ECONOMIC BENEFITS OF WETLAND ECOSYSTEM IN NIGERIA

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Abstract
The mangrove is an extremely important wetland ecosystem that contributes to the economic welfare of the individuals and development of the nation through the benefits it provides. These benefits range from its provision of income, revenues, food, medicine, fuel energy, employment and its efficiency in the moderation of atmospheric carbon. The activities of man (such as oil and gas exploration, dredging, logging etc.) in his environment have been a threat to the existence of this ecosystem. A good knowledge of these benefits is an important key for its effective and sustainable management of the ecozone. It is therefore recommended that the Ministry of Environment, Forestry Department, non-governmental organization as well as the decision makers to organize rehabilitation and educational programmes on mangroves in order to increase the awareness so as to guarantee sustainable use of the resources based on people oriented conservation programmes.

Key words: Economic benefits, welfare, revenues, employment, wetlands
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Introduction

Nigeria is blessed with abundant wetland ecosystem which occupies 2.6% of the country's land area. However, these wetlands are not well documented and gazetted (Nwonkwoala, 2012). The fourteen major wetland belts identified in Nigeria include; Niger Delta, Benin-Owena and Okomu, Cross River, Lagos Lagoon and Lekki Peninsula, Lower Ogun River, Ologe Lagoon, Badagry and Yewa Creeks and the transboundary wetlands of the Upper Benue, Lower Benue-Makurdi, Lower Niger, Middle Niger-Lokoja-Jebba-Lower Kaduna, Upper Niger and Kainji Lake, Lake Chad, Komadugu Yobe and Sokoto-Rima (Oyebande *et al*., 2003 and Asibor, 2009).

Wetlands are rich and valuable ecosystem that provide a variety of resources and services not only to the adjoining communities. Some of the important services they provide are; conservation of biological diversity, water treatment, erosion control, provision of habitat and provision of food. Despite the benefits accrued from this ecosystem, it is exposed to degradation which is due to urbanization, pollution, intensive agricultural production and industrial advancement.

The paper therefore focuses on the economics of the mangrove wetland ecosystem as it affects income and revenue generation, provision of products like fuel wood, charcoal,

and medicinal plants, employment generation as well as provision of some important services to the immediate communities and other stakeholders.

Status of the Mangrove Ecozone

Mangroves are among the most productive ecosystems in the world that harbours various biodiversity (Adedeji, Ibeh and Oyebanji, 2011). They serve as important habitat for diverse species of wildlife and fish and also their decaying leaves serve as a basis for an aquatic food chain. The mangrove forest in Nigeria is the largest in Africa and the third largest in the world extends from Badagry in the West to Calabar in the East with a total area of 10,000Km^2 along the coast (Abere and Ekeke, 2011). The Niger Delta in particular hosts over 60% of the mangroves ecosystem in Nigeria which spread across Ondo, Edo, Delta, Bayelsa and Rivers States (Adedeji, Ibeh and Oyebanji, 2011). Its flora is mainly made up of only three families and six species (Table 1).

Table 1: Economic Timber Species in Mangrove Ecozone

Family	Common Names	Species
Rhizophoraceae	Red mangrove	*Rhizophora racemosa* *R. harrisonii* *R. mangle*
Avicenniaceae	White mangrove	*Avicennia africana*
Combretaceae		*Laguncularia racemosa* *Conocarpus erectus*

Source: Abere and Ekeke, 2011.

The mangrove fauna consist of different species of birds, reptiles, mammals, crabs, prawns, fishes, snails and monkeys. The habitat also houses wide variety of other life forms that play important roles in the economic well being of the people.

Socio-economic activities have resulted to the degradation of the ecosystem. Some of the activities that exacerbate the decline of wetland are logging for wood based industries, fuel wood, harvesting of wood for charcoal production, reclamation of wetlands, population growth and oil pollution. For instance, James *et al*. (2007) have observed that about 21,340 hectares of the mangrove ecosystem in Niger Delta were lost between 1986 and 2003 due to urbanization, dredging activities, activities of the oil and gas industries which resulted to the spread of Nypa palm (*Nypa frutican*) plant species. Even, the Lagos mangrove wetland also has decreased from 88.51 to 19.95Km^2 annually between 1984 and 2006 which was attributable to urban development pressures (Obiefuna, Nwilo, Atagbaza, and Okolie, 2013).

Economic Benefit of Mangrove

The economic the importance of the mangrove ecosystem cannot be over emphasized because the ecozone provides a lot of benefits which are relevant for the well being of man and his environment. Timber and charcoal enterprises have been playing central in the economy of Nigeria as well as rural economies of various of communities endowed with abundant forest resources (Kalu and Okojie, 2009; Kalu and Izekor, 2007). These benefits include income, food, medicines, fuel wood, honey, oil, timber for construction, saplings, nurseries and habitat for fishes, crabs and other sea life.

