



Calling for Collaboration to Cope with Climate Change in Ethiopia: Focus on Forestry

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ABSTRACT

In Ethiopia, climate change and deforestation are major issues hindering sustainable development. Local Ethiopian communities commonly perceive an increase in temperature and a decrease in rainfall. Meteorological data shows that rainfall has declined in southern Ethiopia, and spring droughts have occurred more frequently during the last 10 - 15 years. The frequently occurring droughts have seriously affected the agriculture-dominated Ethiopian economy. Forests can play an important role in coping with climate change. However, deforestation is alarmingly high in Ethiopia, and this is attributed mainly to agricultural expansion and fuel wood extraction. Deforestation has led to a decrease in various benefits from forest ecosystem services, and increased ecological and environmental problems including loss of biodiversity. To resolve the issues effectively, it is crucial to enhance climate change resilience through reforestation and various international collaborations are urgently needed. To continue collaboration activities for resolving these issues, it is first necessary to address fundamental questions on the nature of collaboration: does collaboration aim for a support-benefit or a mutual benefit situation; dividing the workload or sharing the workload; an advanced technology or an appropriate technology; and short-term and intensive or long-term and extensive?. Potential collaboration activities were identified by sectors: in the governmental sector, advancing governmental structure and policy, enhancing international collaborations and negotiations, and capacity building for forest restoration and management; in the research and education sector, identifying and filling gaps in forestry and climate change education, capacity building for reforestation and climate change resilience research, and developing bioenergy and feed stocks; and in the business and industry sector, supporting conservation based forestry businesses and industries, while promoting collaboration with the research and education sectors. It is envisaged that international collaboration for enhancing climate change resilience through reforestation will provide a strong platform for resolving climate change and deforestation issues, and achieving sustainable development in Ethiopia.

Key words: Climate change, Drought, Deforestation, Reforestation, Resilience, Collaboration, Ethiopia

1. Introduction

Currently, Ethiopia is facing two major challenges for its sustainable development: climate change and deforestation. In Ethiopia, droughts have often resulted in crop and livestock failures, food shortages, and famines (World Bank, 2006; Wood, 1977). Global climate models commonly predict that there will be an increased chance of drier summers on the African continent with increased risk of prolonged droughts (Dai 2011; Sillmann and Roeckner, 2008). The predicted

frequently occurring droughts will make Ethiopian economic development harder due to reduced agricultural production and an increased degree of income inequality (Mideksa, 2010). Forests covered around 40% of Ethiopian land in the 19th century (Ethiopian Forestry Action Program, 1994), but that number has shrunk to just 11.4% (FAO, 2015). This severe deforestation and forest degradation have been mainly attributed to agricultural expansion and fuel wood extraction (Lemenih and Kassa, 2014), and they seriously affect the ecosystem, environment, and people's livelihoods: biodiversity

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drastically decreases, while carbon loss increases (Molotoks et al., 2018); reduced water resources result in increasing vulnerability to droughts (Allen et al., 2010); and increased soil erosion often widely damages agricultural fields, roads, houses, and various facilities (Nigussie et al., 2017). The bigger concern is that climate change and deforestation problems are tangled, resulting in escalation of the magnitude of problems and making them too complicated to be handled easily.

One potential solution to resolve the current issues of climate change and deforestation, and to prevent further complication of the issues, can be to enhance climate change resilience and mitigation through reforestation. Reforestation can contribute to enhancing the water holding capacity to reduce damage from droughts or heavy rain falls (Collentine et al., 2018; Calder, 2007). It can also provide various opportunities for diversifying income sources of local communities, which can be a practical measure for enhancing resilience to climate change on the ground (Belay et al., 2017; Barbés-Blázquez et al., 2017). In addition, it is expected that reforestation practices will provide a chance for local communities to get financial benefits through carbon trading schemes that are currently being developed, such as Reducing Emissions from Deforestation and forest Degradation (REDD+) (Beyene et al., 2016; Hailemariam et al., 2015). To successfully enhance climate change resilience and mitigation through reforestation, it is necessary to have various international collaborations, since the task requires substantial amounts of new knowledge and experience as well as accessible finance on the ground, which may not be easily manageable given the current capacities of Ethiopia. Therefore, it is important to understand current climate change and deforestation issues, and to identify potential collaboration activities to deal with the issues.

