The Finima Nature Park Carbon Stock Assessment.

Final report

Compiled by Nigerian Conservation Foundation (NCF) for Nigeria Liquefied Natural Gas (NLNG) Limited. Finima, Bonny Island, Rivers State, Nigeria

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NCF

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List of Acronyms and Abbreviations

AFOLU - Agriculture, Forestry, and Other Land Uses

AGB- Above Ground Biomass
BGB – Below Ground Biomass
FAO- Food and Agriculture Organization
GIS - Geographic Information System
IUCN – International Union for Conservation of Nature
NLNG- Nigeria Liquefied Natural Gas
MRV- Measurement, Reporting and Verification
NCF- Nigeria Conservation Foundation
NTFPs – Non Timber Forest Products
IPCC – Intergovernmental Panel on Climate Change
PSP – Permanent Sample Plots
REDD - Reduction of Emissions from Deforestation and forest Degradation
UNFCCC - United Nations Framework Convention on Climate change.

Executive Summary

Reducing Emissions from Deforestation and Forest Degradation (REDD+) is a climate change mitigation solution that the United Nations has developed. It is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. It goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. This is been implemented under the United Nations Framework Convention on Climate Change. The United Nations Framework Convention on Climate Change (UNFCCC) was signed at the United Nations Conference on Environment and Development in 1992 and entered into force on 21 March 1994. The objective of the UNFCCC is to stabilize greenhouse gas emissions at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system. It states that such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner (REDD+ Law Project 2014, FAO 2015).

Countries, organizations or companies willing to adopt a REDD+ regime are in tandem with global best practices of paradigm shift from extraction to conservation, which has dual function of; enhancing financial benefits and reducing environmental challenges posed by effects of climate change, emanating from Ozone layer depletion and the global warming, which is attributed majorly to anthropogenic activities of deforestation and forest degradation. For the management of Finima Nature Park (FNP) to adopt the REDD+ regime and be in tandem with global best practices, the need for Measurement, Reporting and Verification (MRV) system that provides information on forest carbon stocks and carbon stock changes becomes imperative as justification for this study. Due to the extensive areas covered by forests, the information is generally obtained by sample based surveys. This study adopted internationally accepted methodologies and designs appropriate for the two habitat types (Swamp and mangrove) found in the FNP. Since there were no shape files, maps, remotely sensed imagery, photographs, GIS datasets; a reconnaissance survey of the core area of the FNP using GPS and 2006 remote sensing imagery was carried out, to determine the current sizes of the core conservation areas. A digital map of the core areas was produced. This was then used to determine the number of sample plots to be laid. A nested sample plot design (figure 3) and a 100m x 20m inter sub-sample plots (Figure 4) were used to collect data from the two habitat types within the core conservation areas.

The forest carbon stock assessment is driven by the sampling design chosen and type of carbon pool measured. The study compared biomass of eleven plots using simple random sampling. The results from the assessment, showed a marked variance of biomass/carbon stock between the 11 plots sampled (Figure 5), indicative of variations in species density and specific wood density between plots and species. Having a total carbon of 38,299.39 tons from AGB and BGB, with a corresponding CO_2 e of 140,558.75, the Eastern block of the core conservation area had the highest carbon of 149,293 t/ha, followed by the western block with a carbon value of 79.897 t/ha and Hippo Creek, 43.169 t/ha respectively. 19 species of trees from 9 families were identified and documented. 8 (42%) are

vulnerable (VU), 5 (26%) are of least concern (LC) and 6 (32%) are not evaluated (NE) according to the IUCN Red list 2015[1] (Table 4).

It is worth noting that the FNP is helping to sequester 140,558.75 CO_2 e from the atmosphere. It was however observed that, ocean surge, especially at the coastal side of the park and anthropogenic activities by the fishing communities are the major causes of deforestation. These combined activities will affect the Park's ability to continually perform this function, as the resultant effect of such activities is the reduction in carbon stock and degradation of the ecosystem. The survey presents the results of the carbon stock assessment of the Finima Nature Park, in order to gather better information to support the improved management of the Park. The results provide important information on; the reduction in carbon footprint of the company (NLNG) and for the future sustainable management of the Park, particularly in regards to forest carbon conservation initiatives and the potential of the vulnerable species for reforestation initiatives on degraded portion of the park. In order to increase the financial and environmental benefits from adopting a REDD+ regime or Green economy and to adhere to global best practices, the following recommendations and management/mitigation plans becomes expedient;

- Reforestation of degraded areas of the reserve with endemic species for ecological restoration.
- Detailed mapping of the park to delineate and document the actual land area, including the buffer zones for proper planning and management.
- Building on the preliminary survey and the result of this survey, a monitoring system should be put in place with a plan of a bi-annual carbon assessment for the reserve on a regular basis to assess and monitor the carbon stock of the reserve.
- A more robust assessment be carried out to assess all carbon pools i.e. Above Ground Biomass (AGB), Below Ground Biomass (BGB), dead wood, litter and soil carbon within the core park area for a better representative data of the carbon stock in the Park.

Proposed Management/ Mitigation plan

- Pro-active, engagement of local communities participatory monitoring and protection of the park should be considered.
- Investments should be provided to secure alternative or substitute sources of fuel wood to fishing communities like fish drying kilns, to reduce pressure on flora and the fragile ecosystem.
- Encourage taking examples of world best practices in ecosystem management through environmental education of immediate stakeholders on the dangers and benefits of High Conservation Values (HCV) areas such as the park.
- Support off site conservation efforts of communities to inculcate conservation attitudes.
- Intensify regular patrol of park guards to check poaching and deforestation activities.

