Annex 14 to Project Design Document

Humbo Ethiopia Assisted Regeneration Project

Environmental Analysis

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Greenhouse Balanced

1. Introduction

Carbon bio-sequestration projects sequester atmospheric CO_2 and store it as forest biomass. The establishment of a forest in an area where a forest has not existed for at least 25 years will however have other environmental consequences. These include impacts on water quality and quantity, soil stability and biodiversity.
This report is a summary of the non-sequestration environmental outcomes of the Humbo Assisted Regeneration Project, focused on the proposed sites 1 (Humbo) and 2 (Soddo).

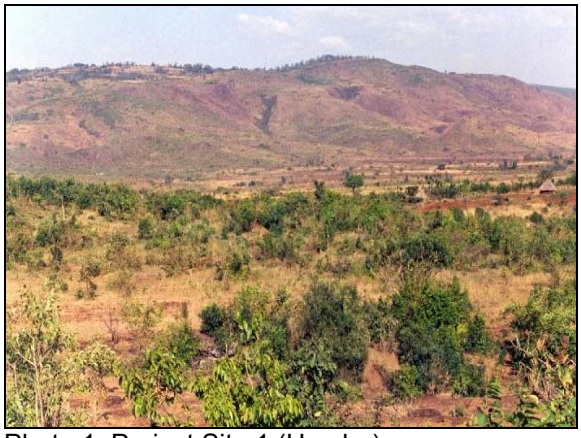


Photo 1. Project Site 1 (Humbo)


Photo 2. Project Site 2 (Soddo)

World Bank Safeguard Summary

The World Bank operates a series of safeguard policies[1]. The project has not yet been classified according to these safeguards, this report will contribute to the Environmental Assessment (OP 4.0.1) safeguard policy (see table 1 for a list of safeguard policies).

Table 1 – Compliance with World Bank Safeguards Policies

Safeguard Policy	Objectives
Environmental Assessment OP 4.01	The Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project.
Natural Habitat OP 4.04	Natural habitats are defined as land and water areas where (i) the ecosystems' biological communities are formed largely by native plant and animal species, and (ii) human activity has not essentially modified the area's primary ecological function.
Forests OP 4.36	Forest restoration and plantation development should meet the following objectives: harness the potential of forests; reduce poverty in a sustainable manner; integrate forests effectively into sustainable economic development, and protect the vital local and global environmental services and values of forests.
Pest Management OP 4.09	Pest Management Plan is required where there are significant pest management issues or where under the proposed project financing, pest control products represent a large component of the proposed project.
Physical Cultural Resources OP 4.11	'Physical cultural resources' are defined as movable or immovable objects, sites, structures, groups of structures, natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings, and may be above ground, underground, or underwater.
Safeguard Policy	Objectives
Involuntary Resettlement OP 4.12	The objective of this policy is: Avoid or minimize involuntary resettlement where feasible, exploring all viable alternative project designs; Assist displaced persons in improving their former living standards, income earning capacity, and production levels, or at least in restoring them; Encourage community participation in planning and implementing resettlement; Provide assistance to affected people regardless of the legality of land tenure.
Indigenous Peoples OD 4.20	The objective of this policy is to: ensure that the development process fosters full respect for the dignity, human rights and cultural uniqueness of indigenous people; ensure that they do not suffer adverse effects during the development process; ensure that indigenous peoples receive culturally compatible social and economic benefits.

[1]See : www.worldbank.org/safeguards

2. Environmental Implications of the Project

3.1 General scope of project activities

Ethiopia's closed high forest cover has been reduced to only 2.7% of its original size. Widespread clearing has resulted in a range of environmental problems including extensive erosion, loss of biodiversity, destructive impacts on water quality, and lack of regulation of both surface and subsurface water quantity. Reforestation projects, particularly those facilitating the reestablishment of a range of native species into their native environment can help to reverse these problems.

The total size of the project is between 4000 and 6000ha[2], located in two contiguous blocks, approximately 20km apart. The proposed regeneration activities are aimed to restore the forest cover for protection of the fragile landscape, and also deliver economic benefits to the local population. This will be done in collaboration with the communities through temporary protection from grazing and firewood collection, seedling plantation, possible establishment of some alternate grazing areas and firewood production plantings on the periphery of, or outside the main forest blocks, as well as significant pruning and tending /training/ of the regenerating forest where ample live root material is present.

3.2 Species to be utilized in the project

Field observations indicate that once the forest has reached maturity it will include the species identified in Table 2.[3]

Table 2– Species selected for afforestation (Deribe to augment)

Species	Located in strata
Acacia Spp	TBC
makhamia lutea	TBC
Olea fricana africana	TBC
Olinia aequipetaia	TBC
Podocarpus falcatus	TBC
Rhus glutinosa	TBC
Syzygium guineense	TBC
Terminalia brownii	TBC
Ximenia mericana americana	TBC
Albizia ophantha lophantha?	TBC
Aningeria adolfi- friederici	TBC
Albizia schimperana	TBC
Annona senegalensis	TBC
Balanites aegyptica	TBC
Bersama abyssinica	TBC
Carissa edulis	TBC
Combretum molle	TBC
Croton macrostachys	TBC
Dodonea viscosa	TBC
Ficus sp.	TBC
maesa lanceolata	TBC
Grewia flavescens	TBC
Erythrina abyssinica	TBC
Acacia senegal	TBC
Acacia abyssinica	TBC
Terminalia ssp	TBC

[2] To be confirmed by World Vision Ethiopia
[3] This will require input from the forester's report

In the establishment of these (or other appropriate species), soil disturbance activities will be minimized. All operations will be conducted manually without mechanical and/or chemical means. This will reduce the environmental impact as well as providing employment and facilitating the involvement and commitment of local communities.

