CARBON SEQUESTRATION POTENTIALS OF THE NIGER DELTA'S MANGROVE FOREST TOWARDS CLIMATE CHANGE MITIGATION

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Abstract
The Niger Delta region of Nigeria is rich in diverse ecosystems of mangrove swamps, fresh water swamps, and rain forest. It has been reported to be the largest wetland in Africa and among the ten most important wetland and marine ecosystems in the world. Carbon dioxide (CO_2) is the primary greenhouse gas emitted through anthropogenic activities. Although carbon dioxide is naturally present in the atmosphere as part of carbon cycle, its concentration has been greatly enhanced through human activities like combustion of fossil fuel, gas flaring, deforestation among others. The consequence is trapping or retention of heat in the atmosphere (Global warming) which ultimately accounts for change in climate. Part of the strategies to achieve carbon emission reductions and removal include Carbon sequestration. Removing this atmospheric C and storing it in the terrestrial and coastal biosphere is one option for mitigating the emission of this GHG. In the light of this, this paper tends to review the potential ability of the Niger Delta's Mangrove ecosystem in sequestrating atmospheric carbon towards climate change mitigation in this tropical coastal region.

Keywords: Niger Delta, Carbon dioxide, Sequestration, Climate Change

Introduction

Emissions of carbon dioxide, the principal greenhouse gas, have risen more than ten-fold since the start of the industrial revolution. Atmospheric concentrations of carbon dioxide have risen more than 30 percent as a result and, at present emission rates, are projected to reach twice the pre-industrial level by the middle of this century. Although there is no consensus on a safe concentration level, stabilizing concentrations at any given target will ultimately require reducing net emissions to zero (Hengeveld *et al*., 2005). The alteration of the climate system which leads to climate variation and change is caused by both natural and anthropogenic factors. The cause of the current climate change has been attributed to anthropogenic factors and among the anthropogenic factors, fossil fuel burning that produces carbon is a major contributor. While these carbons are released more by the developed nations, the developing nations are worse hit by the adverse effects of climate change caused by these carbons and other greenhouse gases like methane, nitrous oxides and chlorofluorocarbons among others (IPCC, 2007).

Various scientists have studied the different components of climate change to some extent. The causes of climate change have been scientifically studied and showed that

industrialization, urbanization, water pollution, deforestation and transportation are among the highest contributors (IPCC, 2007; Hengeveld *et al*., 2005; Nwafor, 2007; Odjugo, 2009). Other researchers have concentrated on the effects of climate change and revealed that it has started impacting and will continue to impact on human health, ecological destabilization, melting of polar ice, sea level rise, coastal flooding, desertification, aggravation of coastal and gully erosion and extreme weather conditions (IPCC, 2007; Ayuba *et al*., 2007; Odjugo, 2009).

Some research efforts have also been focused on mitigation and adaptation to climate change and the few studies in this area show that while climate change is caused more by the developed countries, the developing nations will suffer more of the effects because of their high level of vulnerability and low level of adaptation measures due to poverty and low technological development (Abiodun and Olabinupe, 2007; Adefolalu, 2007; Jagtap, 2007; IPCC, 2007).

Nigeria has a coastal line of approximately 85km towards the Atlantic Ocean lying between latitude 4°15' to 4°50' and longitude 5°25' to 7°37' with a land mass of about 28000sq/km area within the coastal region. The surface area of the continental shelf is 46300sq/km. The coastal areas consist of freshwater swamp, mangrove swamp, beach ridges, sand bars, lagoons marshes and tidal channels. Nigeria has a total land mass of 923,768sq/km; 918,768sq/km being terrestrial land and 13000 sq. /km being aquatic (Kuruk, 2004). The coastal area is humid with a mean average temperature of 24-32°C and coastal area has an average annual rainfall ranging between 1,500-4,000m (Kuruk, 2004).

The Niger Delta is located in the Atlantic coast of Southern Nigeria and is the world's second largest delta with a coastline of about 450km which ends at Imo river entrance (Awosika, 1995). This region is about 20,000sq/km as it is the largest wetland in Africa and among the third largest in the world (CLO, 2002; Anifowose, 2008; Chinweze and Abiola-Oloke, 2009). 2,370sq/km of the Niger Delta area consists of rivers, creeks, estuaries. Stagnant swamps cover approximately 8600sq/km and the Delta mangrove swamp spans about 1900sq/km as the largest mangrove swamp in Africa (Awosika, 1995).

This important Delta is classified as a tropical rainforest with ecosystems comprising of diverse species of flora and fauna; both aquatic and terrestrial. The region can be classified into four ecological zones; coastal inland zone, freshwater zone, lowland rainforest zone, mangrove swamp zone and is considered one of the ten most important wetlands and marine ecosystems in the world (FME, *et al*., 2006; ANEEJ, 2004). As of 1991, the National Census estimated about 25% of the entire Nigerian population lives

within the Niger Delta region (Twumasi and Merem, 2006; Uyigue and Agho, 2007). The Niger Delta region has a steady growing population of approximately 30 million people as of 2005, accounting for more than 23% of Nigeria's total population Twumasi and Merem, 2006; Uyigue and Agho 2007).

