of the altitudes.

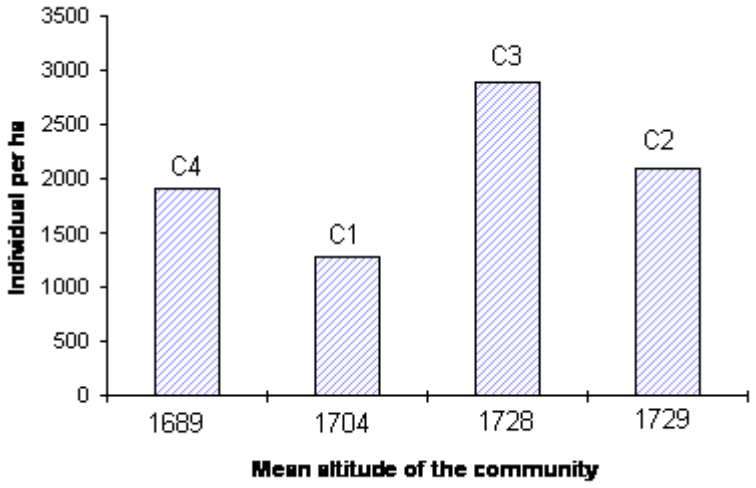


Figure 5: Density of woody species versus altitude of the communities

Communities were arranged according to the increasing order of altitude (Fig. 5). Community type two (C2) is found at relatively higher altitude and had less density (individuals per hectare) than community type three because of anthropogenic interference on the former than latter since the C2 is dominated by trees used by the local people for different household activities. On the other hand, community type one (C1) had the least density owing to its proximity to the periphery of the study area which is highly susceptible to a high magnitude of human and livestock interference.

5.6 Woody species diversity across the community

Of the four community types, community type one (C1) had highest woody species diversity (2.98) and evenness (0.81) and followed by community type four (C4) which has 2.16 and 0.59 diversity and evenness, respectively (Table 3). The least species diversity and evenness was recorded in community type three (C3) (0.69) and (0.19) respectively. Even though, there was no big difference in species richness among C1, C2 and C4, community type two had more species

than the others. The least species rich community was community type three. Even if there is variation in value of Shannon diversity between the communities, Shannon index of the study area were (2.877), which falls with in the range of value recommended (Magurran,1988) between 1.5- 3.5 In general, since the area was severely degraded and closed few years ago, the species found there now was mostly *Acacia* species of drought resistant and low soil fertility tolerant.

Table 3: Shannon diversity index of the four community types for woody species in Dilfaqar Regional Park

	Community types			
	C1	**C2**	**C3**	**C4**
Species Diversity (H')	2.98	1.76	0.69	2.16
Species evenness (E)	0.81	0.48	0.19	0.59
Species Richness (N)	24	36	20	25

5.7 Population structure

Information on population structure is very important to conserve healthy regeneration of the species under utilization (Kindeya G/Hiwot, 2003). To observe regeneration of species in the study area six woody plant species were selected based on their abundance. The population structure of the species is presented below (Fig. 6).