The project team envisages establishing nursery-raised seedlings of several indigenous and non-indigenous species - however these will be exclusively species which already have widespread local utilization. No new species will be introduced to the Humbo and Soddo. These plantings are envisaged to be established on the periphery of the sites, in areas where no trees are currently growing, or in nearby open areas. These trees will be used to provide an alternate fuelwood source for community members whose firewood collection activity will be impacted by the closing of the forest. The seed sources for these trees will be taken from the project area, and species may include *Eucalyptus camaldulensis, Eucalyptus globulus, Eucalyptus saligna, Grevillea robusta*, *Acacia saligna, Shinus molle* . These species are well entrenched in the Humbo and Soddo areas, and have been identified as some of the most suitable species for biomass production in Ethiopia[4].

3.3 Soils

Description

Soils on the project sites have been identified as Vertisol/Nitosols, underlain with ancient Precambrian basement rocks in the plains and calcareous soils at the hills These soil types are common in the Ethiopian Highlands with a Nitosol / Vertisol gradient often occurring between the higher/steeper areas and the lower flatter areas. Nitosols are highly erodible and often quite acidic. Overclearing has led to significant soil erosion problems, with mudslides even occurring on the Damota Site[5].

Anticipated impact on Soil

It is anticipated that the project will stabilize and protect the soils within the project area, leading to a decrease in soil erosion and mudslides.

3.4 Hydrology

Surface Hydrology

Rainfall on the proposed project sites varies from 700-800mm at Abella-Longena to 1000-1400mm at Damota (see Map 1). The sites are elevated and feed a number of streams running into Lake Abaya, about 20 - 30km to the South. Due to the steep terrain and partly denuded soil, erosion can be locally severe, and heavy rains can cause flooding of villages and farms in areas below the project sites. In times of extreme rainfall, mudslides have occurred, and damage to roads, bridges and other infrastructure has resulted. In some cases lives have been lost.

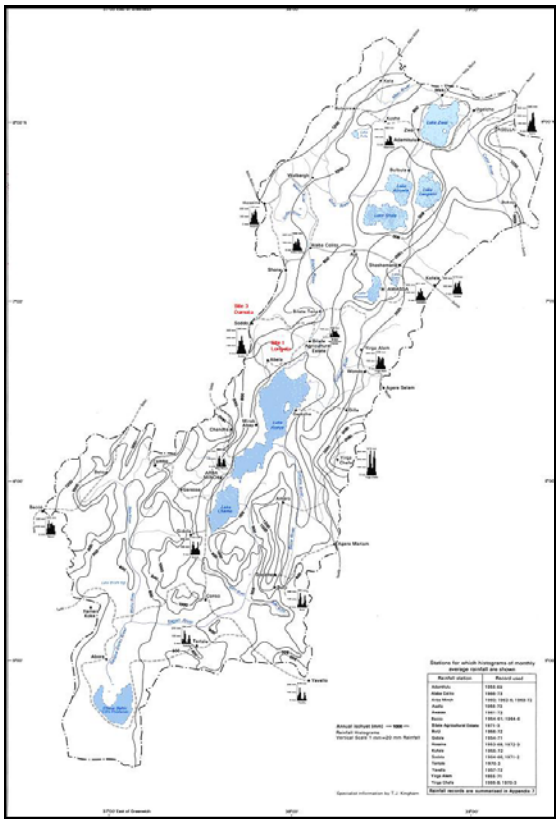
Ultimately both project sites terminate in Lake Abaya to the south which forms part of the Abaya - Chamo Basin, a quasi-endorheic system. The total catchment of the Abaya-Chamo-Basin covers an area of approximately 18,000 km², so the Humbo and Soddo areas are but a small part of this large hydrological system. Lake Chamo and Lake Abaya together have a size of approximately 1,440 km². The headwater areas also extend into the Western and Eastern Ethiopian Highlands; the lakes are located at the bottom of the Rift Valley. Decades of erosion have turned the waters of Lake Abaya to a murky brown color due to the high ferrous hydroxide levels and significant levels of sediment. This sedimentation and turbidity threatens the aquatic ecosystem of the lake.

Subsurface Hydrology

The two proposed project areas also have a significant role as the source of springs used for potable water in for a large proportion of the population. Experts have identified that the Damota Hills (site 3) contribute to the drinking water supply of some 3 million people. The Abella-Longena site is located immediately above the Likemse springs, which deliver potable water to a population of about 65,000 in and around Humbo. Reduction in vegetation cover, clearing for agriculture and grazing on the Damota mountain, in particular, has resulted in a loss of groundwater infiltration which has reduced the spring flow for the township of Soddo, and as a result water is now being transported to the town.

