

# UN-REDD PROGRAMME



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## **Regional Needs Assessment for Countries in West Africa for the Implementation of National Forest Monitoring Systems for REDD+**

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**August, 2016 [*Updated March 2017*]**

## List of Acronyms

AD	Activity Data
C & I	Criteria and Indicators
COP	Conference of Parties
DBH	Diameter at Breast Height
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization of United Nations
FCPF	Forest Carbon Partnership Facility
FD	Forest Department
FRA	Forestry Resource Assessment
GEF	Global Environmental Facility
GFRA	Global Forest Resource Assessment
GHG-I	Green House Gas Inventory
GIS	Geographical Information System
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature and Natural Resources
LULUCF	Land Use Land Use Change and Forestry
MMRV	Monitoring and Measurement, Reporting and Verification
MMU	Minimum Mapping Unit
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
RELS	Reference Emissions Levels
REDD+	Reducing Emissions from Deforestation, Forest Degradation; and the Role of Conservation, Sustainable Management of Forest and Enhancement of Forest Carbon Stocks in Developing Countries
RLs	Reference Levels
RPP	Readiness Preparation Proposal
SFM	Sustainable Forest Management
SLMS	Satellite Land Monitoring System
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Program
WG	Working Group
BCC	Bureau Changement Climatique (Côte d'Ivoire)
BCTT	Bureau de Cartographie Thématique et de Télédétection (Guinée)
BNETD/CCT	Bureau National d'Etudes Techniques et de Développement/Centre de Cartographie et de Télédétection (Côte d'Ivoire)
CARBOVEG	Evaluation des stocks de carbone dans les forêts de Guinée-Bissau
CBRST	Centre Béninois des Recherches Scientifiques et Technologiques
CENATEL	Centre National de Télédétection et Suivi Ecologique (Bénin)
CERE	Centre d'Etude et de Recherche en Environnement (Guinée)
CERF	Centre d'Etudes, de Recherches et de Formation Forestière (Bénin)
CNF	Centre National de Floristique (Côte d'Ivoire)
CNRA	Centre National de Recherche Agronomique (Côte d'Ivoire)
CNRS	Centre National de la Recherche Scientifique
CNTIG	Comité National de Télédétection et d'Informations Géographiques (Côte d'Ivoire)
COP	Conférence des Parties
CURAT	Centre Universitaire de Recherche Appliquée en Télédétection (Côte d'Ivoire)
DE	Direction de l'Environnement (Togo)

DFS	Deutsche Forest Service
DGCC	Direction Générale des Changements Climatiques (Bénin)
DGDD	Direction Générale du Développement Durable (Guinée-Bissau)
DGFF	Direction Générale des Forêts et de la Faune (Guinée-Bissau)
DGFRN	Direction Générale des Forêts et des Ressources Naturelles (Bénin)
DNE	Direction Nationale de l'Environnement (Guinée)
DNEF	Direction Nationale des Eaux et Forêts (Guinée)
DRF	Direction des Ressources forestières (Togo)
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Fund
EF	Emission Factors
FFEM	Fond Français pour l'Environnement Mondial
FFN	Fonds Forestier National (Togo)
FORIG	Forestry Research Institute of Ghana
FRA	Forest Resources Assessment
GEF	Global Environment Facility
GEOFORAFRI	Projet de "Renforcement des capacités et accès aux données satellitaires pour le suivi des forêts en Afrique" de l'IRD
GIZ	Société allemande pour la coopération internationale (Deutsche Gesellschaft für Internationale Zusammenarbeit)
IBAP	Institut de la Biodiversité et des Aires Protégées (Guinée-Bissau)
NFI	National Forest Inventory
IGN	Institut Géographique National
IGT	Institut de Géographie Tropicale (Côte d'Ivoire)
INM	Institut National de Météorologie (Guinée-Bissau)
IRD	Institut de Recherche et de Développement
JICA	Japanese International Cooperation Agency
MADR	Ministère de l'Agriculture et du Développement Rural (Guinée-Bissau)
MEGCCRPNF	Ministère de l'Environnement chargé de la Gestion des Changements Climatiques, du Reboisement et de la Protection des Ressources Naturelles et Forestières
MERF	Ministère de l'Environnement et des Ressources Forestières (Togo)
MINEF	Ministère des Eaux et Forêts (Côte d'Ivoire)
MINESUDD	Ministère de l'Environnement, de la Salubrité urbaine et du Développement Durable (Côte d'Ivoire)
MRN	Ministère des Ressources Naturelles (Guinée-Bissau)
MRV	Measurement, Reporting and Verification
NR/NRE	Niveaux de Référence/Niveaux de Référence des Emissions
ODEF	Office de Développement et d'Exploitation des Forêts (Togo)
PAFN	Plan d'Action Forestier National (Togo)
PBFII	Projet Bois de Feu Phase II (Bénin)
PGFTR	Projet de Gestion des Forêts et Terroirs Riverains (Bénin)
PGRN	Projet de Gestion des Ressources Naturelles (Bénin)
PND	Plan National de Développement (Côte d'Ivoire)
PNUD	Programme des Nations Unies pour le Développement
PRCN-	Projet de Renforcement des Capacités Nationales en matière de Gestion Durable
GDT/LCD	des Terres et Lutte contre la Déforestation/désertification
ProCGRN	Programme de Conservation et de Gestion des Ressources Naturelles (Bénin)

ProREDD	Programme d'appui à la préparation à la REDD+ et à la réhabilitation des forêts au Togo
R-PP	Readiness Preparation Proposal
RWG	REDD Working Group
SEE	Secrétariat d'Etat à l'Environnement
SENASOL	Service National des Sols de Guinée
SEP-REDD+	Secrétariat Exécutif Permanent REDD+ (Côte d'Ivoire)
SIG	Système d'Information Géographique
SNSF	Système National de Surveillance des Forêts
SODEFOR	Société de Développement des Forêts (Côte d'Ivoire)
UNST	Unité Nationale de Surveillance et de Suivi des Terres (Bénin)

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## Executive Summary

Countries considered in the assessment fall within the Guinean Forest of West Africa which stretches from Guinea and Sierra Leone eastwards to the Sanaga River in Cameroon; and has been classified amongst the 25 hotspots for biodiversity conservation. Forests contains about 1800 endemic plant species, 67 endemic mammal species, 75 endemic birds, 52 endemic reptiles, 85 endemic amphibians and 143 endemic freshwater fishes. Forests here constitute a main source of wood energy, construction poles, round wood and export timbers for a population for over 234 million inhabitants. Presently forests and woodlands in West Africa cover a total surface area of about 72.1 million ha and about 27.7 million ha of protected areas.

In response to the UN REDD Programme CNA call, 9 West African countries opted for a regional needs assessment in order to jointly address their capacity needs in some critical cross-cutting REDD+ areas common to them, but in which they differ in their capacity needs (e.g. their technical capacities to accurately monitor forests carbon stocks & stock changes, and to establish Reference emission levels).

Regional needs assessments could help to maximize synergies among countries' readiness processes, enhance south-south cooperation and knowledge exchange, and leverage REDD+ readiness at regional level in a cost-effective manner.

### **Objectives**

To determine the levels at which Partner Countries in West Africa (ECOWAS region) have reached in the formulation/development of their National REDD+ Forest Monitoring and Reference Levels, and to identify institutional and technical challenges in order to better plan/tailor regional capacity building programs for forest monitoring and reference levels.

### **Expected Results**

- Improved and enhanced understanding of national and/or regional REDD+ capacities and needs in forest monitoring & Reference Levels.
- Capacity building Training materials on NFMS and RELs developed based on needs identified.

### CNA Methodology

Data collection was undertaken using questionnaire which was drafted and validated by countries during inception workshop in August 2015, attended by National Experts. The questionnaire was structured according to three technical pillars of MRV (SLMS, NFI & GHG\_I) and one on Forest Reference Levels. In total there were 56 questions (main and sub questions) for NFI, 28 questions for Remote Sensing/GIS, 27 questions for GHG Inventory, and 23 questions for FRELs/FRLs. The validated questionnaire administered in countries by National Experts in collaboration with needs assessment consultant and UN REDD Forestry Officer at FAO Regional Office for Africa (FAORAF) in Ghana in September 2015. The completed questionnaires sent to FAO Regional Office for Africa (FAORAF) for preliminary analysis by Consultant and Forestry Officer and drafting of country reports. Field visits were undertaken by the Consultant to some countries for further in depth information.

Results of the study were presented in a descriptive manner following a number of criteria, including, availability of infrastructure, data availability, level of technical expertise, logistics and equipment and level of training. For each of the technical pillars (**FI, SLMS, GHG\_I, & FREL/FRL**) capacity needs were summarized using 5 criteria above which were coded at 3 levels noted **1** to **3**:

**1: Low capacity** → Expertise, systems and tools do not exist and/or are not well developed or used regularly

**2: Average capacity** → Human and/or technical capacity exists but does not correspond to the real needs for FMS and FREL, and an update and/or enhancement of the existing capacities is needed;



**3: high/advanced capacity** → adequate capacity is available and can be used with minimal updating and/or additional training.

Results obtained are summarized in the following paragraphs:

### **Forest Inventory**

**Institutional arrangements:** Only five (05) countries (Benin, Ghana, Nigeria, Liberia and Sierra Leone) indicated the existence of lead institutions mandated by legal text to undertake NFI. The four (04) others (Côte d'Ivoire, Guinea, Guinea Bissau, and Togo) do not have legally mandated institutions. The mandated lead institutions work with others involved in NFI (see table).

**Financial autonomy:** Almost all countries indicated the lack of financial autonomy, and rely on government subsidies or external funding from projects to undertake inventories.

**Human capacity:** Three countries (Guinea Bissau, Liberia, Sierra Leone) reported none or low capacity; four countries (Benin, Côte d'Ivoire, Guinea and Togo) indicated limited capacity, while only two (Ghana and Nigeria) indicated sufficient capacity to undertake forest inventories; even then, the sufficient capacity reported is more in conventional forest inventories than forest carbon/biomass assessment, hence, a huge capacity gap still exist that requires capacity development.

**Infrastructure/Equipment:** Three countries (Guinea, Liberia and Sierra Leone) indicated few or limited forest inventory equipment; three others (Benin, Côte d'Ivoire, Guinea Bissau) reported limited/obsolete equipment, while only three countries (Ghana, Nigeria and Togo) indicated sufficient equipment. Countries that indicated sufficient equipment have recently benefited from projects, including, the Forest Preservation Programme in Ghana, the GIZ national Forest Inventory in Togo, and the UN REDD Programme in Nigeria (equipped laboratory at Cross River State).

**Existing Inventories, PSPs and Variables measured:** Most historical inventories reported only considered a few parameters (mostly dbh and to a lesser extent tree heights), and the main variable estimated was tree volumes. However, some recent inventories (e.g. in Guinea, Guinea

Bissau, Ghana, Sierra Leone, Togo and Nigeria) included biomass estimation but not for all carbon pools; and none, except for Ghana, included data collection for wood density determination, soil organic carbon estimation, and for the development of country-specific allometric equations.

**Data management and Archiving:** is still an issue given that only one country (Ghana) provided a comprehensive system for data management and archiving. Nigeria has a Forest Information System (FIS), but was not captured in the questionnaire. The ProREDD Project in Togo intends to produce a database for the inventory.

**Quality Assurance/Quality Control (QA/QC)** is not undertaken (or not reported) by 6 countries. Côte d'Ivoire and Sierra Leone made mention of QA/QC, while only Ghana provided a detailed description of QA/QC system.

The capacities for NFI as summarized in terms of available infrastructures, data availability, level of expertise, materials and equipment, and level of training is presented on radar diagram below.

The chart indicates that Togo, Ghana, Nigeria, and Côte d'Ivoire have average/intermediate capacities (1.8-2.4), while the other countries (Guinea, Guinea Bissau, Benin, Liberia and Sierra Leone) have low capacities (1.2-1.6). Countries with capacities in NFI have benefited from some projects, including the Forest Preservation Project (FPP: JICA funded) in Ghana (which led to the production of country-specific allometric equations and partial wood density data); the on-going GIZ funded project in Togo, and the UN REDD Programme in Nigeria (forest carbon inventory undertaken at Cross-River State), and Côte d'Ivoire (planning work for pre-inventory for carbon assessment within UN-REDD Programme).

Overall, the capacity level of the countries can be considered low, as almost all are still reporting at Tier 1 level.

These results still reflect the situation in 2005 (Marklund and Schoene, 2005), in 2009 (Harold, 2009: 77 countries out of 99), and most recently by Romijn *et al* (2015), where most non-Annex 1 countries continue to rely on stem volumes and conversion factors (BEFs, VEFs, IPCC default values) to estimate above ground biomass and below-ground (using shoot-root ratios). According to Romijn *et al*.(2015) overall progress is still rudimentary, with 84 out of 99 countries still

reporting at Tier 1 level, and as such may incur uncertainties as high as  $\pm 70\%$  (Meridian Institute, 2009). Harold (2009) found that only 11 countries out of 99 reported country-specific conversion factors and only 12 reported for soil carbon.

National Forest Inventories are expensive activities and carbon/biomass inventories are even more costly and technically demanding for individual and (small-size) countries to undertake. LTS (2008) reported very high costs per hectare for the implementation of forest monitoring systems in countries with small forest areas, citing amongst others, Ghana, Liberia, and Sierra Leone, as well as other neighbouring countries. LTS recommended that small West African nations could benefit from a partnership amongst themselves, and thus save costs in both remote sensing and forest inventories. In general small countries could partner with each other to establish regional (shared regional capacity) rather than national capacity, especially in remote sensing, not only for cost savings, but could also lead to standardization of methodologies for carbon accounting and reporting, facilitating a regional rather than national integration with carbon markets, and perhaps reducing transaction costs.

### **Remote Sensing / GIS**

**Institutional arrangements:** Six countries (Benin, Ghana, Guinea, Liberia, Nigeria and Sierra Leone) have mandated institutions to undertake satellite land monitoring systems, and several others that work together with mandated ones; while Côte d'Ivoire, Guinea Bissau, and Togo have remote sensing and GIS institutions without government mandates. In general, there are more institutions involved in remote sensing and GIS than in forest inventories.

### **Human Capacity**

- The 6 countries with RS/GIS skills also have good infrastructure (7 countries, including Guinea Bissau, though with limited capacity).
- Also the six countries with sufficient RS/GIS capacity, 3 (Côte d'Ivoire, Ghana and Nigeria) have sufficient capacity to undertake satellite image processing and interpretation, and 3 others (Benin, Guinea and Togo) have limited capacity, while Liberia, Guinea Bissau and Sierra Leone have low to limited capacities. (see table below).

	Remote Sensing/GIS Capacity			
		Low to Limited	Limited	Sufficient
<b>Image processing Capacity</b>	<b>Low to limited</b>	Guinea Bissau, Sierra Leone	Liberia	
	<b>Limited</b>			Benin, Guinea, Togo
	<b>Sufficient</b>			Côte d'Ivoire, Ghana, Nigeria

As for NFIs, those countries with sufficient capacities have benefitted from funded projects like GEOFORAFRI (Benin, Côte d'Ivoire, Togo), Project IGN-AFD (Benin and Côte d'Ivoire), FPP (Ghana) and UN-REDD Programme (Nigeria). Côte d'Ivoire has a number of institutions undertaking RS/GI and various States in Nigeria have RS/GIS units while State and Federal Universities have RS/GIS units. A Space Agency NASRDA also exist in Nigeria with satellites in Orbit. It is worth mentioning here that USAID funded trend studies in West Africa were completely missed by all countries. It is not clear why, given the regional coverage of this study. National institutions were involved in this project.

- Furthermore, the three countries with sufficient image analysis skills and good infrastructure (Côte d'Ivoire, Ghana and Nigeria) also indicated adequate internet downloading capabilities for satellite imagery, while the remaining 6 countries had downloading problems.
- The generation of land use change (activity) data is important for NFMS and FRELS for countries implementing REDD+. However, most countries have not undertaken any “wall-to-wall” studies to generate transition matrices for land use changes. A good example of a study that could provide “wall-to-wall” information is the USAID funded trend studies supposed to have ended in June 2016; which unfortunately, no country made mention of it in the questionnaires.

- **Financial autonomy** is a very deficient/lacking in most countries (6 for RS/GIS) with complete or partial reliance on Government or external funding; with a few institutions depending on contractual services to generate funds.
- **Data management and archiving** is a critical issue with only 2-3 countries (33%: Ghana, Nigeria and Côte d'Ivoire) reported some data management efforts, while 6 countries reported none. Ghana has a more elaborate data management and archiving system.
- **Quality Assurance/Quality Control (QA/QC):** There is a critical gap in quality assurance and control (QA/QC) with basically only one country (Ghana) describing an elaborate QA/QC system.

The capacity needs in satellite land monitoring systems have been summarized in the radar diagram below; which indicates that on the average, Ghana and Nigeria have good capacities; Côte d'Ivoire, Benin and Togo have intermediate capacities, while Guinea Bissau, Guinea, Liberia and Sierra Leone have low capacities.

## GHG Inventory

### Institutional Arrangements

Almost all countries (8 out of 9), except for Guinea Bissau have climate change units and focal points for production of GHG Inventory for National Communications. However, only 3 of the 9 countries (Benin: Ghana, and Nigeria) reported the existence of legally mandated institutions specifically responsible for GHG Inventory for the LULUCF sector. In the other countries, the climate change units exist, and depend directly on ad-hoc recruitment/contractual arrangements for the compilation of GHG Inventory data for all sectors, including LULUCF.

Given that GHG Inventory for LULUCF lends from NFI and RS/GIS units, it seems apparent that countries with these institutions work directly with Climate change units, and governments may not see the need for creating separate units for GHG Inventory units for LULUCF; but can work with technically capable institutions to undertake the tasks. For example Benin indicated that DGFRN as responsible agency for GHG inventory for the LULUCF works with ONAB, CERF and CENATEL for NFI data compilation, and CENATEL with IGN, UNSST for RS/GIS data. In Ghana EPA

works with RMSC (Technical Lead for GHG Inventory for the LULUCF/AFOLU) and CCU works with FSD for NFI and CERGIS for RS/GIS etc..