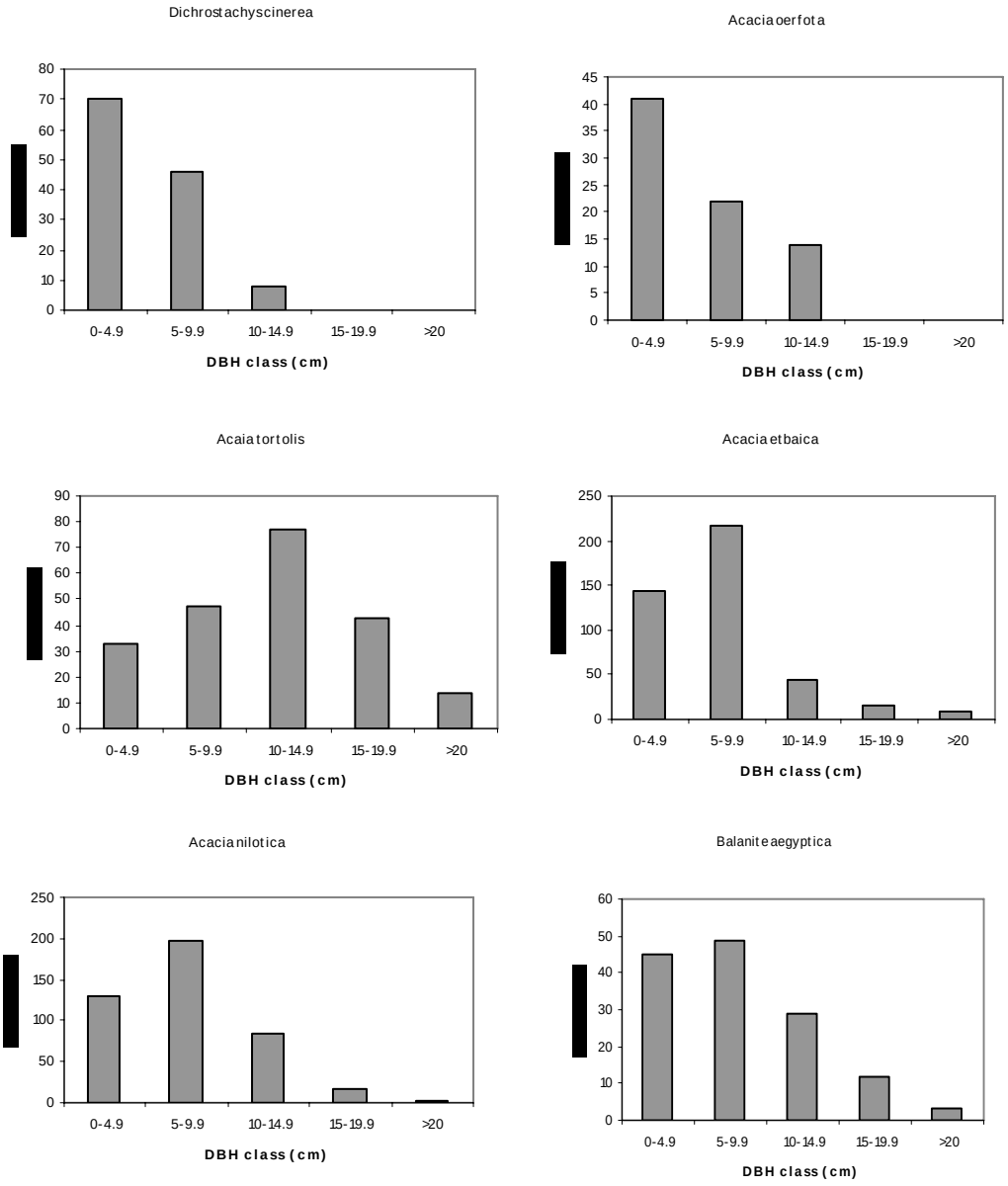


Figure 6: Distribution of individual structure in different DBH class for six most abundant tree species

For *Acacia etbaica* and *A. nilotica,* DBH class 5-9.9cm had highest abundance which is followed by 0-4.9cm than the other classes, where as for *A. tortilis* DBH class 10-14.9cm had highest abundance. From the above figure, all species had least value at higher DBH class especially at greater than 15 cm. Moreover, one can observe that, most of the dominant species had good regeneration status that means the lower DBH class had more abundance than the higher ones. In view of this, *Dichrostachys cineera, Acacia oerfota* and *Balanithes aegypitca* had an inverted J-shape which shows the better regeneration of the species that can recruit to the higher DBH class. These species were not fed by livestock due to its thorny nature. On the other hand, the density of *A. tortilis, A. etbaica* and *A. nilotica* at the lower DBH class is less as compared to the former species; the reason might be the seedlings were consumed by different domestic animals through illegal entrances into the park and wild animals inhabiting in the park. In general, even though there are variations of density in different DBH classes among species, most of the species are not at risk of regeneration. This is due to the protection of the area from domestic animals like cattle, goat and sheep. In some species the higher DBH class had lower abundance due to cutting of big tree for different construction and household utilities through illegal means. When this result is compared six dominant species selected by their relative density at various DBH classes conducted at Dry Afromontane forest of Bale Mountain National Park (Haile Yineger,2005) it confirms that the lower DBH class have higher abundance value than the higher DBH class which have lower value for most of the dominant species. The differences in regeneration status between different species brought by many factors such as biological, climatic soil and anthropogenic factors (Mwalyosi, 1997).

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5.8 Socio-economic importance

Socio-economic data about the importance of and impacts of the study area was collected using participatory rural appraisal (PRA) and semi structured interview (Martin, 1995). The selected respondents from local community for interview showing their level of education versus age category was indicated below (Table 4)

Table 4: Age category versus level of education of respondents.

	Age category																	
Level of education	10-30			31-40			41-50			51-60			>60			Total		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Illiterate	2	1	3	2	1	3	2	1	3	2	1	3	1	1	2	9	5	14
Primary school	2	2	4	4	3	7	3	2	5	2	1	3	1	-	1	12	8	20
High school	2	1	3	2	1	3	1	1	2	1	1	2	1	-	1	7	4	11
>high school	1	-	1	1	1	2	1	-	1	1	-	1	-	-	-	4	1	5
Total																32	18	50

The table shows that 20 or 40%of the respondents were female and 30 or60%of them were male more over most of the respondents are not highly educated.

According to the response from the informants, there are three basic benefits identified namely economic, social and ecological importance that local people obtained due to enclosure of the park. These basic benefits are shown below in table 5

Table 5 Benefits obtained due to enclosure of Dilfaqar Regional park

Benefit obtained due to enclosure of park	Number of respondents	Percentage	Rank
Economic importance	34	68	3rd
Social importance	45	90	1st
Ecological importance	43	86	2nd

5.8.1 Economic importance

Pertinent information from the group discussion mainly underlined that due to the closure of the area and rehabilitation of the vegetation, they could able to get grasses both for house cover and feeding of cattle's in drought season under the permission of the District Agricultural offices free of charge. 68% (34) of the respondents explained that before the closure of the area, since there was no grass for house roof cover and livestock feed, the residents used to go far and buy with expensive price of up to 3.00 ETB per bundle (Table 5). Moreover, in focus group discussion, participants noted that a number of visitors both Ethiopians and foreigners are coming to the park. They were told that they are paying a lot of money to the government offices at the regional level in Addis Ababa and at district level.