[1] *The IUCN Red List is set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies. These criteria are relevant to all species and all regions of the world. The aim is to convey the urgency of conservation issues to the public and policy makers, as well as help the international community to try to reduce species extinction.*

THE FINIMA NATURE PARK CARBON STOCK ASSESSMENT

1.0. Background

Global climate change threatens the livelihoods of people worldwide. A significant portion of the greenhouse gas emissions results from land-use and land use changes, particularly deforestation and forest degradation in tropical areas. Linking deforestation with climate change as a mitigation action was one of the key decisions of the thirteenth Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC). The Bali Action Plan agreed: "Enhanced national/international action on mitigation of climate change, including, inter alia, consideration of policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries". These actions are now referred to collectively as REDD+. Under the UNFCCC, the REDD+ instrument (Reducing Emissions from Deforestation and Forest Degradation), as agreed at the COP-16 of the UNFCCC in December 2010, is critical for developing countries. REDD+ includes the implementation of the following mitigation actions: (a) Reducing emissions from deforestation; (b) Reducing emissions from forest degradation; (c) Conservation of forest carbon stocks; (d) Sustainable management of forest; and (e) Enhancement of forest carbon stocks. This means that, potentially, all forest resources in developing countries are subject to accountable mitigation actions. (Petrokofsky et al. 2012, UNFCCC. 2007, 2010)

REDD+ is intended to be a mechanism to channel funding (both public and private) for reducing emissions from the forest sector, and as an international climate change policy it relies on national implementation. In order to attract and manage REDD+ investments, countries need to implement appropriate policy choices supported by strong legal frameworks. (REDD+ Law Project 2014).

Conferences of the Parties (COP's) have taken place annually since 1994 and provide Member countries with the opportunity to update and coordinate the international response towards climate change. Linked to the UNFCC is the Kyoto Protocol, an international agreement designed to enforce the UNFCCC, which commits its Parties by setting internationally binding emission reduction targets. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997. Due to a complex ratification process, it entered into force on 16 February 2005. It commits industrialized countries to stabilize greenhouse gas emissions based on the principles of the Convention. It sets binding emission reduction targets for thirty-seven industrialized countries and the European Community in its first commitment period. Within the framework of the Cancun Agreements of the UNFCCC (2010), developing country Parties were asked to address the drivers of deforestation and forest degradation, land tenure issues, forest governance issues, gender considerations and safeguards when developing their national strategy or action plan, ensuring the full and effective participation of relevant stakeholders, inter alia indigenous peoples and local communities. More recently modalities for national forest monitoring systems and measuring, reporting and verifying (MRV) have also been established as part of the Warsaw Framework for REDD+ (UNFCCC 2013). In line with international commitments, countries with high forestry coverage are making progress in reforming existing legislation and adopting new legislation on climate change and REDD+.

In light of the recent international developments mentioned above, some countries from Asia-Pacific, Latin-America and Africa (Argentina, Australia, Bangladesh, Brazil, Cameroon, Chile, Colombia, Ecuador, India, Kenya, Nigeria, People's Republic of China, Peru, Philippines, Republic of Korea and South Africa) have recently made considerable progress in enacting forest and climate change related legislation. Therefore, countries seeking to implement REDD+ need to address various different issues in their REDD+ policies, including the development of robust legal structures to facilitate REDD+ implementation. These legal frameworks could be based on existing laws, and could require new law making. (UNFCCC 2010, 2013, REDD+ Law Project 2014, FAO 2015)

The Federal Government of Nigeria has demonstrated its commitment to REDD+ through its participation in international negotiations, by convening technical and policy forums and through the establishment of a number of federal institutions: including, the National Advisory Council on REDD+, the National Technical Subcommittee on REDD+, the National REDD+ Secretariat, and the UN-REDD Nigeria Programme Steering Committee. In addition, Cross River State (CRS), which is the pioneer and demonstration state for most REDD+ activities in Nigeria, has established its own REDD+ structures, mostly around its Forestry Commission and a Stakeholder Forum on REDD+ (Federal Republic of Nigeria 2013).

As in all countries experiencing deforestation, the drivers of deforestation and forest degradation in Nigeria are complex, multi-fold and multi-layered, and vary from region to region and State to State. These have been identified as a result of policy and market failures, governance, demographics, poverty and macroeconomic factors. A number of thematic areas deemed integral to addressing drivers of deforestation have been identified. These are: (i) government policy, legislative and institutional reform; (ii) forest and land use zoning and planning; (iii) forest tenure security for local communities; (iv) introducing alternative agriculture systems; (v) support to forest protection, reforestation and forest enrichment; and (vi) reduced fuel-wood local energy options (Federal Republic of Nigeria 2013).

Carbon sequestration within protected areas is a valuable resource of greenhouse gas removals which would not be available if these protected areas (PAs) were to become cultivated (which causes organic carbon to oxidise) or have their forests cut down. Protected areas in Nigeria and many other parts of the world contain various ecosystem types, each with its own carbon storage characteristics. Carbon pools in these ecosystems include living biomass of trees and understory vegetation and the dead mass of litter, woody debris, soil organic matter and peat. The carbon stored in the above-ground living biomass of trees is the largest pool. While protected areas are believed to contain important carbon stocks, there is very limited knowledge of the actual quantities of carbon stored in their ecosystems, which is the case of the FNP. In light of these issues, climate change and high rates of global carbon emissions have focused attention on the need for high-quality monitoring systems to assess how much carbon is present in terrestrial systems and how these changes over time, in other to put in place proper mitigating actions based on sound scientific information. Hence the need for this study.

