# Preliminary Reflection on the Opportunities and Challenges of Mangrove Ecosystem Management and Restoration in Cameroon

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**Abstract**

In Cameroon, regressive changes in mangrove cover have been observed in recent decades. The establishment of human settlements through the development of various activities has subjected natural spaces to various pressures, based on the perceptions inherent in each social group. The drivers of mangrove deforestation are urban sprouting, climate change, poor administrative follow-up, population increase, and economic growth. To overcome this degradation and better manage the ecosystem, some facts based on opportunities and challenges must be assessed.

Therefore, some opportunities for mangrove management include the Reducing emissions from deforestation and forest degradation in developing countries (REDD+) policy, the African forest reforestation initiative (AFR100) projects, the Cameroon mangrove ecosystem restoration and resilence (CAMERR) projects, and the presence of capacity building institutions. Various challenges exist such as limited funds, stakeholders not being fully involved, a lack of data dissemination, and no monitoring of the reforestation sites. To overcome these challenges, the community and stakeholders should be sensitised, village management committees should be created to follow up planted trees and reforestation, and research data should be documented and disseminated.

**Keywords**: challenges, deforestation, mangrove ecosystem, opportunities, restoration

## 1. Introduction

Mangroves are aquatic ecosystems composed of trees found in tropical and subtropical regions and are influenced by marine tides. They grow at or above the mean sea level which is tidally inundated no more than 30% of the time (Kjerfve 1990). Approximately 14% (20 100 $km^2$) of highly threatened, salt-tolerant, and sheltered intertidal mangrove forests are found worldwide. African mangroves stretch from the coast of Mauritania to Angola in the Gulf of Guinea, covering approximately one-third of the area within the Niger Delta of Nigeria (Ajonina *et al*. 2018).

Historically, the rate of mangrove degradation posed a serious risk of significant greenhouse gas (GHG) emissions. Since the 1950s, it has been estimated that up to 50% of the world's mangroves have been destroyed, largely owing to land-use changes (Alongi 2018). Despite recent estimates of global mangrove loss slowing to 4.0% between 1996 and 2016 (Richards *et al*. 2020), more than 300 million mg of $CO_2$ was emitted as a result of mangrove deforestation between 2000 and 2012 (Hamilton and Friess 2018). The vast majority of the world's mangrove organic carbon is stored, probably because of the conversion of mangroves to agriculture/aquaculture land (Adame *et al.* 2021). Mangrove conservation and restoration programmes at the national scale have been identified as an efficient means of offsetting GHG emissions (Murdiyarso *et al*. 2015, Taillardat *et al*. 2018, Cameron *et al*. 2019), although the prevention of further forest loss outweighs the gains from restoration (Kauffman *et al*. 2017).

The magnitude of forest degradation often leads to the development of global initiatives such as the Bonn challenge, which aimed to restore 150 million hectares of degraded and deforested landscapes by 2020 and 350 million hectares by 2030 (AFR100 2022). Moreover, 2020-2030 has been declared the UN decade of ecosystem restoration (AFR100 2022); AFR 100, is an initiative which is currently operating with countries committing their surface area to restoration. Cameroon, as part of this process, has several degraded ecosystems that need to undergo proper assessment of the state of vegetation, deforestation, and forest degradation, as well as various opportunities and constraints for restoration. Despite extensive research on the ecology, structure, and function of mangrove ecosystems, limited attention has been paid to their regeneration (Kairo *et al*. 2001). This study is based on a rapid reflection on the challenges and opportunities in managing mangroves. More specifically, a study of a literature review and authors' experience based on: (i) stakeholders of the mangrove ecosystem; (ii) linkage of mangrove management and the REDD+ process; (iii) the importance of mangroves; (iv) the restoration dynamics in Cameroon and linkage to mangroves; (v) the changes in mangrove cover; (vi) the drivers of mangrove deforestation; (vii) preliminary activities to mitigate threats to mangroves; (viii) the urgent need of reforestation of mangroves in Cameroon.

