Ethiopian Biodiversity Institute (EBI)

Land/Forest ecosystem restoration for enhanced biodiversity and ecosystem services: Best practices in Ethiopia

(Draft)

June, 2024

Addis Ababa

Background

Forest ecosystems provide services that are crucial for human well-being. According to the IPBES assessment, restoring 15% of converted lands in the right places could prevent 60% of projected species extinctions[1]. Therefore, putting at least 30% of the degraded ecosystems (including forests) under an effective restoration program by 2030, among other things, to enhance biodiversity and ecosystem services is one of the global biodiversity targets[2]. Ethiopia is revising its national biodiversity strategy and action plan (NBSAP) to align with this global target. The EBI is a lead authority reporting on this biodiversity target, whereas, several other federal and regional actors are mainly involved in its implementation.

Ecosystem restoration is the process of reversing the degradation of ecosystems to regain ecological functionality to improve the productivity and capacity of ecosystems, and to meet the needs of society[1]. Ecosystem restoration is a collective name for a continuum of restorative activities that range from reducing impact/ effective management to recovering the structure and functions of a lost ecosystem (Fig. 1). Ecosystem restoration can be carried out at site-level or landscape level.

Forest ecosystem restoration is not a new practice in Ethiopia. In the 15th century, the Menagesha-Suba forest was initially restored on degraded land by planting tree wildings from the Wof-Washa forest[3]. In the past few decades as well, many successful forest ecosystem restoration projects have been implemented. The major task ahead is to scale up these successful practices throughout the country. Therefore, documenting and promoting the good practices of these projects is timely and important.

Forest ecosystem restoration projects in Ethiopia fall within the restorative continuum. The scope of interventions also ranges from site level to watershed or landscape level. The purpose of this paper is to present two of the many successful forest ecosystem restoration projects in Ethiopia. A general description of the projects will be followed by compiling their documented impacts on improved biodiversity and ecosystem services and de-services, if any.

Fig. 1. Ecosyetem restoration as a restorative activities continuum. Reducing impact qualifyes as ecosyetem restoration in as far as it results in a net gain of biodiversity. Afforestation is not within forest ecosystem restoration continuum[4].

Best forest ecosystem restoration projects in Ethiopia

In the past few decades, ecosystem restoration has been at the core of natural resource management in Ethiopia (Table 1). Several actors including the government and NGOs have been massively engaged. Hence, there are many forest ecosystem restoration success stories across the country[5,6]. The 6th national report on the 2nd NBSAP of Ethiopia has indicated that target 10 (that deals on ecosystem restoration) is one of the targets with a high probability of achievement[7]. Here, we present only two of the successful forest ecosystem restoration projects. Both of these projects have been recognized on the world stage.

Table 1: Major ecosystem restoration programs in Ethiopia[5]

Program	Duration	Objective
Food for Work (FFW)	1970s	Welfare safety nets for poor communities in food insecure areas- focused on soil and water conservation measures
Managing Environmental Resources to Enable Transitions (MERET)	2005-2010	Participatory safety net program for food insecure areas- focused on soil and water conservation measures
Sustainable land management phase-I (SLM-I)	2008-2013	Improving food security through ecosystem restoration and livelihood intervention
Sustainable land management phase-II (SLM-II)	2013-	Improving food security through ecosystem restoration and livelihood intervention

As of 2019, the Green Legacy Initiative (GLI) has been an integral part SLM-II. GLI resulted in a record number of seedlings plantation through successive massive public mobilization.

Humbo reforestation: Humbo reforestation project site is found in the Humbo district, Wolayta zone of the Southern region, located 420 km away from Addis Ababa. The area falls within 1690-1842 m elevation. The potential vegetation of the area is Combretum-Terminalia and moist evergreen Afromontane forest[8].