5.8.2 Social importance and view of local people

In most rural areas children learn the name and the importance of different plants from the nearby available forests. But, according to the respondents during group discussion, before the enclosure of the area, there was no forest for many years even to teach the name of trees for their children. The enclosure of the area helped the rehabilitation and growth of different vegetations and in turn helped their children to know the name and the importance of different vegetation practically. The results of interview made with local community (Table5) showed that 90% (45 of the respondents) were agreed on the benefit from the park, which includes availability of woody

species, wind break by the vegetation, growth of grasses used for different purposes and eco-tourism, out weighs its negative impact like restriction of domestic animals from entrance in to the park, crops damaged by wild animals and lack of benefit share. Moreover, greater than 95% 48 of the respondents) were strongly emphasized on the sustainability and willingness for managing the area.

Even though, most of the respondents have positive attitude towards the sustainability and rehabilitation of the park, 5% of the informants feel that the enclosure is part of the reason that made them landless. Yet there seems to be a visible reluctance to take full participation in the conservation effort and considerable incidences of intrusions are recorded. This may be due to the crises that people had experiences before. The respondents stressed that the park will have great benefit for the future only if it is made to be managed by the alliance of government and local community. According to the rules and regulations set by the local people and later approved by Woreda Administrative office, if domestic animals entered into the territory of the park, the owner will pay 5 ETB per animal as punishment. Besides these, the local people have great tendency to listen seriously what ever is told to them by their own community members and elders than any outsider which shows that including such knowledgeable person have tremendous value for the future aware ness creation campaigns and sustainable conservation of the resources in Dilfaqar Regional Park...

5.8.3 **Ecological importance/change in the ecosystem**

According to the information from group discussion and individual's interview, the major ecological benefit that people of the study area obtained from the park includes rejuvenation of different woody species and grasses, re-occurrence of different wild animals, gully stabilization and wind break against the strong wind which came towards the town of Dhera and other neighboring villages. Around 86% (43) (Table 5) of the informants pointed out that the climate and the rain patterns are increasingly changing better and better due to the rejuvenation of the vegetation in the park. It is also interesting to see that the informants were aware of the relationship between forests and climatic change. Indeed one elder from Dilfaqar said the fact that we could view greenness in our surrounding is a reward by it self.

Urban dwellers see the area as part of the life of Dhera town. Without protecting the area from intensive human use, the survival of the town is under question, because gully which had formed between the park and the town possibly could have expanded if the area would not have put under closure. After the closure, due to reestablishment of vegetation, the gullies became stabilized and the expansion has stopped. From this point of view the respondents from the urban dwellers realized the importance of protecting the area and some knowledgeable consider the protected areas as part of their daily life because directly or indirectly their life is associated with the resources in the park.

Based on individual's interview of 50 informants, the social importance ranked first, since they strongly believed that rehabilitation of the area is means for their children to know the names and related importance of trees and/or shrub. Moreover, ecological importance takes the second rank, whereas economic importance ranked least, because they were devoid of getting their benefit share of income generated from eco-tourism which was promised to them.

5.9 Major problems and suggested solutions

Despite the fact that enclosure of the area has many importances there are also some problems associated with it which are shown on table 5 below.

Table 4: summary of the respondents view on problem associated to the park

List of problems	Number of respondents	Percentage	Rank
Poverty induced …	48	96	1st
Demand for house construction	33	66	5th
Lack of fencing	39	78	3rd
Conflicts of wildlife and local community	35	70	4th
Inadequate water supply	23	46	6th
Creation of a quarry	17	34	7th
Lack of budget	46	92	2nd

5.9.1 Poverty-induced degradation of the natural resources of the Park

According to the information from group discussion and individual informants, a number of rural people as well as residents of Dhera town whose daily life depends on selling fuel wood see the park as the only place where they get wood which is also true in reality. As it is indicated in (Table 6) 96% of individual respondents agreed that most of the people living around the park have very low income, which even does not satisfy their daily need consequently, they have to secretly sneak and collect wood, in spite of the risk of being caught by the guards and the consequence that follow. The fuel wood demand is not only limited to wood sellers but also to the consumers. This is the case in which both rural people as well as urban centers in the country; wood is the major energy sources for cooking. The saddening situation is that these people do not collect only the dried trees but also peel the barks of the green trees to make sure that it will get it dried when they come back again. Such irresponsible activities are said to be predominantly done by Dhera town dwellers that are assumed to have better awareness. This justifies and reinforces the necessity of introducing fuel saving stoves, which greatly contribute to the minimization of the demand for fuel wood.

5.9.2 Demands for house construction

Almost all rural houses and most houses in urban centers are made of wood. 66% of individual respondents mentioned that people living around the park including Dhera town use wood from the park for house construction.(See Table 6) In Dhera in particular, people are accustomed to use wood from termite resistant indigenous trees for constructing latrines and they get it from the park. Such needs unless met with other alternatives would remain a pressure behind people's intrusion in the forest. The habit of using bricks from mud with locally designed instruments in most parts of Dhera town have to be encouraged by all means to the extent that dependence of the residents on construction wood is decrease and their interference in the forest is minimized.