## 2. Importance of mangroves

Some studies have indicated that firewood, fish, crabs, and prawns are collected from mangroves to generate income, such that non-agricultural activities provide 32% of the total income (Aye *et al*. 2019). Moreover, food resources from mangroves have nutritional value such as calcium (Selvam 2007). As such, vulnerable people rely on forests and woodlands for their livelihood because these are their sole income-generating activities (Simon 2018). It is documented that, there has been contribution in the environmental goods and services, however, this is insufficient (Chhetri *et al*. 2015, Aye *et al*. 2019); their significance within forest-dependent communities remains insufficiently explored.

Mangroves provide shelters and nursery habitats for aquatic animals. Aye *et al*. (2019) stated that the importance of mangroves in fisheries is apparent, particularly for the white 'banana' shrimp (*Penaeus merguiensis*). They depend on mangrove forests for shelter during the juvenile stage. Some species, such as tiger prawns (*Penaeus monodon*) and *Penaeus indicus* also depend on mangroves during certain phases of their life cycle. Mangroves provide breeding grounds and life cycles for many fish (Snedaker 1978).

Economically, locals can generate income from mangroves. Furthermore, the chemical compounds and extracts of mangroves are primarily used in traditional medicine. Rhizophora seedlings can cure sore mouth (Bandaranayake 1998). Mangrove extracts are helpful in treating health disorders (Tirupathi *et al*. 2013). *Rhizophora mucronata* and *Rhizophora apiculata* Blume have anti-stringent, anti-diarrhoeal, and homeostatic properties (Bandaranayake 1998). Mangrove extracts have been used for centuries to treat health disorders.

Seventeen mangrove species are found in Africa (Tomlinson 1986), whereas eight species are unique to West and Central Africa, of which *Rhizophora* and *Avicennia* are dominant and require conservation. Red mangrove (*Rhizophora racemosa*) is the most purchased fuelwood (Dongmo Keumo Jiazet 2019).

Moreover, mangroves play an important role in the Douala culture and traditions. They termed this the 'Ngondo' festival. The Douala ethnic group use the mangrove ecosystem as a shrine to conduct sacrifices.

Mangrove ecosystems, if well managed, attract tourists, which will not only lead to an increase in the livelihood of the local people but also an increase in the state budget through ecotourism. Thus, if properly managed using national policies, Cameroon's mangroves will regain their potential.

## 3. The role of stakeholders in mangrove ecosystems management in Cameroon

Cameroon's mangroves are an important part of its rich ecosystems, subject to care by the CBD and United Nations Framework Convention on Climate Change (UNFCCC) (NBSAP 2012) through the existence of institutional bodies such as:

- The Ministry of Forests and Wildlife (MINFOF) oversees the rational management of offshore and wildlife resources.
- The Ministry of the Environment, Protection of Nature and Sustainable Development (MINEPDED) is responsible for monitoring the conservation and protection of natural resources, environmental assessments and inspections, raising awareness, and monitoring structuring projects.
- The Ministry of Livestock, Fisheries, and Animal Industries (MINEPIA) develops supplements and evaluates state policy in matters of breeding, fisheries, and harmonious development of animal industries.
- The Ministry of Mines, Water and Energy (MINEE) which ensures the management of water, hydrocarbons, and marine minerals, assisted this mission through the National Hydrocarbons Company.
- The Ministry of Public Works (MINTP) coordinates the realisation of seaport works or marine infrastructure (construction of pipelines, oil pipelines, oil and gas platforms) in the maritime domain.
- The Ministry of Transport (MINTRANS), including the Merchant Navy, secures travel in rivers and at sea.
- The Ministry of Tourism (MINTOUR) is responsible for promoting tourism in coastal areas.
- Center for Biotechnology with laboratories in tissue culture, microbiology, and genetics.
- The National Committee on Biotechnology handles matters on biosafety and biotechnology and proposes modalities for appropriate national biosafety guideline legislation.

With respect to various cooperation, biodiversity related issues are handled by public and private institutions in Cameroon. These organisations include the WWF, IUCN, GTZ, WCS, CIFOR, BIRDLIFE International, IRAD, CDC, FAO, and ECOFAC. Several international cooperation agreements have been signed with many organisations to enhance the sustainable use of Cameroon's biodiversity. The Ramsar Convention was also considered for ratification. Cameroon ratified this convention on 20 July 2006 and is now recognised as possessing sites on the international wetland list. These sites include the Ebogo wetland, Lake Tchad, Rio del Rey, Waza Logone flood plain, Barombi Mbo Crater Lake, Sanaga River, and Ntem River.