**Human Capacity:** GHG Inventory Units (or Climate change units) have few staffs dedicated to managerial duties (Directors, Deputy Directors...), and no permanent staffs with expertise for compiling GHG inventories. There is therefore some reliance on contractual arrangements from experts from various ministerial departments or external consultants. For example, Benin reported no permanent staffs; while in Côte d'Ivoire, the Climate Change Unit (BCC) hires consultants on *ad-hoc* basis; and in Guinea there are few staffs drawn from various institutions, while Guinea Bissau indicated that few staffs exist.

**Infrastructure:** Infrastructure is either none existent (or not mentioned) [Benin, Togo, Guinea, Liberia], low/few (Nigeria, Ghana, Sierra Leone, Côte d'Ivoire, Guinea Bissau). The lack of infrastructure may be linked to the fact that GHG inventory for the LULUCF is part of a wider GHG Inventory for NC and staffs appointed to head the units are Government based in ministerial departments with no specific structures for GHG.

**Data Management and Archiving:** Virtually no data management and archiving system exist for GHG data in all countries (except for Ghana). This is probably linked to dependence of the GHG units on expertise elsewhere to provide data on ad-hoc basis through contractual services.

**Quality Assurance/Quality Control (QA/QC)** is not undertaken (or reported) by almost all the countries except Ghana.

The capacity needs for GHG Inventories for the LULUCF sector, as summarized in the radar diagram below; indicates that, except for Ghana, and to some extent Nigeria, all countries have low capacities for compiling GHG inventories for the LULUCF sector. All countries depend on external funding (e.g GEF) and external implementing Agencies (e.g. UNDP for Ghana, Nigeria, Liberia, Guinea Bissau, and Guinea) and UNEP (e.g. Liberia and Côte d'Ivoire) for production of their National Communications.

The lack human capacity, infrastructure and financial autonomy raise concerns about the sustainability of the institutions in general, and for GHG Inventory reporting to UNFCCC. In fact,

except for Ghana, all countries have low capacities for compiling GHG Inventory data for LULUCF. There is need to capacity building and for measures to insure sustainability for UNFCCC reporting. Probably, the on-going project on GHG Inventory for some West African countries seeks to address these issues of sustainability.

### ***Forest Reference Emissions Levels/Forest Reference Levels (FREL/FRL)***

Generally countries of the region have not yet initiated or undertaken the development of Forest Reference (emissions) levels/Forest Reference levels (FREL/FRL). No analyses of historical remote sensing data have been done, nor has the scope and scale of the FREL/FRL for different countries been; and few countries have crafted their national forest definitions within the framework of REDD+.

While Ghana, Liberia and Nigeria have initiated activities towards establishment of FREL/FRL, Ghana and Liberia depend on external consultants (e.g. Winrock International and Conservation International for Liberia), and Indufor for Ghana. Nigeria recently held a workshop to draft a sub-national FREL/DFRL at Cross-River State, with support from UN-REDD Programme, and reliance on nationals. Liberia undertook a workshop that led to crafting of their forest definition, and Côte d'Ivoire also had training workshop on FREL/FRLs. In general, technical capacity is low and there is urgent need to organize training workshops on the establishment of FRELs/FRLs destined to decision makers and technical staffs involved in the implementation of REDD+ mechanism.

## **Summary Conclusions and Recommendations**

### **Conclusions**

#### **As regards NFI**

1. Human capacity building is low to average, with available capacity mostly in conventional forest inventories for volume estimation, and not for biomass estimation. The huge capacity gap can be filled through the organization of regional capacity building training workshops on biomass assessment and data analysis

2. Countries continue to report at **Tier 1** using defaults IPCC values, and inventories do not include aspects of wood density determination and development of allometric equations. Capacity building is also needed in these areas.

### **Concerning satellite land monitoring systems/RS/GIS**

1. Existing human capacity in countries is more on remote sensing and less on image processing and interpretation for land use change studies.
2. Internet downloading capabilities for satellite imagery are problematic for most countries. There is a need for a centralized downloading facility that can serve many countries. This problem was also raised in the LULC study funded by USAID West Africa.
3. “**Wall-to-wall**” work is lacking in the countries and different classification systems have been used within countries and across countries. There is a need for harmonization/standardization of methodologies within and across the region

### **GHG for LULUCF Sector**

1. 8 out of the 9 countries have climate change units and focal points, but the few permanent staffs in the units are dedicated to undertaking GHG in the LULUCF sector. The units depend on expertise from various ministerial departments and consultants
2. Human capacity and infrastructure are lacking: permanent staffs undertake mainly managerial duties (directors, sub-directors..), hence technical work rely on contractual arrangements with experts from various ministerial departments and consultants
3. The lack of human, infrastructural and financial autonomy, and dependence on external funding, raises the problem of sustainability of GHG inventories for national communications and reporting by countries. [some of these issues are being handled within the *UNFCCC West Africa Capacity Development Project*]



**Forest Reference Emissions Levels/Forest Reference Levels (FRELs/FRLs)**

Generally countries in the West African region have not initiated or undertaken any development of FRELs/FRLs.

No analyses of historical remote sensing data have been done, nor has the scope and scale of the FREL/FRL for different countries been undertaken; and few countries have crafted their national forest definitions within the framework of REDD+.

While Ghana, Liberia and Nigeria have initiated activities towards establishment of FREL/FRL, Ghana and Liberia depend on external consultants. In general, technical capacity is low and there is urgent need to organize training workshops on the establishment of FRELs/FRLs destined to decision makers and technical staffs involved in the implementation of REDD+ mechanism.

There is therefore an urgent need to undertake capacity building on the development of FRELs/FRLs in the sub-region.

## Regional Recommendations

With the exception of Côte d'Ivoire, Ghana, Nigeria and Togo, West Africa countries covered by this assessment of capacity are lagging in the preparation for the implementation of the REDD + mechanism. Some regional initiatives could be undertaken (*subject to availability of funds*) to meet the major needs for an operational, robust and reliable NFMS. The following, non-exhaustive list of actions could be undertaken to strengthen regional capacity in West Africa:

- Development of a regional training portfolio (training modules) on various REDD+ MRV topics for all countries; development of action plans for the operational NFMS over the long term (all countries) and support to the development of national strategies REDD + ;
- Creation and strengthening of a regional network of experts on the monitoring of forests and the estimation of forest carbon stocks to improve data sharing as well as the coordination and technical exchanges on practices and methods relating to NFMS and MRV;
- Development of a regional programme for strengthening regional collaboration and harmonization of methodologies for satellite image processing and analysis for monitoring forest cover and land use changes;
- Development of a regional programme for the operationalization of a regional network of permanent sample plots (including identifications and remeasurements of existing ones, installation of new plots, collection, centralization and analysis data, etc.) in order to assess evolution of forest stands and to estimate emission factors in different forest/land use types in West Africa.
- Strengthening the regional research centre (for example, CILLS/AGRHYMET (Niamey, Niger) to support countries in the development of NFMS in West Africa, animate the regional network of experts to support regional collaboration and the exchange of experience among countries, manage the regional network of permanent sample

plots in collaboration with the forest directors and other research centres, strengthen coordination and the collection of existing data develop a regional database for estimation of forest biomass, facilitate data sharing between institutions holders of data-sharing agreements and available free of charge existing data through a data sharing platform.

## Chapter 1: Introduction

Within the global context to combat climate change resulting from anthropogenic emissions of greenhouse gases (GHG), Parties to the UN Framework Convention on Climate Change (UNFCCC) approved the Climate change agreement in Paris during the 21<sup>th</sup> Conference of Parties (COP21) held in December 2015. The Paris agreement, in addition to confirming the previous decisions, recognizes explicitly the role of forests in combating climate change, and also encourages Parties, notably through results-based payments, to implement activities related to the Reduction of Emissions caused by Deforestation and Degradation of forests (REDD), conservation of forests, sustainable management of forests and enhancement of forest carbon stocks (known by the acronym REDD +).

In order to participate in the REDD + mechanism, countries must respect the "Warsaw Framework" (COP 19, 2013), a results-based framework. Countries are required, amongst others, to develop *national forest monitoring systems* (NFMS) for *monitoring, measurement, reporting and Verification* (MRV), as well as forest reference levels to serve as benchmarks for performance-based monitoring of REDD+ activities. NFMS is used by countries for reporting to the UNFCCC on the performance of policies and measures (PAMs) relating to REDD+ in terms of emissions and removals of GHGs.

With a view to maximize impact and improve the efficiency and focus of support to national REDD+ readiness, the UN-REDD Programme issued a call for proposals to support countries to undertake country needs assessments (CNA). As part of the *Support to National REDD+ Action - Global Programme Framework 2011-2015* (SNA), the CNA focused on identifying country or regional needs, and capacities and opportunities to complete REDD+ readiness as well as on enhancing coordination of support from different sources. Regional needs assessments was also envisaged in order to maximize synergies among countries' readiness processes, enhance south-south cooperation, serve as a means for better understanding of existing capacities in the region, and to leverage REDD+ readiness at regional level in a cost-effective manner.

In response to the call, nine West African countries (Benin, Côte d'Ivoire, Ghana, Guinea, Guinea Bissau, Liberia, Nigeria, Sierra Leone and Togo) opted for a regional approach for the aforementioned reasons and in order to jointly address capacity needs for some critical cross-cutting REDD+ issues common to them, but in which they differ in their levels of achievement. Most of these countries currently lack reliable data and human, technical and financial capacities to implement and operationalize national forest monitoring systems capable of responding to the requirements of the UNFCCC.

The purpose of the needs assessment was to determine the levels or stages at which these countries have reached in the development of their REDD+ Readiness process with regards forest monitoring, MRV and Reference Levels, and to identify various (institutional, technical and financial) challenges they encounter. The assessment is limited these aspects which are amongst the key REDD+ Readiness activities in the Cancun Agreement as well as in the Warsaw Framework for REDD+, and which are cross-cutting in the West African Region.

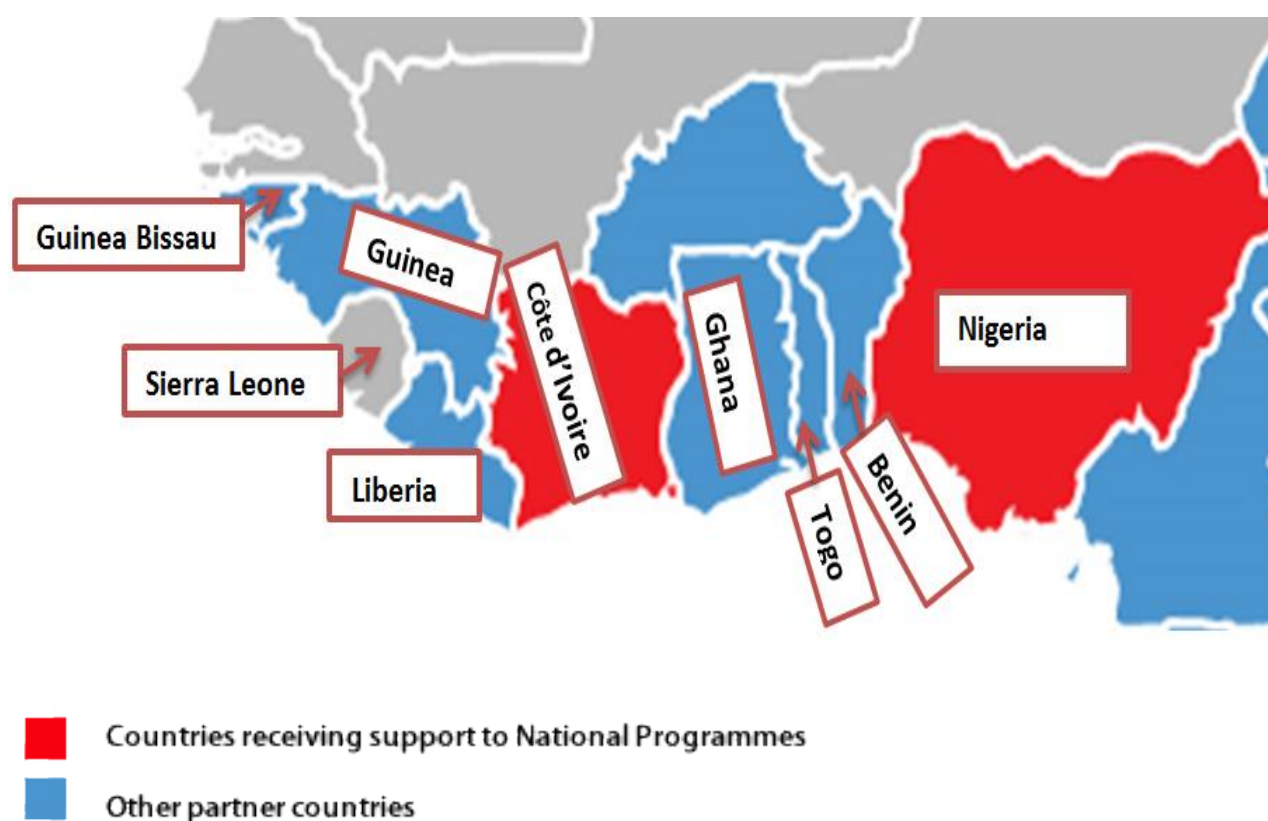
The assessment was conducted through questionnaires and surveys of national institutions in the countries of West Africa with skills in remote sensing and geographic information system (GIS), as well as forest inventories. The questionnaires relating to the three technical pillars of NFMS (i.e. Satellite Land Monitoring System (SLMS), National forest inventory (NFI), and Greenhouse Gas (GHG) inventory), and Forest Reference (emission) Levels (FRELs) were developed by UN-REDD Programme team, validated during an Inception Workshop by national experts, who later on administered them for data collection in their respective countries. Field visits were undertaken in some countries to collate further information.

This report presents a synthesis of the completed questionnaires and information collected during country visits. It provides an overview on existing national capacities and the needs of the countries for the development of national forest monitoring system and forest reference levels<sup>1</sup>.

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<sup>1</sup> Readers are advised that the results may not be exhaustive of the existing capacities and needs, as they are based mostly on the information drawn from the questionnaires provided by national Experts. While Country Reports are available, the study was not meant to be a country needs assessment for 9 countries independently.

Countries considered in the assessment fall within the Guinean Forest of West Africa which stretches from Guinea and Sierra Leone eastwards to the Sanaga River in Cameroon; and has been classified amongst the 25 hotspots for biodiversity conservation. Forests contains about 1800 endemic plant species, 67 endemic mammal species, 75 endemic birds, 52 endemic reptiles, 85 endemic amphibians and 143 endemic freshwater fishes. Forests here constitute a main source of wood energy, construction poles, round wood and export timbers for a population for over 234 million inhabitants. Presently forests and woodlands in West Africa cover a total surface area of about 72.1 million ha and about 27.7 million ha of protected areas.



Countries involved in CNA in West Africa include: Six (06) UN REDD Partner Countries (Benin, Ghana, Guinea, Guinea Bissau, Liberia and Togo), Two (02) UN REDD NP Countries (Nigeria and Côte d'Ivoire), and One (01) non UN REDD Partner Country (Sierra Leone)

In response to the UN REDD Programme CNA call, 9 West African countries opted for a regional needs assessment in order to jointly address their capacity needs in some critical cross-cutting REDD+ areas common to them, but in which they differ in their capacity needs (e.g. their technical capacities to accurately monitor forests carbon stocks & stock changes, and to establish Reference emission levels).

Regional needs assessments could help to maximize synergies among countries' readiness processes, enhance south-south cooperation and knowledge exchange, and leverage REDD+ readiness at regional level in a cost-effective manner.

## Objectives

To determine the levels at which Partner Countries in West Africa (ECOWAS region) have reached in the formulation/development of their National REDD+ Forest Monitoring and Reference Levels, and to identify institutional and technical challenges in order to better plan/tailor regional capacity building programs for forest monitoring and reference levels.

## Expected Results

- Improved and enhanced understanding of national and/or regional REDD+ capacities and needs in forest monitoring & Reference Levels.
- Capacity building Training materials on NFMS and RELs developed based on needs identified.

## Chapter 2: CNA Methodology

Data collection was undertaken using questionnaire which was drafted and validated by countries during inception workshop in August 2015, attended by National Experts. The questionnaire was structured according to three technical pillars of MRV (SLMS, NFI & GHG\_I) and one on Forest Reference Levels. In total there were **56** questions (main and sub questions) for NFI, **28** questions for Remote Sensing/GIS, **27** questions for GHG Inventory, and **23** questions for FRELs/FRLs. The validated questionnaire administered in countries by National Experts in collaboration with needs assessment consultant and UN REDD Forestry Officer at FAO Regional

Office for Africa (FAORAF) in Ghana in September 2015. The completed questionnaires sent to FAO Regional Office for Africa (FAORAF) for preliminary analysis by Consultant and Forestry Officer and drafting of country reports. Field visits were undertaken by the Consultant to some countries for further in depth information.

Results of the study were presented in a descriptive manner following a number of criteria, including, availability of infrastructure, data availability, level of technical expertise, logistics and equipment and level of training. For each of the technical pillars (**FI, SLMS, GHG\_I, & FREL/FRL**) capacity needs were summarized using 5 criteria above which were coded at 3 levels noted 1 to 3:

**1: Low capacity** → Expertise, systems and tools do not exist and/or are not well developed or used regularly

**2: Average capacity** → Human and/or technical capacity exists but does not correspond to the real needs for FMS and FREL, and an update and/or enhancement of the existing capacities is needed;

**3: high/advanced capacity** → adequate capacity is available and can be used with minimal updating and/or additional training.

The coded results were finally presented in form of radar charts.