The objectives of this study were to summarize climate change in Ethiopia, to identify potential roles of forestry for coping with climate change and the current status of forests in Ethiopia, and to suggest potential collaboration activities and partners.

2. Climate change in Ethiopia and potential roles of forestry for coping with climate change

Local Ethiopian communities have commonly perceived an increase in temperature and a decrease in annual total rainfall (Bewket, 2013; Amsalu and Adem, 2009). Collected meteorological data shows that rainfall has declined in southern Ethiopia during both the rainy seasons of February - May and June - September, and also that spring droughts have occurred more frequently in all parts of Ethiopia during the last 10 - 15 years (Viste et al., 2013). Climate prediction studies have found that the temperature is expected to increase by 1°C by 2030 and 2°C by 2050 compared to that in 1975, and the frequency of extreme events, such as severe droughts, is expected to increase (Cities Alliance, 2017; Eshetu et al., 2014).

Crop farmers commonly perceive the impact of climate change as four different issues (Bewket, 2013; Amsalu et al., 2013): 1) a decrease in the length of the growing period, 2) an increase in crop damage due to insects and pests, 3) an increase in crop diseases, and 4) a shift in suitable growing areas. Pastoralists commonly perceive the impact of climate change as four different issues (Bewket, 2013; Amsalu et al., 2013): 1) a shortage of feed, 2) an increase in livestock disease, 3) the scarcity of water supplies for livestock, and 4) mass die-offs of livestock. It is predicted that climate change will make Ethiopian economic development harder in at least two ways (Mideksa, 2010). First, climate change may decrease Ethiopia's economic growth by about 10% from its benchmark level, since climate change may reduce agricultural production and output in the sectors linked to the agricultural sector. For example, the available area for crop production is predicted to decrease due to predicted climate change in Ethiopia (Evangelista et al., 2013). Second, climate change may increase the degree of income inequality by about 20% and this will likely further decrease the economic growth of Ethiopia. Adaptation activities, such as tree planting, soil conservation, changing crop variety, and water harvesting, have been conducted in response to the perceived temperature and rainfall changes in Ethiopia (Bryan et al., 2009). However,

according to surveys in 5 regions in Ethiopia [Tigray, Amhara, Oromiya, Benishangul Gumuz, and Southern Nations Nationalities and Peoples (SNNP)], over 40% of local communities have done nothing in terms of adaptation, and major barriers to adaptation include shortages of labor, finance, and relevant information (Bryan et al., 2009).

Forests can play an important role in coping with climate change in Ethiopia. Reforestation practices can increase the water reserving capacity in forest soils and enhance drought resilience (Collentine et al., 2018; Calder, 2007). At the same time, reforestation practices can protect lands from runoff and erosion caused by heavy rain falls (Nigussie et al., 2017; Huang et al., 2017). Restoring indigenous agroforestry practices, such as home gardening or coffee agroforestry, can also help with adapting to climate change (Mbow et al., 2014), and can also contribute to enhancing carbon sequestration and mitigating greenhouse gas (GHG) emissions (Kim et al., 2016). Various forestry products can also contribute to coping with climate change since they provide different opportunities for income diversification, especially for women and indigenous peoples. It is expected that carbon and emission trading schemes that are currently being developed, such as REDD+, may provide an opportunity for local communities to get financial benefits through their reforestation activities on the ground. Therefore, research and practices aimed at identifying and implementing locally relevant climate change coping strategies through reforestation are urgently needed.