It is noted that 60% of the people in the Niger Delta region depend on mangrove resource exploitation for survival while 44.2% of them are engaged in forestry, agriculture, and fishing industries (FGN, 2007 and Mmom and Arokoyu, 2010). Table 2 identifies 6 common economic systems engaged by the Niger Delta people for survival which are logging of mangrove timber species, fishing and harvesting of sea food, trading and other forms of business, farming, public service and artisans.

Table 2: Common economic systems for Niger Delta people

	Types of economic systems	Percentage
1.	Local craft/logging of mangrove trees	32
2.	Fishing and harvesting of seafood	29.5
3.	Trading and other forms of business	20
4.	Farming	4.5
5.	Public service	5.5
6.	Artisans	8.5
Total		100%

Source: Mmom and Arokoyu, 2010.

The mangrove ecosystem is also used for specific farming activities like crop production, poultry keeping, livestock farming and fishing. An observation revealed that between 1989 and 2009, a total of 13,633,140 and 27,591,120 Naira were generated as revenues to both the government and the people from harvesting a total of 130,724 mangrove trees (Table 3). Omogoriola et al., (2012) and Okpiliya, Oka and Effiong, (2014) have opined that the benefits accruable to the government from the mangrove forest as revenue accounted for 33.07 while 66.93 is accruable to individuals

Table 3: Revenue Accrued from the Sales of Mangrove Trees in Year 1989 to 2009

	Revenue (₦)	Percentage
Revenue		
Government	13,633,140	33.07
Individuals	27,591,120	66.93
Total	41,224,260	100

Source: Okpiliya, Oka and Effiong, 2014.

Food from Mangrove Ecosystem

The mangrove ecosystem provides a variety of food for human and animal. Fruits especially of families like Sonneratiaceae and Avicenniaceae serve as food to both man and animals. In Sri Lanka, a pulp from *Sonneratia sp*. is used to make fruit drinks and ice creams (Jayattissa *et al*., 2006). Leaves of *Acanthus spp.* are used for making herbal tea. The flower stalks from the palm family produces sweet sap which is either eaten raw or processed into alcoholic drinks, sugar and vinegar. The sugar sap of the flower stalks *of Nypa fruticans* (nypa palm) and *Cocos nucifera* provide a diversity of products like yeast, ethanol, cooking oil and cigarette wrappers (Yamagata *et al*., 1980 and Paeivoeke *et al*., 1984).

Nectars from many mangrove species produce excellent honey which is widely utilized by bee-keepers in many communities where the mangroves exist. For example, in northern India *Pongamia pinnata* is an important summer food plant for a variety of wild solitary and social bees (Apoidea) (Jain and Dhingra, 1991). Also, in the western part of the mangrove forest of Bangladesh an estimated 185 tonnes of honey and 44.4 tonnes of wax are harvested yearly (Siddiqi, 1997). The scented white fragrant flowers of *Sonneratia caseolaris* open at night for the bats to feed on the hundreds of stamina and at the same time pollinate the flowers (Bandaranayake, 1999).

The coastal regions of West Africa use the ash from the leaves of *Avicennia africana* as a substitute for salt and extract salt from the wood ash (Bandaranayake, 1999). *Rhizophora racemosa* is used in smoking fish because the smoke from it adds colour and flavour to the fish. Mangroves, most specially *Avicennia spp*. are used as nutritive feed for goats, sheep, buffaloes and cattles (Kathiresan, 2012). Moreover, the tender leaves, fruits, seeds, and seedlings of *Avicennia marina* and vegetable parts of other species are traded and consumed as vegetables (Bandaranayake, 1998).

Medicinal Value of Mangroves

Every traditional society in tropical coastal areas use mangrove leaves, fruits, bark or other products for traditional medicines. These medicinal plants are used to secure cure