Finima Nature Park (FNP) established in 1999, is approximately 35 km southeast from the capital. It is located in the south of Bonny and south east of Finima community. It lies within latitude 4°22'49" and 4°23'53" and longitude7°8'40" and 7°12'17". The Finima Nature Park evolved from a consensus between the Nigerian Liquefied Natural Gas Company (NLNG) Limited and the Finima communities, Bonny Island in Rivers State in Nigeria, to protect the forests for its integrity and its biodiversity, under the sole sponsorship of NLNG. The Park was estimated to cover an area of about 1000ha. However, following a ground-truth survey, using GPS and 2006 remote sensing imagery the three Reserve patches that makes up the core conservation area viz; Eastern block, Hippo Creek and the Western block were estimated to cover an area of 375.68ha, 30.76ha and 228.08h respectively. The total core area is now estimated to cover 634.43ha.The park area has a climate typical for much of Nigerians' coastal states, in terms of annual rainfall, dry season, mean annual temperatures, which are consistent with other coastal locations throughout the year. The reserve area covers the rain forest and mangrove swamps, as well as an ecologically important area of sandy soil with fresh water ponds and tall timber between the swamps and the beach. The reserve is home to some wildlife species of high conservation value, a variety of mammals, bird species and reptiles, such as the Mona monkeys, crocodiles, snakes and monitor lizards. FNP is home to a number of species classified by International Union for Conservation of Nature (IUCN) as vulnerable or critically endangered such as the African Grey Parrot – *Psittacus erithacus*, Hooded Vulture – *Necrosyrtes monachus*, Ekki – *Lophira alata* and *Mitragyna stipulosa.* The diversity in FNP is a good representation of the Niger Delta ecology, which affords a unique opportunity for research and educational activities. There have been series of physical and ecological changes in FNP over the years and it is considered appropriate to carry out a carbon stock assessment for the Park as a way of generating scientific information on the current status of the reserve vis-a-vis the ecosystem functions and services provided by the Park for the past 16 years.

The objective of this survey therefore was to assess the carbon stock of the FNP forest in the various pools: Above Ground Biomass, Below Ground Biomass, Dead Wood – Standing and Lying, using internationally recognized methodology to provide base line information on the amount of carbon sequestered by the FNP forest and to provide recommendations for enhancing carbon sequestration by the forest. Four sampling approaches and anticipated different cost schemes for field surveys and remote sensing imagery were selected to show the effect of both the inventory designs and the associated costs on the cost-efficiency and reliability of carbon inventory and monitoring systems. Assumptions and methods used in this survey were compatible with those laid down in the IPCC GPG (Intergovernmental Panel on Climate Change Good Practice Guidance). The IPCC (Good Practice Guidance 2003, and Guidelines for National Greenhouse Gas Inventories in Agriculture, Forestry, and Other Land Uses [AFOLU] 2006) provides the framework for estimating of CO_2 in the AFOLU sector. This was used to design the Sampling Framework for this survey. The IPCC framework is based on estimating the carbon stocks in five IPCC recognized carbon pools (aboveground biomass, belowground biomass, soil organic matter, litter, and dead wood) caused by changes in forest cover (IPCC 2003, 2006).

2.0. METHODS

2.1. Sampling plots design and intensity

For forestry activities, permanent or temporary sampling plots can be used for sampling over time to estimate changes in the relevant carbon pools. Permanent plots are applicable only where both the trees and the plots are permanently marked. For all other pools, temporary plots are used. Due to the spatial variability of land-use change drivers as well as the spatial variability of forest carbon stocks in different habitat types, a stratified random sampling design is often useful in a forest carbon sampling design. Stratification of forest land is known to reduce sampling effort while maintaining accuracy and precision in estimates of carbon stocks (Köhl et al. 2009)

The goal of stratification is to reduce within stratum variance and improve the precision of each stratum, thereby minimizing the number of samples required to achieve an overall level of certainty. A stratified sampling design also allows flexibility in designing a sampling protocol within each stratum that is tailored to the desired level of precision (targeted at a 90% confidence interval with a half width equivalent to ±10% of the mean) as well as the time and resources available to collect the data. For instance, if there are certain areas that are unlikely to experience change in the next ten years, it may be appropriate to reduce sampling in those areas relative to sampling conducted in areas more likely to experience change. Different sampling design alternatives can be used in the scope of carbon measurement or REDD monitoring. These sampling designs can employ in-situ (field plot) data, remote sensing-based data, or a combination of the two (Köhl et al. 2011).

For this survey, a combination of remote sensing and in-situ assessments was utilized. In-situ (Field plot) data was used for the carbon assessment, while remote sensing-based data (2006 GIS Imagery) was used to determine the actual size of the core conservation areas of the Park, to enable the survey team determine the number of plots to be laid. The estimation of carbon stocks for this survey was limited to two carbon pools. i.e.; Above Ground Biomass (AGB) and Below Ground Biomass (BGB), due to time and budget constrain.