3. Current status of Ethiopian forests

In Ethiopia, forests covered around 40% of the country's total landmass around the 19th century (Ethiopian Forestry Action Program, 1994). However, forest areas have alarmingly decreased to 15.1 million ha by 1990 and 12.5 million ha by 2015, covering only 11.4% of the total landmass (FAO, 2015). This was a loss of 2.6 million ha, or an average loss of 105,000 ha per year. Deforestation and forest degradation were attributed to various factors including population growth, agricultural expansion, overgrazing, fuel wood extraction, and resettlement. For instance, agricultural lands were expanded by about 4 million hectares in Ethiopia from 2000 to 2008, and 80% of these new expansions were from the conversion

of forest lands, woodlands, and shrublands (EDRI, 2010). At the national level, fuel wood collection is a leading direct driver of deforestation. The woodlands are the main source of fuel wood consumed in both rural and urban areas. While the majority of rural dwellers use fuel wood, urban dwellers mostly use charcoal.

Deforestation and forest degradation directly and indirectly affect livelihoods and the food security of local communities that rely on the forest and its ecosystem service. The cost of these losses to deforestation were estimated to be about \$23 million (Yesuf et al., 2005), and the annual cost of land degradation associated with land use and cover change in Ethiopia is estimated to be about \$4.3 billion (Gebreselassie et al., 2016). In addition, this enormous loss has impaired ecosystem services, eroded local livelihood and food security, decreased soil fertility and carbon sequestration, and increased greenhouse gas emissions.

A variety of reforestation approaches are practiced in Ethiopia, and they are grouped into three broad categories: 1) area enclosure, 2) plantation, and 3) improvement of cook stove fuel efficiency and renewable energy development. Area enclosure is the dominant type of reforestation practice used on degraded lands to rehabilitate degraded land and its biodiversity (Lemenih and Kassa, 2014). Currently, over 3 million ha of degraded land are under area enclosure (Lemenih and Kassa, 2014). On the other hand, reforestation through small-scale plantations, and industrial and peri-urban plantations have been conducted throughout Ethiopia (Lemenih and Kassa, 2014). While small-scale plantations on degraded lands have been carried out by local communities, industrial plantations and peri-urban plantations have been driven by government initiated development projects (Lemenih and Kassa, 2014). Lastly, since fuel wood extraction is one of the major causes of deforestation in Ethiopia, improving the fuel efficiency of cooking stoves has been recognized as a practical and feasible option for preventing deforestation (Gizachew and Tolera, 2018). Various non-governmental organizations and governmental institutions have been working on developing, demonstrating, and disseminating improved cook stoves throughout the country (Gebreegziabher et al., 2017). At the same time, interest in renewable energy has been increasing and various types of renewable energy

including hydropower, wind energy, and solar energy have been tested and installed. Further developments are also on the way throughout the country.

4. Collaboration opportunities in forestry to cope with climate change in Ethiopia

4.1 Fundamental questions for collaboration activities

To develop collaboration activities for resolving climate change and deforestation issues in Ethiopia, it may be necessary to address fundamental questions to define the nature of the collaboration. In this study, we have provided four different questions as shown in the following figure (Fig. 1).

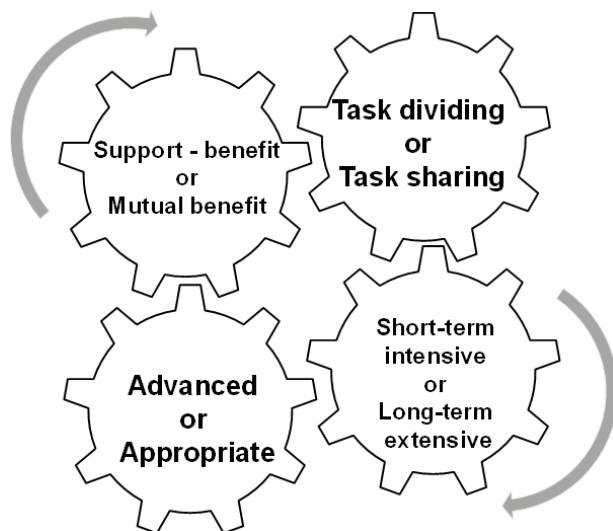


Fig. 1. Fundamental questions for developing collaboration activities.