for ailment such as stomach disorder, ulcers, hepatitis, toothache, bleeding, fever, kidney stone, malaria, sore throat, dysentery, fungal infection, skin diseases, constipation, and rheumatism. For instance, the root, leaf and stem extracts of Rhizophora trees have inhibitory properties that affect the growth of various human pathogenic organisms like bacteria, fungi and viruses (Hernandez and Perez, 1978). Kathiresan (2000) has noted that extract from mangroves seem to have a potential for human, animal and plant pathogens growth inhibition and for the treatment of incurable viral diseases. A number of them contain poisonous substances which also show biological activities like antifungal, antibacterial, antiseptic, antifeedant, molluscicidal, insecticidal and pesticidal properties (Kokpol, 1984). Species of Avicennia, Rhizophora, Sonneratia, Bruguiera, Exocoecaria, Juncus, Heritiera, *Barringtonia asiatica*, *Podocarpus dispermus*, *Camptostemon schultzi* and *Cyanometra iripa* have been reported to possess antiviral activity (Collins *et al*., 1990). Premanathan et al. (1999) reported that the polysaccharide extract of the leaf of *Rhizophora apiculata* inhibited HIV-1 or HIV-2 or SIV strains in various cell cultures and assay systems. Also, the leaf extracts of *Bruiguiera cylindrical* and bark of *Rhizophora mucronata* have been found to exhibit antiviral activity against Newcastle disease, vaccinia and hepatitis-B virus (Prabhakaram and Kavitha, 2012).

In China and Thailand, *Acanthus ilicifolius* have been used against cancer, as its crude alcoholic extract of its leaves is known to possess antioxidant, hepatoprotective, antitumour and anticarcinogenic effects. It also has been applied in the treatment of other ailment like asthma, paralysis, diabetes, rheumatism, hepatitis, leprosy, neuralgia, ringworms, snake bites and stomach pains (Agshikar *et al*., 1979; Graham *et al*., 2000).

Fagara zanthoxyloides (a littoral shrub) found in Nigeria and in the coastal sands north of the Casamance River in Senegal, is used in dental hygiene as chewing sticks against the bacteria *Bacteriodes gingivalis* and *B. melaninogenicus* (Berghen 1982; Rotimi *et al*. 1988). Table 4 shows the medicinal value of some mangrove plants in Nigeria.

Table 4: Medicinal Uses and utilizable parts of Some Mangrove Plants in Nigeria

Botanical Name		**Uses**
Avicennia africana	***	Cancer, cure for thrush, gangrenous wounds, lice, mange, ring worms, skin parasites, tumours, (B), ulcers, (B).
Avicennia germinans	***	Incontinence, rheumatism, (B), throat pains, ulcers of the mouth, (L, B).
Concocarpus erecta	***	Catarrh, (R), Febrifuge, (L), gonorrhoea, malaria, stops bleeding, (B).
Fagara zanthoxyloides	*	Dental hygiene, (St).

Nypa fruticans	***	Asthma, diabetes, leprosy, rheumatism, snake bite, (L, Fr).
Rhizophora mangle	***	Angina, boils and fungi infections, (B), antiseptic, diarrhoea, dysentery, elephantiasis, fever, malaria, leprosy, (B, L), minor bruises, (B), plaster for fractured bones, (B), tuberculosis, (B, L).
Rhizophora racemosa	***	Stops bleeding, (L).

Source: Bandaranayake, 1999.

Key
*** - Mangroves, * - Mangrove associates, B - Bark, L - Leaves, Fr - Fruits, R - Roots, St - Stem

Habitat Function of Mangroves

The mangrove ecosystem creates a suitable, valuable and diverse structural habitat for a host of species which have important economic benefits. These include; sponges, meiofauna (i.e. copepod, harpacticoid, nematode, etc.), macro fauna, prawns, insects, elasmobranches, fishes, birds, mammals (like rodents, monkeys, bats, wild pigs and antelope), amphibians and reptiles (i.e. crocodiles, snakes, lizards and frogs). In fact, molluscs like bivalves, oysters, cockles, mussels, crabs and shrimps are harvested in mangrove for domestic needs and /or commercial uses. In some communities, some hours of school time table are set around the tides to enable children to support parents in the mollusc harvest (Mackenzie, 2001). It has been reported that the mangrove ecosystem in eastern part of Lagos lagoon hosts a number of species which include molluscs like periwinkles (*Tyopantonous fuscatus* and *Pachymelaian aurita*), oysters (*Crassostrea sp.*), crustaceans like purple mangrove crab (*Cardiosoma armatum*), tilapia (*Sarothenedon melanopterus*), mudskipper (*Petriopthalmus barbatum*) and larva stages of some important fishes and shrimps (Omogoriola *et al*., 2012).

There are at least 600 species of fishes in mangrove ecosystems located in the Indo-West Pacific region which stretches from the east coast of Africa through south and south-east Asia to Australia and the Central Pacific. This region has the highest diversity of fishes in the world. One of the key characteristics of the mangrove ecosystem that influences the presence of fishes in this ecozone is the physical structure they provide. These are their pneumatophores, prop-roots, trunks, fallen branches and leaves that serve as a complex habitat for a host of potential prey and their rich epiflora of algae and diatoms that are important source of food for many fishes (Blaber, 2000; Verweij *et al*., 2006a). Moreover, they also serve as fish nurseries and breeding grounds for shrimps, molluscs and crabs. According to Akegbejo-Samsons and Omoniyi (2009) the mangrove forest ecosystem in

Nigeria provides the nursery and breeding ground for many of the commercial fish species caught in the Gulf of Guinea.