Map 1. Rainfall in the Ethiopian lower Rift Valley[6]

[4] see http://www.ilri.cgiar.org/InfoServ/Webpub/Fulldocs/Workp30/role.htm
[5] see http://www.fao.org/Wairdocs/ILRI/x5493E/x5493e19.htm
[6] [6] Ethiopian Government Mapping Agency, prepared by British Government Ministry of Overseas Services, 1975



Expected Hydrological Outcomes

The projected project outcomes on hydrology will include a decrease in overall peak runoff from the project sites (as a result of an increased water holding capacity of the soil). This will lead to a decrease in erosion, flash flooding and damage to infrastructure. The project is also expected to moderate water runoff, leading to an increase in the duration of runoff after rainfall events[7]. The project is expected to regulate recharge to groundwater, assisting to enhance subsurface water supplies. Secondary benefits from these changes in hydrology are anticipated to include a decrease in the siltation of farmlands, sedimentation of the streams flowing from the project sites, and a possible decrease in the sedimentation of Lake Abaya.

3.5 Biodiversity

The project offers a significant opportunity to realize meaningful biodiversity outcomes alongside those of climate protection. The project allows for the reestablishment of significant areas of natural habitat. Indigenous species will be naturally regenerated and pruned, or planted within the project areas proper, resulting in an increase in biodiversity. Natural regeneration will precipitate ecological succession, creating the conditions for establishing climax species for the ecological community, and maintaining the forest cover in the future.[8]

There is potential that fast-growing species common in the area, but not necessarily locally indigenous, will also be planted on the perimeter of the project to enhance fuelwood and charcoal supply. These non-indigenous species are limited in number, and well entrenched as timber species in the region, having been utilized by the communities in the area for an extended period of time.

The re-establishment of native forests will provide wildlife habitat, improving animal biodiversity and will enhance the dispersion of seeds to areas outside the project. This region contains several threatened species identified in the World Conservation Union (IUCN) red list associated with the temperate and tropical mountain forest habitat which are anticipated to benefit directly from the proposed project. These are identified in Table 3.

Table 3. IUCN Red List Species endemic to the project area

[7] see http://www.ctahr.hawaii.edu/forestry/Data/hydrology.asp

[8] Completion of this section will require some input from the report of Dr. Deribe

Afrixalus enseticola	ETHIOPIAN BANANA FROG (E)
Caprimulgus solala	NECHISAR NIGHTJAR (E)
Grammomys minnae	ETHIOPIAN THICKET RAT (E)
Heteromirafra sidamoensis	SIDAMO BUSHLARK
Hipposideros megalotis	ETHIOPIAN LARGE-EARED ROUNDLEAF BAT (E)
Kerivoula eriophora	ETHIOPIAN WOOLLY BAT (E)
Lycaon pictus	AFRICAN WILD DOG
Panthera leo	AFRICAN LION
Vulpes pallida	AFRICAN SAND FOX
Phoenicopterus minor	LESSER FLAMINGO

Vegetation Communities to be included in the project area

The two specific biological communities that will be directly affected by the project are Ethiopian montane grassland and woodland, and Ethiopian montane forest.[9] The information in these bioregional descriptions correspond to the experience at field level. An excerpt from the World Wildlife site is given below, prepared by Chris Magin and Miranda Mockrin.

Ethiopian montane grasslands and woodlands (AT1007)

Conservation Status: **Critical/Endangered**

Ranging up to 3,000 m, the montane vegetation includes Hagenia abyssinica, Podocarpus falcatus and Juniperus procera, but intact vegetation is increasingly fragmented. The region is densely populated because it contains the best arable land in Ethiopia. A variety of Ethiopian endemics can be found, including the critically endangered Walia ibex (Capra walie) and endangered mountain Nyala (Tragelaphus buxtoni). Plant endemism in this region peaks in the forest/ woodland/ grassland complex.

Location and General Description

This is a biologically rich and severely threatened ecoregion that covers the majority of two Ethiopian mountain massifs (Eastern and Western), separated by a part of the African Great Rift Valley. This ecoregion ranges from 1,800 m to 3,000 m in elevation, with montane forest at lower altitudes and Afro-alpine habitat at higher altitudes.

Phytogeographically, the ecoregion is mapped as Afromontane vegetation and is considered to be part of the Afromontane archipelago-like regional center of endemism[10]. The natural vegetation of the temperate zone, called dega or weyna dega in Amharic, was probably a mixture of closed forest in areas with higher rainfall (mainly to the southwest of the two main massifs and on some higher mountains), grassland, bushland, and thicket in other lower rainfall areas. Forest structure and composition varies with locality and elevation. There is a cloud forest belt at 2,000 to 2,500 m in the south, while in drier locations (particularly on steep hillsides) the forest consists of Podocarpus falcatus and Juniperus procera, often associated with Hagenia abyssinica. In the north, between 2,300 and 2,700 m in the Simien Mountains, there is an evergreen broadleaved montane forest dominated by Syzygium guineense, Juniperus procera, and Olea africana[11].

Woodland and shrubland dominated by Acacia species was probably the natural vegetation over the majority of the lower plateau. The forest/woodland/grassland complex contains a high number of endemic plants[12].