Figure 1: Map showing Finima Nature Park core conservation area**.**

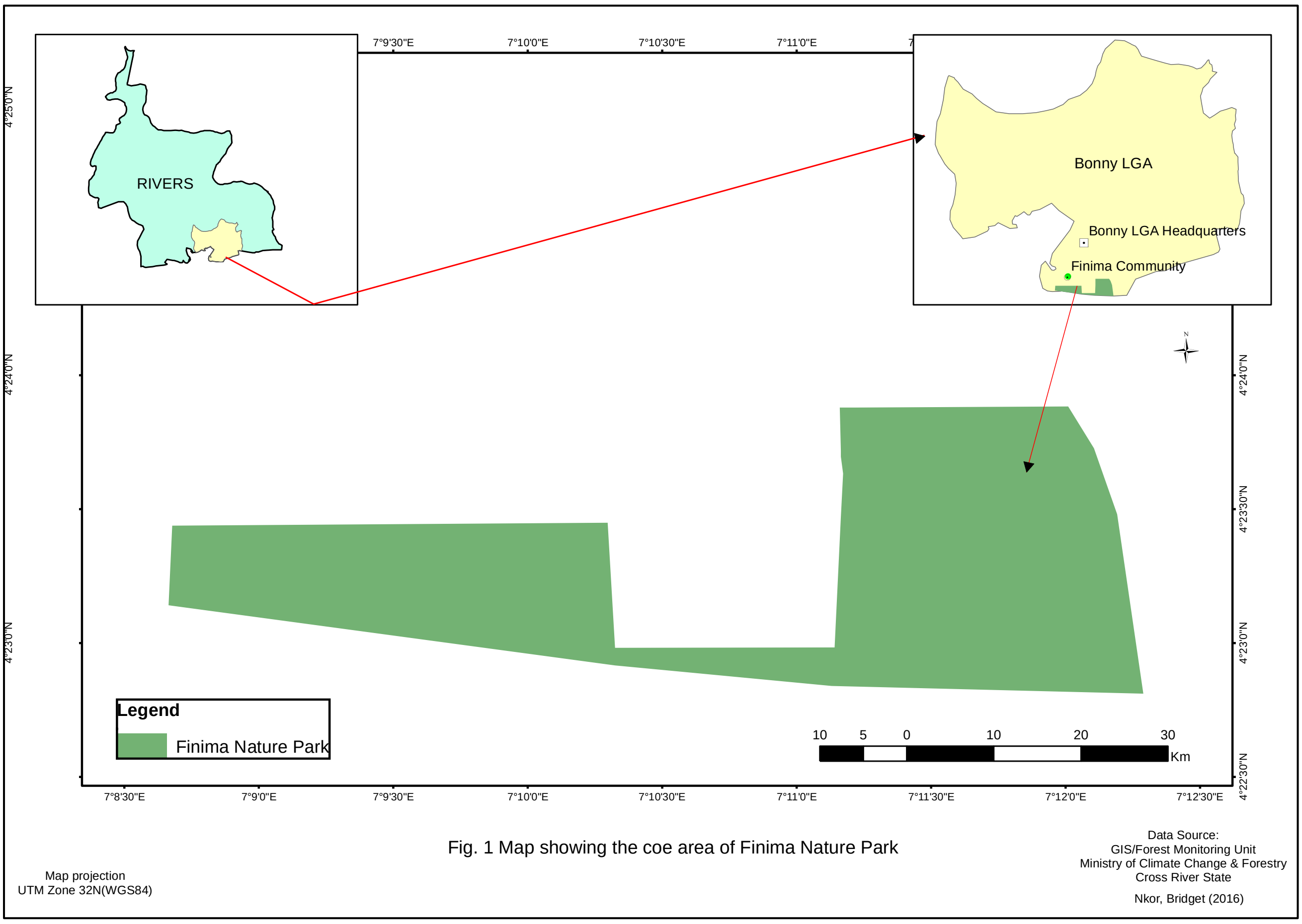

Figure 2: Map showing the sample plot locations

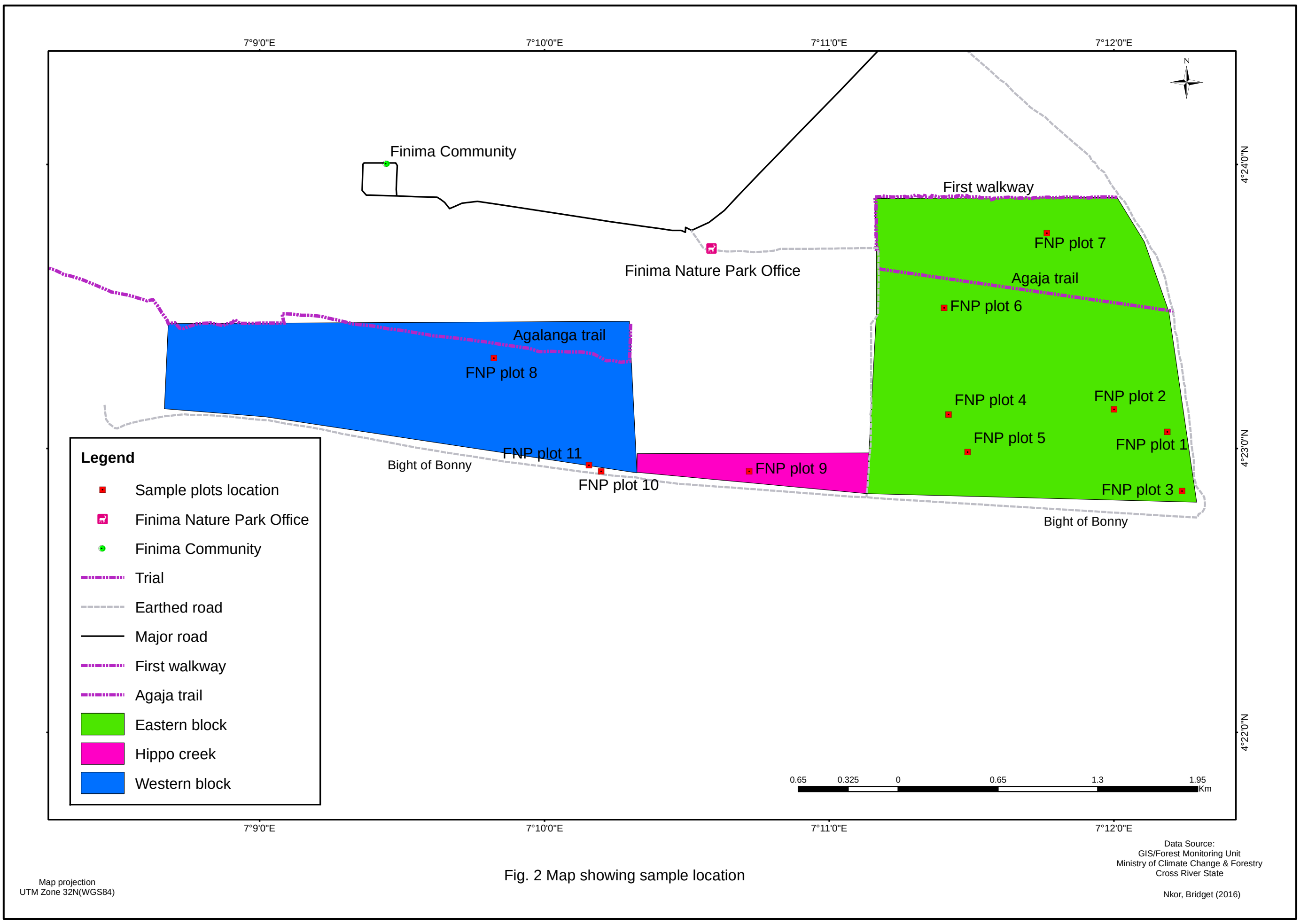

Fig. 2 Map showing sample location

2.2. Data collection

To minimize biases, an MS- excel simulation was used to allocate sample plots in the core conservation area. 12 sample plots were randomly selected. GPS coordinates for each plot location was recorded for verification and to assess changes over time if maintained as Permanent Sample Plots (PSP). The habitat types were also characterized for each plot as shown in (Table 1).

Floral or AGB survey was carried out using two types of design base on two major habitat types in the study area. In the swamp forest, a 35m x 35m 3 nested sample plot (sub-divided into 2mx 2m,7mx 7m,25mx25m) was used (Figure 3). In the mangrove habitat, a two 100m x 20m transects (sub-divided into 10m x 20m sub-plots, at every other intervals, making up 5 sub-plots in each 100m) running in a west to east direction at the distal coast side was adopted (Figure 4). In each 2m x 2m sub-plots, all saplings below 5cm in diameter but that are above breast height are counted and recorded. Trees of 5cm-19.9cm were measured in the 7m x 7m sub-plots, 20cm – 49.9cm in 25m x 25m sub-plots, and in 35m x 35m, trees of 50cm > were measured respectively. These 46 sub-transects covered a total of 1.5025 ha in 11 sample plots, which gives a sampling intensity of 9.5337% of the total core area. Though according to IPCC 2006, sampling generally takes place within specified areas (typically 0.01 ha to 1 ha).

The forest structure of each plot was characterized using the following variables: estimated tree height (e.g. using clinometers), tree diameter at breast height (DBH) using diameter tape and relative abundance of each tree species in the plots were measured. Data pulled from the above-ground living biomass of trees helped in identifying areas with higher biomass. Habitat types where identified and categorized (Table 1). A predesigned form was used to record data collected from the sample plots accordingly (Appendix 1)