Politically, the government has implemented various policies, such as the Forest Law of 1996. Cameroonian Law on Wildlife: Forestry and Fishery Activities regulate agricultural policy by improving

planting materials and best farming practices. To improve capacity building, the following learning centres have been established:

- Biologists – University of Yaounde I
- Forest Engineers – University of Dschang
- Agronomists – University of Dschang
- Wildlife Specialists – College of Wildlife – Garoua
- Forestry Technicians – School of Forestry, Mbalmayo

There are also local stakeholders regarding mangrove management, such as:

- ACB: Based in Kribi and is in charge of sustainable fish smoking
- Cameroon ecology (CAMECO): Based in Edea and is in charge of creating mangrove community forest
- 'Organisation pour l'Environnement et le Développement Durable' (OPED): Based in Yaounde and is in charge of carbon stock measurement
- Watershed task group (WTG): Based in Douala and is in charge of reforestation
- Hamerkop: in charge of carbon market

Thus, there are many actors and institutions working on the mangrove ecosystem. However, this ecosystem continues to decline and render poor products and services.

**4. Changes in mangrove cover in Cameroon**

Mangrove forest cover is gradually declining owing to human activities. Zogning Lontsi *et al*. (2021) conducted a study in three blocks of mangroves and found that, in 2003, the built-up area was 20.55 ha, whereas in 2012, it increased to 39.9 ha. Similarly, in 2003, agricultural land was 10.91 ha, whereas in 2012, it rose to 39.98 ha; and degraded forest from 168.54 ha to 212.56 ha in 2012.

Statistics for the Tiko-Limbe III mangrove forest, an analysis of satellite image data for a period of 26 years, reveal that intact mangroves and associated coastal forests have decreased significantly by more than 40%, whereas degraded mangrove forests have increased by nearly 30 (Anonymous 2017).

In 1974, dense mangrove forest was 467.11 ha which decreased to 188.99 ha in 2003 and to 74.99 ha in 2012. The statistics are presented in Table I (Zogning Lontsi *et al*. 2021).

Table 1: Statistical dynamics of mangrove in Cameroon

| Main mangroves block/region | Geographical location | Surface area (ha) (2012) | Level of human activities (ha) | Surface area degraded (ha) |
|---|---|---|---|---|
| Rio Del Rey (1994 to 2012) | Bakassi to Limbe (south west region | 118 800 | 467.11 | 74.99 |
| Douala Estuary (1994 to 2012) | Douala and Tiko (littoral region and south west) | 99 000 | 168.54 | 212.56 |
| Ntem Estuary (1994 to 2012) | Kribi (south region) | 2 200 | 7.98 | 18.98 |

Source: Zogning Lontsi *et al*. (2021)

Mangrove areas covering over 200 000 ha are commonly grouped into three main blocks: Rio Del Rey estuary mangroves (54%) within the south west region from the Nigerian coastal border, from the disputed Bakassi to Limbe city having an oil refinery; Douala estuary mangroves (45%) within the Littoral region between Mount Cameroon, Tiko through the Wouri estuary covering the entire Douala, the largest city in Cameroon with a population of over 2 million, and the Sanaga Estuary; and Ntem estuary mangroves (1%) within the south region to the borders with Equatorial Guinea. Cameroon's mangroves are the sixth largest in Africa, the first in Central Africa (Corcoran *et al.* 2007) and one of the largest mangroves in the world (Ajonina 2008). The mangroves of the Rio Del Rey and Ntem estuaries are relatively intact, although increasingly threatened by oil and gas exploration and invasive nypa palm from Nigeria, whereas the Cameroon estuary mangroves are severely degraded by population pressures and impacts from urbanisation, petroleum and gas exploitation, uncontrolled agro-plantation establishment, development projects, and mangrove wood exploitation for processing fishery products, particularly through smoking. These threaten the livelihoods and ecological security of over five million coastal communities (NBSAP 2012).