## Chapter 3: Regional Overview

### 3.1. Understanding of REDD + mechanism and the MRV System

In general, the understanding of REDD + and MRV themes remains low in West Africa, although trends exist varying from one country to the other. Countries with a relatively good understanding of REDD + mechanism are those that have benefited from awareness-raising campaigns in the preparation of REDD+ programs (e.g. the UN-REDD Programme and the FCPF (*Forest Carbon Partnership Fund*) of the World Bank). Thus, amongst the most advanced in terms of understanding of REDD + mechanism in general, and the MRV are Nigeria and Côte d'Ivoire



(implementing National UN-REDD Programmes and FCPF), Ghana, Liberia, and Togo (implementing FCPFs), have some level of understanding of REDD+ mechanism and MRV. Conversely, countries non-beneficiaries of REDD+ Programmes (e.g. Benin, Guinea, Guinea Bissau, and Sierra Leone) have little understanding of REDD+ mechanism, and therefore have some delay in REDD + readiness preparation.

Although countries like Ghana, Ivory Coast, Liberia, Nigeria and Togo have already benefited from awareness campaigns on REDD+ under UN-REDD and FCPF programmes, the understanding of the terms REDD + and MRV remains marginal in West Africa. In most cases, knowledge and understanding has been centralized and limited to government technical staffs in forestry and some non-governmental organizations and civil society organizations who participated in the awareness raising/training sessions.

Generally, the understanding of climate change and REDD+ themes is still low amongst politicians and the general public. Consequently, it appears that the leading politicians and stakeholders do not understand neither the principles of REDD+ mitigation mechanism, nor its usefulness, and are therefore not well prepared to assist their countries in setting up sound national REDD+ strategies.

### *Recommendations/Proposed Actions*

In order to address these shortcomings and strengthen the understanding and involvement of all stakeholders concerned with the REDD+ mechanism, further national campaigns for awareness raising and training on REDD + in general and MRV topics in particular need to be undertaken, particularly in countries that have not yet developed their R-PP documents for REDD+. These campaigns will ensure that key stakeholders have a clear understanding of the implications of REDD+ mitigation mechanism and conscious of the importance of NFMS for their countries.

Awareness and training sessions should allow the main stakeholders (politicians, executives and technicians from governmental and non-governmental structures NGOs, civil society organizations, private sector, local communities, etc.) to understand the theoretical and technical foundations of REDD + mitigation mechanism, and of the NFMS and the implications of forest

monitoring and MRV system and the requirements to progress from the current situation to an operational NFMS.

### 3.2. Institutional arrangements

The absence of institutional anchorage within a legal framework would mean that institutional arrangements could remain highly dependent on the political situation of the government and of the hierarchical structure established at the time of its implementation and will therefore be transitional in nature. Consequently, the sustainability of achievements could be compromised by a Government reshufflements and the changes that this could entail in terms of political and organizational orientation.

However, a clear assignment of roles and responsibilities to the most appropriate institutions, made through legal political decisions can help root the adoption and respect of engagements, and will ensure future continuity even following government and/or political changes in a country.

The establishment of institutional arrangements, including clear definitions of roles and responsibilities of different actors, the definition of lines of communication between the various structures/institutions as well as the clarification of the financial arrangements, is essential in order to develop a sustainable national system for forest monitoring.

In general, most countries in West Africa (except Ghana) do not yet have clear institutional arrangements for operationalizing NFMS; and this could affect their long-term commitment of countries to implement the REDD+ mitigation mechanism and the development of an effective and sustainable NFMS.

While countries like Côte d'Ivoire, Ghana, Liberia, Nigeria and Togo have validated their R-PP (*Readiness Preparation Proposal*) documents in which opportunities for institutional arrangements for the REDD+ activities MRV system are suggested; other countries (Benin, Guinea, Guinea Bissau and Sierra Leone) have no R-PP documents and nothing is currently envisaged to initiate the process. Even then, without legal backing through legislature, the institutional arrangements in the validated R-PPs may not be considered effective.

### *Recommendations and Proposed Actions*

One crucial step in the development of a NFMS should be to officially promulgate institutional arrangements related to the NFMS and REDD+. This will require a sustainable and valid policy decision within the national legal/judiciary system, the identification/establishment of institutions that will be responsible for the NFMS and clarification of working relationships and how information exchange will be undertaken, and to determine how the various stakeholders will act or interact. This process will require a close consultation and coordination with all stakeholders at the national level, consultations that could be carried out during the workshops and awareness training on REDD+ and MRV mentioned above.

Depending on national circumstances and the status of the various countries, several priority actions can be undertaken to enact institutional arrangements related to REDD+ and NFMS:

- Establishment of a stable legal framework for REDD+ mitigation mechanism and NFMS, including its mainstreaming within the most important national development strategy documents, and which will represent the political commitment of the countries towards the adoption of the decisions of the UNFCCC
- Formal allocation of structures and staff responsibilities: identifying the most appropriate structures/institutions for the development of NFMS and assigning them duties and responsibilities.
- Stability and continuity of institutional arrangements - ensuring that assigned responsibilities will persist despite political changes and possible reorganization of departments and structures upon which they depend.
- Preparation to the REDD+ (R-PP) documents, national REDD+ strategies and action plans for the implementation of NFMS (recruitment of experts, awareness-raising of stakeholders, national consultations, etc.).

## Chapter 4. Satellite Land Monitoring System (SLMS)

In the context of REDD + and the GHG\_I for the land use land use change and forestry (LULUCF), the SLMS is used to collect activity data (AD), i.e. data on land use changes, including changes in forest cover due to human/anthropogenic activities. This is undertaken through the use of remote sensing to assess changes in forest area and historical trends of forest areas using archived satellite imagery. The use of remote sensing also allows the reduction of the amount and therefore the cost of ground-based measurements needed to assess the evolution of forest areas or any other land use.

The questionnaire addressed a number of aspects that are summarized below (**see details in Appendix**):

### 4.1. Institutional Arrangements:

Six out of the 9 countries (67%) have lead institutions mandated to undertake remote sensing/GIS (CENATEL for Benin, RMSC for Ghana, DNEF, BCTT for Guinea, LISGIS for Liberia, NASRDA for Nigeria, and the Meteorological Department for Sierra Leone). Côte d'Ivoire has several institutions (e.g. CCT, BNETD/CTC, CURAT..) undertaking Remote Sensing/GIS activities but indicated that none is legally mandated by the government. RPP for Côte d'Ivoire indicates that the REDD+/MRV unit will be in charge in collaboration with BNETD/CTC. Togo also has several institutions (e.g. ANGEL, FDD, DE, FADOS, DGC, LBEV, UL and NGOs) that will be coordinated by FEDOS under Order No. 94/MERF. Guinea Bissau has no legal institution responsible for Remote Sensing/GIS, but DGFF of MARD and DGDD of EES have coupled efforts to undertake RS/GIS in partnership with AMESD project, and support from AGRHYMET (hosted by SEE).

### 4.2. Institutional Functioning

Most lead institutions work collaboratively with other institutions to complement efforts (e.g. in Ghana RMSC works in collaboration with CERGIS, EPA and the Climate change unit (CCU); in Guinea DNEF, BCTT works with WARMEY, CERE and IG; IGN in Benin; In Liberia LISGIS works with FDA's Remote Sensing & GIS Unit). In Benin, GEOFORAFRI Project has created a Land Surveillance

and Monitoring System (UNSST) within the DGFRN; however, roles and responsibilities of CENATEL and UNSST need to be clarified. In Nigeria, NASRDA works with the National Centre for Remote sensing (NCRS), JOS and the Centre for Space Science & technology (CSSTE), ILE-IFE also mandated by decree; as well as the Forestry Geographic Information System (FGIS) Unit of the Federal ministry of Environment, and the RS/GIS at the Cross-River State<sup>2</sup>.

#### 4.3. Financial Autonomy

Most countries (Benin, Liberia, Guinea, Guinea Bissau, Sierra Leone, and Togo) indicated that the institutions lack financial autonomy and completely or partially depend on government support for functioning. Subventions from government are usually insufficient. For example, CENATEL in Benin depends on government financial support which is insufficient; In Côte d'Ivoire BNETD/CCT has financial autonomy, CURAT depends on University budget, CSRS depends on funds from Swiss and Ivorian governments, and IGT is partly autonomous, and partly dependent on university budget. In Ghana, RMSC, CCU and EPA receive support from the government (salaries, office space..) but depend on donor support for RS and GIS tasks(e.g. FCPF and CIF funds for CCU and RMSC; and GEF for EPA for NC). CERGIS generates their own funds from contractual services and some donor-driven; so is autonomous. In Nigeria NASRDA and FDIS receive Federal government financial allocations, while the CRS RS/GIS lab has received support from UN REDD Programme. NASRDA own a satellite system (NigeriaSat).

#### 4.4. Human Capacity

Except for Guinea Bissau, Liberia and Sierra Leone, most (6 out of 9) countries stated the existence of sufficient staff in the area of Remote Sensing and GIS. Côte d'Ivoire has well trained staff in its several RS/GIS institutions (BNETD/CCT, CURAT,..); in Ghana, RMSC, CERGIS and EPA indicates they have qualified RS/GIS experts; NASRDA in Nigeria has highly qualified (PhDs, MSCs..) staff in RS/GIS. Benin and Togo, have through the GEOFORAFRI Project received training and strengthened RS/GIS capacities in the RS/GIS units in their countries. UN REDD Programme

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<sup>2</sup> Nigeria has many RS/GIS units in different States and in University Institutions that was not address in this assessment. Hence, we expect to have several such institutions whose roles and responsibilities are not coordinated by the Federal Government.

in Nigeria and Côte d'Ivoire is also providing capacity building trainings in Remote Sensing and GIS.

#### 4.5. Available data/Information

Some countries reported the existence of satellite images (Landsat images, SPOT, MODIS, ASTER,..) and vegetation and land cover maps. For example, Benin reports the availability of about 3282 Landsat scenes (Landsat 4, Landsat5, Landsat 7 and Landsat 8) at CENATEL supplied by the Directorate General for Climate Change (DGEC); covering the period 1990-2014. Côte d'Ivoire indicates the availability of vegetation maps at 1:500 000 and 1:2000 000 from ORSTOM and land cover maps at 1:200 000 at BNETD/CCT. Guinea Bissau obtained land cover maps from CARBOVEG project.

#### 4.6. Infrastructure/equipment/Laboratories

Apart from Liberia and Sierra Leone, most countries reported the existence of adequate equipment for image analysis and processing. Benin and Togo have benefited from the GEOFORAFRI Project (and IMIS Project of ITTO for Togo) to equip their RS/GIS labs with hardware and software, including Desktop computers/workstations, UPSs, A0 plotters, printers, scanners, GPSs, GIS software (Erdas Imagine, ENVI, ArcGIS licences, Anti-Virus ..), QGIS, and satellite imagery (Landsat, Spot, RapidEye..). In Guinea Bissau the RS/GIS lab at MARD/SEE has been equipped by the AMESD Project, with an installed system for reception, processing of satellite imagery, and others from UNDP Project (3 computers, A0 Plotter, scanner, printer, 5 GPSs, PDA, ArcGIS 10); IBAP has a lab equipped with 4 workstations, plotter, printer, scanner, A0 plotter, several GPS, ArcView and ArcGIS licences). However, Guinea Bissau lacks staff (at MARD/SEE) to use these equipment. Guinea indicates that BCTT has computers, GIS software and various types of satellite imagery (Landsat, SPOT, MODIS, ASTER images), but lacks software for image processing. WARMY has computers, printers, GPSs, scanners, plotters and a reception station and image processing facilities from AMESD Project, and SPOT 4 imagery. NASRDA (in Nigeria) has over 20 computers/laptops, A0 plotter, satellite imagery (Landsat, SPOT, NigeriaSat), and software, including open software (QGIS, ILWIS). Cross River State Forest Commission RS/GIS lab has been equipped with hardware and software through the UN REDD programme. The FDIS is also equipped with .... Unfortunately details of equipment from NCRS, Jos and CSSTE, Ife were

not provided. Côte d'Ivoire probably has RS/GIS labs well equipped with hardware and software. For example, BNTD/CCT has 12 workstations, aircraft for aerial photographs, ArcGIS (4) and Erdas Imagine (4) licences, Microstation, Landsat, SPOT, GeoEye, Quickbird images, Pro 600, LPS, ORIMA, COVADIS, CURAT has 26 Workstations and EMUSAT reception station, ILWIS, ArcGIS and QGIS software and LandSat images; CSRS has a drone (eBee), RS/GIS with 24 Desktop computers, network printer and ArcGIS; IGT has 6 Laptops, ArcGIS 10.2, ENVI 4.8, QGIS, PCI and LandSat images.

#### 4.7. Awareness of free satellite imagery and open source GIS software

Five out of the nine countries (55.6%) indicated none awareness of free satellite imagery (Benin, Liberia, Guinea, Guinea Bissau, Sierra Leone). Côte d'Ivoire, Ghana, Nigeria, and Togo indicated good awareness of free satellite imagery: Landsat, Radar (by Côte d'Ivoire), Google Earth (Collect Earth) by Ghana. As regards open source software, Benin, Guinea, Guinea Bissau, Liberia and Sierra Leone indicated their none awareness, while Côte d'Ivoire, Ghana, Nigeria and Togo are aware of open source software, citing, QGIS, ILWIS, GRASS GIS, and OpenForis Collect Earth.

#### 4.8. Existence of internet download capabilities

Only Ghana, Côte d'Ivoire and Nigeria reported adequate internet downloading capabilities for satellite imagery. The remaining six countries either indicated the existence of internet facilities, but with insufficient bandwidth for downloading.

#### 4.9. Data management and archiving

Again, apart from Ghana, Côte d'Ivoire (BNETD/CCT), and Nigeria, the other countries do not have data management and archiving systems. Ghana has an elaborate data management system for storing both remote sensing and forest inventory data. In Nigeria, NASRDA has an archiving system at the ICT department as well as on a ground station facility. In Ghana the RMSCD of the RMSC of the FC hosts the main database / GIS server containing the national GIS information, forest inventory data. Workstations at RMSC are connected by Local Area Network (LAN) to the main database/ GIS servers. A back-up server has been placed at the Forestry Commission,

headquarters in Accra. There is also a web server which holds data accessible to all registered persons (web address: [www.fcforestinfo.gov.gh](http://www.fcforestinfo.gov.gh))

#### 4.10. Existence of studies on land use/land cover change

None of such studies indicated for Benin, Côte d'Ivoire?? and Sierra Leone. Change detection studies reported for Ghana (using historical Landsat TM/ETM+ (30 m), ALOS AVNIR (10m), DMC (22 m) and Lidar). 2014 Vegetation maps produced in Guinea using NDVI indices, but no mention of land use studies. Also four studies on land use classification in Guinea Bissau, need harmonisation of the classification system (no mention of change detection). Recent studies by GeoVille in Liberia, but no land use change study undertaken. Land use mapping undertaken in Togo within the ProREDD Project for NFI using RapidEye high resolution but no mention of land use change. Several land use change analysis undertaken in Nigeria, but not covering the entire country ("wall-to-wall"). Within-and between countries, there are differences in the classification systems used and hence a need to harmonize classification systems (both within and across countries in West Africa).

#### 4.11. Knowledge of image analysis/processing for land use change studies

Only Côte d'Ivoire, Ghana and Nigeria reported adequate knowledge in image analysis/processing. However, Benin and Togo have received training within GEOFOAFRI project to undertake image processing. Guinea, Guinea Bissau, Liberia, and Sierra Leone have limited or no skills in image analysis/processing.

#### 4.12. Approaches used in change detection Analysis:

Benin, Guinea, Guinea Bissau, Liberia and Togo provided no indication of approaches used. Côte d'Ivoire indicates the use of Approaches 1, 2 and 3, with no details provided. Some "wall-to-wall" studies have been undertaken in the past (Ref. BD GEO 200 (2005) 1969 Land occupation map). Ghana and Nigeria reported examples of land use change analysis using Approaches 1, 2, and 3.

#### 4.13. Quality Assurance / Quality Control (QA/QC)

Almost all the countries, except Ghana, and to a lesser extent, Côte d'Ivoire reported undertaking **QA/QC**.



### 3.14. Capacity Development Programs:

Almost all countries, except Ghana, indicated the non-existence of a capacity development programme. Ghana has recently developed SOPs (Standard Operations Procedures) for most activities related to **NFMS**.

An attempt to codify the results resulted in the following table and radar chart.