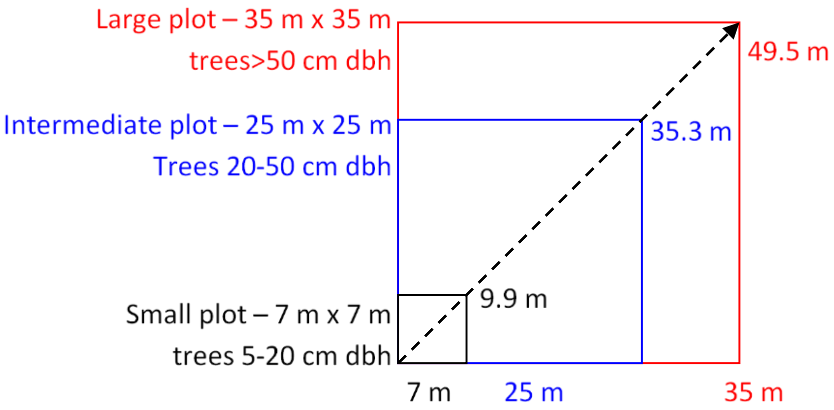

Figure 3: Nested sample plot design for the Swamp forest

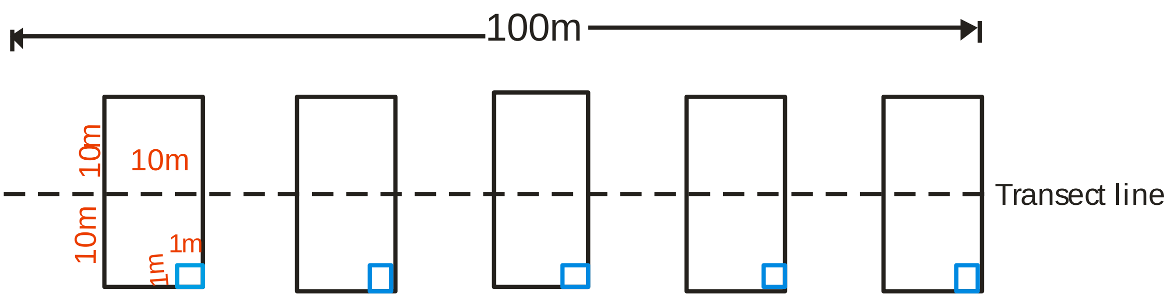

Figure 4: Straight line sample plot design for the Mangrove

2.3. Method of data analysis

The in situ data (Field data) was analyze adopting allometric equation for Rhizophora and tropical species, according to Chave et al. (2014), Komiyama et al, (2005), IPCC (2007) and Winrock International (2011)

Allometric equation for Rhizophora AGB - $0.225pD^{2.46}$

Where:

AGB_{est} - Above Ground Biomass (kg)

P = species specific wood density (g/cm^3)

D = diameter at breast height (cm)

Allometric equation for Rhizophora BGB – $0.199p^{0.899} X D^{2.22}$ (Komiyama et al 2005)
Where:

BGB_{est} - Below Ground Biomass (kg)
P = species specific wood density (g/cm^3)
D = diameter at breast height (cm)

This equation was updated by Chave et al. (2014):

$AGB_{est} = 0.0673 x (P x D^2 x H^{0.976})$

Where:

AGB_{est}= Above Ground Biomass (kg)
P = species specific wood density (g/cm^3)
D = diameter at breast height (cm)
H = height (m)

Table 1: Distribution and coordinates of sample plots in the different habitat types

S/N/Plots	HABITAT TYPES	GPS CORDINATES
1	Swamp Forest	04°.38433N007°.20313E
2	Swamp Forest	04°.38565N 007°.20001E
3	Swamp Forest	04°.38085N 007°.20398E
4	Swamp Forest	04°.38535N 007°.19032E
5	Swamp Forest	04°.38313N 007°.19144E
6	Swamp Forest	04°.39161N007°.19006E
7	Swamp Forest	04°.39599N007°.19608E
8	Swamp Forest	04°.38864N 007°.16372E
9	Swamp Forest	04°.38201N007°.17866E
10	Mangrove Forest	04°.38201N007°.16999E
11	Mangrove Forest	04°.38238N 007°.16928E

Source: Finima Nature Park field survey data, 2016

2.4. Tree identification and classification

Trees were separated into morphospecies – groups of individual trees that share a number of unique morphological characters to distinguish them as separate species, each of which was assigned unique field codes of 6, 4 and 2 digits respectively, stating the genus and species. Voucher specimens were collected for all the morphospecies and matched at the end of fieldwork to harmonize the taxonomy in different transects.

3.0. Results

3.1. Biomass t/ha per sample plots

Nine (9) plots fell in the swamp forest, while only 2 were in mangrove forest with significant tidal impact. The 12^{th} plot could not be assessed due to high tide and time constraint. Result from the analysis indicated that, Above Ground Biomass (AGB) is proportionate to the Below Ground Biomass (BGB).

Plot 6 had the highest biomass, as compared to plots 8,5,2,4, 1, 7, 9, 11, 10. In plot 3, no AGB was recorded (Table 2 & Figure 5).

Table 2: Biomass per sample plot

Plot ID	Habitat Type	AGB (t/ha)	BGB (t/ha)	Total AGB + BGB
FNPL1	Swamp Forest	140.14	28.03	168.17
FNPPL2	Swamp Forest	160.29	32.06	192.34
FNPPL3	Swamp Forest	0.00	0.00	0.00
FNPPL4	Swamp Forest	159.93	31.99	191.91
FNPPL5	Swamp Forest	168.01	33.60	201.61
FNPPL6	Swamp Forest	204.02	40.80	244.82
FNPPL7	Swamp Forest	38.49	7.70	46.19
FNPPL8	Swamp Forest	174.01	34.80	208.81
FNPPL9	Swamp Forest	35.97	7.19	43.17
FNPPL10	Mangrove Forest	4.12	0.82	4.94
FNPPL11	Mangrove Forest	21.62	4.32	25.94