**5. Forest degradation, the need and commitment to restore degraded ecosystem**

The primary causes of mangrove deforestation are population growth leading to urban sprouting and land grabbing, economic and political trends, climate change, and changes in upstream habitats. The Bonn challenge aims to restore 150 million hectares of degraded and deforested landscapes by 2020 and 350 million hectares by 2030 (AFR100 2022). In Africa, the global dynamics aim to restore 100 million hectares. Cameroon is committed to restoring 12 million hectares of land. Cameroon focused on the semi-dry parts of the countries which fall within the three primary regions (Adamawa, North, and Far North). Thus, Cameroon received funds from the German government to plant trees in the three northern regions to counter deforestation. Other restoration projects are in the Yoko and Dzeng communal areas

with the participation of the local community, who understand the tenure issues related to forest restoration.

Many of these projects are operational in terrestrial ecosystems, however, less attention has been paid to aquatic ecosystems, specifically mangrove ecosystems. This provides scope to lobby for more funding to conduct reforestation in some degraded part of the mangrove of southern Cameroon. Mangrove reforestation has several challenges which are, political, climate, identification of reforestation site and monitoring of the planted seedlings. Therefore, it is necessary to overcome these challenges in future studies. Mainstream mangrove ecosystem restoration can positively impact the current trend of mangrove ecosystem forest cover in Cameroon.

## 6. Drivers of mangrove deforestation in Cameroon

Four key drivers have been identified as principal factors influencing mangrove deforestation and degradation: population growth, economic and political trends, climate change, and changes in upstream habitats (Corcoran *et al.* 2007, Feka and Ajonina 2011).

Various activities have rendered coastal ecosystems more attractive owing to their varied and converted resources (IPCC 2007). Urban extension has led to the cutting down of trees and increasing climate change not only at the national level but also at the regional and global levels (Obiefuna *et al*. 2021). Changes in landscape patterns linked to urbanisation are critical drivers of climatic and ecological changes at the local, regional, and even global levels (Weng *et al.* 2007).

Overexploitation of mangrove resources has become a significant environmental problem owing to population growth around the coast, leading to changes in land cover (Amosu et al. 2012, Mclnnes 2010).

Anthropogenic impacts, particularly land-use change and deforestation, coastal development, various forms of pollution, illegal exploitation, and charcoal production, play a major role in mangrove loss (Hamilton and Casey 2018, Mafi-Gholami *et al*. 2020). Alongi (2018) argued that deforestation and hydrological changes are the most devastating factors for soil nutrient–plant relationships and mangrove productivity.

Tagne *et al*. (2022) conducted a study on the change in mangrove cover in the Monako area of Cameroon and found that settlements in inland forests cause forest degradation. Tagne *et al*. (2022) found that the conversion of certain occupancy classes to other land use categories between 1986 and 2018 was 31.57 ha of inland forest and 17.8 ha of degraded mangrove, which was converted to built-up land. The surface area of the degraded inland forest space increased from 1986 to 2018, to the detriment of inland forests. Nearly 80.18 ha of undisturbed inland forest and 270 ha of undisturbed forest mangroves was transformed into degraded inland forests.

Fish smoking is another contributor to mangrove deforestation. Njisuh and Mario (2008) reported an annual fuelwood harvest for five study sites to be 102,650 m3 (i.e. an amount equivalent to clearing

approximately 205.3 ha of mangrove forests annually). Approximately 62% of this total is used to smoke fish. Similarly, Jiazet (2019) found that traditional ovens require 53 h to smoke 525 kg of fish and consume 1.205 kg of wood at a cost of 6500 FCFA. He explained that a modern cinder block oven requires only 5 h to smoke 160 kg of fish and consumes 122 kg of wood at a cost of 3500 FCFA. This is because the cinder blocks conserve more heat than the traditional open-air oven, and as such, the cinder blocks use less wood.

## 7. Activities to reduce the threats on mangroves stand

### 7.1. REDD+ and mangroves

Reducing emissions from deforestation and degradation (REDD+) provides developing countries with financial incentives to protect their forests and lower GHG emissions. Until recently, REDD+ discussions and preparations centred on terrestrial forests. Mangroves also benefit coastal communities, particularly the fishing trade. However, few carbon certification schemes under REDD+ are open to mangrove forests because of the lack of carbon models for deep sediments.