*5.9.*3 Lack of fencing

According to key informants' group discussion, although fencing of the park has been attempted by the district Agricultural and Rural Development Offices, only small portion of the enclosure

could be fenced due to shortage of budget and other problems. As it is indicated in (Table 6) 78% of the informants noted that both the death of wild animals by car accident, and damages being done by wild animals on crop reduce if the fencing is completed. Moreover, fencing can protect the farmer's livestock from entering to the park, hence reducing the frequency of the payment of punishment fees which is one of the factors that constituted the local community complaints.

5.9.4 Conflicts of wild animals of the Park and the local community

Even though the majority of the respondents agreed on the positive benefit of the park, they stressed that their crops are frequently damaged and eaten by wild animals especially warthogs, Greater and Lesser Kudus and porcupines. On the other hand, Hyenas are also said to have inflicted considerable damage on their properties and indeed two men were eaten alive some two years ago. According to key informants' group discussion, protecting their cattle and crops from wild animals become extremely difficult. As it is indicated in (Table 6) 70% of individual respondents suggested that the completion of the fence would significantly reduce these negative impacts and emphasized that the number of warthogs and hyenas has become so large that needs arrangement of legal hunting mechanism as a means of mitigating their damage on crops and animals. They further noted that such kinds of step would be killing of two birds with one stone and getting back the stone, as it minimize the magnitude of the damage the animals are inflicting on the people in one hand and generating income from controlled hunting on the other. Such suggestions also indicate the awareness level of the community members.

5.9.5 Inadequate water supply for wild life

Wild animals in the park get water from reservoirs constructed by Association for Sustainable Development Alternatives (ASDA). 46% of the informants noted that since the reservoirs constructed are not enough for the highly increasing number of wild animals, they escape from the park in search of water (Table6). When the animals come out of the park in search of water, they cause serious damage on both domestic animals and crops of the surrounding people. In order to tackle this problem the informants pointed out that constructing extra reservoir based on preliminary assessment of the sites where to construct will minimize the problem.

5. 9. 6 The creation of a quarry

Relatively few respondents (34%) mentioned that the different road construction projects undertaken in the Doddota-sire district are mining selected materials for construction purposes changing considerably large area with in the park in to a quarry (Table6). This has exposed part of the land to uncontrolled water and wind erosion, incapable of rehabilitation and rejuvenization of the land and the disturbance of some wild animals contribute additional problem for enforcing the animals out of the park because of habitat disturbance, so measurement has taken to control these activity.

5.9.7 Lack of budget

Shortage of budget is a mentioned as one of the major problems to protect Dilfaqar Regional Park, to implement effective conservation activities and rehabilitation works. 92% of the individual respondents, key informants' discussion have noted that shortage of budget (Table6) has retarded fencing of the park which directly or indirectly affects their livelihood. Moreover, information from district bureau of natural resources supported the above idea as, park preservation activities had no an ear-marked budget, as a result whatever work have been done they were budgeted from different budget titles such as food security and safety–net programs. It was also noted that the allotment of money for different activities in the district for the fiscal year 1998 has decreased substantially, especially on some budget titles such as the safety–net program which create difficulty on management and sustainable use of the resources of the park.

Poverty is ranked first (See table 6) as it is related to the livelihood of the local community followed by lack of budget which has direct or indirect influence on the properties of the people around the park. Whereas, creation of quarry take the last rank as it has no great problem on the daily activities of the local people and on the management and sustainable use of the park as compared to the others problems affecting the sustainability and rehabilitation of the park.

6 CONCLUSION AND RECOMMENDATIONS

The floristic composition and socio-economic importance and impacts of Dilfaqar Regional Park was studied and the result of the vegetation from the study showed that 39 woody species. This belongs to 24 different families in which most of the dominant species belong to family Fabaceae with 4 genera and 9 species. The Shannon diversity index of the woody species was 2.877 and evenness index of 0.785. The cluster analysis of the woody species data of the park revealed that four community types which are distinct in terms of species composition were analyzed.

The four community types in the study area were: *Acacia oerfota-Acacia tortilis-Solanum incanum* community, *Acacia etbaica Leucas abyssinica* community, *Vernonia natalensis-Eculea schimperi-Rhus natalensis community* and *Croton dichogamous* community: The mean Shannon diversity index of the four communities was 1.90 which varies from an index value of 2.98 for community type 1 to 0.69 for community type 3. The mean evenness index of the communities was 0.52 with the highest 0.81for community 1 and lowest 0.19 for community 3.

Dilfaqar Regional Park has high importance both ecologically and economically. The short distance of the park from Sodere resort coupled with accessibility and high visibility of the wild life make this Regional Park the center of tourists. Not only this but also the keen interest of the local people due to thatch grass they obtain ascertain the sustainability of the park. Moreover, except some complaints associated, damages on crops by wild animals, majority of the local respondents had positive attitude towards the preservation of the park. Despite its ecological, social and economic importance, Dilfaqar Regional Park is not under proper management and due attention is not given to the area.