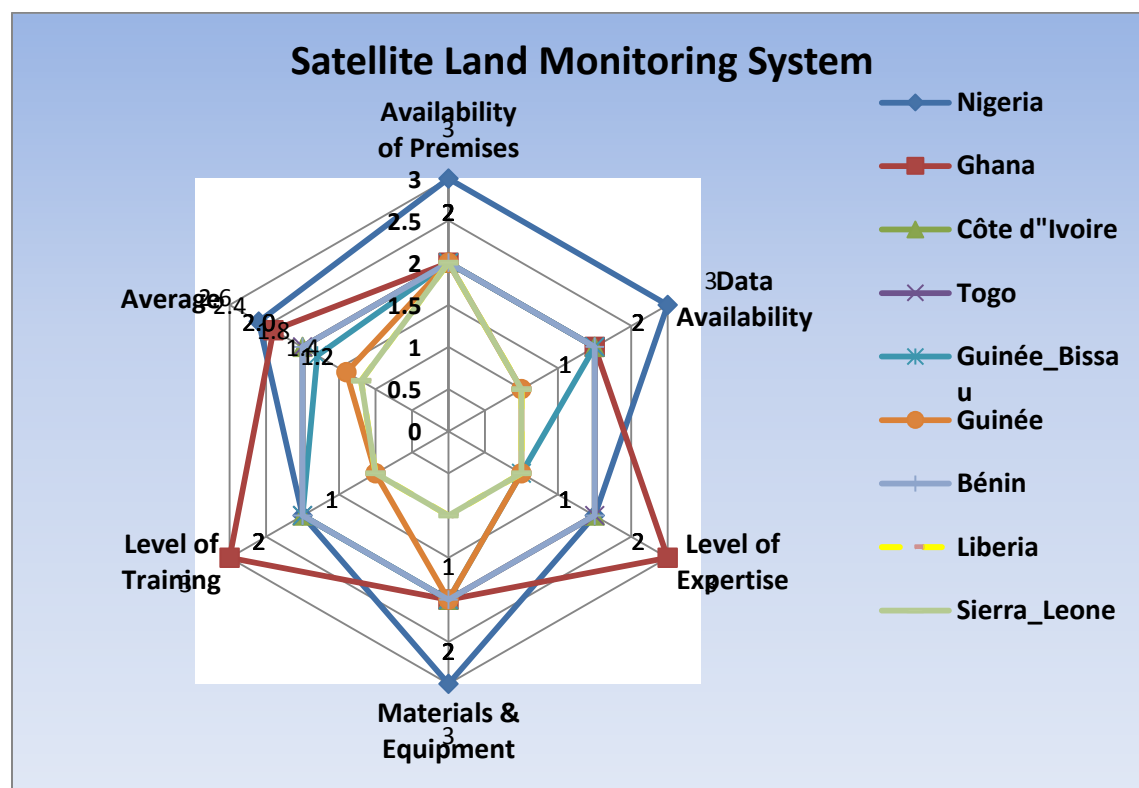


Figure 1. Radar Chart for Satellite Monitoring System Needs Assessment

Table 1: Coded Results for Satellite Monitoring System Needs assessment

SLMS	Nigeria	Ghana	Côte d'Ivoire	Togo	Guinée_Bissau	Guinée	Bénin	Liberia	Sierra_Leone
<i>Availability of Premises</i>	3	2	2	2	2	2	2	2	2
<i>Data Availability</i>	3	2	2	2	2	1	2	1	1
<i>Level of Expertise</i>	2	3	2	2	1	1	2	1	1
<i>Materials &amp; Equipment</i>	3	2	2	2	2	2	2	1	1
<i>Level of Training</i>	2	3	2	2	2	1	2	1	1
<i>Average</i>	2.6	2.4	2.0	2.0	1.8	1.4	2.0	1.2	1.2

In general, most countries have institutions, attached to ministerial departments, universities or research institutes, with competences in remote sensing (RS) and GIS, most often with more skills in GIS and mapping than in remote sensing and image processing. They were not however, specifically established to monitor land use change through analysis of satellite images, nor were their staffs trained for these purpose, hence there is a need for tailored training in this area in the context of REDD+ MRV.

However it is worth mentioning that, most recently, some countries, supported by programs or projects of capacity-building, now have national RS/GIS laboratories relatively well suited for monitoring of forest cover. This includes Togo, Benin and Côte d'Ivoire who currently benefited from GEOFORAFRI project (project on "Capacity-building and access to satellite data for the monitoring of forests in Africa").Guinea Bissau has also been recently supported by the CARBOVEG project, and has an equipped RS/GIS laboratory, even though trained staffs are lacking to use the equipment. Conversely, the availability of materials remains more elementary in Guinea, currently not benefiting from any external support. While computer hardware and software equipment are sometimes available, internet facilities are often limited, with random and slow connections that do not allow downloading of satellite images.

In general, the countries of the region lack centralized management systems and spatial data archiving. Agreements for data sharing between structures or institutions with spatial data are sporadic, while collaborations between institutions remain marginal.

### 3.15. Recommendations and Proposed Actions

This assessment indicates that human, technical and material capacity of countries of the region for the development of SLMS are low to moderate and, although national situations may differ, need to be strengthened.

In general, the capabilities exist in the region but do not correspond to the real needs for the development of operational SLMS, hence there is a need to formally established and properly

funded, structures/national institutions in charge of the monitoring of forests, consisting of personnel from the various national agencies with skills in GIS and RS, should benefit from a programme of capacity-building (equipment and training) with the objectives to assess changes in land use and especially monitoring of forest cover to estimate activity data and to be able to report the results of eventual REDD+ activities to the UNFCCC.

While specific country needs may differ, several priority actions should be considered:

- Setting up of technical working groups for SLMS;
- Promulgation of institutional arrangements (roles and mandates of structures, lines of communication, patterns of funding, etc.) for the implementation and SLMS operations;
- Creation of national RS/GIS laboratories and procurement of equipment
- Improvement of information sharing and complementarity between national structures with skills in GIS and RS as well as between any capacity strengthening programs;
- Collation and management of existing data in a centralized database to facilitate data sharing and use;
- Development of an action plan for the operationalization of SLMS.

## Chapter 5: National forest inventory

National forest inventory (NFI) is an indispensable tool for assessing national forest resources and planning their management in a sustainable way. Under REDD+, field measurements are needed to provide data for the estimation of forest carbon and carbon stock changes (Emission Factors: EF) and thus to estimate emissions and removals of GHGs associated with forests or more generally the LULUCF sector. Allometric equations and/or biomass expansion and conversion factors are used to convert field measurements into forest biomass and carbon stocks.

Results for NFI needs assessment are summarized below:

### 5.1. Institutional Arrangements:

Some countries have lead institutions mandated to undertake inventories, with legal backing (Acts/Policies) (e.g. RMSC in Ghana, FRA of FDF in Nigeria, FDA in Liberia, and NPAA in Sierra Leone); others have institutions responsible for NFI with no clear mandate or legal backing (e.g. DNEF in Guinea, DGFF in Guinea Bissau, DGFRN in Benin, SODEFOR in Côte d'Ivoire, and FEDOS and FDD in Togo).

### 5.2. Institutional Functioning

In some cases, there may be more than one institution with NFI capabilities. Under such circumstances, roles and responsibilities and/or lines of communications need to be clearly defined in order to avoid confusion/conflicts or duplications of efforts. In some cases (e.g. DGFRN in Benin is supported by ONAB, CENATEL and CERF), the lead institution may not have the full technical capacity and may resort to contractual arrangements with relevant institutions. Guinea Bissau also needs to legitimize institutions to undertake NFI (DGFF and IBAP). RMSC in Ghana works with FSD, FDA in Liberia undertakes NFI in collaboration with LISGIS and Dept., of Forestry; University of Liberia), while in Nigeria FDF works with State Forest Services/Departments and relevant academic institutions to undertake NF1's.

Where NFIs have been undertaken, there is a huge influence of external expertise linked to sources of funding and whether or not there is in-house (national) capacity. Hence, data sets or archives for the inventories may be lacking in-country.

### 5.3. Financial autonomy

The sustainability of institutions depends on their financial capacity. Almost all institutions, while legally mandated, either, lack financial autonomy and depend on government for subsidies or depend on external funding from projects to undertake forest inventories. For example, in Benin DGFRN has some financial autonomy but limited funds; SODEFOOR in Côte d'Ivoire; RMSC and FSD in Ghana receive government subsidies for routine work, but depend on donor support for inventory activities; FDA, University of Liberia also depend on government for funds.

### 5.4. Human capacity

There is a great variation in human capacity from one country to another, with limited or no capacity in NFI reported in Guinea Bissau, and where inventories have been undertaken by international experts/consultants, even at IBAP. Liberia indicates that FDA and LISGIS have no specialized staff in inventories, but a few exist at the Department of Forestry, University of Liberia; Sierra Leone states that they have insufficient staff at the newly created NPAA to undertake forest inventories); while Côte d'Ivoire indicates that they need capacity enhancement. Guinea indicates that existing capacity in forest inventory and data analysis is aging; while in Togo expertise is difficult to assess because no institution is mandated to undertake forest inventories. However, Togo is undertaking a National Forest Inventory funded by GIZ and this certainly involved capacity building. While Nigeria and Ghana reported the existence of sufficient staff to undertake inventories, only Ghana has provided some details on actual staffing at RMSC unit with NFI skills (12 staffs specialized in Forest Inventory/carbon assessment and forest mensuration). Nigeria simply stated that most of the technicians are found at State level.

Worth mentioning is the fact that even where human capacity is available for conventional NFI, there is still a high need for capacity building in forest biomass assessment. Countries with UN REDD Programmes and FCPF have initiated training on forest carbon inventory and data analysis

(e.g. UN REDD Programme in Nigeria..) and some projects as well (e.g. NFI in Togo by DFS; SOPs developed in Ghana within the FFP project), and there are also prospects within the Regional TS for West Africa to undertake capacity building in biomass assessment and data analysis (e.g. Regional Workshop in Ghana, 15-19 February 2016).

### 5.5. Infrastructure/Equipment/Laboratories

In addition to human capacity, equipment is needed and staff trained to use them to undertake forest carbon inventories. Some countries reported complete lack of forest inventory equipment (e.g. Guinea, Sierra Leone-not indicated), obsolete equipment (e.g. Benin), a few calipers and GPSs (e.g. Côte d'Ivoire – SODEFOR). Guinea Bissau indicates that the hypsometers, compasses, Suunto clinometers, soil augers etc. used by DGFF during inventory got missing afterwards. Only Nigeria (due to UN REDD Programme) and Togo (due to GIZ ProREDD Project) indicate the existence of sufficient modern equipment to undertake forest carbon inventories (about 7 out of 9 = 78 % countries lack adequate equipment).

### 5.6. Existing Inventories and PSPs

Most historical data reported are based on projects (e.g. PBFII, 2007 in Benin funded by ADF; three projects in Guinea Bissau funded by German, French and Portuguese collaborations); or outdated (e.g. 1968 NFI in Liberia; and also inventories in Nigeria). It is also not known if these inventories can be useful for REDD+ MRV for emission factor estimations<sup>3</sup>. The availability of the datasets is also not known. A number of the inventories have used a combination of TSPs and PSPs and PSP data could be useful for emission factor/carbon stock change estimation (e.g. using IPCC stock change method). However, it is not known if the PSPs are being maintained or not. Some interesting reports include the outputs from the FPP project in Ghana (2012-2014), CARBOVEG Project (2011) in Guinea Bissau, the GIZ ProREDD NFI project in Togo; the forest carbon inventory in Sierra Leone (based on 609 nested plots at Gola forest), and the on-going forest carbon inventory at Cross-River State, Nigeria (UN REDD Programme and Governors Climate Fund (GCF) support).

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<sup>3</sup> The on-going Targeted Support for strengthening biomass assessment in West Africa will address this issue of data availability and potential uses within the framework of REDD+ MRV.

Most countries covered in the assessment have not undertaken nationwide forest inventories and few have permanent sample plots (PSP) networks for monitoring forest stand dynamics. Some of the existing plots in the region are located in Ghana and are mainly managed by the FORIG (*Forestry Research Institute of Ghana*). AfriTRON (African Tropical Rainforest Observation network), probably has a non-exhaustive reference to most sampling plots (permanent and temporary) in Africa, and data can be obtained on request ([www.afritron.org](http://www.afritron.org)). Countries do not have regular budgetary allocations for periodic measurement of forest stands. Currently, only Togo, in collaboration with the GIZ, has an on-going NFI.

### 5.7. Variables measured/Estimated

Most questionnaires indicated only a few parameters (dbh, ht..) to have been measured and tree volumes estimated via the use of volume allometric equations (Benin, Côte d'Ivoire, Guinea Bissau, Liberia,...), while some most recent inventories have included biomass estimation for some carbon pools (e.g. Ghana, Guinea, Sierra Leone, Togo and Nigeria).

Regarding whether or not data for wood density, allometric equations and soil organic matter are included in inventories, only Ghana reported the existence of a partial country-specific WD database, allometric equations and SOM based on work undertaken within the FPP project. It is worth mentioning that inventory methodologies were developed for specific objectives, and were limited to variables of interest (e.g. commercial value), without taking account of biomass estimates for the different carbon pools as defined by IPCC. The inventories were only focused on forest lands, and omitting the other land use types.

### 5.8. Data management and Archiving

Again only Ghana provided detail on data management and archiving system. Nigeria has an inventory information system (FIS) from FORMECO study but was not captured in the questionnaire. In Benin, DGFRN lacks a centralized database for PBFII Study, none in Côte d'Ivoire, Guinea and SCET and Atlanta Consult inventories in Guinea Bissau don't have any existing database (that of CARBOVEG exist). None described for Liberia, and an Excel database indicated for Sierra Leone, while ProREDD project strives to establish a NFI database for Togo.

It is worth noting that occasionally forest inventories are made in limited regions within countries by various stakeholders and tailored towards specific objectives (logging, conservation of biodiversity, scientific research, etc.). However, the data from these inventories are rarely available and most often remain the property of their authors (offices, research centres, environmental NGOs, etc.); while for those undertaken by national forestry administrations, data is generally not properly archived in a database and in most cases, not readily available today. Data-sharing agreements are rare and it is often difficult to have access to information even when available (*Availability and Accessibility issues*).

### 5.9. Quality Assurance/Quality Control

QA/QC is not undertaken or has not been reported by most countries (6 out of 9 = 67%). Mention is made by Côte d'Ivoire, and in Sierra Leone in the Gola forest inventory and well detailed in Ghana for the FPP project. The capacity gap here is very wide.

### 5.10. Capacity Gaps and Capacity Building Program

The preceding analysis highlights a number of capacity gaps that require further attention.

Results as summarized in radar chart and coded table is as follows.

The chart indicates that Togo, Ghana, Nigeria, and Côte d'Ivoire have average/intermediate capacities (1.8-2.4), while the other countries (Guinea, Guinea Bissau, Benin, Liberia and Sierra Leone) have low capacities (1.2-1.6). Countries with capacities in NFI have benefited from some projects, including the Forest Preservation Project (FPP: JICA funded) in Ghana (which led to the production of country-specific allometric equations and partial wood density data); the on-going GIZ funded project in Togo, and the UN REDD Programme in Nigeria (forest carbon inventory undertaken at Cross-River State), and Côte d'Ivoire (planning work for pre-inventory for carbon assessment within UN-REDD Programme).

Overall, the capacity level of the countries can be considered low, as almost all are still reporting at Tier 1 level.

These results still reflect the situation in 2005 (Marklund and Schoene, 2005), in 2009 (Harold, 2009: 77 countries out of 99), and most recently by Romijn *et al* (2015), where most non-Annex



1 countries continue to rely on stem volumes and conversion factors (BEFs, VEFs, IPCC default values) to estimate above ground biomass and below-ground (using shoot-root ratios). According to Romijn *et al.*(2015) overall progress is still rudimentary, with 84 out of 99 countries still reporting at Tier 1 level, and as such may incur uncertainties as high as  $\pm 70\%$  (Meridian Institute, 2009). Harold (2009) found that only 11 countries out of 99 reported country-specific conversion factors and only 12 reported for soil carbon.

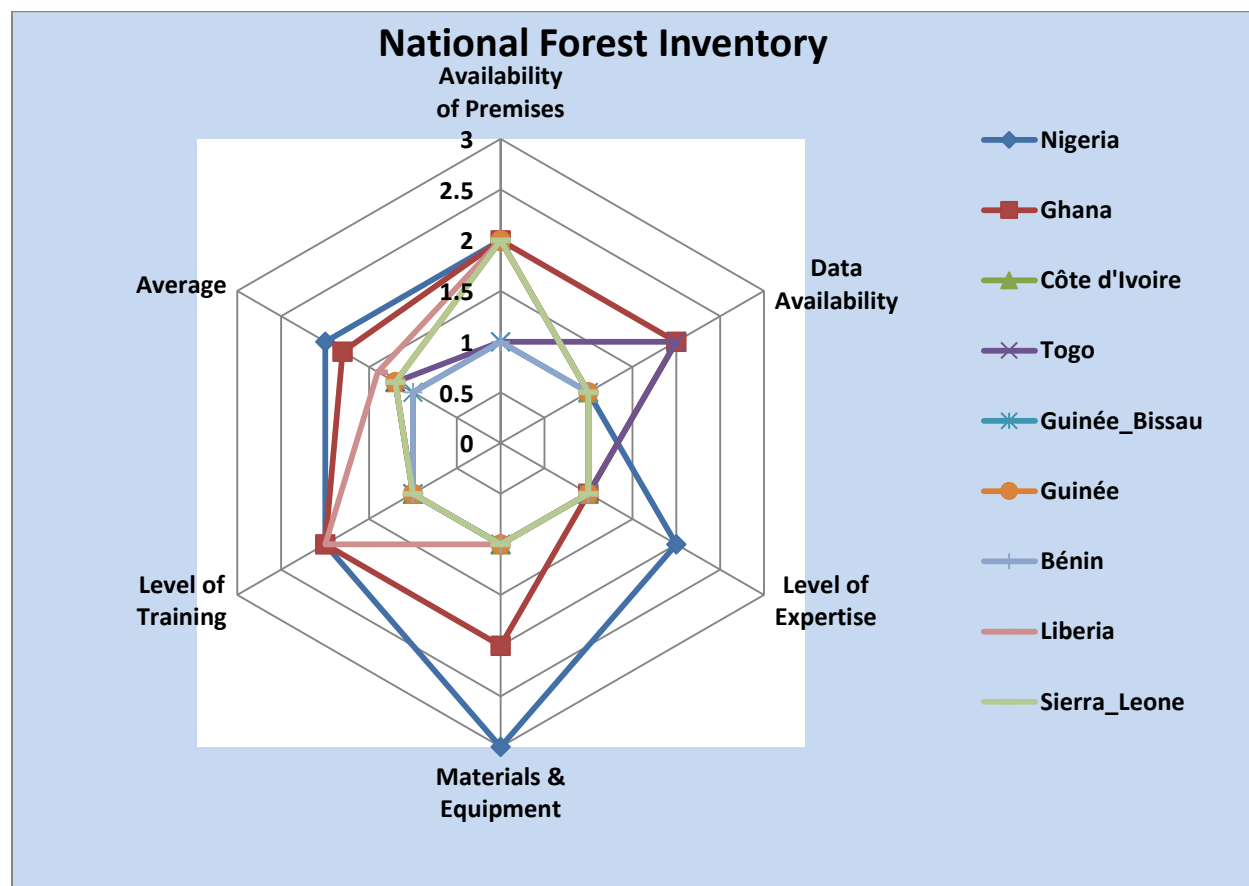


Table 2: Coded Results for National Forest Inventory Needs assessment

NFI	Nigeria	Ghana	Côte d'Ivoire	Togo	Guinée_Bissau	Guinée	Benin	Liberia	Sierra_Leone
<i>Availability of Premises</i>	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
<i>Data Availability</i>	1.0	2.0	2.0	3.0	2.0	2.0	1.0	1.0	2.0
<i>Level of Expertise</i>	2.0	2.0	2.0	2.0	1.0	2.0	2.0	2.0	1.0
<i>Materials &amp; Equipment</i>	3.0	2.0	1.5	3.0	2.0	1.0	1.0	1.0	1.0
<i>Level of Training</i>	2.0	2.0	1.5	2.0	1.0	1.0	1.0	1.0	1.0
<i>Average</i>	2	2	1.8	2.4	1.6	1.6	1.4	1.4	1.2

### 5.11. Recommendations and Proposed Actions

The evaluation indicates that human and technical capacities and material infrastructure from countries of the region for the realization of national forest inventories are low and need to be considerably strengthened. The current technical and financial capacities do not correspond to the real needs for the realization of national forest inventories.