Thus, reducing emissions related to mangrove deforestation and degradation appears to be an important way to overcome the decline in mangrove vegetation and the related environment. Although it can focus on climate change mitigation actions, its co-benefits include maintaining and restoring the biodiversity of this ecosystem. REDD+ activities can be conducted at national and sub-national levels, supported by the coordination of stakeholders and the appropriate use of policy documents and road maps. Restoring mangroves is important because they fall within the Blue Carbon dynamics.

The REDD+ activities could be handed in many ways:

-1. Mitigation action is a process in which actions are implemented to reduce the negative impact of climate change. These actions include the sensitisation of all stakeholders at the local, national, and international levels.

-2. Creation of a community forest and protected area.

-3. Encourage fish smoking using modern rather than traditional ovens.

-4. Reforestation has been implemented in some projects such as the Tiko-Limbe III REDD+ project.

### 7.2. Attempts to reduce mangrove deforestation

Various strategies can be implemented to reduce mangrove threats in Cameroon. Some of the activities are as follows:

Creation of improved ovens. This activity not only leads to a reduction in the quantity of fuelwood but also improves the social life of the community in terms of fish smoking. Cinderblock ovens are preferable both ecologically and economically, and could be one of the multiple solutions for the sustainable management of mangrove wood resources (PNDP 2018).

Sustainable forest management which can be implemented by:

- Demarcation of less-degraded sites to become a protected area, and therefore, managed by the community which can become a community forest.
- Train farmers living inland in techniques of vegetative propagation, such as macotting, air layering, grafting, and cutting, leading to the construction of a propagator.

Moreover, to encourage ecotourism it is necessary to conduct ecotourism activities to improve ecotourism sites and construct ecotourism towers around beaches. For example, the construction of birdwatching towers has attracted more tourists. Moreover, ecoguards must be trained to accompany tourists to tourist sites.

### 7.3. Activities of mangrove reforestation in Cameroon

To bring back mangrove vegetation which is the chief and most important component of the coastal ecosystem, some preliminary activities have been initiated. Table 2 presents some of these activities.

Based on Table 2, it was noticed that the deforestation rate is not only increasing, but also that mangroves are being exploited unsustainably. As such, some mitigation measures were suggested to curb the action to increase the mangrove cover in the Douala-Edea Reserve, where 4 ha of mangroves were planted (Moudingo *et al*. 2015). Owing to mangrove reforestation activities in the Douala-Edea Reserve, there has been a leakage belt causing mangrove wood exploiters to shift to the Tiko-Limbe III mangroves (Anonymous 2017).

To mitigate the mangrove deforestation and degradation within the Tiko and Limbe III mangrove ecosystem so that it can perform its functions fully, reforestation is one of the activities necessary for reducing emission from mangrove deforestation and degradation (REDD+).

Mangrove reforestation activities were performed in Tiko-Limbe III, where 21 ha of mangroves were regenerated within seven communities for over one year by the ‘Reduction of Tiko-Limbe III mangrove deforestation and degradation through integrated sustainable mangrove and associated coastal forest management’ (PNDP 2018).

Table 2: Chief reforestation projects in Cameroon mangroves

| No. | Name of the project | Location | Surface area targeted | Chief promoter of the restoration initiative | Enabling factor of restoration initiative | Chief constraints | Comments |
|---|---|---|---|---|---|---|---|
| 1 | Douala Edea reserve reforestation project | Douala | 10 ha | CWCS | Community should collaborate<br>- funds | A lack of community sensitisation and awareness | Some strategic measures need to be implemented |
| 2 | Tiko-Limbe III REDD+ project | Tiko - Limbe | 21 ha | AFD/PNDP | -Village management community should be formed<br>-A lack of funds | A lack of village management committee | Some strategic measures need to be implemented |
| 3 | CAMERR | Bonendale, Sodiko and Akwa Nord in Douala | 100 ha | 'Planète urgence' in partnership with CWCS | Ongoing | Ongoing | |

Source: Author

Another ongoing reforestation project is in Mouanko-Bolondo the 'Cameroon mangrove ecosystem restoration and resilience' (CAMERR) under the supervision of 'Planète Urgence'. The Cameroon estuary, in which the Mouanko-Bolondo area is located, is estimated to have around 203,600 hectares of mangrove, associated coastal forests, plantation, habitats and associated non-vegetated lands, including 93,550 hectares of 'pure' land covered by the mangrove. It has been implemented by a consortium of civil society organisations, including the Cameroon Wildlife Conservation Society (CWCS) and Watershed Target Group (WTG). The Cameroon mangrove ecosystem restoration and resilience (CAMERR) project began in 2022, under which 40 000 trees will be planted.