Therefore it is high time to recommend the following:

- Participatory management of the area by the local people and concerned Governmental and/or NGO's for sustainable use of the resources in the park
- Enhanced conservation education, public awareness by establishing schools', eco-clubs and build their capacities, and organize experience sharing travels (visits) for selected community members
- Make use of knowledgeable community members in the awareness creation campaigns, considering the fact that people have great tendency to listen seriously what ever is told to them by their own community members and elders than any outsider and assigning qualified person for conserving and rehabilitation of Dilfaqar Regional Park.
- Construct additional water sources based on well articulated design and most convenient locations within park and continue the fencing and access road building and repairing activities
- Ensure that beneficiaries are treated equally and fairly in terms of distribution of available benefit

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2 APPENDICES

Appendix 1: National Parks, Sanctuaries, Game Reserves, Controlled Hunting Areas and National Forest Priority Areas

National park

Abijatta-Shalla Lakes
Awash
Bale Mountains
Gambella
Mago
Nechisar
Omo
Simien Mountains
Yangudi Rassa

Sanctuaries

Babile Elephant
Kuni-Muktar Mountain Nyala
Senkelle Swayne's Hartebeest
Yabello

Game Reserves

Alledeghi
Awash West
Bale
Chelbi
Gewane
Mille-Sardo
Shire
Tama

Controlled Hunting Areas

Afdem-Gewane
Akobo
Arsi
Awash West
Bale
Borana
Boyo Swamp
Chercher and Arba Gugu
Dabus Valley
Eastern Hararghe (Harar-Wabi Shebelle)
Erer-Gota
Jikao
Maze
Mizan-Teferi
Murle
Omo West
Segen Valley
Tedo

National Forest Priority Areas

Abelti Gibie
Abey-Albasa
Abobo-Gog
Aloshie-Batu
Anferara-Wadera
Arba-Minch
Arero
Babiya-Fola
Belete Gera
Bonga
Bore-Anferara
Bulki-Melakoza
Butajira
Chato-Sengi-Dengeb
Chilalo-Gallema
Chilimo-Gaji
Deme-Laha
Dengego-Melka Jedbu
Denkoro
Desa-A
Dindin-Arbagugu
Dire-Gerbicha
Dodola-Adaba-Lajo
Gara Muleta
Gebre Dima
Gedo
Gergeda
Gidole-Kemba
Godere
Goro-Bele
Gumburda-Grakaso
Gura Ferda
Harena-Kokosa
Jalo-Addes
Jarso-Gursum
Jibat
Jorgo-Wato
Kahatasa-Guangua
Komto-Waga-Tsige
Konchi
Kubayo
Megada
Mena-Angetu
Menagesha-Suba
Munesa-Shashemene
Negele (Mankubssa)
Sekela Mariam
Sele Anderacha
Shako
Sibu-Tole-Kobo
Sigmo-Geba
Tiro-Boter-Becho
Wof-Washa
Yabelo
Yayu
Yegof-Erike
Yeki
Yarer

Appendix 2: Protected Area, Reason of Establishment, Ongoing projects and Damage

Protected area	**Reason established**	**Ongoing projects**	**Damage**
Abijatta-Shalla National Park	Protects aquatic birds; two rift valley lakes	Biologist training project, WCS, Infrastructure Improvements, UNDP and WCS	Infrastructure looted and destroyed, government vehicles burned
Awash National Park	Protects the Beisa Oryx, Soemmerring's Gazelle, and Swayne's Hartebeest	Development of a management plan, WCS	No damage and no reported poaching
Babille Elephant Sanctuary	Protects endemic sub-species of elephant		No infrastructure or staff ; Incursions of large numbers of refugees from Somali.
Bale Mountains National Park	Protects endemic Mountain Nyala, Ethiopian wolf, and giant mole rat; also protects a rare Afro-alpine habitat and moist highland forest	Conservation research for the Ethiopian wolf, WCS and WWF Infrastructure development project, WWF	Livestock control fences were cut, all outposts were destroyed, Mountains nyala and wolves were shot.
Gambella National Park .	Protects Nile Lechwe, white eared kob, and whale-headed stork in extensive swamp habitat		Infrastructure and vehicles were destroyed
Kuni-Muktar Mountain Nyala sanctuary	Protects Mountain nyala and remaining highland forest	Conservation project for the protection of Mountain Nyala,	Mountain nyala were shot, forestlands were cleared; no infrastructure existed
Mago National Park	Primarily for protection of buffalo, giraffe, and elephant	Infrastructure improvements, WCS and WWF	Park was abandoned by staff and store and houses were looted