The project site was once forested, but was cleared in the 1970s to be degraded. The degraded forest site was freely grazed, with remnant shrubs to be observed. Erosion was a major phenomenon and land productivity was significantly reduced. About 85% of the population lived below the poverty line. In 2006, World Vision started the Humbo reforestation project with the aim of restoring the forest to sequester carbon, increase land productivity, and eradicate poverty. The project was designed as a clean development mechanism (CDM). Communities restored the degraded forest and sold carbon credit to companies in the global north. Communities living in the seven kebeles/villages adjoining the forest were organized in forest users' cooperatives and were granted forest ownership. The local government was willing to transfer its ownership right to the cooperatives. In a very short time (within 4 years), using the farmers managed natural regeneration (FMNR), a significant level of

forest restoration was recorded (Fig. 2). The project was able to successfully restore 2,728 hectares of forest of which, only the 500 hectare was exotic trees plantation. The success story of the project has motivated the nearby Sodo/Damota reforestation project, and beyond, other projects in Africa. The major interventions were:[9,10]

- farmers managed natural regeneration
- enrichment tree planting
- credit service
- alternative fuel wood/energy supply

Some of the best practices of the project include:

- appropriate project design aligned to CDM opportunity
- effective match of the site with the restoration method (FMNR)
- facilitated transfer of forest ownership right from the local government to the forest users' cooperatives

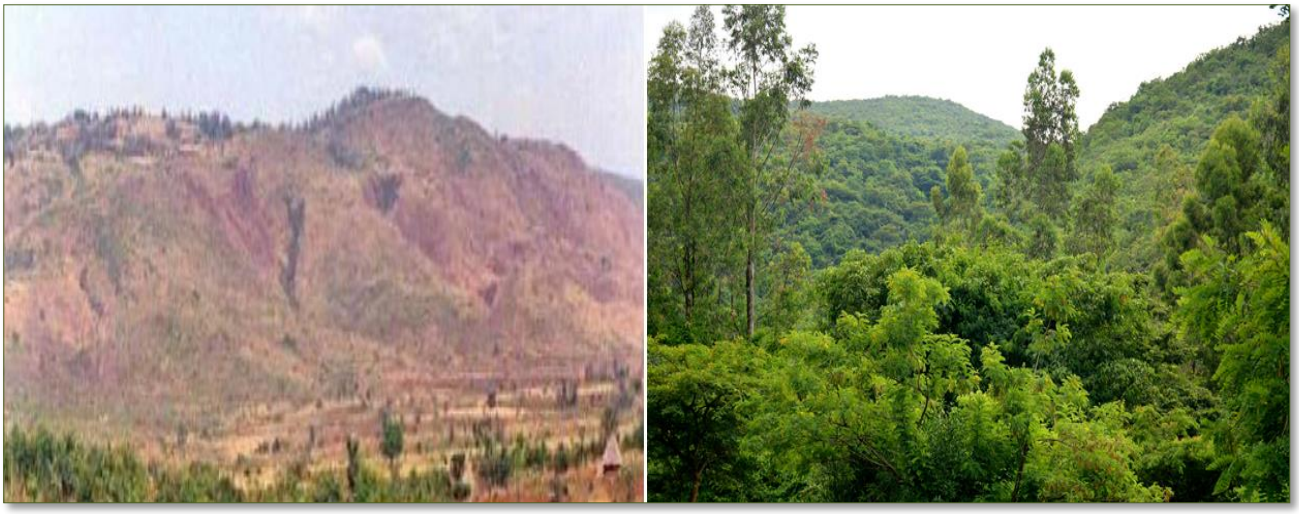

Fig. 2: Humbo forest before (left) and after (right) restoration intervention. This transformation indicates a significant gain in biodiversity

What is farmers managed natural regeneration?