Biodiversity Features
The ecoregion has a number of endemics in all taxonomic groups, and covers the majority of two endemic bird areas (EBAs)[13]. The south Ethiopian Highlands EBA is centered on the forests, grasslands and thickets

[9] These two biological communities and the threats they face have been detailed by the World Wildlife Fund, and can be found at *www.worldwildlife.org*.
[10] White, F. 1983. *The vegetation of Africa, a descriptive memoir to accompany the UNESCO/AETFAT/UNSO Vegetation Map of Africa (3 Plates, Northwestern Africa, Northeastern Africa, and Southern Africa, 1:5,000,000).* UNESCO, Paris
[11] Nievergelt, B., Good, T. & Güttinger, R. 1998. A survey of the Flora and Fauna of the Simen Mountains
[12] Tilahun, S., Edwards, S. & Egziabher, T.B.G. (eds.) 1996. *Important Bird Areas of Ethiopia*. Published by Ethiopian Wildlife and Natural History Society. Semayata Press. Addis Ababa, Ethiopia.

to the southwest of the Bale Mountains and around the town of Yabello. Ruppell's chat (*Myrmecocichla melaena*) and Ankober serin (*Serinus ankoberensis*) are two notable near-endemics. Among the birds, only the lineated pytilia (*Pytilia lineata*) is endemic to this ecoregion. A number of Ethiopian endemics occur only in this ecoregion and the Ethiopian Montane Moorland ecoregion, so that they are considered near-endemic in each. These high altitude ecoregions are especially known for their diversity of small mammals with over 10 near-endemic species, but also harbor notable near-endemic large mammals, such as the Walia ibex (Capra walie), the mountain Nyala (Tragelaphus buxtoni), and the gelada baboon (Theropithecus gelada). Most of these species are shared with the Ethiopian Montane Moorland ecoregion.

At least 10 amphibians are endemic or near-endemic to the ecoregion, together with five species of near-endemic reptiles. Most of the species are shared either with the lower altitude Ethiopian Montane Woodland ecoregion, or with the higher altitude Ethiopian Montane Moorland ecoregion.
The mountain Nyala is not a montane specialist, but has been restricted to Afromontane areas through habitat loss. Found only in the southern part of the highlands, the lower reaches of its altitudinal range are more suitable to the mountain Nyala than the higher, less vegetated ones, but the lower habitat has mostly been converted to cultivation and pastoralism[14]. The mountain Nyala population in Bale Mountains National Park was thriving until 1991 when it was severely reduced by local people, in protests and upheaval associated with the change in government. Another antelope commonly found at lower elevations is Menelik's bushbuck (*Tragelaphus scriptus meneliki*), a subspecies of bushbuck endemic to Ethiopia.
A number of the endemic species are endangered. Threatened bird species include two near-endemics, the Ankober serin (*Serinus ankoberensis, EN*) and the white-winged flufftail (*Sarothrura ayresi, EN*). Several distinctive mammalian endemics face global extinction. The Walia ibex (CR) numbers fewer than 400 individuals (Nievergelt et al. 1998), and it is threatened through habitat loss and hybridization with free-ranging domestic goats. Other mammals found in this ecoregion include olive baboon (*Papio anubis*), black and white colobus monkey (*Colobus guereza*), golden jackal (*Canis aureus*), leopard (*Panthera pardus*), lion (*Panthera leo*), spotted hyaena (*Crocuta crocuta*), caracal (*Caracal caracal*), serval (*Felis serval*), bush duiker (*Sylvicapra grimmia*) and bush pig (*Potamochoerus porcus*). Two different subspecies of the *Cercopithecus* superspecies are found in this ecoregion: the Djam-djam or Bale monkey (*Cercopithecus aethiops djamdjamensis, DD*), which is restricted to the southern highlands and the black-faced vervet (*Cercopithecus aethiops aethiops*).
All these species, including the black and white colobus monkey, are suffering from a decrease in suitable habitat. Colobus populations are increasingly fragmented, with groups living in small remnant forest patches, often a single church graveyard.
Cultivated fields and grazed woodlands attract a diverse butterfly fauna, with far more species found here than in Ethiopian Montane Moorland ecoregion. Papilio and Charaxes are well represented and Pieridae and Lycaenidae are also present[15]. The distribution of the butterfly fauna illustrates the conversion of forest to farmland, with species adapted to cultivated areas.
The low trench of the Great Rift Valley has remained a formidable barrier, with several species distributed only on one side. The Walia ibex and Gelada baboon are found only in the northern highlands whereas the mountain Nyala lives only in the southern highlands. Many of the small rodent species are similarly restricted. The Ethiopian wolf Canis simensis, endemic to the higher Ethiopian Montane Moorland ecoregion, is an exception to this rule, since it occurs in both the northern and southern highlands.

Current Status
By the early twentieth century, only 5 percent of the Ethiopian Highlands were forested, although it is believed that at one time forest covered most of them[16]. Podocarpus and Juniperus species once covered 176,000 km2 in the central, eastern and northern regions. Less than 1% of these forests remain because Podocarpus and Juniperus provide the most commonly used timber in Ethiopia[17]. The natural vegetation has been altered and destroyed by intensive human use over millenia, and today only fragments are left. Remaining grassland and thorn scrub patches are generally confined to rocky and steep areas. Besides

[13] Stattersfield, A.J., Crosby, M.J., Long, A.J. & Wege, D.C. 1998. *Endemic Bird Areas of the World. Priorities for Biodiversity Conservation*. BirdLife Conservation Series No. 7. BirdLife International, Cambridge, UK. 846 pp.
[14] Kingdon, J. 1989. Island Africa: The evolution of Africa's rare animals and plants. Princeton University Press. Princeton, NJ, USA. 287 pp
[15] Nievergelt, B., Good, T. & Güttinger, R. 1998. A survey of the Flora and Fauna of the Simen Mountains National Park, Ethiopia. *Special Issue of Walia, Journal of the Ethiopian Wildlife and Natural History Society*. Addis Ababa, Ethiopia
[16] Friis, I. 1992. *Forests and Forest Trees of Northeast Tropical Africa*. HMSO, Kew Bulletin Additional Series XV
[17] Gemachu, D. (undated). Environment and Development in Ethiopia. Department of Geography, Addis Ababa University, Addis Ababa, Ethiopia. Unpublished report