4.1.1 Support—benefit or Mutual benefit

The first fundamental question is whether the collaboration will seek a support—benefit situation or a mutual benefit situation. A support-benefit situation indicates that a partner provides support to a counter-partner, who gets a benefit from the support. It is a one-way flow from a partner to counter-partner in terms of support and benefit. In contrast, a mutual benefit situation indicates that both partners benefit mutually through supporting each other. It is a bi-directional flow between partners. There may not be a clear and simple

answer for which one would be more appropriate or effective for a particular collaboration.

4.1.2 Task dividing or Task sharing

The second question is how partners work together to deal with a given task: whether they will deal with a given task by dividing the workload or sharing the workload. Task dividing would be when the main task is divided into smaller sub-tasks and then these are assigned to partners. Then, each partner continues with their efforts to figure out the given task. In contrast, task sharing would be to create a new approach to figure out the given task together. Instead of dividing the given task and then allocating certain portions of the task to each partner, partners would make a new group and develop a new approach to figure out the given task. Depending on a given task or the level of each partner's knowledge and experience, task dividing or task sharing can bring different levels of performance and efficiency. Therefore, a combination of both task dividing and task sharing may be required according to the nature of a given task and the progress of the collaboration.

4.1.3 Advanced or Appropriate

To aim for technical advances or to deal with a technical challenge, it is necessary for a partner to share knowledge and experience on the relevant technology with counter-partners. To this end, there may be two different methods. One is to transfer an advanced technology and another is to develop an appropriate technology. Transferring an advanced technology is when a partner transfers a technology to a counter-partner, and the transferred technology can be a new and highly advanced technology for the counter-partner. Developing an appropriate technology is when partners collaborate to develop a new technology that can be based on existing technology and resources on the counter-partner's side. Sharing advanced technology provides an opportunity for the counter-partner to quickly advance its technology to a certain level, but there is the risk that the technology may not be feasible or sustainable due to a lack of understanding or resources on the counter-partner's side. Developing an appropriate technology may not provide an opportunity for

fast improvement of the technology, but the developed technology will be feasible and sustainable since it is based on the available technology and resources on the counter-partner’s side.

4.1.4 Short-term intensive or Long-term extensive

Depending on the nature of the collaboration activities, different time scales (short-term or long-term) and different magnitudes of intensity (intensive or extensive) may be needed to effectively accomplish the desired goals. A short-term and intensive approach may be useful to achieve quick outcomes from simple and light tasks. The quick outcome can provide another chance to reflect on the results and to design the next steps promptly. However, this approach can bring a biased decision since it cannot monitor the long-term impact and any unintended interactions with other factors. In contrast, a long-term and extensive approach may provide stabilized outcomes from complicated and heavy tasks. The outcomes can be practical and feasible solutions to resolve complicated and serious issues. However, this approach requires a long-term investment and taking the risk of wasting substantial time and finances in the worst case scenario, since the final outcome will only be known at the end of the collaboration project.

4.2 Potential collaboration activities and partners by sectors

4.2.1 Governmental sector

In the governmental sector, experience sharing and support

are very useful for capacity building and institutional development to manage climate change and reforestation. Potential collaboration activities are provided in Table 1 and potential collaboration partners are listed in Table 2.

1) Advancing governmental structure, policy, and relevant laws and regulations

As climate change has been seriously affecting Ethiopia, the Ethiopian government has recognized the importance of managing the risks and challenges of climate change. Accordingly, governmental structure, policy, and relevant laws and regulations have been adapted to address climate change and other relevant issues. However, due to a lack of experience and capacity to deal with a new agenda including climate change, advancing the adaptation process has been slow compared to the rapidly spreading impacts of climate change. Therefore, it is anticipated that experience sharing and support in the governmental sector will be helpful for advancing institutional structure, policy, and relevant laws and regulations to manage the risks and challenges of climate change.