They form prime nesting sites for a large number of shore birds, rare birds, land birds, migratory birds and waterfowl. Approximately 200 species of birds have been found around mangrove communities (Ewel *et al*., 1998). They also constitute habitats for many endangered species such as West Africa manatees, and red colobus monkey. For example, the Apoi Creek forests located in the Niger Delta mangrove ecosystem houses an endangered species of monkey such as Red Colobus monkey (*Procolobus badius*) (Chidumeje, Lalit and Subhashni, 2015). Furthermore, their prop roots houses terrestrial and marine plants, algae, invertebrates and vertebrates. These are use as substrate for colonization by algae, wood borers, barnacles, molluscs, sponges and oysters. For example, Engel and Pawlik (2005) have identified 1195 sponges comprising ten species that occupied 73.5% of available mangrove root space.

Mangrove as a Carbon Sink

The mangrove habitat has been proven by researchers to be efficient in carbon sequestration. They remove CO_2 from the atmosphere through photosynthesis and store as biomass. According to Farnsworth *et al*. (1996) the *Rhizophora mangle* under high CO_2 conditions which double normal for one year show greater accumulation of biomass. The biomass encompasses the above ground biomass which is the shoot and the below ground biomass which is the root. The ratio between the above ground biomass and below ground biomass is about 2.5:1 unlike the upland forest which is 4:1. This shows that the below ground biomass in relation to the above ground biomass is higher when compared to that of other forest types (Kathiresan, 2012).

Mangroves are also able to accumulate and store large quantities of carbon in the soil. It has been estimated that the organic-rich soils of mangrove which range from a depth of 0.5m to more than 3m accounts for 49-98% of carbon storage in the mangrove systems. Due to the high level of below ground biomass and the storage of carbon in its sediment soil, the mangroves is considered 50 times greater than any other tropical forest in its carbon sequestration capacity, 5.2 fold as high as sea grasses and 2.4 fold as high as salt marshes (Kathiresan, 2012).

The restoration of lost mangrove forests has even been recommended as a counter measure for global warming due to the enormous carbon sequestration potentials of mangroves. According to Bouillon *et al*. (2008) the global mangrove net primary production is 218 trillion grams of carbon annually with litter fall, wood and root production accounting for 31, 31 and 38% of the overall production and this contributes carbon to the ocean through the process of export, sediment burial and mineralization. Though, a greater than 50% of the carbon fixed by mangrove vegetation is accounted for.

This unaccounted carbon sink was estimated at 112±85 trillion grammes of Carbon per area (TgC/a).

Mangrove and Recreation

Mangrove ecosystem is as important as any other ecozone in recreation and tourism. It is of aesthetic value because of its fauna, most especially birds, fishes and reptiles like crocodiles. It provides revenues due to payment for services like relaxation, bird watching, sports fishing, boating and other recreational activities. These recreational activities are beneficial to the health of people as it help to relieve stress. Tourism plays an important role in the economy of some nations as it provides jobs, foreign exchange earnings, business opportunities and emphasizes the political and social importance of conservation (Mulongay and Gidda, 2008; Kathiresan and Bingham, 2001).

World Travel and Tourism Council 'WTTC' (2005) has opined that travel and tourism has generated US$30.3 thousand million, US$1004.4 million and US$1858.4 in South Africa, Namibia and Tanzania respectively. The Tanzania's value accounted for 9.7% of its GDP and 7.7% of total employment. Unfortunately in Nigeria, the benefits of this area have not been fully harnessed.

Conclusion

This paper has reviewed the mangrove ecosystem in Nigeria, its' status and the services it provides to man and his environment which are many a time economic in nature. The mangrove ecosystem is thus unique, irreplaceable and among the most productive ecosystems in the world which hosts wonderful and rare flora and fauna. A recent estimate put the annual values of benefits and services provided by one Kilometre of mangrove at a range of US$200,000 to US$900,000 (UNEP-WCMC, 2006a). The activities of man have led to the degradation of this ecosystem due to the threats they pose to its existence. Thus, it is pertinent to consider a harvesting regime that accommodates sustainable management, conservation and rehabilitation of this ecosystem. This can be achieved through the development of rehabilitation programmes, strengthening of conservation regulations and the promotion of the practice of Environmental Impact Assessment before the commencement of exploitation of forest resources endemic in the ecozone. Regular public awareness campaign should be organized on the importance of this ecosystem, roles on the societal stability and the attendant threats faced at the exploitation of the resources to meet human needs.

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