these inaccessible areas, the only remaining forested areas are church graveyards. Even these forests are not totally protected. A survey of Syzygium forest in graveyards in the Simien region found that trees were harvested for local use and cattle grazed within the graveyards, affecting the regeneration of the forest[12]. Parts of the ecoregion are officially protected within the Bale Mountains National Park, but about 2,500 people currently live in the Park along with 10,500 livestock. Controlled hunting areas and wildlife reserves offer very little, if any, protection for native flora and fauna[18]. The forests, woodlands, and grasslands remaining to the southwest of the Nechisar National Park are not protected. The proposed Termaber-Wufwasha-Ankober conservation area in the western highlands would protect much of the ecoregion's biodiversity, as would the proposed areas for protecting the forests further to the southwest. Smaller-scale actions are undertaken throughout the ecoregion by local NGOs and specific projects.

Types and Severity of Threats
Conversion to cropland is nearly complete in this ecoregion, where sedentary cereal production has continued for thousands of years and agricultural production is extremely intensive. As a result, the remaining habitats are highly fragmented. With the population increasing by 3.1% each year, people are heavily dependent on natural resources, particularly grazing pasture and wood for construction or firewood. In the Bale region on the southern border of the Harenna forest large timber trees are being cleared. The Harenna forest is increasingly being utilized to supply construction material, fuel and charcoal for the expanding urban population in this region. Traditionally, forests were used for gathering honey, coffee and other forest products as well as cattle grazing[19].

Ethiopian montane forests (AT0112)

Conservation Status: **Critical/Endangered**

The Ethiopian Montane Woodland ecoregion is biodiverse, poorly known and highly threatened. The rugged topography of this ecoregion rings the highlands of Ethiopia and Eritrea, extending to outlying massifs in Sudan. Remnant patches of natural vegetation consist mostly of podocarp and juniper forests, with some acacias found at lower elevations. While soils are rather infertile, this area is densely populated and most land has been converted to agriculture. Notable endemics found here include the yellow-throated serin and Prince Ruspoli's turaco. Many of the endemic species are threatened due to the loss of their habitat

Location and General Description
This ecoregion is highly biodiverse, relatively poorly known and highly threatened. It is mainly found on the margins of the highlands of Ethiopia and Eritrea. Isolated montane outliers include Jebel Elba and Jebel Hadai Aweb, parts of which are politically in Egypt although they are administered by Sudan; Jebel Ower near Port Sudan; and the Goda and Mabla massifs in Djibouti. The altitudinal limits of the ecoregion vary from one locality to another depending upon annual precipitation, but are generally between 1,100 and 1,800 m.

Ancient Precambrian basement rocks form the substrate of the montane forests in southwestern Ethiopia and Eritrea. The topography is generally rugged, and soils are rather infertile. The main Ethiopian and Eritrean dome began to rise 75 million years ago, eventually dividing into two halves, the northern and southern highlands. A turbulent volcanic period ended four to five million years ago, followed by climatic fluctuations in the Pliocene and Pleistocene. Glaciers formed on the peaks of the Ethiopian highlands while surrounding areas, including this ecoregion, were covered with vegetation similar to Eurasian tundra. Separated by the Great Rift Valley, the northern and southern highlands were colonized by new species from different directions. The jebels and escarpments along the Red Sea linked Eritrea and northern Ethiopia with the Palearctic region while southern Ethiopia had a rift-wall connection to the Horn of Africa. Both the western and eastern highlands were invaded by tropical species that could penetrate the Nile floodplains in the west or the Kenyan deserts in the south. Despite the climatic differences, the surrounding lowlands

[18] Yalden, D.W., Largen, M.J., Kock, D., Hillman, J.C. 1996. Catalogue of the mammals of Ethiopia and Eritrea. 7. Revised checklist, zoogeography and conservation. *Tropical Zoology* **9:** 3-164
[19] Tilahun, S., Edwards, S. & Egziabher, T.B.G. (eds.) 1996. *Important Bird Areas of Ethiopia*. Published by Ethiopian Wildlife and Natural History Society. Semayata Press. Addis Ababa, Ethiopia

provided the most consistent source of new species, so that these highlands show both Afrotropical and Palearctic influences[20].

Phytogeographically, the ecoregion is part of the Afromontane archipelago-like regional center of endemism[21]. The area supports East African evergreen and semi-evergreen forests through to bushlands. At lower elevations, woodland, known as kolla, is dominated by *Terminalia, Commiphora, Boswellia* and *Acacia* species. However, at moister or higher locations the vegetation is of weyna dega type and is increasingly dominated by the conifers *Podocarpus falcatus* and *Juniperus procera*. The low, dry portion of the Harenna forest south of the Bale Mountains National Park reflects the type of forest that once covered a large part of Ethiopia and possibly Yemen. *Coffea arabica* is the dominant understory shrub and wild coffee is still harvested extensively. The tall, open canopy consists of *Warburgia ugandensis*, *Croton macrostachyus*, and *Syzygium guineense*, with emergent *Podocarpus falcatus*. At higher elevations, moist pockets of dense forest grow, with abundant lianas and epiphytes. Trees here are typical of eastern Africa, with *Aningeria* and *Olea* being dominant[22].