## 8. Challenges of mangroves restoration in Cameroon

Most projects do not attain their targets for several reasons. Nurseries should be constructed in the open rather than in the shade because shade encourages snail activities, as they consume Rhizophora propagules. *Rhizophora racemosa* is found to be a co-inhabitant with other mangrove species in wetter areas and large catchment estuaries of the Atlantic Ocean. The occurrence of *R. racemosa* appears to be restricted to the equatorial estuaries of larger river systems with more continuous freshwater flows (Duke and Allen 2006). Its reforestation should be performed for the management of tides.

Genetic diversity may occur owing to the fact that *Rhizophora racemosa* is the dominant species in the Cameroon mangrove ecosystem and, as such, could not resist or adapt to changes in the environment.

Another challenge encountered during reforestation is land tenure. In some traditions, women do not own land, and it is difficult for them to be implicated in the reforestation process. Therefore, only a few planters were involved in the planting process. Moreover, women are mostly involved in fish smoking to generate quick income.

Another challenge is motivating planters, diggers, carriers, fillers, and propagule collectors. However, project failures can occur in cases where financial resources are limited.

Further, from a political viewpoint, the mangrove ecosystem has been neglected by the government, considering that it only concentrates on fishery resources, leaving out floral resources.

Socially, the local community does not understand the aspects of mangrove reforestation, such that they are convinced that mangroves grow on their own. Therefore, they need constant sensitisation to encourage their participation in mangrove reforestation.

Women, who are the key drivers of mangrove exploitation for fish smoking, usually do not participate in the project. Most local stakeholders, who are villagers (85.83%), often depend on mangroves for subsistence (Pham *et al*. 2022). Thus, there are no opportunities to participate in mangrove reforestation.

Thus, all the aforementioned challenges should be considered in future mangrove reforestation projects.

## 9. Conclusion and future prospects

This study aimed to reflect on the opportunities and challenges of mangrove management and reforestation. Mangrove ecosystems play a vital role not only for the local population but also for the world at large, as it provides food and medicine, generates income, protects the marine ecosystem, helps in ecotourism and climate change mitigation by maintaining important stock of carbon and a shrine for the ‘Ngondo’ festival. Reforestation is one way to properly manage mangrove ecosystems and mitigate the effects of climate change. There is significant opportunity to conserve the ecosystem considering that there have been some reforestation activities such as AFR100, and the presence of local stakeholders and international organisations such as CIFOR and Planète Urgence, and the REDD+ policy. To date, some reforestation projects have been conducted to restore ecosystems that are undergoing degradation owing to urban sprouting, climate change, and deforestation for agriculture and fish smoking. However, this study has identified several challenges. To overcome these challenges there should be more reforestation activities on degraded sites; community sensitisation both on mangrove reforestation and the preservation of the ecosystem against urban expansion or sprouting; the creation of village management committees; stakeholder involvement; the creation of a steering committee, funding, and many other solutions. This provides an important vehicle for Cameroon to achieve international commitments to the United Nations Framework Convention on Climate Change, Convention on

Biological Diversity, and RAMSAR Convention among others. If implemented well, it will enable local and national stakeholders to determine effective solutions to achieve the Sustainable Development Goals (particularly SDG 1, 13, and 15). Thus, this is a way to add to Cameroon's efforts on AFR 100 initiatives and strengthen its participation in the UN decade of restoration.

Thus, this study is preliminary work that needs to be complemented by further studies that will pave the way for future restoration activities rooted in scientific findings. Current policies related to restoration emphasise terrestrial ecosystems which provide room for the development of mangrove restoration strategies and/or road maps that are consistent with the existing national development and environmental policies of Cameroon.

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