1 Introduction

1.1 Forest and land degradation in Ethiopia

The annual rate of deforestation in Ethiopia ranges from 100,000 to 200,000 hectares (FAO 1988). It has been accelerating in recent years due to unwise use mainly for subsistence and local economic activities, increased population and incidence of uncontrolled forest fires. The human population in 2001 was over 65 million with an average annual growth rate of 3.2 % (CSA 2001) as compared to 11.8 million in 1900, 36 million in 1960 and 47.3 million in 1988 (UN 1997). The wild fires in the year 2000 in the Bale and Borana Zones of the Oromia Region (Southern Ethiopia) alone caused more than US $ 39 billion damage (DECHASSA and PERAULT 2001). In the early 1990's, only about 2.7 % of the land mass was covered by closed forests (EFAP 1994). If the present trend continues, all these remaining forests could be lost in 15 to 20 years time (DECHASSA and PERAULT 2001).

Prevailing deforestation in Ethiopia has resulted in serious ecological degradation and loss of socio-economic welfare (HURNI 1988; TEWOLDE 1989; KINDEYA 1995; GETACHEW 2000). It has caused the disappearance of various indigenous wild animals and plants. ENSERMU *et al.* (1992) listed 120 threatened endemic plant species. It is estimated that 12% of the 6500-7000 species of vascular plants in Ethiopia are endemic (SEBSEBE 1993). According to the Environmental Protection Authority (EPA) of Ethiopia some two million hectares of land in the country has now become irreversibly barren as a result of the extensive deforestation (WIC 2002). Earlier estimates indicated that 1.5 - 2.0 billion tons of soil are lost annually as a result of erosion (CHADHOKAR 1988).

As a consequence, various forest products are no longer easily available. Their price has escalated. This has the greatest impact on rural communities, which depend primarily on forest resources for construction materials, farm implements, energy and fodder needs. More than 85% of the population of Ethiopia live in rural areas, and more than 90% of the energy requirement of the country comes from fuelwood (EFAP 1993). In

the early 1980's, the annual fuel wood deficit in the country was estimated to be 18.7 million m^3 (NEWCOMBE 1987). Forest products represent 2.5% of Ethiopia's GDP (GOERGE and MUTCH 2001). Considering that this income is generated from forested area that covers less than 3% of the country's land area, even a relatively small reduction of the forested land will have a serious impact on the GDP of the country (DECHASSA and PERUALT 2001).

The present study was undertaken in the Tigray Region (northern Ethiopia) where environmental degradation has been a serious problem. Subsequent sections give an account of the challenges and opportunities in the Region from the forest resources perspective. The Region is mainly a dryland area. Drylands (including the arid, semi-arid and dry sub-humid areas) in Ethiopia account for about 70 percent of the total land mass (EPA 2000). Therefore, the results of the present study in the Region may indicate the condition of the large dry areas throughout Ethiopia.

1.2 Development challenges in the Tigray Region

Many parts of the Tigray Region in northern Ethiopia have experienced a development trend, which threatened the natural resources reserve. The Region is characterised by a long history of human settlement. The available time series land use reports about Tigray (HUNTING TECHNICAL SERVICES LTD. 1976; MANN 1988) have documented shifts in land use pattern towards agricultural production at the expense of forest lands. Most of the current agricultural land was during earlier times under forest cover (PANKHURST 1990). However, the extent to which forest or woodland communities may have covered the Region is not known. No detailed research has been done on the vegetation history of northern Ethiopia (DIBLASI 1997). Nonetheless, significant amounts of closed forest were already destroyed in Tigray by the 9^{th} and 10^{th} centuries A.D. (MELAKU 1992). Based on the accounts of European travellers, the barren landscape of present-day northern Ethiopia dates back to before the 17^{th} century (PANKHURST 1992). The British expeditionary force had extreme difficulty in obtaining

wood while heading to Meqdala against Emperor Tewodros in 1867-68 (PANKHURST 1989, cited in MELAKU 1992).

In most of land use related reports about the Region (e.g. TFAP 1996), the present use of the term "forest" refers to the very localized groves around numerous churches throughout the highlands, in sparsely settled margins of the plateau, in deep valleys and inaccessible places. Scattered remnants of *Juniperus procera*, *Olea europaea*, *Cordia africana*, *Podocarpus gracilior*, *Acacia* spp., *Croton macrostachys*, *Ficus* spp., *Boswellia* spp., *Balanites aegyptiaca*, *Oxytenanthera abyssinica* and other species are common in most parts of the Region. At present, closed forests, although highly impoverished, can be found in some localities such as Dese'a, Hugumbrda and Grat Kahsu. These forests together with the thousands of groves around the churches strengthen the view that most of the highlands of the Region were once covered with closed forests.