Biodiversity Features
Forest types present in this ecoregion range from wet to dry, giving the area high biodiversity values. The patterns of endemism and their association with the forests of the area are complex and have been presented elsewhere[23] [24]. There is an area of bird endemism on the southeast corner of the southern Ethiopian highlands and another one in the higher plateau of the northern Ethiopian highlands and Eritrea[25]. Other plant and animal endemics are found along the drier northeastern margins of the Ethiopian highlands, which link to the mountains of northern Eritrea and Somalia as well as the Day Forest in the Goda Massif in Djibouti. This small outlier in Djibouti is an important forest island in a sea of semi-desert, with at least four known endemic plant species[26].
Because humans have intensively occupied the highlands of the Horn of Africa for thousands of years, it is difficult to gauge the extent to which the ecoregion was formerly forested, and the extent to which it has always consisted of a natural grassland, thicket, and forest mosaic. Remnant ancient trees in enclosed cemeteries provide evidence that forest was previously much more widespread[27]. However some report that even these forests may be used for cattle pasture or to obtain wood. A large portion of the ecoregion is now covered by farmland or secondary vegetation derived from agricultural or wood-harvesting activities[20]. For example, 88 percent of the Day Forest in Djibouti has been lost in the last two centuries, and more than 20 percent of the loss has occurred in the last 50 years[28].

Threatened species include four strict endemics, including Djibouti francolin (*Francolinus ochropectus*, CR), Harwood's francolin (*Francolinus harwoodi,* VU), Prince Ruspoli's turaco (*Tauraco ruspoli*, VU) and yellow-throated seedeater (*Serinus flavigula*, VU), all of which are primarily threatened by habitat loss[29] (Magin 2001). Prince Ruspoli's turaco is further restricted where its range overlaps with the near-endemic white-cheeked turaco (*Tauraco leucotis*). Where both species are present, Prince Ruspoli's turaco is only found in juniper forest, but where it occurs alone, it inhabits both broad-leaved and juniper forest. Both birds are part of a recent radiation of small, red-winged turacos. However, the white-cheeked turaco is extremely adaptable

[20] Kingdon, J. 1989. Island Africa: The evolution of Africa's rare animals and plants. Princeton University Press. Princeton, NJ, USA. 287 pp
[21] White, F. 1983. *The vegetation of Africa, a descriptive memoir to accompany the UNESCO/AETFAT/UNSO Vegetation Map of Africa (3 Plates, Northwestern Africa, Northeastern Africa, and Southern Africa, 1:5,000,000).* UNESCO, Paris
[22] Kingdon, J. 1989. Island Africa: The evolution of Africa's rare animals and plants. Princeton University Press. Princeton, NJ, USA. 287 pp
[23] Friis, I. 1992. *Forests and Forest Trees of Northeast Tropical Africa*. HMSO, Kew Bulletin Additional Series XV
[24] Lovett, J. C. and I. Friis. 1996. Patterns of endemism in the woody flora of north-east and east Africa. Pages 582-601 in L. J. G. van der Maesen, X. M. van der Burgt, J. M. van Medenbach de Rooy, editors. The Biodiversity of African Plants. The Netherlands: Kluwer Academic Publishers
[25] Stattersfield, A.J., Crosby, M.J., Long, A.J. & Wege, D.C. 1998. *Endemic Bird Areas of the World. Priorities for Biodiversity Conservation*. BirdLife Conservation Series No. 7. BirdLife International, Cambridge, UK. 846 pp
[26] Magin, C. editor. 1999. Monographie Nationale de la Diversité Biologique de Djibouti. Direction de l'Environnement, Ministère de l'Habitat, de l'Urbanisme, l'Environnement et de l'Aménagement du Territoire, Djibouti et l'UICN, Nairobi, Kenya.
[27] Nievergelt, B., Good, T. & Güttinger, R. 1998. A survey of the Flora and Fauna of the Simen Mountains National Park, Ethiopia. *Special Issue of Walia, Journal of the Ethiopian Wildlife and Natural History Society*. Addis Abeba, Ethiopia
[28] Comité National pour l'Environnement (CNE). 1991. Rapport National Environnement. Secrétariat Technique du Comité National pour l'Environnement ONTA/SPSE, Djibouti
[29] Magin, G. 2001. Djibouti chapter in: Fishpool, L.D.C. and Evans, M.I. (eds). Important Bird Areas in Africa and associated islands: priority sites for conservation. Newbury and Cambridge, U.K: Pisces Publications and BirdLife International (BirdLife Conservation Series No. 11)