Nechisar National Park .	Protects Swayne's hartebeest and Burch ell's zebra; also portions of two rift valley lakes in the park that protect crocodile and hippopotamus		Outposts located far from the headquarters were damaged and looted; incursions into the main grassland plain by the Gugi agro pastoralist
Omo National Park	Protects an extensive grassland wilderness and numerous large mammal species; among the most important are common eland, buffalo, and elephant	Development of a management plan, EWCO Infrastructure improvements, WCS and WWF	No infrastructure damage but poaching increased
Senkele Swayne's Hartebeest Sanctuary	Protects Swaynes hartebeest namesake; most viable population in Ethiopia		All infrastructure was destroyed and the herd was widely dispersed Simien
Semen Mountain National Park	Protects the Walia ibex and Ethiopian wolf	Development of a management plan, UNDP, UNESCO listed Simien mountains as a World Heritage Site in. 1978	Simien National Park was inaccessible between 1984 and 1991; all park infrastructure was destroyed
Yabello Sanctuary	Protect a population of Swayne's hartebeest, Stresemann's bushcrow, and white-tailed swallow	Conservation project: Swayne's Hartebeest, University of Oslo	Not developed, no infrastructure
Yangudi Rassa National Park	Primarily to protect the wild ass	None	Not developed, no infrastructure

Source**: Michael J. 2001. *Www .BSPonline.org* accessed on 18 March 2006.**

Appendix 3: List of species in and outside the plots in Dilfaqar Regional Park

Scientific name	Family name	Vernacular name	Habit	In/outside the plot
Acacia etbaica. Schweinf	Fabaceae	Dodota	Tree	in
Acacia nilotica (L) Wild ex Del	Fabaceae	Qordimo	Tree	In
Acacia oerfota (Forssk*)* Schweinf	Fabaceae	Ajoo	Shrub	In
Acacia Senegal var Senegal L. Wild	Fabaceae	Saphansa	Tree	Out
Acacia seyale Del	Fabaceae	Waccu	Tree	Out
Acacia tortilis (Forssk).Hayne	Fabaceae	Loxobbaa	Tree	In
Acokanthera schimperi (A.D C.) Schweinf	Apocynaceae	Qaraaruu	Tree	In
Asparagus africanus Lam	Asparagaceae	Shaartii	Shrub	In
Balanithes aegypitca (L) Del	Balanitaceae	Baddana	Tree	In
Cadaba farinosa Forssk	Capparidaceae	Heebsataa	Climb	In
Caesalipinia dectaptela (Roth*)* Altson	Fabaceae	Qonxir	Shrub	Out
Calupurnea aurea (Ait.) Benth	Fabaceae	Ceekkaa	Shrub	In
Capparis fascicularis Dc	Capparidaceae	Harangama	Climb	In
Carisa edulis(Forssk) Vahl	Apocynaceae	Agamisa	Shrub	In
Casuarinas equisetifolia L	Casaurinaceae	Shashawwee	Tree	Out
Cenchrus pennisetiformis Steud	Poaceae	Marga	Grass	In
Combretum Molle R.Br.ex G.Don.	Combertaceae	Rukeessa	Tree	In
Commiphora rostrata Engl	Burseraceae	Hameessa	Tree	In
Cordia africana Lam	Boraginaceae	Waddessa	Tree	Out
Cordia ovalis R.Br.ex.Dc.	Boraginaceae	Madheera	Tree	In
*Croton dichogamous P*ax	Euphorbiaceae	Bali adii	Shrub	In
Croton macrostachus Del	Euphorbiaceae	Bakkannisa	Tree	
Cyndon dactyl on (L.) Rich	Poaceae	Coqorsa	Grass	In
Dichrostachys cineera (L.)Wight	Fabaceae	Jirmee	Tree	In

&Arn				
Dodonea angustifolia L.F	Sapindaceae	Ittacha	Shrub	In
Eculea schimperi (Dc.)Dandy	Ebenaceae	Midheessaa	shrub	In
Ehertia cymosa Thonn	Boraginaceae	Ulaagaa	tree	In
Erithrina brueci Schweinf	Papilionaceae	Walensuu	Tree	Out
Eucalyptus globules Labill	Myrtaceae	Baargamoo	Tree	In
Euphorbia candelabrum Kotshy	Euphorbiaceae	Hadaamii	Tree	Out
Euphorbia tirucalli L	Euphorbiaceae	Qincibii	Shrub	Out
Ficus sur Forssk	Moraceae	Harbuu	Tree	Out
Ficus sycomorous L	Moraceae	Odaa	Tree	Out
Ficus vasta Forssk	Moraceae	Qilxuu	Tree	Out
Fleuggea virosa (Wild) Viogt	Euphorbiaceae	Qacaacillee	Shrub	In
GamPhocarpus integer (N.E.Br.) Bullock	Ascelepidaceae	Ananee	Shrub	In
Grewia bicolor Juss	Tiliaceae	Harooreessa	Tree	In
Grewia molls Juss	Tiliaceae	Harooressa arbaa	Tree	In
Grewia tenax (Forssk)	Tiliaceae	Qococcee	Shrub	In
Heliotropium longifolium (A.D.C.) Bunge	Boraginaceae	Baalcabbii	Shrub	Out
Hyparrhenia cymosa (L.) Stapef	Poaceae	Marga	Grass	In
Hyparrhenia multiplex	Poaceae	Sambaleexa	Grass	In
Hypoests forskaoli (Vahl.) Soland ex Roem &Schultz	Acanthaceae	Darguu	Shrub	Out
Jasminium grandiflorum Hoechst .ex Dc.	Oleaceae	Bluu	Shrub	In
Lannea Schimperi (A.Rich .)Engl	Anacardaceae	Andaraku	Tree	Out
Lucas abyssinica (Benth) Briq	Lamiaceae	Ashaalee	Shrub	In
Maerua angolensis Dc.	Capparidaceae	Qanqalcha	Tree	In
Maytenus senegalensis (Lam) Exell	Celastraceae	Kombolcha	Tree	In