It is a kind of forest restoration method in which tree planting is avoided and rootstocks, stamps, and the soil seedbank are relied on to restore forests. The restoration site is excluded from animals and humans (exclosure) and re-sprouting roots and stamps are monitored periodically. During each visit, re-sprouting stalks are cut to leave the sturdy ones, side branches are pruned halfway up the stalk, and thicket formation is controlled by thinning. Hence, cutting, pruning, and thinning are the major interventions and farmers do not need sophisticated equipment. FMNR is therefore a cheap method of forest restoration where appropriate; it is not effective in areas that lack rootstocks and/or stamps that could re-sprout. Different tree species require different pruning techniques, and these are determined through onsite observation[11].

Des'a forest restoration: Des'a forest is one of the 58 national forest priority areas of Ethiopia and is part of the Eastern Afromontane biodiversity hotspot. According to WeForest baseline study, the forest area is 154,000 hectares, majorly found in Tigray (>90%), stretching into the Afar region. Des'a forest falls within 900-3000 m elevation, thus comprises of Acacia woodland, transitional forest between Acacia woodland and dry evergreen Afromontane forest (DAF), and single dominant DAF. It is the second-largest DAF in Ethiopia. However, about 74 % of the forest has been deforested and the remaining forest is also severely degraded (Fig. 3). Climate change and desertification are major threats to the forest. The *J. procera* and *O. europaea* tree line has already shifted 500 m up in elevation[12]. Therefore, restoring Des'a forest is very crucial to buffer desertification into the highlands and maintain and increase other biodiversity and ecosystem services. Accordingly, the project is part of African great green wall initiative.

Fig. 3: the severely degraded Des'a forest landscape. Dwarfed *Juniperus procera* are conspicuous. Photo credit (Aklilu Nigussie)

In 2016-2017, WeForest started Des'a forest restoration project by conducting a detailed biophysical and socio-economic-cultural baseline survey. Accordingly, 56% of the communities within and near the forest live below the poverty line. Restorative activities were started in 2018 with an ambitious goal of restoring about 40,000 ha (26%) of the forest by 2030. This makes the project the biggest WeForet forest restoration project globally. By effectively restoring the forest, the project aims to improve the catchment hydrology, make the forest climate resilient, and reduce poverty. Tigray Bureau of Agriculture and Natural Resources, Tigray Plan and Finance Bureau, Mekelle University, and Ethiopian Forest Development are project partners of WeForest. The project employs the biosphere model to implement restorative activities. In the core area, effective management is prioritized with minimal tree planting (only native). In the buffer and transition areas, tree planting is maximum. Whereas native trees and mainly *J. procera* and *O. europaea* subsp. *cuspidata* are planted in the buffer zone, fast-growing exotic trees, and high-value fruit trees are among the mix in transition

zone plantings. So far, 18,632 ha (13%) of the forest has been put under a successful restoration program (Fig. 4). The good practices of the project are being adopted in other forest restoration projects including the Wof-washa forest. The major interventions are:[13]

- exclosure
- assisted natural regeneration (ANR)
- framework species planting
- soil and water conservation
- agroforestry and livelihood improvement packages
- energy conservation packages

Some of the best practices of the project include:

- permanent plots established and comprehensive baseline data recorded
- community participation including free labor and cost-sharing by farmers (also for goods supplied under the livelihood improvement package)
- seedling after planting care ensured a high survival rate (>90% after three years)

But, what is assisted natural regeneration?

It is similar to that of FMNR, but interventions are broader. Hence, ANR promotes trees and shrubs to re-sprout from the rootstocks, stamps, and soil seed banks. Moreover, it encompasses activities that enhance soil fertility and moisture (e.g., fertilization and soil and water conservation), reduce competition from weeds, control wildfires, and increase seed rain (e.g. constructing bird perches)[13]. Both FMNR and ANR do not rely on tree planting, but could be augmented by enrichment panting of selected tree species for better restoration outcomes[14].

And, framework species planting?

It is a restoration method where about 10% of the tree and shrub species of the target forest are planted on degraded lands to facilitate rapid canopy cover to facilitate regeneration/restoration. Selected tree and shrub species are usually a mix of species from different functional groups with N-fixing tree/shrubs included[14].