In order to undertake a NFI, competent agencies need appropriate and sustainable financing schemes. Furthermore, technical staffs should undergo considerable capacity-building programmes for forest resource assessment as well as for the assessment of forest carbon stocks (e.g. the design and execution of multi-resource inventories).

NFI methodology should also include sampling for wood density data and soil organic matter, as well as for collection of data to develop country-specific allometric equations: information needed to develop country-specific databases. The inventory should provide data needed to estimate biomass for the major forest carbon pools identified by the IPCC (i.e. above ground biomass, below ground biomass, Soil organic matter, litter and dead wood).

While specific country needs may differ, the following priority actions should be considered:

- Setting up and defining roles of a technical workgroup for NFMS (same as for SLMS);
- Definition and promulgation of institutional arrangements (mandates and roles of structures, lines of communication, patterns of funding, etc.) for the operationalization of the NFI;
- Establishment and equipment of units in charge of NFI;
- Collation and management of existing data in a centralized database to facilitate data sharing and use;
- Establishment and validation of the definition of national forest;
- Review of existing NFI methodologies taking into account the specificities of REDD +;
- Development of an action plan for the operationalization of the NFI (sampling methodology, forest stratification, budgeting and planning of field campaigns, training teams, purchase and securing equipment, treatment and analysis of data, publication of the results, etc.).

## Chapter 6: Greenhouse gas inventory for LULUCF

Within the framework of REDD+, GHG Inventory (GHG-I) is an essential tool for estimating and reporting of emissions and GHG removals in the forestry sector and, more generally, to the LULUCF sector. The results of the GHG\_I allow, inter alia, the identification of GHG emission reduction policies, and to report on the results of the policies and measures (PAMs) related to REDD+.

The need assessment for GHG Inventory for the LULUCF Sector is summarized below.

### 6.1. Institutional Arrangements

In Benin DGFRN is the mandated institution for compiling GHG inventory for the LULUCF sector; in Côte d'Ivoire BCC is responsible for GHG Inventory and no institution for GHG Inventory for the LULUCF sector; in Ghana RMSC is responsible/mandated institution for GHG Inventory for the LULUCF sector; in Guinea DNE is in charge of GHG Inventory and none for the LULUCF sector; in Guinea Bissau there is no institution mandated for GHG Inventories: experts are selected from various institutions and coordinated by Head of National Commission for Climate Change in SEE to undertake GHG Inventory. In Liberia, EPA is responsible for overall coordination of GHG Inventories for LULUCF (no mandated institution). In Sierra Leone, the Ministry of Transport and Aviation is in charge of national communications, and coordinates the activities of NPAA-SL, MLCPE and EPA-SL during the compilation of GHG inventories; but there is no lead institution for GHG in the LULUCF sector (although there are indications of plans to create one). In Nigeria the Department of Climate Change (DCC) is mandated to undertake GHG Inventories, while the Federal Department of Forestry (FDF) is mandated to undertake GHG Inventory for the LULUCF sector.

### 5.2. Institutional Functioning/Management

In Benin, the Directorate General for Climate Change (DCEC) is responsible for production of NC. For their third national communications (TM+NC) (implemented by UNDP with GEF funds), there are plans to institutionalize the process of GHG-I compilation by setting up a permanent structure

with representatives from relevant institutions; with roles and responsibilities clearly defined. In Côte d'Ivoire there is no structure for GHG\_I, and in Guinea, Guinea Bissau, and Sierra Leone no other institutions are responsible for GHG Inventories. In Liberia, other institutions concerned are the FDA, Ministry of Agriculture (MoA), LISGIS, and the ministry of lands, mines and energy partake in the compilation of GHG inventories. In Nigeria DCC is responsible for compilation and submission of both NC and BUR to the UNFCCC, and depends on FDF for information on the LULUCF sector. In Togo, during preparation of the first three national communications, assistance was requested from University of Lome for its preparation. Hence no institutional continuity is ensured; but is however, underway, with formal assignment of roles and responsibilities for different sectors of the report. Ghana has probably the most advanced structure in terms of institutional arrangements and functioning with regards to GHG Inventories.

**In Ghana, RMSC** works in collaboration with the EPA, (mandated by the EPA Act 490), which serves as the national focal point for Climate Change and NCs to the UNFCCC. The **Climate Change Unit (CCU)** of the Forestry Commission (also mandated by Act 571) coordinates all REDD+ activities and acts as the REDD+ Secretariat, and co-leads the compilation of GHG inventory data for the LULUCF sector. As part of national greenhouse gas inventory reporting obligations to the UNFCCC, four task groups have been formed with responsibility for finalizing the GHG inventory outputs from the various sectors. The task groups are as follows:

1. **Energy Sector** task group
2. **Industry Processes** and Product Use task group
3. Agriculture, Forestry and Other Land Use (**AFOLU**) task group
4. Waste sector task group

**For NC**, roles and responsibilities are clearly defined: e.g. EPA coordinates the work of the task groups, ensures that quality assurance and quality control is undertaken on the outputs from the task groups.

The **AFOLU** task group has an overall responsibility for compiling GHG inventory data for the LULUCF sector as well as data for other agricultural activities (livestock, urea application, enteric fermentation etc.). This task group has representation from the National REDD+ Secretariat (Lead), Ministry of Food and Agriculture (co-lead), the RMSC (technical lead for estimating the GHG emissions), Academia and CSO.

### 6.3. Financial Autonomy

All countries indicated lack of financial autonomy, most depending on external support to undertake GHG Inventories for national communications.

## 6.4. Human Capacity

Most institutions do not have enough staff for compilation of GHG. In Benin no permanent staff and expertise exist, but some training has been undertaken on IPCC Guidelines and Guidance, and one researcher from CBRST Benin coordinates the preparation of TNC. In Côte d'Ivoire there are no truly dedicated staffs for the realization of GHG\_I: **BCC** hires consultants on a one-time basis depending on availability of funds. The existing staffs include: 3 doctorates (Mines & Environment, meteorology), 2 DEAs (water resources & Environment, Environment, RS/GIS), 1 Masters (Environmental economics) and 1 Forester. Ghana indicates low human capacity: The **RMSC** unit has 12 staffs. The **CCU** has 3 MScs, 2 BSCs in charge of REDD+ implementation, including GIS/MRV. 3 MScs in Geo-Information Science, in charge of providing technical backstopping/ support for GIS related tasks completed by the sectors. Nigeria has only 3 staffs with MSc and 2 staffs trained and received technical capabilities and in-depth knowledge on the generation of a National GHG inventory and the calculation of emissions and removals estimations for AFOLU sector through course of the "Capacity Building for REDD+ II" project (CD-REDD II). In Guinea there are few staffs for compilation of GHG\_I drawn from various institutions: DNE, CERE, DNEF, National Directorate of Meteorology, DNA & WARMY. In Guinea Bissau few to no staffs are specialized in GHG Inventories. Experts are temporary selected from various institutions for the NC production, hence there is no sustainability in GHG Inventory skills. In Liberia there are a few staffs: 1 Technician in Forestry, 1 BA in Sociology, 2 BSc's (1 in Forestry, 1 in GIS); 3 MSc's in Forestry, Environmental Mgt & Sustainable Dvpt. 1 MSc in Forestry, 1 MSc in Biodiversity Conservation, 1 MA/MBA in Economics; M&E. In Sierra Leone there are no sufficiently trained staffs at NPAA-SL: Only three staffs mentioned: Head of NPAA, Director and Assistant Director. Two staffs are cited at the MLCPE: Director of Environment: and Deputy Director. And at EPA-SL two staffs are enlisted: Director and Assistant Director. In Togo no mention is made of staff, given that no institution is mandated to undertake GHG Inventories.

## 6.5. Infrastructure/Equipment/Laboratories

In Benin no details of equipment is provided, but mention is made of computers; in Côte d'Ivoire BCC has computers equipped with IPCC software. In Ghana same equipment is mentioned as for NFI, while in Guinea no infrastructure exist for compilation of GHG Inventories. No equipment is

mentioned for Liberia; a few equipment in Nigeria (2 computers, printer, server and IPCC software). In Sierra Leone NPAA-SL has computers equipped with GHG 1996 Inventory software and GPS; MLCPE has computers, GPS, and EPA has computers and GPS. In Togo there is no laboratory unit or database unit for compilation of GHG\_I. They are specifically recruited consultants that develop national communications and manage data with their own equipment.

## 6.6. Data management and Archiving

Virtually no data management and archiving systems are reported by countries except Ghana (**see box below**). In Benin there are no indications of database management and archiving, no mechanism for data storage/archiving and data sharing in Guinea and Guinea Bissau, and nothing mentioned for Liberia and Togo. In Côte d'Ivoire data is stored on external hard disks as well as on computer hard disks/drives at BCC. There is neither a real database nor a data exchange platform, and GHG inventory results are inputted into NAIS software. In Nigeria there is no existing data management and archiving system but indicates that the National GHG Inventory System (NGIS) will provide a sustainable system to collect, archive and process data for National GHG Inventories as well as data storage and retrieval system. In Sierra Leone the Meteorological Dept. of the Ministry of Transport and Aviation, Ministry of Agriculture, Forestry and Food Security (MAFFS) Planning Division and Statistics Sierra Leone, share data with relevant organisations for the needed service delivery.

### Ghana: Data management

Data sharing: Ghana's EPA serves as a hub for assembling data from the various sectors including the AFOLU sector. The Environmental Data & Information Management Department of EPA has put in place a central data storage server for the inventory data.

A GHG inventory Central database was created as part of processes leading to the submission of Ghana's National Inventory Report in 2015. The database serves as a data management hub and archiving system for storage of all documented inventory information. However, the central database ([www.epa.gov.gh/tnc](http://www.epa.gov.gh/tnc)) is currently down

### Ghana: Key Category Analysis (KCA)

**Key Category Analysis (KCA)** are undertaken to identify sources with significant influence on GHG inventory. The following KCAs were identified: CO<sub>2</sub> (from land converted to cropland; forest land remaining forest land; Land converted to forest land; and land converted to grassland); CH<sub>4</sub> (from emissions from biomass burning), and N<sub>2</sub>O (from emissions from biomass burning and emissions from managed soils). The method used was quantitative and at **Tier 2** level

### Ghana: Quality Assurance/Quality Control

The **AFOLU** working group responsible for the LULUCF GHG inventory have responsibility for the QA/ QC procedures as outlined above. The EPA provides technical backstopping on the QA/ QC to the various sectors on the following fronts: **1.** Creating a checklist of QA/ QC procedures; **2.** Collecting and reviewing checklists for completeness, and following up when necessary to ensure that the required QA/ QC procedures were observed; **3.** Delivering all documentations to the online database manager; **4.** Facilitating all technical reviews at the national and international

The needs assessment for GHG Inventory for the LULUCF sector was summarized in coded form and radar chart as presented below.

Generally, the involvement in the countries of West Africa in REDD + mechanism is still low. Therefore, it is not surprising that governments do not yet have stable institutional arrangements for the collection of data and regular mechanisms to report to the UNFCCC, via national communications, on emissions and removals of GHGs from LULUCF sector. It should also be noted that most of the governments of the countries involved in the assessment lack the technical capacity for the development of GHG\_I in general and monitoring / reporting on the results of the REDD + activities in particular.

There is generally no structure or national team specifically in charge of the compilation GHG\_I and the preparation of national communications. They are usually developed by consultants specifically recruited for this purpose in the context of national communications development projects funded by international donors (e.g. GEF, UNDP, UNEP etc.). In addition, there is no mechanism for data sharing between institutions in possession of relevant data for the

compilation of the GHG. Consultants are often responsible for collecting the data in one way or another, and sometimes default databases are consulted (e.g. IPCC and FAO databases).

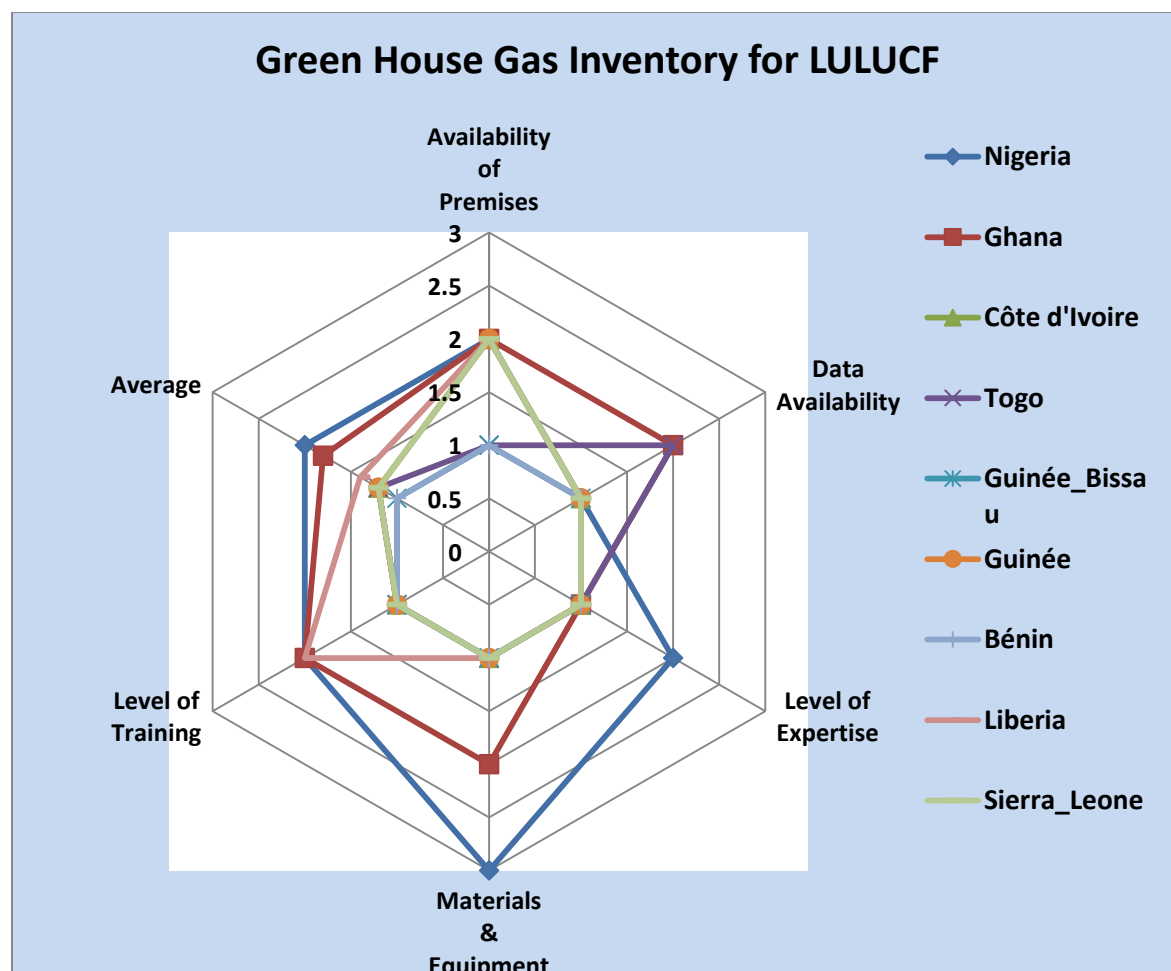


Figure 3. Radar Chart for Green House Gas (GHG) Inventory Needs Assessment

Table 3: Coded Results for Green House Gas (GHG) Inventory Needs assessment

GHG_I	Nigeria	Ghana	Côte d'Ivoire	Togo	Guinée_Bissau	Guinée	Bénin	Liberia	Sierra_Leone
<i>Availability of Premises</i>	2	2	2	1	1	2	1	2	2
<i>Data Availability</i>	1	2	1	2	1	1	1	1	1
<i>Level of Expertise</i>	2	1	1	1	1	1	1	1	1
<i>Materials &amp; Equipment</i>	3	2	1	1	1	1	1	1	1
<i>Level of Training</i>	2	2	1	1	1	1	1	2	1



<i>Average</i>	2	1.8	1.2	1.2	1.0	1.2	1.0	1.4	1.2
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## 6.7. Recommendations and Proposed Actions

This assessment indicates that the human and technical capacities of the countries of West Africa for the compilation of GHG\_I are low. Several recommendations can be made:

- Creating a sustainable institutional framework to improve the management and the quality of the GHG Inventories;
- Strengthening of the technical capabilities for the preparation, updating and improvement of GHG\_I on a continuous and sustainable basis;
- Promotion of quality, completeness, transparency and timeliness in the compilation of GHG\_I;
- Integration of all institutions in possession of relevant datasets and promoting data-sharing agreements and lines of communication for the compilation of GHG\_I;
- Strengthening of the national institutional arrangements for the collection, updating and archiving of data;
- Development of a quality control and quality assurance mechanism for data used to compile the GHG\_I.