and the regional representative of a type that is found across all of Africa. Prince Ruspoli's turaco has not become significantly distinct and is declining as the white-cheeked turaco advances[19]. The ecoregion also contains part of the South Ethiopian highlands endemic bird area[22], centered on the forests, grasslands and thickets to the southwest of the Bale Mountains and including the Yabello Sanctuary at around 1,700 m where the endemic Sidamo lark (*Heteromirafra sidamoensis*, EN), white-tailed swallow (*Hirundo megaensis*, VU) and Ethiopian bush-crow (*Zavattariornis stresemanni*, VU) occur. Other birds considered as near-endemic to this ecoregion include dark-headed oriole (*Oriolus monacha*), Abyssinian catbird (*Parophasma galinieri*), Abyssinian slaty flycatcher (*Dioptrornis chocolatinus*), and yellow-fronted parrot (*Poicephalus flavifrons*).
Mammals with ranges restricted to Ethiopia that occur in this ecoregion include the shrew, (*Crocidura harenna)* CR, the narrow-footed woodland mouse (*Grammomys minnae*), and Menelik's bushbuck (*Tragelaphus scriptus meneliki*), a subspecies of bushbuck with long, dark fur. Males are black while females are chestnut colored with white spots. Some other mammals found in this ecoregion are: olive baboons (*Papio anubis*), black and white colobus monkeys (*Colobus guereza*), black-faced vervet monkey (*Cercopithecus aethiops aethiops*), bush duikers (*Sylvicapra grimmia*), warthogs (*Phacochoerus aethiopicus*), bush pigs (*Potamochoerus porcus)* and hippopotamus (*Hippopotamus amphibius*). Predators include caracals (*Caracal caracal*), golden jackals (*Canis aureus*), black backed jackals (*Canis mesomelas*), leopards (*Panthera pardus*, EN), lions (*Panthera leo*, VU), spotted hyaenas (*Crocuta crocuta*) and servels (*Felis serval*). Antelope species found here include Swayne's hartebeest (*Alcelaphus buselaphus swaynei*, EN), Guenther's dikdik (*Madoqua guentheri*) and greater kudu (*Tragelaphus strepsiceros*). Many of these larger mammals are only found in protected areas, most notably Nechisar National Park and Sikele reserve. In the early 1900s, elephant (*Loxodonta africana*), black rhinocerus (*Diceros bicornis*), buffalo (*Syncerus caffer*) and oryx (*Oryx gazella*) were found in the Nechisar area but all have been eliminated[30].
Although accurately ascribing species of amphibian and reptile to this complex ecoregion has proven problematic, there are believed to be a number of strict and near-endemic species of both taxonomic groups in these forests. Of the five endemic amphibians two are tree frogs (*Afrixalus clarkei* and *Afrixalus enseticola*), two are ranid frogs (*Phrynobatrachus bottegi* and *Phrynobatrachus sciangallarum*), and one is a caecilian (*Sylvacaecilia grandisonae*) . Two endemic chameleons are found, including two species of chameleons, *Chamaeleo balebicornutus* and *Chamaeleo harennae*.

Current Status
The ecoregion is poorly protected, although some small areas are included in Ethiopian protected areas that primarily encompass other ecoregions. Ethiopian Montane Woodland is contained in the Babile Elephant Sanctuary, Awash National Park, Omo National Park, and Nechisar National Park. Many of these protected areas, such as controlled hunting areas and wildlife reserves, offer little to no protection for native flora and fauna[27]. The very few patches of natural forest remaining are mostly found in the southwest where rainfall is highest. Smaller areas of drier forest are also found to the north on the scarp slopes facing the Red Sea and Gulf of Aden. Non-forest habitats are also found, but are principally located within areas of very high population density; and, little remains in a natural state, except in rocky ravines and other inaccessible areas.

Types and Severity of Threats

All natural habitats in the ecoregion are highly threatened because they have been reduced to small patches, are severely fragmented, and poorly protected. Agriculture is the main threat, coupled with exploitation of trees for fuelwood and timber. Tilahun et al. (1996) report that a sawmill has been constructed in Mena, on the southern border of the Harenna forest and the large timber trees are being logged out. The expanding urban population in this region, which utilizes these forests for construction material, fuel and charcoal, threatens the Harenna forest. Traditionally, the Harenna forest was used for gathering honey, coffee and other forest products as well as cattle grazing.

In many places within this ecoregion, poor agricultural methods and overgrazing have resulted in intense soil erosion. Cultivation, grazing and removal of firewood are all serious concerns within protected areas as well. Nechisar National Park is threatened by intensive natural resource use, fueled by the fast growth of

[30] Yalden, D.W., Largen, M.J., Kock, D., Hillman, J.C. 1996. Catalogue of the mammals of Ethiopia and Eritrea. 7. Revised checklist, zoogeography and conservation. *Tropical Zoology* **9:** 3-164

population in the nearby town of Arba Minch. Previously one of the best protected areas in the country, Nechsar park is now exploited for livestock grazing and wood for construction and fuel[31].

Other environmental impacts

Restoration of native forest to degraded lands is anticipated to have smaller and less obvious environmental impacts. These may include:

- Lower ground temperatures on the project sites;
- Increased humidity at ground level;
- Increased aesthetic qualities to local inhabitants;
- Improvements in the quality and quantity of non-timber forest products available for community utilization such as traditional medicine, honey, traditional hunting;
- Reduced levels of atmospheric dust.

Impacts outside project areas[32] [33]

Adaptation of techniques to other regions
This project seeks to replicate the Farmer-Managed Natural Regeneration (FMNR) technique developed and refined in Niger Republic since 1980, but enhanced with interplanting where appropriate Once farmers understood the techniques (mainly selecting, pruning, and protecting of natural regrowth) and benefits, the application of FMNR spread by world of mouth throughout a large proportion of the country, and to neighboring countries Chad and Burkina Faso. While the process was slow (taking almost 20 years), it is possible that a similar outcome may result in Ethiopia.

Grazing Pressure
There is potential that the project could result in an increase in grazing pressure on lands near the project area due to the relocation of some grazing activity. Areas that will be revegetated through coppicing of the existing rootstock may be eligible to introduce grazing shortly after the project inception (6-24 months). Areas where interplanting is required will be required to restrict grazing for up to 36-60 months. However given that the project will allow for grazing in some parts of the project area, as well as cut and carry of grass to livestock located outside the project area, it is anticipated that the removal of some grazing animals will cause minimal impact.