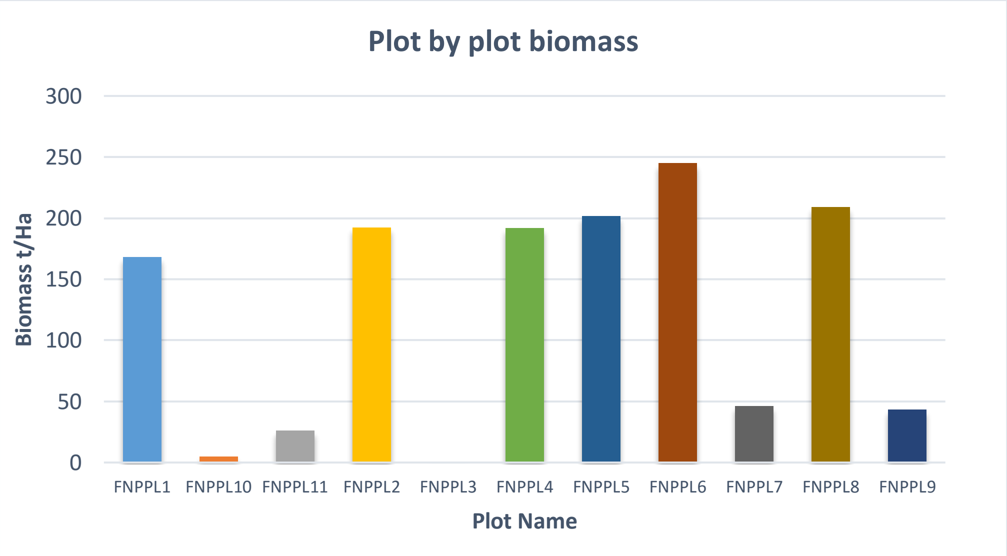

Figure 5: Biomass t/ha per plot

The biomass in t/ha of the 3 sample areas which makes up the FNP core conservation area (Eastern Block, Hippo Creek and Western Block) are 149.29, 43.17 and 79.90 respectively (Table 3 & figure 6).

Table 3: Total biomass t/ha for the core conservation areas of the park

Parcel	No of Sample plot	Total Biomass (tons)	Average Biomass (t/ha)
Eastern block	7	1045.04	149.29
Hippo creek	1	43.17	43.17
Western block	3	239.69	79.90

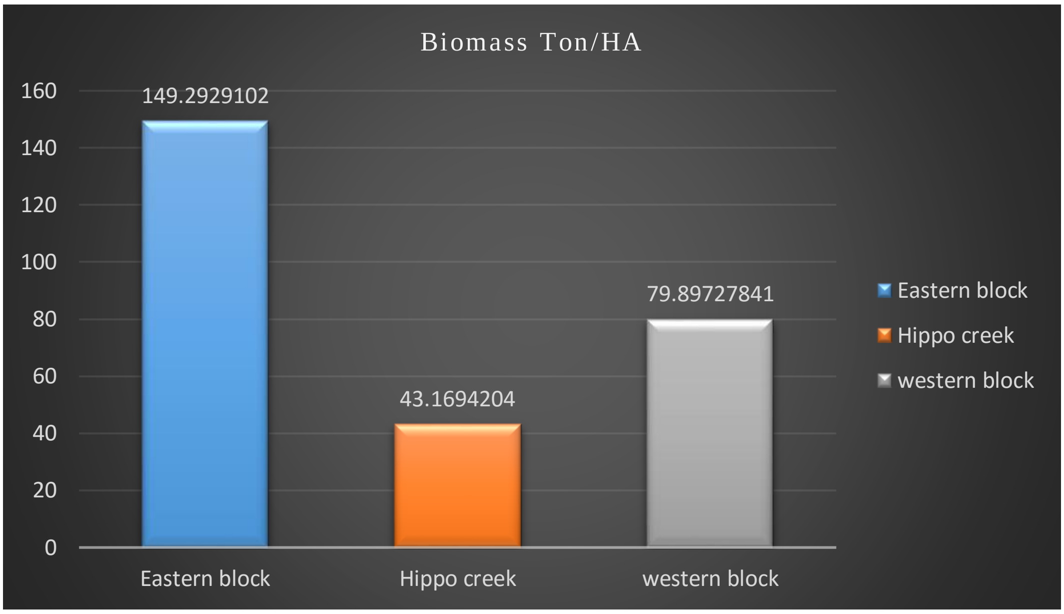

Figure 6: Bar chart showing biomass t/Ha for the 3 sampled blocks.

[2]The total biomass in the sampled plots (Core conservation areas of the Park) is 1,327.91 tons, in average of 120.72 (t/Ha) in approximately 634.52Ha. The total biomass is 76,598.77tons, carbon stock was 38,299.39 and carbon dioxide CO_2 e tons is 140,558.75 t.

a. Total biomass in the sample plot	-	1,327.91 tons
b. Average biomass	-	120.72 t/Ha
c. Approximate core area of FNP	-	634.52 Ha
d. Total biomass in FNP	-	76,598.77 tons
e. Total Carbon stocks in FNP	-	38,299.39 tC
f. Carbon dioxide - CO2 e	-	140,558.75 tons of CO_2 e

3.2. Diversity of tree species

The survey recorded a total of 19 tree species, belonging to 16 families, with Apocynaceae recording the highest frequency of 25, Palmae 12, Rhizophoraceae 10, Euphorbiaceae 14, Leguminosae `and Irvingiaceae 5. Annonaceae 4. 3 for Fabacea, Loganiaceae, and Simaroubaceae respectively. 2 for Avicenniaceae, Euphorbiaceae and 2 for Papilionaceae, Leguminosae, Ochnaceae, Rubiaceae and Verbenaceae respectively.

3.2.1. Conservation status of tree species in sample plots

A total of 19 species of trees from 9 families were identified and documented within the sample plots. 8 (42%) out of the 19 are vulnerable (VU), 5 (26%) are of least concern (LC) and 6 (32%) are not evaluated (NE) according to the IUCN Red list 2015 (Table 4).