## Chapter 7: Forest Reference Emissions Levels/Forest Reference Levels (FREL/FRL)

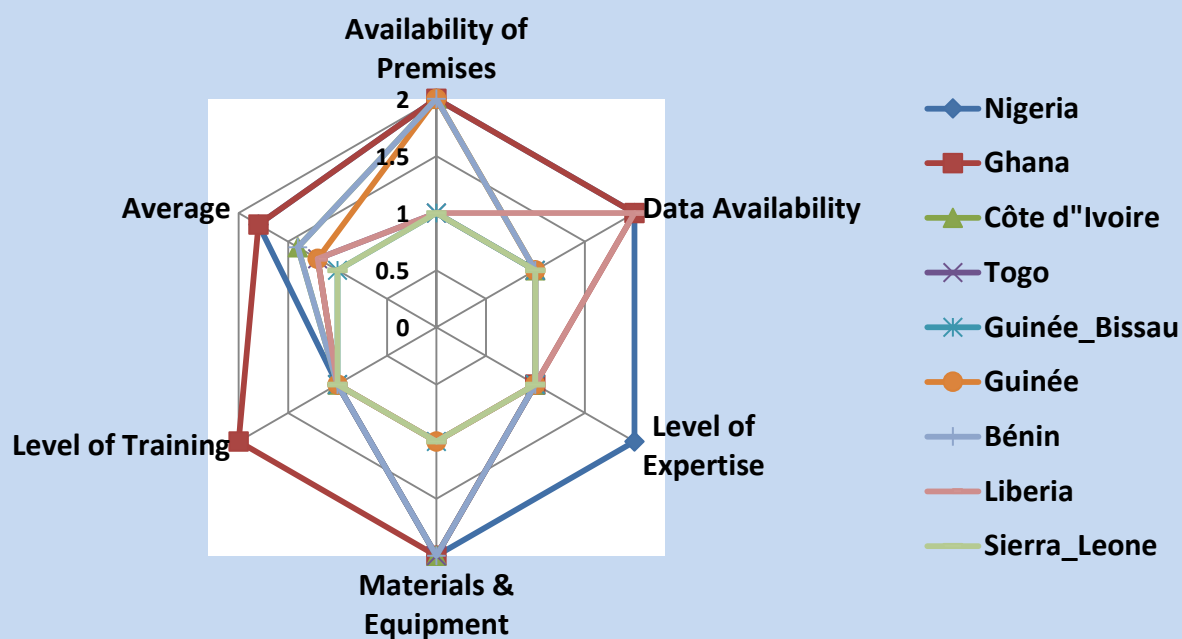
Generally countries of the region have not yet initiated or undertaken the development of Forest Reference (emissions) levels/Forest Reference levels (FREL/FRL). Analyses of historical remote sensing data as well as the analysis of the national circumstances which might have an influence on the FREL/FRL have so far not been initiated. In addition, the scope and scale of the FREL/FRL from different countries have generally not yet been discussed. Finally, few countries have a proper national forest definition or have revised existing ones within the framework of REDD+.

With the exception of activities planned in R-PP documents existing and partially funded by the UN-REDD programme in Côte d'Ivoire and Nigeria and by the FCPF in Ghana, Côte d'Ivoire, Liberia and Nigeria it appears that no capacity building project aims specifically the establishment of FREL/FRL for countries in the region.

The needs assessment for FRELs/FRL were summarized in table and radar chart below.

FREL/FRL	Nigeria	Ghana	Côte d'Ivoire	Togo	Guinée Bissau	Guinée	Bénin	Liberia	Sierra_Leone
<i>Availability of Premises</i>	2	2	2	1	1	2	2	1	1
<i>Data Availability</i>	2	2	1	1	1	1	1	2	1
<i>Level of Expertise</i>	2	1	1	1	1	1	1	1	1
<i>Materials &amp; Equipment</i>	2	2	2	2	1	1	2	1	1
<i>Level of Training</i>	1	2	1	1	1	1	1	1	1
<i>Average</i>	1.8	1.8	1.4	1.2	1	1.2	1.4	1.2	1

## Forest (Emission) Levels



## Chapter 7. Thematic and General Regional Recommendations

This assessment indicates that countries of the region have not yet initiated the development of their FRELs/FRLs and that the capabilities required to do this are low. The first recommendation is therefore the organization of a technical training on the establishment of the FRELs/FRLs destined for decision makers and technicians involved in the implementation of the REDD+ mechanism. Also, prominent work on the development of FRELs/FRLs, the countries of the region could undertake the following priority actions:

- Validation of national forest definitions;
- Analysis of historical remote sensing data for historical land use changes;
- Assessment of the scope, scale and methodology for the development of the FREL/FRL;
- Identification of emission factors for use in the construction of the FRELs/FRLs;
- Evaluate national circumstances which might have an impact on the FRELs/FRLs.

### 7.1. Thematic Regional Recommendations

#### 7.1.1. National Forest Inventory

The evaluation indicates that human and technical capacities and material infrastructure from countries of the region for the realization of national forest inventories are low and need to be considerably strengthened. The current technical and financial capacities do not correspond to the real needs for the realization of national forest inventories.

In order to undertake a NFI, competent agencies need appropriate and sustainable financing schemes. Furthermore, technicians should undergo considerable capacity-building programmes for forest resource assessment as well as for the assessment of forest carbon stocks (including the design and execution of multi-resource inventories).

NFI methodology should also include sampling for wood density and soil organic matter, as well as for data collection to develop country-specific allometric equations, and information needed to develop country-specific databases. The inventory should provide data needed to estimate biomass for the major forest carbon pools identified by the IPCC (i.e. above ground biomass, below ground biomass, Soil organic matter, litter and dead wood).

While specific country needs, may differ the following priority actions should be considered:

- Setting up and defining roles of a technical workgroup for NFI;
- Definition and promulgation of institutional arrangements (mandates and roles of structures, lines of communication, patterns of funding, etc.) for the operationalization of the NFI;
- Establishment and equipment of units in charge of NFI;
- Training of Forestry staff on Forest carbon inventories
- Collation and management of existing data in a centralized database to facilitate data sharing and use;
- Establishment and validation of the definition of national forest;
- Review of existing NFI methodologies taking into account the specificities of REDD +;

#### 7.1.2. RS\_GIS/Satellite Land Monitoring Systems (SLMS)

The assessment indicates that human, technical and material capacity of countries of the region for the development of SLMS are moderate, and vary with countries, and need to be strengthened. In general, the capabilities exist at the regional level but do not correspond to the real needs for the development of operational SLMS. Hence, existing RS and GIS staff need capacity-building and equipment for land use change analysis, especially for monitoring of forest cover to estimate activity data for REDD+ activities to the UNFCCC.

While specific country needs may differ, several priority actions should be considered:

- Setting up of a technical working group for SLMS;
- Promulgation of institutional arrangements (roles and mandates of structures, lines of communication, patterns of funding, etc.) for the implementation and SLMS operations;

- Creation of national RS/GIS laboratories and procurement of equipment, including installation of high speed internet facilities.
- Capacity building of RS/GIS staff on land use change analysis techniques
- Improvement of information sharing and complementarity between national structures with skills in GIS and RS as well as between any capacity strengthening programs;
- Collation and management of existing data in a centralized database to facilitate data sharing and use;
- Development of an action plan for the operationalization of SLMS

### 7.1.3. Forest Reference Emissions Level (FRELs)

This assessment indicates that most countries of the region have not yet initiated the development of their FRELs/FRLs and that the capabilities required to do this are low. There is therefore, a need for organizing a regional technical training on the establishment of the FRELs/FRLs for decision makers and technicians involved in the implementation of the REDD+ mechanism.

Also, prominent work on the development of FRELs/FRLs, the countries of the region could undertake the following actions:

- Drafting and validation of structural national forest definitions in the context of REDD+;
- Analysis of historical remote sensing data for historical land use changes;
- Assessment of the scope, scale and methodology for the development of the FREL/FRL;
- Identification of emission factors for use in the construction of the FRELs/FRLs;
- Evaluation of national circumstances which might have an impact on the setting up a reference (BAU) FRELs/FRLs.

### 7.1.4. GHG Inventory

This assessment indicates that the human and technical capacities of the countries of West Africa for the compilation of GHG\_I are low. Several recommendations can be made:

- Creating a sustainable institutional framework to improve the management and the quality of the GHG Inventories;
- Strengthening of the technical capabilities for the preparation, updating and improvement of GHG\_I on a continuous and sustainable basis;

- Promotion of quality, completeness, transparency and timeliness in the compilation of GHG\_I;
- Integration of all institutions in possession of relevant datasets and promoting data-sharing agreements and lines of communication for the compilation of GHG\_I;
- Strengthening of the national institutional arrangements for the collection, updating and archiving of data;
- Development of a quality control and quality assurance mechanism for data used to compile the GHG\_I

## 7.2. General Regional Recommendations

With the exception of Côte d'Ivoire, Ghana, Nigeria and Togo, West Africa countries covered by this assessment of capacity are lagging in the preparation for the implementation of the REDD + mechanism. Some regional initiatives could be undertaken (*subject to availability of funds*) to meet the major needs for an operational, robust and reliable NFMS. The following, non-exhaustive list of actions could be undertaken to strengthen regional capacity in West Africa:

- Development of a regional training portfolio (training modules) on various REDD+ MRV topics for all countries; development of action plans for the operational NFMS over the long term (all countries) and support to the development of national strategies REDD + ;
- Creation and strengthening of a regional network of experts on the monitoring of forests and the estimation of forest carbon stocks to improve data sharing as well as the coordination and technical exchanges on practices and methods relating to NFMS and MRV;
- Development of a regional programme for strengthening regional collaboration and harmonization of methodologies for satellite image processing and analysis for monitoring forest cover and land use changes;

- Development of a regional programme for the operationalization of a regional network of permanent sample plots (including identifications and re-measurements of existing ones, installation of new plots, collection, centralization and analysis data, etc.) in order to assess evolution of forest stands and to estimate emission factors in different forest/land use types in West Africa.
- Strengthening the regional research centre (for example, CILLS/AGRHYMET (Niamey, Niger) to support countries in the development of NFMS in West Africa, animate the regional network of experts to support regional collaboration and the exchange of experience among countries, manage the regional network of permanent sample plots in collaboration with the forest directors and other research centres, strengthen coordination and the collection of existing data develop a regional database for estimation of forest biomass, facilitate data between institutions holders of data-sharing agreements and available free of charge existing data through a data sharing platform.
- Development of a regional strategy to support national and/or international fundraising to continue the preparation of the countries for the REDD + mechanism;



## 8. Appendices

### Appendix 8.1. Capacity Assessment Methodology

This section presents an analysis of the national capacities of the countries of West Africa for the implementation of national systems for forest monitoring. The results are presented for the different technical pillars of NFMS (i.e. SLMS, NFI, and GHG\_I) and FREL/FRL as well as for each five capacity areas considered in the assessment.

For the different pillars, the following capacities were assessed: (i) availability of premises, (ii) availability of information, (iii) level of expertise, (iv) material and equipment, and (v) training. Each capacity was assessed using a score ranging from 1 to 3, as follows:

- 1: low capacity, across the test application to be developed
- 2: average capacity, capabilities exist but do not correspond to the real needs, an update/upgrade is necessary
- 3: advanced capability, adequate capacities are available and can be used with a minimum update/upgrade

The following table presents interpretations for different quotations (1, 2 and 3) for each information domain.

#### Interpretations of quotations for each information domain

<i>Capacity</i>	<i>Availability of premises</i>	<i>Availability of information</i>	<i>Level of expertise</i>	<i>Materials and equipment</i>	<i>Training</i>
<i>Low</i>	Not available/not secure premises / not generators / institutions unable to make premises available	little/no information available / non-centralized information	little/no understanding / new themes	Most of the necessary equipment for operationalizing is missing	No training
<i>Average</i>	More or less secure premises / electricity most of the time / functional generator / available premises but needs improvement	Available evidence / centralization of part of the information	Understanding but significant gaps	Part of the necessary equipment is available but a significant part is missing / no inventory of existing hardware	Some formations but not sufficiently targeted
<i>Advanced</i>	Secure premises / functional generator / premises available without need for improvement	Data available quality and relevant information / centralized database	Understanding	Availability of most of the equipment necessary for operationalizing / inventory of existing hardware	Appropriate and targeted training

## Summary Quotations for each pillar and for each information field

Country	R PP	NNSW	Availability of premises	Availability of information	Level of expertise	Materials and equipment	Training	NNSW	
Benin	X	NFI	2	1	1	1	1	1.2	1.45
		SLMS	2	2	2	2	2	2.0	
		GHG_I	2	1	1	1	1	1.2	
		FREL/FRL	2	1	1	2	1	1.4	
Côte d'Ivoire	✓	IFN	1	2	1	1	1	1.2	1.45
		SSTS	2	2	2	2	2	2.0	
		GHG_I	2	1	1	1	1	1.2	
		FREL/FRL	2	1	1	2	1	1.4	
Ghana	✓	NFI	2	2	2	2	2	2.0	1.95
		SSTS	2	2	2	2	3	2.2	
		GHG_I	2	2	1	2	2	1.8	
		FREL/FRL	2	2	1	2	2	1.8	
Guinea	X	NFI	2	2	2	1	1	1.6	1.35
		SLMS	2	1	1	2	1	1.4	
		I GES	2	1	1	1	1	1.2	
		FREL/FRL	2	1	1	1	1	1.2	
Guinea-Bissau	X	NFI	2	2	1	2	2	1.8	1.40
		SLMS	2	2	1	2	2	1.8	
		GHG_I	1	1	1	1	1	1.0	
		FREL/FRL	1	1	1	1	1	1.0	
Nigeria	✓	NFI	2	1	2	3	2	2.0	2.10
		SLMS	3	3	2	3	2	2.6	
		GHG_I	2	2	1	2	2	1.8	
		FREL/FRL	2	2	2	2	2	2.0	
Liberia	✓	NFI	2	1	2	1	1	1.4	1.30
		SLMS	2	1	1	1	1	1.2	
		GHG_I	2	1	1	1	2	1.4	
		FREL/FRL	1	2	1	1	1	1.2	
Sierra Leone	X	NFI	1	2	1	1	1		
		SLMS	1	1	1	1	1		
		GHG_I	1	1	1	1	1		
		FREL/FRL	1	1	1	1	1		
Togo	✓	NFI	2	3	2	3	2	2.4	1.80
		SLMS	2	2	2	2	2	2.0	
		GHG_I	1	2	1	1	1	1.2	
		FREL/FRL	2	2	1	2	1	1.6	
Average			1.88	1.63	1.34	1.66	1.50	1.60	

## Appendix 8.2: Country Summaries of Needs Assessment

### Benin

<b>NFI</b>	<b>Information obtained (Benin)</b>
Institutional arrangements	DGFRN is responsible for national forest resources management (including forest inventories?).
Institutional Functioning/management	DGFRN is supported in its functions by ONAB, CENATEL and CERF (Centre d'Etude, de Recherche et de Formation Forestière)
Financial Autonomy	There is some financial autonomy but limited funds
Human Capacity	Human capacity is limited, and are mainly staff from DGFRN, CENATEL, CERF and ONAB who participated in the 2006-2007 NFI
<b>Infrastructure (equipment/laboratories)</b>	Instruments used during the PFBII study are obsolete.
<b>Inventories undertaken</b>	The NFI (PBFII, ) funded project by African Development bank generated some data, but DGFRN lacks a centralized database for this study. Data exist in paper format (not readily available or accessible)
<b>Existence of PSPs/Status</b>	
<b>Variables measured for biomass/ carbon estimation*</b>	Dbh, ht, tree volume, stem biomass, wood density?, NTFPs and Biodiversity
<b>Data management and archiving</b>	DGFRN lacks a centralized database for the PBFII study.
<b>NTFPs and Biodiversity Indicators</b>	Not mentioned
<b>Existence of country specific WD &amp; capacity</b>	Not mentioned
Existence of Country-specific Allometric equations & Capacity	Not mentioned
Existence of country-specific SOM & Capacity	Not mentioned
QA/QC	Not mentioned
Capacity Development plan	Not mentioned

<b>RS_GIS</b>	<b>Information obtained(Benin)</b>
Institutional arrangements	CENATEL is responsible for satellite monitoring systems, under decree No. 2010-334 of July 2010.
Institutional Functioning/management	Other institutions include IGN that has expertise in RS and GIS. GEOFORAFRI Project has supported setting up of a National Land Surveillance & monitoring system (UNSSST) within the DGFRN. Roles & Responsibilities of CENATEL and UNSSST need to be clarified.
Financial Autonomy	Government ensures functioning of CENATEL but the financial resources are insufficient to fully implement their work
Human Capacity	CENATEL has several geographers, cartographers and foresters well experienced in GIS and Remote sensing, and have produced several maps. GEOFORAFRI confirmed their skills, and some in image processing; and has further created a national surveillance unit and trained staff (28 technicians) in RS and forest cover monitoring
Available data/information	Forest and vegetation maps from Landsat and SPOT images respectively. CENATEL received from Directorate General for Climate Change (DGEC) Landsat4, Landsat5, Landsat7 & Landsat 8 scenes (3282 in total). Scenes cover 1990-2014. The unit is composed of experts from CENATEL, IGN and DGFRN.
Infrastructure (equipment/laboratories)	CENATEL has software (3 licenses ERDAS, 2 licenses for ArcGIS, MapInfo, QGIS), 10 Desktops, 2 laptops, 4 GPS and 1 AO plotter. UNSSST Geomatics Lab. created by GEOFORAFRI is equipped with: 8 Desktop Computers HP, 9 UPS (Inverters??), 1 printer, 8 licenses ERDAS IMAGINE 2015, 9 Licenses MS Office, 4 Licenses ArcGIS, 8 Licenses Anti-virus, 8 licenses Adobe Acrobat Pro and QGIS, Inter Image & Monteverdi.
Awareness of free satellite imagery	Not mentioned
Awareness of open source software for RS/GIS	Not mentioned but have QGIS
Existence of adequate Internet downloading facilities	Internet connection is problematic
Data management and archiving	Not mentioned
Existence of studies on land use change analysis	
Knowledge of Image analysis /processing for land use change studies	Training within GEOFORAFRI in image analysis and processing.
Approach to land use change detection “wall-to-wall” or sample-based	Not mentioned
QA/QC	Not mentioned
Capacity Development plan	Not mentioned