The effects of deforestation on the socio-economic and ecological conditions of the Region can easily be observed (TFAP 1996). Severe shortage of fuelwood has rendered rural communities to be increasingly dependent on animal dung for fuel and agricultural crop residues, contributing to the problem of declining soil fertility (FITSUM *et al.* 1999). The percentage share of agricultural residues in total energy supply has been estimated to be 21% (EFAP 1994). Tigray Region depends mainly on imported construction material. Shortage of feed sources is the major livestock production problem (BERHANU *et al.* 2000). HURNI (1990) estimated an average annual soil loss of 12 metric tons by sheet and rill erosion. The productivity of agricultural lands has declined. Agricultural produce in most areas of Tigray usually fail to exceed the subsistence level even at times of adequate rainfall. The Region has been traditionally cited as a food deficit area, and food security has become a top priority issue for the people of Tigray (REST/NORAGRIC 1995). Such profound ecological problems and socio-economic collapse are related to deforestation in one way or another.

As BERHANU *et al.* (2000) have put it, the Region is known not only for severe resource degradation, but also for concerted efforts to redress the problem, especially since 1991.

Towards this end, conservation measures are being undertaken to minimize the degradation of forest resources. Nonetheless, more intensive efforts are still required. As the main focus of this study is on the dry deciduous forests, the subsequent section highlights the need to study the ecology and management of these dry forests in northern Ethiopia.

1.3 Rationale to study the ecology and management of dry forests in Ethiopia

1.3.1 Vegetation study in the dry forests

Dry forests are the largest component (42%) of all the tropical forests (MURPHY and LUGO 1986a). They occur in the frost-free areas of the tropics where the mean annual biotemperature is higher than 17°C, mean annual rainfall is between 250-2000 mm and the annual ratio of potential evapotranspiration to precipitation exceeds one (HOLDRIDGE 1967). The largest proportion of dry forest is in Africa, where it accounts for 70-80% of the forested area (MURPHY and LUGO 1986a). However, it should be noted that the many names and terms used to describe 'dry forests' (cf. HEGNER 1979, cited in LAMPRECHT 1989) indicate that this term is neither clear in definition nor uniform in usage (GERHARDT and HYTTEBORN 1992; SWAINE 1992). According to the simplified classification of tropical forests in LAMPRECHT (1989), the dryland forests of the persent study area in northern Ethiopia fall under the dry deciduous lowland forest. These are densely to sparsely stocked, mainly xerophytic and deciduous forests with 1-2 storeys. They are generally less diverse with low species richness, biomass and simpler in structure, fewer in trees and undergrowth as compared to tropical moist forests (MURPHY and LUGO 1986a; JANZEN 1988; LAMPRECHT 1989; GERHARDT and HYTTEBORN 1992). Nevertheless, these forests have been important in supplying the daily needs of the human beings for longer period of time (MUC 1996; KINDEYA 1995).

Dry forests in northern Ethiopia provide not only timber and fuelwood but also their non-timber forest products (NTFP) (e.g. leaves, fruits, roots, etc.) are used as food, medicines, dyes and serve other needs. At times of drought, these dry forests become

the only means of survival for livestock by providing feed. Species in these forests also play key roles in maintaining genetic diversity, protecting soils and providing niches for other organisms (KINDEYA 1995). Besides, many tree species in the drylands hold potential promise for yielding economically valuable products, e.g. oleo-gum resins (MULUGETA *et al*. in press). Owing to these benefits, dry forests continue to support a larger human population than humid forest areas (GERHARDT and HYTTEBORN 1992). This has resulted in intensive human interventions (e.g. fire, grazing, use of forest land to obtain fuel or fodder, etc), which have subsequently transformed the dryland forests. As a result, most formations are now open. JANZEN (1988) underlined that dry deciduous forests are one of the most threatened of all ecosystems in terms of biodiversity loss and face multiple-faceted threats. In Central America, less than 2% of the tropical dry forests remained in more or less intact state and less than 0.1% have some kind of conservation status (JANZEN 1988). FRIES (1991) reported that the natural forests in semi-arid West Africa are rapidly disappearing. The situation in Tigray (northern Ethiopia) is by no means an exception (cf. MUC 1996; TFAP 1996).

Unfortunately, such disappearance of tropical forests in general and dry forests in particular comes at a time when our knowledge on their structure and dynamics is inadequate (HUBBELL and FOSTER 1992). In tackling such lack of knowledge, far less attention has been given to the study of tropical and subtropical dry forests as compared to the other types of tropical ecosystems (MURPHY and LUGO 1986a; DEMEL 1996). Most work on the ecology of tropical forest has focused on moist forests. This is partly because dry forests contain few large tree species, which could be used for commercial exploitation (SWAINE *et al*. 1990). JANZEN (1988) argues that an approach which considers habitats worth for conservation merely on the number of species is incomplete. Dry forests also deserve thorough study to streamline conservation strategies. The lack of studies in dry forests is particularly conspicuous with respect to taxonomy, stand structure, biomass, primary production, rates of carbon turnover (MURPHY and LUGO 1986b), forest dynamics, patterns of species succession (GERHARDT and HYTTEBORN 1992), species composition, regeneration patterns; (GETACHEW 2000) and domestication (LEAKEY *et al.* 1999).