Myrsine africana L	Myrsinaceae	Qacamaa	Shrub	In
Olea africana Mill.	Oleaceae	Ejersa	Tree	Out
Opuntia ficus –indica (L). Miller	Cactaceae	Abshuqii	Tree	Out
Ocimium lamiifolium Forssk	Lamiaceae	Dama kassee	Shrub	In
Osyris weightiana Wall ex. Wight	Salantaceae	Kaaroo	Shrub	In
Ozora insigns Del	Anacardaceae	Garii	Tree	Out
Pappea capensis Eckl &Zeyh	Sapinadaceae	Biiqaa	Tree	In
Pentharrhinum insipidium E. Mey	Ascelipidaceae	Galee	Climber	Out
Premna resinosa Schaver	verbenaceae	Urgeessaa	Shrub	In
Rhus natalensis Bent hex Krauss	Anacardiaceae	Xaaxessaa	tree	In
Rhus retinorrhoea Steud ex Olive	Anacardiaceae	Hawaasee	Tree	In
Sacrostemma viminale. (L.)R.Br	Ascelpidaceae	Anannoo	Tree	Out
Schinus mollie L	Anacardaceae	Turimaan turii	Tree	In
Solanum incanum L	Solanaceae	Hiddii	Shrub	In
Solanum somalensis Franch	Solanaceae	hiddii bidoo	Shrub	In
Steganotaenia araliacea Hoechst	Apiaceae	Luqqeessa	Tree	Out
Syzygium guineensis (Wild).Dc	Myrtaceae	Baddeessaa	Tree	Out
Terminalia brownie Fressen	Comebrtaceae	Birressa	Tree	In
Vernonia natalensis Sch -Bip	Asteraceae	Muka Chibboo	Shrub	In
Withania sominfera (L) Dunal	Solanaceae	Da'oo	shrub	Out
Ziziphus mucoronata Wild	Rhamnaceae	Qurquraa	tree	In

Appendix 4 : Shannon species diversity index

Scientific name	**Density**	**Pi**	**lnPi**	**pilnpi**	**D/ha**
Acacia nilotica	433	0.15225	-1.88223	-0.28657	264.0244
Acacia etbaica	428	0.150492	-1.89384	-0.28501	260.9756
Acacia oerfota	77	0.027075	-3.60916	-0.09772	46.95122
Acacia Senegal var Senegal	128	0.045007	-3.10094	-0.13956	78.04878
Acacia tortilis	190	0.066807	-2.70594	-0.18078	115.8537
Acokanthera schimperi	46	0.016174	-4.12433	-0.06671	28.04878
Asparagus africanus	17	0.005977	-5.11975	-0.0306	10.36585
Balanithes aegypitca	138	0.048523	-3.02571	-0.14682	84.14634
Cadaba farinosa	47	0.016526	-4.10282	-0.0678	28.65854
Calupurnea aurea	1	0.000352	-7.95297	-0.0028	0.609756
Capparis fascicularis	42	0.014768	-4.2153	-0.06225	25.60976
Commiphora rostrata	5	0.001758	-6.34353	-0.01115	3.04878
Cordia ovalis	18	0.006329	-5.0626	-0.03204	10.97561
Croton dichogamous	225	0.079114	-2.53687	-0.2007	137.1951
Dichrostachys cineera	123	0.043249	-3.14078	-0.13584	75
Dodonea angustifolia	151	0.053094	-2.93569	-0.15587	92.07317
Eculea schimperi	27	0.009494	-4.65713	-0.04421	16.46341
Ehretia cymosa	1	0.000352	-7.95297	-0.0028	0.609756
Eucalyptus globules	43	0.01512	-4.19177	-0.06338	26.21951
Fleuggea virosa	2	0.000703	-7.25982	-0.00511	1.219512
Grewia bicolor	8	0.002813	-5.87353	-0.01652	4.878049
Grewia tenax	82	0.028833	-3.54625	-0.10225	50
Jasminium grandiflorum	1	0.000352	-7.95297	-0.0028	0.609756
Lucas abyssinica	160	0.056259	-2.87779	-0.1619	97.56098
Maerua angolensis	6	0.00211	-6.16121	-0.013	3.658537
Maytenus senegalensis	21	0.007384	-4.90844	-0.03624	12.80488
Myrsine africana	42	0.014768	-4.2153	-0.06225	25.60976