Fuelwood collection and Charcoal Burning
Fuelwood collection outside the project area, including the production and sale of fuelwood in the form of charcoal may increase in areas outside the boundary of this project. This may in turn lead to negative environmental impacts in other areas (clearing, forest destruction). The potential for this negative consequence is discussed in the baseline report, specifically the leakage analysis. This problem will be mitigated by a progressive exclusion of the current forest user rights, as well as purposely established plantation areas to compensate for the loss of fuelwood production.

4. Environmental Monitoring

In order to quantify the non-sequestration impacts of this project on the environment, a data collection program will be initiated for soil, water, and biodiversity factors.

4.1 Soil conservation indicators

Soil loss will be monitored by referencing the initial level of the soil surface, permanently recorded on each aboveground biomass plot marker. The plot marker consists of an iron bar inserted into the ground with the initial soil level permanently inscribed. In the course of monitoring, changes in the soil level relative to the initial mark will be measured and recorded. Results will be compared to results from a control marker on an adjoining site outside the project on another similar highland area (possibly on site 2), likewise monitored over time.

[31] Tilahun, S., Edwards, S. & Egziabher, T.B.G. (eds.) 1996. *Important Bird Areas of Ethiopia*. Published by Ethiopian Wildlife and Natural History Society. Semayata Press. Addis Ababa, Ethiopia

[32] This section will be clarified with Dr. Menale's report.

[33] See also reports on permanence, and baseline specifically the issue of leakage

4.2 Biodiversity Monitoring

Monitoring biodiversity is an important component of the monitoring process. As the project areas are in a degraded state, the project will contribute significantly to biodiversity, and will have regional benefits in this regard. The changes in the floristic composition, structure and status will be monitored every year by establishing permanent plots within the project sites.

Need to discuss with Deribe the likely succession phases in this forest.

Baseline biodiversity indicators will include both floral and avian diversity and intensity. It is not anticipated that mammals and other non-avian fauna will be monitored due to their lower abundance and the difficulty in sampling. Monitoring will be in accordance with standard procedures including the application of Simpson's biodiversity index for both species richness and evenness.

4.3 Water quality and quantity monitoring

It is anticipated that water quality and quantity will be monitored from both surface and subsurface flows. Calculations will be made to determine the required number of sampling points, and the number and timing of samples taken annually. These will be taken at fixed points along the streams emanating from the project sites, as well as from springs which have their source in subsurface flows. This data will be used to calculate the impact of the project on water quality and quantity.

5.0 Summary / Conclusion

The non-sequestration environmental impacts of this project are anticipated to be overwhelmingly positive. A summary of the environmental issues considered and anticipated outcomes are as summarized below in table 4.

Table 4. Summary of Environmental Impacts

1. Soil Loss	Soil loss will be reduced due to the increased level of root material stabilizing the soils, and the projected increased soil water holding capacity.
2a Surface Water Quality	Water quality from surface flow is predicted to improve due to a reduction in soil erosion
2b Surface Water Quantity	Water quantity from surface flows is predicted to have reduced peak flow, due to increased soil water holding capacity, and increased total runoff duration. Total water quantity is predicted to reduce due to the increased evapotranspiration and the increased percolation to groundwater.
2c Subsurface Water Quality	It is anticipated there will be little change to the quality of groundwater as a result of this project, with the possible exception of avoided contamination due to protection of the Damota forest from more intensive settlement.
2d Subsurface Water Quantity	It is anticipated there may be an increased quantity of subsurface water due to the increased water holding capacity of the soil (due to an increase in organic matter from decomposing leaves and small branches) allowing for increased percolation to groundwater.
2e Water Quality in Lake Abaya	Though only making up a small proportion of the Lake Abaya catchment, this project anticipates reducing sediment contamination to the waterways originating from the sites, and therefore possibly having small positive impact on the water quality of Lake Abaya
3 Biodiversity	Significant biodiversity benefits can be realized from the reestablishment of native ecosystems. The two ecosystem types identified within the project boundary have been significantly depleted, and the project offers considerable potential as a key habitat for both flora and fauna endemic to the area.
4 Atmospheric Dust	The project anticipates a reduction in atmospheric dust emanating from the project sites.
5 Aesthetic qualities	The project anticipates increased aesthetic beauty from the reforested sites.
6. Local Flooding and Mudslides	Flooding and mudslides are due to a loss of deep-rooted perennial vegetation (trees), and the inability of the soil to hold significant quantities of the precipitation. Thus, flooding and mudslides can be expected to be reduced at sites 1 and 3 over time.
7a Nearby Forestry Practices	There may be a transfer of technology and skills to neighboring areas and leading to an increase in the quality of forest management in other areas following observation of the success of the FMNR technique, along with interplanting where appropriate, in the Humbo and Soddo areas.
7b Relocation of fuelwood utilization	There is a possibility of relocation of fuelwood collection activities to other sites, thereby causing project leakage. In order to avoid this, fast growing plantations of fuelwood are planned for certain areas on the periphery of the forest proper[34].
7c Relocation of grazing pressures	There is the possibility of relocation of grazing pressure from the project area to other sites, creating environmental problems elsewhere. This potential risk is managed according to the permanence analysis and leakage component of the baseline analysis[34].

[34] See Baseline and monitoring methodology analysis reports