2) Capacity building in international collaborations and negotiations

Since climate change is a global scale issue rather than either a regional or local one in terms of causes, effects, and solutions, it is necessary for Ethiopia to actively participate in international collaborations and negotiation processes. In particular, beyond the typical relationship of North-South, newly recognized South-South or South-North-South collabo-

Table 1. Summary of suggested collaboration activities by governmental, research and education, and business and industry sectors

Sector	Suggested collaboration activities
Governmental sector	Advancing governmental structure, policy, and relevant laws and regulations Capacity building in international collaborations and negotiations Capacity building in carbon & emissions trading schemes (ex. CDM, REDD+, and MRV) Forest restoration and management
Research & education sectors	Identifying and filling gaps in forestry-climate change education Reforestation and climate change resilience and mitigation Bioenergy & feed stock development
Business & industry sectors	Supporting forest conservation-based forestry businesses and industries Collaboration with research and education sector

rations are urgently required to break through long-lasting barriers and limitations on international collaboration and negotiation. It is crucial to support capacity building in international collaboration and negotiation to cope with climate change.

3) Capacity building in carbon and greenhouse gas emission trading schemes

Globally, various carbon and GHG emission trading schemes, such as Clean Development Mechanism (CDM), REDD+, and Measurement, Reporting, and Verification (MRV) have been in development and will be developed further in the near future. These schemes are definitely great opportunities for Ethiopia to get attention and support from the global society for reforestation practices, which can enhance carbon sequestration and GHG mitigation. Therefore it is very important to support the enhancement of technical capacity for measurement of carbon and GHG emissions, and the administrative capacity for managing related activities, procedures, and feedback.

4) Forest and degraded area restoration and management

A better understanding and accurate assessment of existing forest resources would be the most important stepping stone for future progress, such as restoration and sustainable management. Recently, reforestation practices have been increasing throughout Ethiopia. However, there is a lack of a comprehensive, integrated management program dealing with all of the processes, such as species selection, seed nursing, planting, maintenance, harvesting, and utilization. Without such an integrated management program, reforestation practices may not be practical or sustainable on the ground. Therefore, technical and financial support and collaborations for capacity building in the assessment of existing forest resources and the development of integrated management programs will bring promising outcomes for successful reforestation and sustainable management.

4.2.2 Research & education sectors

The research and education sectors can receive great benefits through collaboration. Potential collaboration

activities have been provided below and collaboration partners are listed in Table 2.

1) Identifying and filling gaps in forestry-climate change education

The most urgent and crucial collaboration activity would be to identify gaps and to make a plan to fill those gaps in Ethiopian forestry-climate change education. Throughout such collaborative activities, all procedures from curriculum, education contents, teaching and training materials, laboratory and field practices, evaluation to monitoring feedbacks need to be critically assessed and existing gaps should be identified. Once the gaps are identified it will be necessary to make a plan to fill the gaps through various collaborative activities including sharing knowledge and experience through various channels (e.g., student & scholar exchange programs, co-teaching & supervising programs, providing laboratory and field equipment).

2) Reforestation and climate change resilience and mitigation

Various topics of research need collaborative activities to achieve reforestation and enhance climate change resilience and mitigation. Important research topics requesting collaborative activities are listed as follows:

- Identifying suitable indigenous species for climate change resilience and adaptation
- Monitoring carbon stocks and greenhouse gas emissions in forests
- Developing timber and non-timber products and value addition
- Socio-economic research to identify a win-win solution for enhancing both climate change mitigation and local livelihood

3) Bioenergy and feed stocks development

Since fuel wood consumption is one of the major drivers of deforestation in Ethiopia, improving the fuel efficiency of cooking stoves and developing renewable bioenergy are urgently needed. Collaborative research can work on developing fuel efficiency improved cooking stoves and bioenergy production systems utilizing locally available resources and