<b>GHG Inventory</b>	<b>Information obtained(Benin)</b>
<b>Institutional arrangements &amp; permanence</b>	<b>DGFRN</b> is responsible institution for compiling GHG_I for LULUCF sector, mandated by Decree 2014-417 of 04 August 2014. . Other institutions like ONAB, CENATEL and deer? Provide AD and EF data to DGFRN.
<b>Institutional Functioning/ management</b>	The Directorate General for Climate Change (DCEC) is responsible institution for production of NC. For the 3 <sup>rd</sup> NC (implemented by UNDP with GEF funding), there are plans to institutionalize the process of GHG_I compilation by setting up a permanent structure with representatives from relevant institutions; with roles and responsibilities clearly defined.
<b>Financial Autonomy</b>	Production of national Communications based mainly on financial support from GEF??
<b>Human Capacity</b>	No permanent staff and expertise exist but some GHG training has been undertaken on IPCC Guidelines and Guidance. One researcher from CBRST Benin coordinates the preparation of the 3 <sup>rd</sup> NC (TNC).
<b>Available data/information</b>	CENATEL has 3282 Landsat scenes covering all the countries over the period 1990-2014, which should allow to estimate the AD; The country lacks its own database on the EF.
<b>Infrastructure (equipment /laboratories)</b>	No details of equipment, but indicates the existence of computers.
<b>Data management and archiving</b>	No indication of database management and archiving
<b>Key Category Analysis</b>	Check NC
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Not indicated
<b>QA/QC</b>	Not indicated
<b>Capacity Development plan</b>	Not indicated

## Côte d'Ivoire

<b>NFI</b>	<b>Information obtained (Côte d'Ivoire)</b>
Institutional arrangements	Several structures are involved in forest management: the MINEF, (SODEFOR) MINESUDD (manages protected areas), with none specifically concerned with NFI
Institutional Functioning/management	There is no specific institution for undertaking NFI, and hence no institutional structure with roles and responsibilities for NFI.
Financial Autonomy	SODEFOR that undertakes inventories of classified forests has some financial autonomy??
Human Capacity	No details, simple mention of some staff that need capacity strengthening for biomass assessment for REDD+
<b>Infrastructure (equipment/laboratories)</b>	Mention of a few equipment (calipers, GPS, computers, statistical software and GIS software) at SODEFOR.
<b>Inventories undertaken</b>	SODEFOR undertakes inventories on temporary and permanent sample plots. Inventory data is available in paper and digital formats
<b>Existence of PSPs/Status</b>	SODEFOR undertakes inventories on temporary and permanent sample plots
<b>Variables measured for biomass/ carbon estimation*</b>	Dbh and ht
<b>Data management and archiving</b>	There is no data management and archiving system. Data is either on paper or digital format.
<b>NTFPs and Biodiversity Indicators</b>	Not indicated but could be undertaken by
<b>Existence of country specific WD &amp; capacity</b>	Uses CIRSD data base
Existence of Country-specific Allometric equations & Capacity	Volume allometric equations exist, not biomass equations
Existence of country-specific SOM & Capacity	Not indicated
QA/QC	Quality control done by remeasuring a selected sample of plots and comparing with previous measurements.
Capacity Development plan	

RS_GIS	Information obtained(Côte d'Ivoire)
Institutional arrangements	Several institutions exist using remote sensing like CCT, but their mandate is not specifically for monitoring land use/land cover changes. CCT . The R - PP indicates that the evolution of forest cover will be monitored by the cell MRV/REDD + in collaboration with BNETD/CTC
Institutional Functioning/management	The R - PP indicates that the evolution of forest cover will be monitored by the cell MRV/REDD + in collaboration with BNETD/CTC. Other structures could also be assigned roles and responsibilities
Financial Autonomy	BNETD/CCT has financial autonomy, CURAT depend on university budget, CSRS receives funds from Swiss and Ivorian governments; IGT is partly autonomous, and partly dependent on university budget.
Human Capacity	The BNETD/CTC has a staff trained in techniques of TD as well as GIS software. The bureau is composed of a geospatial technology engineer, from a specialist forest management in GIS and TD, a cartographer, five surveyors and two specialists in photo-interpretation.
Available data/information	Use of the FAO to harmonize LCCS system land classification systems;  4 maps of vegetation to the 1: 500,000 (ORSTOM & IGT, 1968-1969);  Map of vegetation to scale 1: 2,000,000 (ORSTOM, 1979);  Map of land cover of Côte d'Ivoire to 1/200,000 (BNETD/CTC, 2004)
Infrastructure (equipment/laboratories)	<b>BETD/CCT:</b> Landsat, SPOT, GeoEye, QuickBird images, RS/GIS lab with 12 Work stations, ArcGIS (4), ErDAS(4), MicroStation(1), Pro 600, LPS(1), ORIMA (1), COVADIS(1), AUTOCAD(2), aircraft for aerial photographs <b>CURAT:</b> 26 Computers and EUMETSAT reception station, ILWIS, ArcGIS and QGIS softwares, and Landsat Images <b>CSRS:</b> 1 Drone (eBee), RS/GIS lab with 24 Desktops, 1 network printer, ArcGIS <b>IGT:</b> 6 Laptops, ArcGIS 10.2, EVI 4.8, PCI, QGIS, Landsat Images
Awareness of free satellite imagery	LANDSAT RADAR (write to European Space Agency) <a href="http://earthexplorer.usgs.gov/">http://earthexplorer.usgs.gov/</a> <a href="http://fr.softonic.com/s/images-satellites-en-temps-r%C3%A9el-gratuites">http://fr.softonic.com/s/images-satellites-en-temps-r%C3%A9el-gratuites</a> <a href="http://geosud.teledetection.fr/web/guest/actualites/-/blogs/telechargement-gratuit-d-images-landsat-8">http://geosud.teledetection.fr/web/guest/actualites/-/blogs/telechargement-gratuit-d-images-landsat-8</a>
Awareness of open source software for RS/GIS	Yes, have QGIS
Existence of adequate Internet downloading facilities	Also, it seems that the BNETD/CCT Internet installation is adequate for the download of satellite images
Data management and archiving	Yes, SGBSIG for BNETD/CCT ; the other institutions do not have a data management and archiving system
Existence of studies on land use change analysis	
Knowledge of Image analysis /processing for land use change studies	Yes, provides evidence of knowledge of image processing for land use change studies
Approach to land use change detection “wall-to-wall” or sample-based	Indicates approaches 1, 2 and 3 analysis but no details. Some “wall-to-wall” had been done in the past. (Ref: BD GEO 200 (2005) 1969 Land occupation map).
QA/QC	BETD/CCT and CURAT undertake quality control (detailed in questionnaire)
Capacity Dvpt. plan	

<b>GHG Inventory</b>	<b>Information obtained(Côte d'Ivoire)</b>
<b>Institutional arrangements &amp; permanence</b>	The BCC of the MINESUDD is the body responsible for the development of the GHG_I. No institution is particularly responsible for GHG for the LULUCF sector.
<b>Institutional Functioning/ management</b>	No other structure is responsible for GHG_I.
<b>Financial Autonomy</b>	BCC has no financial autonomy, and depend on funding from external partners
<b>Human Capacity</b>	Staff at BCC include 3 doctorates (Mines & Environment, meteorology), 2 DEAs (water resources & Environment, Environment, RS/GIS), 1 maters (Environmental economics) and 1 Forester. There is not truly dedicated to the realization of the GHG_I within the BCC of MINESUDD. The BCC hires consultants on a one-time basis for the development of the GHG_I depending on availability of funds.
<b>Available data/information</b>	The acquisition of the data remains a problem because protocols agreed sharing of data between the MINESUDD and the holding of data structures are not applied.
<b>Infrastructure (equipment /laboratories)</b>	The BCC has computers equipped with IPCC software as well as the Zen software.
<b>Data management and archiving</b>	Data is stored on external hard disks as well as on computer hard drives at BCC. There is no real database nor a data exchange platform Results are stored in NAIS software.
<b>Key Category Analysis</b>	
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Not indicated
<b>QA/QC</b>	QA/QC is undertaken (see
<b>Capacity Development plan</b>	Capacity building trainings on (i) Initiation to GHG, (ii) training on preparation of GHG_I for LULUCF sector (iii) international workshop GHG_I in AFOLU sector and (iv) training on the use of Collect Earth in LULUCF sector.



## Ghana

<b>NFI</b>	<b>Information obtained (Ghana)</b>
Institutional arrangements	Lead Agency is the Resource Management Support Centre (RMSC) of the FC, mandated by Act 571 of 1999.
Institutional Functioning/management	RMSC works in collaboration with Forest Services Division (FSD) of the FC that undertakes NFI
Financial Autonomy	RMSC and FSD receive government support for routine office activities and salaries, but depend on donor-support for inventory activities
Human Capacity	Indicate adequately/sufficiently trained staff to undertake forest inventories: <b>RMSC unit</b> has 12 staffs, including 1 MPhil in Forest Resources Dynamics in charge of forest inventory/carbon assessment, 1 MSC in Forest Ecosystem Science, in charge of carbon stock assessment, 2 BSCs in natural forest production and mensuration, 1 diploma in natural forest production and mensuration, and 8 Certificate holders in charge of forest mensuration.
<b>Infrastructure (equipment/laboratories)</b>	RMSC has computers, printers, relascope, d-tapes, calipers. FSD has computers and d-tapes [More details needed]
<b>Inventories undertaken</b>	<ul style="list-style-type: none"> <li>- Ghana Forest inventory Project (1985–1989): used both TSPs &amp; PSPs</li> <li>- Forest Inventory and Management Project (1989–1995) : used both TSPs &amp; PSPs</li> <li>- Multi-resource inventory (2000 – 2001): used both TSPs &amp; PSPs</li> <li>- Forest Preservation Programme (2012 – 2014): used temporary plots</li> </ul>
<b>Existence of PSPs/Status</b>	<b>Yes</b> , during the inventories enlisted above
<b>Variables measured for biomass/ carbon estimation*</b>	All variables, including dbh, ht, stem volume, stem biomass, branch, twigs, and leaf biomass, dead wood (standing or lying), litter, root biomass, SOM, wood density, BEFs and BCEFs, root-shoot ratio measured/estimated during the Forest Preservation Programme (FPP) study. NTFPs and
<b>Data management and archiving</b>	For the Ghana Forest Inventory Project, Forest Inventory and Management Project and Multi-Resource Inventory; data were inputted from datasheets and saved electronically on computers with appropriate backups. For the FPP, the RMSC of the Forestry Commission hosts the main database/GIS server which has the national GIS information, forest inventory data and spatial databases. The workstations at RMSC are connected through Local Area Network (LAN) to main database/ GIS servers; with a back-up server placed at the Forestry Commission, headquarters in Accra. There is also a web server which holds data accessible to all registered persons ( <a href="http://www.fcforestinfo.gov.gh">www.fcforestinfo.gov.gh</a> )
<b>NTFPs and Biodiversity Indicators</b>	Biodiversity information was obtained during the multi-resource inventories.
<b>Existence of country specific WD &amp; capacity</b>	A partial country-specific WD database based on data collected during the FPP through destructive sampling, and analyzed at the WD Laboratory at FORIG. Few experts exist to undertake wood density analysis; and the laboratory has inadequate facilities and lack modern equipment for wood density analysis.
Existence of Country-specific Allometric equations & Capacity	FORIG has undertaken preliminary development of country/ecozone-specific allometric equations for above ground and below ground biomass, based on some studies, including those within the FPP.
Existence of country-specific SOM & Capacity	Within the FPP soil analysis were undertaken: expertise exist within 3 Labs. of the Soil Research Institute of Ghana: Soil Chemistry and Mineralogy laboratory; Soil Data Repository Centre; and GIS and Remote Sensing Laboratory.
QA/QC	QA/QC are undertaken during field inventory and data processing, at different levels, in order to ensure that field measurements are reliable, to verify field data collected and to ensure that data entered into database is clean .
Capacity Development plan	Standard Operations Procedures (SOPs) have been developed

RS_GIS	Information obtained(Ghana)
Institutional arrangements	The Lead agency/unit for the Satellite monitoring system is the Resource Management Support Centre (RMSC) of the Forestry Commission, mandated by ACT 571 of 1999
Institutional Functioning/management	RMSC works in collaboration with Climate Change Unit (CCU) of the Forestry Commission, and the Center for Remote Sensing and Geographic Information Services (CERSGIS), mandated by Act 806 of the University of Ghana, and EPA, mandated by EPA Act (490). Roles & Responsibilities are clearly defined
Financial Autonomy	The three government agencies : CCU, RMSC and EPA receive some support from the central government, (salaries, office space etc.) but have limited support for RS and GIS tasks; which is mostly donor-driven (e.g. FCPF, CIF for CCU & RMSC; and GEF for EPA for NC to UNFCCC). CERSGIS generates their funds from contractual services and some donor-driven; so are autonomous
Human Capacity	Questionnaire indicates sufficiently trained staffs to undertake Remote Sensing and GIS. <b>RMSC</b> has 1 MSc in Geo-information science specialized in GIS and Remote sensing and 4 BSCs in Remote Sensing; <b>CERSGIS</b> has 1 PhD in Remote Sensing and Change Detection and 6 BSCs in Remote Sensing and data analysis; while <b>EPA</b> has 2 MSCs in Geo-information science that provide technical backstopping/support for GIS related tasks
Available data/information	
Infrastructure (equipment/laboratories)	No detail information was provided about Laboratories and Equipment RMSC: Computers ; Printers ;GIS server ;Lidar data ; ArcGIS ; Erdas Imagine ; PostgreSQL ; ArcSDE ; CCU: ArcGIS software ; ERDAS imagine software ; Computers ; Printers EPA : Computers ; Printers ; GIS software
Awareness of free satellite imagery	Good awareness of free satellite imagery, (citing Landsat, Google Earth, and GRID-Arendal (in collaboration with UNEP) – <a href="http://maps.grida.no">http://maps.grida.no</a> .)
Awareness of open source software for RS/GIS	Good awareness of open source GIS software (citing GRASS GIS, Quantum GIS., Open Foris – Collect Earth).
Existence of adequate Internet downloading facilities	Internet facilities for downloading satellite imagery are adequate
Data management and archiving	Yes: The RMSC of the FC hosts the main database / GIS server containing the national GIS information, forest inventory data. Workstations at RMSC are connected by Local Area Network (LAN) to the main database/ GIS servers. A back-up server has been placed at the Forestry Commission, headquarters in Accra. There is also a web server which holds data accessible to all registered persons (web address: <a href="http://www.fcforestinfo.gov.gh">www.fcforestinfo.gov.gh</a> ).
Existence of studies on land use change analysis	Yes, change detection studies have been undertaken using historical Landsat TM/ETM+ (30 m), ALOS AVNIR (10m resolution), DMC (22 m) and Lidar.
Knowledge of Image analysis /processing for land use change studies	Image processing using ArcMap and Erdas Imagine (during Forest Preservation Programme: FPP).
Approach to land use change detection “wall-to-wall” or sample-based	The Land representation uses <b>Approach 2</b> : Land use/transition matrices ( <b>Approach 2 of the IPCC</b> ).
QA/QC	Quality assurance and control (QA/QC) is undertaken during land use/land cover analysis
Capacity Development plan	SOPs have been developed

GHG Inventory	Information obtained(Ghana)
<b>Institutional arrangements &amp; permanence</b>	The Lead agency for the GHG Inventory for the LULUCF sector in Ghana is the Resource Management Support Centre (RMSC) of the Forestry Commission, mandated by ACT 571 of 1999.
<b>Institutional Functioning/ management</b>	<p><b>RMSC</b> works in collaboration with the EPA, (mandated by the EPA Act 490), which serves as the national focal point for Climate Change and NCs to the UNFCCC. The <b>Climate Change Unit (CCU)</b> of the Forestry Commission (also mandated by Act 571) coordinates all REDD+ activities and acts as the REDD+ Secretariat, and co-leads the compilation of GHG inventory data for the LULUCF sector.</p> <p>As part of national greenhouse gas inventory reporting obligations to the UNFCCC, four task groups have been formed with responsibility for finalizing the GHG inventory outputs from the various sectors. The task groups are as follows: 1. <b>Energy Sector</b> task group, 2. <b>Industry Processes</b> and Product Use task group 3. Agriculture, Forestry and Other Land Use (AFOLU) task group, 4. Waste sector task group</p> <p><b>For NC</b>, roles and responsibilities are clearly defined: e.g. EPA coordinates the work of the task groups, ensures that quality assurance and quality control is undertaken on the outputs from the task groups.</p> <p>The <b>AFOLU</b> task group has an overall responsibility for compiling GHG inventory data for the LULUCF sector as well as data for other agricultural activities (livestock, urea application, enteric fermentation etc.). This task group has representation from the National REDD+ Secretariat (Lead), Ministry of Food and Agriculture (co-lead), the RMSC (technical lead for estimating the GHG emissions), Academia and CSO.</p>
<b>Financial Autonomy</b>	The Units have not budgetary autonomy.
<b>Human Capacity</b>	<p>The questionnaire indicates that human capacity is low. The <b>RMSC</b> unit has 12 staffs, The <b>CCU</b> has 3 (1 in Environmental Science and 2 in) 2 BSCs in charge of REDD+ implementation, including GIS/MRV.</p> <p>3 MSCs in Geo-Information Science, in charge of providing technical backstopping/ support for GIS related tasks completed by the sectors.</p>
<b>Available data/information</b>	Not details provided
<b>Infrastructure (equipment /laboratories)</b>	Indicates same equipment as for NFI
<b>Data management and archiving</b>	<p>Data sharing: Ghana's EPA serves as a hub for assembling data from the various sectors including the AFOLU sector. The Environmental Data &amp; Information Management Department of EPA has put in place a central data storage server for the inventory data.</p> <p>A GHG inventory Central database was created as part of processes leading to the submission of Ghana's National Inventory Report in 2015. The database serves as a data management hub and archiving system for storage of all documented inventory information. However, the central database (<a href="http://www.epa.gov.gh/tnc">www.epa.gov.gh/tnc</a>) is currently down</p>
<b>Key Category Analysis</b>	<b>Key Category Analysis (KCA)</b> are undertaken to identify sources with significant influence on GHG inventory. The following KCAs were identified: CO <sub>2</sub> (from land converted to cropland; forest land remaining forest land; Land converted to forest land; and land converted to grassland); CH <sub>4</sub> (from emissions from biomass burning), and N <sub>2</sub> O (from emissions from biomass burning and emissions from managed soils). The method used was quantitative and at <b>Tier 2</b> level
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Under the Forest Preservation Programme (FPP), Ghana was able to develop a land use matrix for 3 epochs (1990, 2000 and 2010). This dataset was used for estimating activity data for the GHG inventory for the LULUCF sector for Ghana's National Inventory Report submitted to the UNFCCC in 2015. The emission factors for the land use categories were derived from annual biomass increment, biomass stocks in each land representations, the reference soil organic carbon stocks and their stock change factors according to land management. These elements for estimating the emission factors were also derived from the FPP inventory study