What are Mangrove Forests?

Shigeyuki *et al.*, (2004) defined Mangroves as trees and shrubs of the genera *Rhizophora*, *Brugiera, Sonneratia* and *Avicennia* or more generally, communities dominated by these genera. They are salt-tolerant, arboreal, flowering plants growing in the intertidal zone of tropical and sub-tropical shores. These coastal forests are found in sheltered estuaries and along river bank sand lagoons in the tropics and subtropics. Global distribution area of mangroves consists of 157,000 km^2 to 160,000 km^2 (Patil *et al*., 2012).

Mangroves possess a range of features which make them uniquely adaptable to their stressful environment, they are halophytic or salt tolerant, have aerial roots for gathering oxygen and seeds that geminate on the tree. Irrespective of the range of species and forest types, the manifold ecological role of mangrove ecosystems is, economically and socially, highly significant.

The Mangrove Forest of the Niger Delta is rich in biological resources that are heavy income earners as well as source of food to the people (Mmom and Arokoyu, 2010). It is reported to be home to about 60 exclusive species and many other non-exclusive ones. Nigeria's extensive Mangrove Ecosystem, a great proportion of which lies within the Niger Delta is estimated to cover between 500,000 and 880,000 hectares (Kuruk, 2004).

This ecosystem is dominated by red mangroves (Rhizophoraceae) in association with white mangroves; *Avicennia nitidae* and *Laguncularia racemosa. Rhizophora racemosa* is the most common species covering more than 90% of the mangrove ecosystem. *R. harrisonii* and *R. mangle* are the other species of the genus Rhizophora found in the Niger Delta. The Mangrove Forest serves as source of varied plant and animal products. These include different kinds of medicinal plants, log, fuel wood, charcoal, wood chips, paper pulp, materials for roof thatching, bark for tannin, dye, fish, shellfish, crabs and other sea foods.

Its uniqueness is also useful in providing essential intangible benefits such as coastal stabilization, food chain support for near-shore fisheries, filtering and trapping of water-borne pollutants, provision of nesting sites for shore and sea birds, provision of nursery and feeding grounds for numerous species of finfish and prawns, provision of habitat for crabs and molluscs, provision of resources for tourism and recreation among others. Specifically, Mangroves also help to reduce coastal erosion and stabilize estuarine

floodplains by serving as free flood control zone. The problem of erosion in the South-South region of Nigeria could chiefly be as a result of the destruction of this natural reservoir for ocean overflow and surge.

Mangrove Forests and Carbon Sequestration

Carbon sequestration can be defined as the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. It prevents carbon emissions produced by human activities from reaching the atmosphere by capturing and diverting them to secure storage. Carbon sequestration also provides associated ecosystem co-benefits such as increased soil water holding capacity, better soil structure, improved soil quality and nutrient cycling reduced (Kambale and Tripathi, 2010; Sethi *et al.*,2011).

Mangrove plantation is expected to be one of the options of afforestation as a Clean Development Mechanism (CDM) project. In spite of the importance of mangrove forests as carbon sinks, most of the research on carbon storage is focused on terrestrial ecosystems and little attention has been given to this type of ecosystem. Compared to other land forest, mangrove ecosystem accumulates sequestered carbon in the sediment (Wojick, 1999). The below ground content of mangroves is 4 to 18 times higher than the carbon content of tropical rainforest. This indicates positive action in mangrove conservation and rehabilitation would contribute immensely to sequestration of CO_2 (Tateda, 2005).

In the specific case of mangrove soils, where decomposition rates are low and their ability to store carbon is high, mangrove forests are an attractive alternative for carbon sequestration. Mangroves like many other plants have the ability to change the physical and chemical properties of soils in which they occur (Sathyanathan *et al.*, 2009). The fast-growing young trees absorb about 30% more carbon than mature wood, but an old-growth forest generally stores more carbon in the soil, groundwater and surface vegetation than a plantation of trees with the same size.

Mangrove forests cover vast extensions along the coastal zone in tropical regions. However, this surface is being lost at a yearly rate between 10,000 and 40,000 ha, mainly due to aquaculture, agriculture, deforestation and change in land use. The following facts further elucidate the great carbon sequestration potentials inherent in Mangrove.

- The global storage of carbon (C) in mangrove biomass is estimated at 4.03 Pg C. The average rate of wood production is 12.08 Mg $ha^{-1}y^{r-1}$, which is equivalent to a global estimate of 0.16 Pg C/yr stored in mangrove biomass. The net ecosystem production in mangroves is about 0.18 Pg C/yr (Ong, 1993).