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[2]*Note: (a=sum of the total biomass in the sampled plots, b=a/11, c=total area of park, d=b*c, e=d/2, f=e*3.67 (molecular weight of CO2))*

Table 4: List of tree species and their conservation status (IUCN Red list 2015)

S/N	Scientific Name	Frequency	Family	[3]Species Status (IUCN Red List 2015)
1	*Albizia spp ***	3	Fabaceae	
2	*Alstonia boonei*	25	Apocynaceae	LC
3	*Anthocleista djalonensis*	3	Loganiaceae	VU
4	*Anthostema aubryanum*	6	Euphorbiaceae	NE
5	*Avicennia africana*	2	Avicenniaceae	LC
6	*Baphia spp*	1	Papilionaceae	LC
7	*Cleistopholis patens*	3	Annonaceae	VU
8	*Elaeis guineensis*	12	Palmae	NE
9	*Erythrophleum ivorense*	1	Leguminosae	NE
10	*Klainedoxa gabonensis*	5	Irvingiaceae	NE
11	*Lophira alata*	1	Ochnaceae	VU
12	*Macaranga*	2	Euphorbiaceae	VU
13	*Mitragyna stipulosa*	1	Rubiaceae	VU
14	*Parkia bicolor*	5	Leguminosae	LC
15	*Pierreodendron africanum*	3	Simaroubaceae	NE
16	*Rhizophora recemosa*	10	Rhizophoraceae	LC
17	*Spondiathus preussii*	8	Euphorbiaceae	NE
18	*Vitex spp***	1	Verbenaceae	VU
19	*Xylopia aethiopica*	1	Annonaceae	NE

** Species need to be verified.

4.0. Discussion, conclusion & recommendations

In the 1990's tropical deforestation was estimated to cause approximately 20 percent of the global anthropogenic carbon emissions (IPCC 2007). Between 1997 and 2006, deforestation, forest degradation and peat land fires contributed between 8 and 20 percent to the global anthropogenic carbon emissions (van der Werf et al. 2009). Food and Agriculture Organization (FAO) estimated an annual loss of carbon stocks in forest biomass of 0.5 Gt between 1990 and 2010, which is considered to be mainly a result of tropical deforestation (FAO 2010). The deforestation, degradation, and fragmentation of Nigeria's forests are the result of agricultural expansion over many decades, fuel wood demand, uncontrolled harvesting in the forest, urbanization, the compounding factor of population growth in rural areas and ocean tidal surge as it is the case in Finima Nature Park. The degradation of forests has increased considerably across all of Nigeria's coastline and there is a need

[3]*Vulnerable (VU) – High risk of endangerment in the wild.*
Least concern (LC) – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.
Not evaluated (NE) – Has not yet been evaluated against the criteria.

to address the high levels of deforestation and to work to restore large forest areas, especially in coastal vegetation. The survey presents the results of the carbon stock assessment of the Finima Nature Park, in order to gather baseline information on the amount of carbon the FNP forest is sequestrating. The results provide important information on; the reduction of the company's (NLNG) and for the future sustainable management of the Park, particularly in regards to forest carbon conservation initiatives and the potential of the vulnerable species for reforestation initiatives on degraded portion of the park.

It is worth noting that the FNP is helping to sequester 140,558.75 CO_2 e from the atmosphere. It was however observed that, ocean surge, especially at the coastal side of the park and anthropogenic activities by the fishing communities are the major causes of deforestation. These combined activities will affect the Park's ability to continually perform this function, as the resultant effect of such activities is the reduction in carbon stock and degradation of the ecosystem. To increase the financial and environmental benefits from adopting a REDD+ regime or Green economy and to adhere to global best practices, the following recommendations becomes expedient;

- Reforestation of degraded areas of the reserve with endemic species for ecological restoration and possibly, increasing the carbon stock of the Reserve
- A more robust assessment be carried out to assess all carbon pools i.e. Above Ground Biomass (AGB), Below Ground Biomass (BGB), dead wood, litter and soil carbon within the core park area for a better representative data of the carbon stock in the Park.
- Building on this preliminary survey and the results, a monitoring system should be put in place with a plan of a bi-annual carbon assessment for the reserve to assess and monitor the carbon stock of the reserve.
- Detailed mapping of the park to delineate and document the actual land area, including the buffer zones for proper planning and management.

Proposed Management/ Mitigation plan

- Pro-active, engagement of local communities participatory monitoring and protection of the park should be considered.
- Investments should be provided to secure alternative or substitute sources of fuel wood to fishing communities like fish drying kilns, to reduce pressure on flora and the fragile ecosystem.
- Encourage taking examples of world best practices in ecosystem management through environmental education of immediate stakeholders on the dangers and benefits of High Conservation Values (HCV) areas such as the park.
- Support off site conservation efforts of communities to inculcate conservation attitudes.
- Intensify regular patrol of park guards to check poaching and deforestation activities.

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Appendix 1:

Forest Carbon Inventory: Field Data Collection Template

Date:	**State:**	**LGA:**	**Recorder:**
Plot No./code:	**Name of Community(ies):**	**Team leader:**	**No in team:**
			Time:
GPS points:	**Landuse type:**	**History of fallow land (if applicable):**	

Nest 1 (35x35)						**Nest 2 (25 x 25)**						**Nest 3 (7 x 7)**						**Nest 4**
Tree no.	**Tree spp**	**Spp code**	**DBH (cm)**	**Mercht (m)**	**Tot ht (m)**	**Tree no.**	**Tree spp**	**Spp code**	**DBH (cm)**	**Merc ht (m)**	**Tot ht (m)**	**Tree no.**	**Tree spp**	**Spp code**	**DBH (cm)**	**Merch ht (m)**	**Tot ht (m)**	**No of saplings**