Ocimium lamiifolium	18	0.006329	-5.0626	-0.03204	10.97561
Osyris weightiana	17	0.005977	-5.11975	-0.0306	10.36585
Pappea capensis	4	0.001406	-6.56667	-0.00924	2.439024
Premna resinosa	2	0.000703	-7.25982	-0.00511	1.219512
Rhus natalensis	117	0.041139	-3.19079	-0.13127	71.34146
Rhus retinorrhoea	2	0.000703	-7.25982	-0.00511	1.219512
Sacrostemma viminale	1	0.000352	-7.95297	-0.0028	0.609756
Schinus mollie	3	0.001055	-6.85435	-0.00723	1.829268
Solanum incanum	31	0.0109	-4.51898	-0.04926	18.90244
Solanum somalensis	2	0.000703	-7.25982	-0.00511	1.219512
Vernonia natalensis	179	0.06294	-2.76558	-0.17406	109.1463
Ziziphus mucoronata	6	0.00211	-6.16121	-0.013	3.658537

Appendix 5: Summary of Mammals and Birds in Dhera Dilfaqar Regional Park

No	**Order**	**Family**	**Species**	**Remark**
1	Chiropteran	**	**	mammal
2	Rodentia	Muridae	1	mammal
3	Primata	Cercopitecidae	2	mammal
4	Carnivora	Canidae	1	mammal
		Viveridae	4	mammal
		Hyaenidae	2	mammal
		Felidae	3	mammal
5	Artiodactyla	Hipopotamidae	1	mammal
		Suidae	1	mammal
		Bovidae	5	mammal
6	Lagomorphs	Leporidae	1	mammal
7	Tubulidentata	Oryeteropodidae	1	mammal
8	Anseriformes	Anatidae	1	Bird
9	Accipitriformes	Accipitridae	**	Bird
10	Falconiformes	Falconidae	4	Bird
11	Galiformes	Phasianidae	2	Bird
		Numididae	1	Bird
12	Gruifomes	Otididae	1	Bird
13	Charadriiformes	Charadriidae	3	Bird
14	Columbiformes	Columbidae	8	Bird
15	Psittaciformes	Psittaacidae	1	Bird
16	Cuculiformes	Musophagidae	1	Bird
17	Strigiformes	Tytonidae	1	Bird
		Strigidae	1	Bird
18	Apodiformes	Apodidae	1	Bird
19	Coliiformes	Colidae	2	Bird
20	Coraciformes	Meropidae	3	Bird

		Coracidae	2	Bird
		Upupidae	1	Bird
		Phoeniculidae	2	Bird
		Bucerotidae	3	Bird
21	Piciformes	Capitonidae	4	Bird
		Picidae	3	Bird
22	Passeriformes	Alaudidae	3	Bird
		Hirundinidae	3	Bird
		Motacillidae	3	Bird
		Pyrenenotidae	1	Bird
		Turdidae	4	Bird
		Sylviidae	4	Bird
		Monarchidae	2	Bird
		Timalidae	1	Bird
		Paridae	1	Bird
		Nectariniidae	2	Bird
		Laniidae	5	Bird
		Corvidae	2	Bird
		Sturinidae	4	Bird
		Buphagidae	1	Bird
		Passeridae	2	Bird
		Ploccidae	8	Bird
		Estrildidae	5	Bird
		Fringillidae	2	Bird

** To be identified in the future

Source: Abdurahiman Kubssa, 1995.

Appendix 6: Semi-structured questionnaires prepared to collect information on socio-economic issues**.**

General information

Kebele _____Village_____

Gender: Female_____ Male_____ Age_____

Level of Education 1_____ 2_____ 3_____ 4_____

Key: 1-Elementary 2- junior secondary 3- High school 4-Above high school level

1 For how long you lived in this area? _____

2 Would you tell me the general information you have about Difaqar game reserve?

_____

_____

_____

3 Who protected the area and when?

_____

_____

Socio-economic data

4 What benefits you get from this game reserve?

a)_____

b)_____

c)_____

d)_____

5 Who manages the area from unwise utilization?

_____

_____

6 Do you have local rules and regulations for managing the area?

a) Yes _____ b) No _____

6.1 If yes, would you mention some of them?

a)_____

b)_____

c)_____

7 What type of punishment is given for individuals who broke the rules?

_____

_____

8 Are foreign and local tourists visit the area? Yes _____No _____

8.1 If yes, how much money does he/she pay per head? Local _____

Foreigner _____

9 Who decides the amount of the payment? _____

10 Who collect the charge? _____

11 For what purpose does the charge used?

a)_____

b)_____

c)_____

12 In which month does the number of visitors/tourists becomes high, and why?

_____

13 Have you faced any problem due to protection of the game reserve?

Yes _____ No _____

If yes, would you mention some of them?

_____

_____

_____

14 Have you got any special benefit from the protected game reserve that you could not get before? Yes _____ No _____

If yes, would you mention some of them?

_____

_____

Conclusion remark

15 What do you want to be done from the Government side to enhance the utilization of the game reserve?

_____

_____

_____

16 What do you want to be done from the local people to enhance the utilization of the game reserve?

_____

_____

_____

17 If you have any idea or suggestion concerning the game reserve?

_____

_____

_____

_____

Declaration

I, the undersigned, do hereby honestly declare to the Senate of Addis Ababa University, that the content of this thesis is my original work and it has never been submitted for any Degree in any other academic institution to fulfill a similar purpose. All sources of material used for the Thesis have been duly acknowledged.

Name: Dereje Mekonnen

Signature _____

Place and date of submission

Addis Ababa University

July 2006