Fig 4: Soil and water conservation structure constructed at Hawaile site to assist natural regeneration. Before intervention (left), in 2021, and after intervention (right), in 2023. Similar structures are constructed on more than 18,000 ha of forest area. Photo credit (Aklilu Nigussie)

Restoration impacts on biodiversity and ecosystem services

Ever since the release of the Millennium Ecosystem Assessment (MA) report that recognized four categories of ecosystem services, *viz.* supporting, provisioning, regulating, and cultural services, new perspectives have been evolving to narrow these categories with the emerging concept of nature's contribution to people[15]. For our purpose, we present the impact of the two successful forest ecosystem restoration projects on biodiversity. Then, we compile the biodiversity and ecosystem services, Viz., provisioning, regulating, and cultural services as presented in Table 2.

Supporting biodiversity: both Humbo and Des'a forest restoration projects have transformed degraded lands into forests or have recovered degraded forests. Therefore, the transformation or the recovery, inherently, results in new gain in biodiversity. Plant, animal, and bird diversity were observed to have increased significantly after 3 years of Humbo reforestation[16]. According to the Des'a forest restoration project site manager, despite the short project implementation period, the

restoration impact on biodiversity has been significant. Some of the migrated wild animals have already started to return, there is an observed increase in *Erica arborea* abundance and forest undergrowth abundance and diversity has significantly improved (personal communication).

Table 2: Forest ecosystem restoration impacts on biodiversity and ecosystem services

Site	BES		
	Provisioning services	Regulating services	Cultural services
Humbo[9,10,17]	• annual $70,000 payment for the community due to carbon credit sell (payable up to 30 years) • agricultural production increased by 100% • honey production, fuelwood, and forest fruit supply increased significantly • forage supply significantly improved; became important source of income • water sources rejuvenated • local temperature cooled	• 73,000 metric tons of carbon dioxide sequestered • Erosion significantly reduced; silt deposition into the nearby Abaya Lake reduced	• Several research and scientific visits carried out
Des'a[13]	• Small-scale irrigation facilities enabled 87 households to increase crop production • Grass/forage supply significantly increased through the cut and carry modality; more than100% of	• erosion of 338,906 tons of soil reversed • 1.47 million cubic meters of runoff harvested • rivers base flow duration increased	

	the forage demand met in some villages

Provisioning services are tangible benefits people get such as food, fiber, and water; Regulating services are those benefits people get due to climate regulation, air and water quality regulation, soil fertility regulation, etc.; Cultural services are benefits such as learning and inspiration, recreation, supporting identities[15]

Biodiversity and ecosystem de-services

Many restoration/ reforestation projects in Ethiopia are challenged by wild animal-human conflict upon the return of wild animals. Similarly, the restoration of the Humbo forest has increased wild animal-human conflicts[18]. The animals that cause the major damage are reported to be similar for most projects. Therefore, forest restoration projects should anticipate effective measures to minimize biodiversity and ecosystem de-services due to wild animal-human conflict. Fencing the restoring forests is recommended in the case of Humbo[18]. However, ecological solutions could be more appropriate, particularly for large-scale restoration projects.

Factors of success

Forest ecosystem restoration success could be related to several factors. The lowland *Combretum-Terminalia* and *Acacia-Comiphora* ecosystems, for instance, can easily be restored through exclosure owing to the fact that the soil seed bank is rich. The geology and soil types could also determine restoration success. There could also be other factors, however, the four most important factors that can greatly determine forest ecosystem restoration success as evidenced by these successful forest restoration projects are:

- effective design of the restoration project
- effective local communities engagement
- local governments' commitment (e.g. facilitated transfer of forest use right to local communities at Humbo).
- tailored livelihood improvement packages and credit services, particularly for the marginalized segment of the communities

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