- It is estimated that mangroves sequester approximately 25.5 million tonnes of Carbon every year. Mangroves take up (sequester) approximately 1.5 metric tons/hectare/yr of carbon or 3.7 lbs/acre/day of carbon (1336 lbs/acre/yr) (Ong, 1993).
- The global carbon burials of mangroves are approximately 18.4 Terra grams of carbon per year (Tg C yr-1) and therefore they have the potential of providing an efficient sink of CO_2 (Tomlinson, 1989).
- Mangroves provide more than 10% of essential dissolved organic carbon that is supplied to the global ocean from land (Laffoley and Grimsditch, 2009)
- According the Mangrove Action Project, almost 225,000 metric tons of carbon sequestrations potential are lost each year with current rates of mangrove destruction. Disturbed mangrove soils release greater than an additional 11 million metric tons of carbon annually.

Extent of Mangrove Forest in the Nigeria and Africa

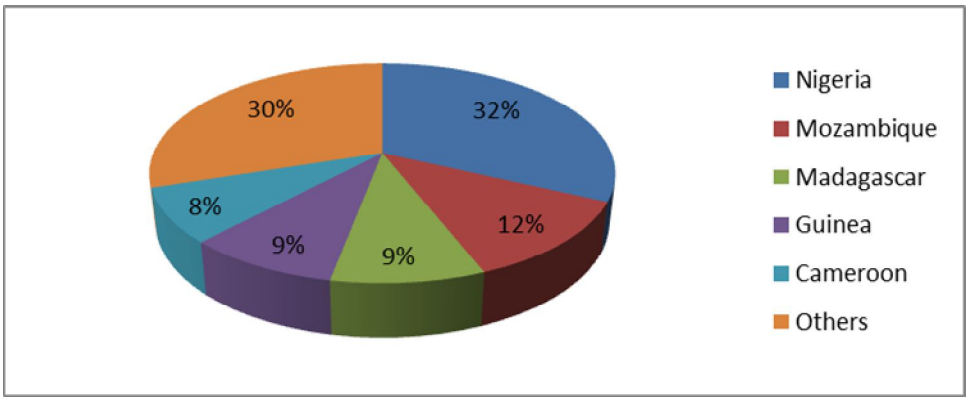

Fig. 1: Distribution of Mangrove Forest in Africa
Source: FAO 2007

Nigeria has the highest concentration of Mangroves (997,700ha) in Africa; the bulk of which is located in the Niger Delta (FAO 2007). Niger Delta ecosystem, being a wetland, provides a transition between the aquatic and terrestrial habitat and has been described as one of the most productive ecosystems in the world; highly diverse and supportive of numerous species of terrestrial and aquatic flora and fauna and human life (1dowu *et al.*, 2011). Kuruk (2004) reported that it spans over 70, 000km^2 of the total land area of the country with mangrove swamps estimated to cover about 7,000 km^2 of Africa's 9,000

km^2. This extensive mangrove ecosystem is found mainly in Rivers, Delta, Cross-River, Akwa Ibom and Ondo States of Nigeria (Kuruk, 2004).

Mangrove Forest Loss in the Niger Delta

Many local inhabitants of the Niger Delta rely on the extraction of products from the mangroves for their daily livelihood. The predominant occupation of the people includes timber logging, fishing and seafood picking. This in itself is not a problem but the overreliance of the rural dwellers on the Mangrove Forest (Mmom, 2007). Exploitation is wreckless without regard for preservation. Apart from this, mangrove forests are constantly being converted to other uses as a result of urbanization and industrialization (Mmom and Arokoyu, 2009). In a satellite based study, it was reported that about 21,340 hectares of mangrove forests were lost from 1985 to 2003 (James *et al.,* 2007). More area is definitely being lost since there has not been any deliberate effort to change.

The Way Forward

Mangrove Forest Conservation

The usefulness of the mangrove ecosystem in the removal of CO_2 from the atmosphere has been lucidly espoused in this write up. It has become highly imperative to conserve these fast depleting species for the numerous benefits that have been highlighted including the emerging great potential in carbon sequestration and climate change amelioration. The present uncontrolled and reckless utilization of resources from this delicate ecosystem must give way to controlled exploitation of all category of resources especially the timber and non-timber products from such forests.

It has also become highly imperative for the local inhabitants of the Niger Delta to be well educated for better appreciation of the usefulness of mangrove resources as well as the need for the stoppage of its willful destruction through over exploitation. The drive for industrialization and urbanization should not directly or indirectly affect the survival or existence of this highly important ecosystem. State governments in the Niger Delta, should therefore give ecological considerations to their developmental drives.

More importantly, the Federal Government must, in the interest of the overall development and well being of the Niger Delta environment tackle the problem of poverty and unemployment which are two deadly plagues that are the root causes of most developmental challenges in the region. Curtailing this would help in bringing, to the barest minimum, occurrences of oil spillages and lead to the preservation of the numerous Niger Delta resources including this highly treasured mangroves.

Finally, efforts should be intensified at ensuring that the polluted areas in the Niger Delta are gradually cleaned up such that various natural resources that had been negatively

impacted could be restored. Therefore, the recent pronouncement by the Federal Government of Nigeria regarding the implementation of the 2011 UNEP report on Ogoni Land is a step in the right direction.

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