Table 2. List of potential Ethiopian collaboration partners by sectors

Sector	Potential collaboration partners
Governmental sector	Environment, Forest, and Climate Change Commission →REDD+ secretariat →Forest Sector Capacity Building Program (FSCBP) →Forest Sector Transformation Unit (FSTU) Ministry of Agriculture Ministry of Urban Development and Construction Ministry of Tourism and Culture Ministry of Water, Irrigation, and Energy Regional Environmental Protection and Forest Authorities Ethiopian Wildlife Conservation Authority Organization for Rehabilitation and Development (Amhara and Tigray Regional States)
Research & education sectors	Hawassa University (Wondo Genet College of Forestry and Natural Resources) Addis Ababa University (Climate Center; Department of Plant Biology and Biodiversity Management) Haramaya University (College of Agriculture) Mekelle University (College of Dryland Agriculture and Natural Resources) Jimma University (College of Agriculture and Veterinary Medicine) Dilla University (College of Agriculture and Natural Resource) Arba Minch University (College of Agriculture) Gonder University (College of Agriculture and Rural Transformation) Bahir Dar University (College of Agriculture and Environmental Sciences) Debre-Tabor University (College of Agriculture and Environmental Science) Wollo University (College of Agriculture, Department of Forestry) Madda Walabu University (College of Agriculture and Natural Resources) Ethiopian Environment and Forest Research Institute Ethiopia Biodiversity Institute Ethiopian Climate Research Center (ECRC) at Ethiopian Development Research Institute Ethiopian Institute of Agricultural Research National Meteorological Agency Ethiopian Mapping Agency Ethiopian National soil laboratory Gulele Botanical Garden Ethiopian Forest Society Biological Society Center for International Forestry Research (CIFOR) World Agroforestry Center (ICRAF) Food and Agriculture Organization (FAO)
Business & industry sectors	Oromia Forest and Wildlife Enterprise Amhara Forest Enterprise Plywood, MDF, chip wood, particle board, fiberboard factories Coffee unions (coffee marketing and value addition; coffee husk composting and pellet production) Ethiopian National Youth Coalition for Climate Change The Ethiopian Civil Society Network on Climate Change Association for Development and Biodiversity Conservation Environment, Climate Change, and Coffee Forest Forum Ethiopian Rural Self Help Association Plan Ethiopia Forum for Environment Ethiopian Gum and Resin Enterprise Ethiopian Gaia Association (bioenergy and ethanol stoves)

techniques. Also, collaborative research can develop techniques and protocols for effectively establishing and managing plantation forests for producing bioenergy feedstocks.

4.2.3 Business and industry sector

Potential collaboration activities have been provided below and potential collaboration partners are listed in Table 2.

1) Supporting forest conservation based forestry businesses and industries

Forestry businesses and industries can achieve conservation and financial benefits simultaneously. For instance, locally rooted forestry businesses and industries, such as eco-tourism, agroforestry practices, small scale woodlots and plantations, and indigenous herbal and tree medicines, can enhance forest conservation and biodiversity, while also creating opportunities to diversify income sources for local communities. These are also very useful for enhancing climate change resilience on the ground. Therefore, financial and technical support or experience sharing (e.g., workshop, training, site visiting) to those forestry businesses and industries can provide various opportunities to effectively enhance forest conservation and climate change resilience on the ground.

2) Collaboration with the research and education sectors

The Ethiopian forestry businesses and industries can obtain great benefits through integration and collaboration with national and international research and education institutes. In particular, any business and industry aiming towards forest conservation based activities may need a substantial amount of investment to conduct assessments and research on the activities. Collaboration with research and education institutes will help the forestry businesses and industries to effectively conduct the needed assessments and research, and to develop further collaboration opportunities for production and marketing. This collaboration can also be even more effective if there is an established policy frame to facilitate and oversee these partnerships.

5. Conclusions

In Ethiopia, climate change and deforestation have been negatively affecting people's livelihoods, ecosystems, and the environment, and these issues are seriously hindering sustainable development. Urgent efforts to enhance climate change resilience through reforestation are required to resolve these issues. It is envisaged that collaborative efforts with global communities throughout the governmental, research and education, and business and industries sectors will provide a strong platform for resolving these issues and achieving sustainable development for Ethiopia.

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