<b>QA/QC</b>	The <b>AFOLU</b> working group responsible for the LULUCF GHG inventory have responsibility for the QA/ QC procedures as outlined above. The EPA provides technical backstopping on the QA/ QC to the various sectors on the following fronts: <b>1.</b> Creating a checklist of QA/ QC procedures; <b>2.</b> Collecting and reviewing checklists for completeness, and following up when necessary to ensure that the required QA/ QC procedures were observed; <b>3.</b> Delivering all documentations to the online database manager; <b>4.</b> Facilitating all technical reviews at the national and international levels
<b>Capacity Development plan</b>	Existence of <b>SOPs</b>

## Guinea

<b>NFI</b>	<b>Information obtained (Guinea)</b>
Institutional arrangements	DNEF is responsible Institution for NFI. Database unit has been created within DNEF <a href="http://www.eaux-forêts.gouv.gn">www.eaux-forêts.gouv.gn</a>
Institutional Functioning/management	No other institution for Forest Inventory apart from DNEF
Financial Autonomy	Not mentioned
Human Capacity	Several staff (≈1504 staff) at DNEF with expertise in Forest inventory; but aging and require training of new generation on forest inventory and data analysis;
<b>Infrastructure (equipment/laboratories)</b>	Forest Inventory equipment is lacking
<b>Inventories undertaken</b>	Several inventories within projects
<b>Existence of PSPs/Status</b>	Some PSPs exist
<b>Variables measured for biomass/ carbon estimation*</b>	W.I undertook biomass assessment in 2004
<b>Data management and archiving</b>	Most inventory databases not available or were not archived; 7 technicians at DNEF received training on data management
<b>NTFPs and Biodiversity Indicators</b>	Not stated
<b>Existence of country specific WD &amp; capacity</b>	None, used CIRAD Data base
Existence of Country-specific Allometric equations & Capacity	None, except a few from project work
Existence of country-specific SOM & Capacity	None. SENASOL Lab has necessary capacities to undertake soil sample analysis
QA/QC	Not stated
Capacity Development plan	None existent

<b>RS_GIS</b>	<b>Information obtained(Guinea)</b>
Institutional arrangements	The DNEF, BCTT is responsible for satellite monitoring forest cover (by 2010 Order)
Institutional Functioning/management	Other institution is mandated to monitor forest cover include WARMY, CERE & IGN
Financial Autonomy	
Human Capacity	15 staffs, mostly engineers or forestry and mapping technicians at BCTT; and 42 experts in various areas of RS and GIS at WARMY
Available data/information	Maps & aerial photos of the 80s and 90s that need updating to reflect realities of Guinea
Infrastructure (equipment/laboratories)	BCTT has computers, GIS software & different types of satellite imagery (Landsat, SPOT, MODIS, ASTER images. BCTT lacks software for image processing; WARMY has computers, printers, GPS, scanners, plotters and Reception Station and image processing facilities from AMESD Project, and SPOT4 Imagery. BCTT lacks satellite station and database facilities
Awareness of free satellite imagery	Both BCTT & WARM Y not aware of free satellite imagery
Awareness of open source software for RS/GIS	Not mentioned
Existence of adequate Internet downloading facilities	BCTT lacks strong internet facilities
Data management and archiving	BCTT lacks adequate data management & archiving capabilities
Existence of studies on land use change analysis	2014 Vegetation maps produced by WARMY based on NDVI indices; no mention of land use studies
Knowledge of Image analysis /processing for land use change studies	Less skills in RS and image processing, more in GIS
Approach to land use change detection “wall-to-wall” or sample-based	Not mentioned
QA/QC	N/A
Capacity Development plan	N/A

<b>GHG Inventory</b>	<b>Information obtained(Guinea)</b>
<b>Institutional arrangements &amp; permanence</b>	DNE is in charge of GHG Inventory, and no institution specifically responsible for GHG_I in LULUCF sector
<b>Institutional Functioning/Mgt.</b>	No other institutions are in charge of GHG Inventories
<b>Financial Autonomy</b>	
<b>Human Capacity</b>	Staffs for compilation of GHG_I are drawn from various institutions: DNE, CERE, DNEF, National Directorate of Meteorology, DNA & WARMY.
<b>Available data/information</b>	First NC in 2002 used default IPCC values, with no country-specific data.
<b>Infrastructure (equipment /laboratories)</b>	Currently no laboratory or unit for compilation of GHG Inventory
<b>Data management and archiving</b>	No mechanism exist for data storage/archiving and sharing amongst institutions
<b>Key Category Analysis</b>	Not mentioned
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Not mentioned
<b>QA/QC</b>	Not indicated
<b>Capacity Development plan</b>	Not mentioned

## Guinea Bissau

<b>NFI</b>	<b>Information obtained (Guinea Bissau)</b>
Institutional arrangements	DGFF of MARD and IBAP attached to SEE are responsible for NFI in G. Bissau. IBAP mandated for monitoring of biodiversity in marine & terrestrial protected areas (financed by IUCN & GEF).
Institutional Functioning/management	There appears to be regular competition between IBAP and DGFF for financial and human resources. While DGFF maybe the legitimate institution for NFI management, there is need for both institutions to collaborate.
Financial Autonomy	No funds have been allotted for forest inventory from the Forest Development Fund of DGFF, so inventories rely on projects. IBAP is public institution with financial autonomy.
Human Capacity	Staff (forest engineers and technicians) at DGFF lack expertise to undertake forest inventories, and the several inventories are undertaken by international experts/consultancies.. SEE has expertise (foresters, land inventory specialists, GIS and RS experts), but still appeal for external support (e.g. CARBOVEG project). IBAP also seeks international experts for inventories.
<b>Infrastructure (equipment/laboratories)</b>	Most Forest Inventory equipment 9Hypsometers, calipers, GPSs, Compasses, Suunto Clinometers, soil augers,...) used by DGFF during IMFYE S.A. Inventory were missing after the inventory
<b>Inventories undertaken</b>	Three main inventories undertaken include one by SCET International (1978 through French Cooperation); second by Atlanta Consult (1985, through German Cooperation) and third by CARBOVEG (2011, through Portuguese Cooperation).
<b>Existence of PSPs/Status</b>	Temporary and permanent sample plots (CARBOVEG)
<b>Variables measured for biomass/ carbon estimation*</b>	Dbh, ht, tpha, basal area/ha, volume/ha, quadratic diameter, Natural regeneration, dead tree measurements, Wood density determination, foliage sampling...
<b>Data management and archiving</b>	Data sets for the SCET and Atlanta Consult Inventories are not available; that for CARBOVEG is available of project website
<b>NTFPs and Biodiversity Indicators</b>	None indicated
<b>Existence of country specific WD &amp; capacity</b>	None
Existence of Country-specific Allometric equations & Capacity	None
Existence of country-specific SOM & Capacity	None
QA/QC	None
Capacity Development plan	None



<b>RS_GIS</b>	<b>Information obtained(Guinea Bissau)</b>
Institutional arrangements	No legal institution responsible for RS_GIS, however, DGFF of MARD and DGDD of EES are coupling efforts for a GIS and RS lab, in partnership with AMESD Project, and support from AGRHYMET (hosted at SEE).
Institutional Functioning/management	-
Financial Autonomy	
Human Capacity	The equipment installed at MARD/SEE Lab, lacks expertise to run them;
Available data/information	IBAP has plan for forest and mangrove monitoring in G. Bissau (with manual on procedures). CARBOVEG project also generated data on forest areas (land cover: SCET International) and forest carbon stocks and changes. Mapping of existing forest types in G. Bissau for 1986, 1990, 1994, 1998, 2002 and 2007 Data from Inventory by ATLANTA CONSULT (1989)
Infrastructure (equipment/laboratories)	National lab for RS/GIS at MARD/SEE has equipment provided by AMESD Project, with installed system for reception, processing of satellite imagery; Other equipment from UNDP Project (3 Computers, a plotter A0, A scanner A0, a printer, 5 GPS, a PDA, an external Hard Drive, ArcGIS 10 licence); IBAP has a lab equipped with 4 workstations, printer, plotter, scanner A0, scanner A4, several vehicles, several GPS, ArcView & ArcGIS licenses.
Awareness of free satellite imagery	Not mentioned
Awareness of open source software for RS/GIS	Not mentioned
Existence of adequate Internet downloading facilities	Not mentioned
Data management and archiving	Country lacks centralized data mgt and archiving systems for geo-spatial data
Existence of studies on land use change analysis	Four classification systems indicated, two of which were used by Atlanta Consult and CARBOVEG. They need to be harmonized for the national territory.
Knowledge of Image analysis /processing for land use change studies	Not mentioned
Approach to land use change detection “wall-to-wall” or sample-based	None
QA/QC	None
Capacity Development plan	None

<b>GHG Inventory</b>	<b>Information obtained(Guinea Bissau)</b>
<b>Institutional arrangements &amp; permanence</b>	<b>No specialized institution for GHG Inventory. Staff selected to undertake NC based on their expertise from various institutions, and coordinated by Head of National Commission for Climate Change in SEE</b>
<b>Institutional Functioning/Mgt</b>	Not mentioned
<b>Financial Autonomy</b>	Not mentioned
<b>Human Capacity</b>	Few to no staffs are specialized in GHG Inventories. Experts are temporary selected from various institutions for the NC production, hence there is no sustainability in GHG Inventory skills.
<b>Available data/information</b>	
<b>Infrastructure (equipment /laboratories)</b>	Indicates available equipment and infrastructure to undertake GHG Inventory with desired rigour, but there is lack of trained staff.
<b>Data management and archiving</b>	Virtually no archives on GHG Inventory, however, a data management and archiving system was proposed by the Working Group. Data used is based on default IPCC values and FAO.
<b>Key Category Analysis</b>	Not mentioned
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Not mentioned
<b>QA/QC</b>	Not mentioned
<b>Capacity Development plan</b>	Not mentioned

## Liberia

<b>NFI</b>	<b>Information obtained (Liberia)</b>
Institutional arrangements	The Forestry Development Authority (FDA) is the lead institution in charge of forest inventories, mandated by the FDA Act of 1976 and the 2006 National Forest Reform Law.
Institutional Functioning/management	FDA undertakes inventory activities in collaboration with LISGIS. Other institutions include, the Department of Forestry, University of Liberia
Financial Autonomy	Both the University of Liberia and the Forestry Development Authority are autonomous agencies with financial resources dedicated by government for training and managing forest resources in Liberia including forest inventory.
Human Capacity	FDA has no staff specialized in Forest Inventory. However, Department of Forestr, University of Liberia has 3 MSc ( in Forest Biometrics & Mgt; Forest Mgt, Forest Governance, MA Natural resource Economics), and 1 PhD/Prof. Forest Sampling, Inventory and Statistics
<b>Infrastructure (equipment/laboratories)</b>	No forest inventory equipment. Questionnaire indicates: Hand Lenses (2 pcs), GPS (2 pcs), Meter Tape (50m) (4 pcs), Compass (4 pcs)
<b>Inventories undertaken</b>	Not indicated in Questionnaire, but NFI in 1968?? Was undertaken.
<b>Existence of PSPs/Status</b>	Also PSPs established by LFR Project in 2005; another NFI in 1968
<b>Variables measured for biomass/ carbon estimation*</b>	None
<b>Data management and archiving</b>	Not described
<b>NTFPs and Biodiversity Indicators</b>	Not described
<b>Existence of country specific WD &amp; capacity</b>	None mentioned
Existence of Country-specific Allometric equations & Capacity	None Mentioned
Existence of country-specific SOM & Capacity	None mentioned
QA/QC	None mentioned
Capacity Development plan	None mentioned

<b>RS_GIS</b>	<b>Information obtained(Liberia)</b>
Institutional arrangements	The lead institution for SLMS is the Liberia Institute of Statistics and Geo-Information Services (LISGIS) created by 2004 Act
Institutional Functioning/management	LISGIS works with the Forestry Development Authority (FDA), GIS & Remote Sensing Unit created by The 1976 Act of the FDA and the 2006 Forestry Reform law
Financial Autonomy	No financial autonomy
Human Capacity	Insufficient staffing, with only 2 BSc Forestry , and 2 Certificate level staffs
Available data/information	
Infrastructure (equipment/laboratories)	Insufficient equipment: One laptop, one printer and 3 desktops
Awareness of free satellite imagery	None awareness of open source satellite imagery
Awareness of open source software for RS/GIS	None awareness of open source GIS Software
Existence of adequate Internet downloading facilities	Internet exist but insufficient bandwidth for downloading
Data management and archiving	Not clearly described
Existence of studies on land use change analysis	Recent studies by GeoVille; earlier ones by ... and Chevalier (2004)
Knowledge of Image analysis /processing for land use change studies	Land use/Land cover study by Agrehmet using SPOT, ASTER (written HSTER) and LANDSAT  No evidence of country staff knowledge in image analysis/processing
Approach to land use change detection “wall-to-wall” or sample-based	No indications made
QA/QC	No indications made
Capacity Development plan	No indications made

<b>GHG Inventory</b>	<b>Information obtained(Liberia)</b>
<b>Institutional arrangements &amp; permanence</b>	The EPA is responsible for overall coordination and compilation of the GHG inventory for LULUCF
<b>Institutional Functioning/ management</b>	Other agencies and ministries such as the Forestry Development Authority, Ministry of Agriculture, Liberia Statistics and Geo-Information Services and the Ministry of Lands, Mines and Energy conduct assessment, provide, compile and manage data
<b>Financial Autonomy</b>	No financial autonomy
<b>Human Capacity</b>	1 Technician in Forestry, 1 BA in Sociology, 2 BSc's (1 in Forestry, 1 in GIS); 3 MSc's in Forestry, Environmental Mgt & Sustainable Dvpt.1 MSc in Forestry, 1 MSc in Biodiversity Conservation, 1 MA/MBA in Economics; M&E
<b>Available data/information</b>	
<b>Infrastructure (equipment /laboratories)</b>	None mentioned
<b>Data management and archiving</b>	None mentioned
<b>Key Category Analysis</b>	Key category analysis undertaken at Tier 1 level
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Not mentioned
<b>QA/QC</b>	Not mentioned
<b>Capacity Development plan</b>	Not mentioned

## Nigeria

<b>NFI</b>	<b>Information obtained (Nigeria)</b>
Institutional arrangements	The Forest Resource Assessment, Federal Department of Forestry has the mandate to undertake forest inventories, backed by the National Forest Policy
Institutional Functioning/management	No other institution has this mandate; however, the FDF works with State Forest Departments and relevant Academic institutions to undertake forest inventories.
Financial Autonomy	No financial autonomy
Human Capacity	FDF have sufficient technical staff to undertake forest inventories; however, many of the Technicians are at the state levels. The Head of Unit has MSc Environmental Mgt including four additional with BScs, while most of the technicians are at the state levels.  - Within UN REDD Programme, the capacities at Federal and CRS level has been enhanced through NFI and RS capacity building workshops.
<b>Infrastructure (equipment/laboratories)</b>	Computer hardware and software and peripherals: At Federal Level: 1 HP Prollant Server, 10 Workgroup Computers, 1 Scanner A0, 1 Scanner A4, 1 Plotter A01 Photocopy machine, 1 A4 Printer, (Laserjet) 1 A3 Printer (Deskjet), 1 Projector <b>Software:</b> ArcGIS 10 Concurrent Use License (10 systems), Windows server 2008, Microsoft SQL Server 2008 Rc2 <b>WEB-BASE</b> Intranet, Website ( <a href="http://www.nfis.gov.ng">www.nfis.gov.ng</a> ) CRS Level: RS/GIS Lab equipped with: 1 A4 scanner HP, 12 Desktops HP, 3 Laptops HP, 1 Server HP, 2 Colour Printers (Deskjet) HP, 13 UPS, 1 Projector LG . <b>Complete Forest Carbon Inventory equipment procured within UN REDD Programme</b>
<b>Inventories undertaken</b>	Forest Carbon Inventory at CRS within the UN REDD Programme, and GCF Support. Preliminary work was done by Winrock with GCF Funds.
<b>Existence of PSPs/Status</b>	PSPs exist (cf. Lowe ..) but most of them have been abandoned
<b>Variables measured for biomass/ carbon estimation*</b>	
<b>Data management and archiving</b>	Forest inventory database exist at Federal Department of Forestry.
<b>NTFPs and Biodiversity Indicators</b>	
<b>Existence of country specific WD &amp; capacity</b>	None, but on-going work at university (FUTA) to collect wood density data
Existence of Country-specific Allometric equations & Capacity	Country-specific volume allometric equations exist, but few biomass allometric equations for plantation species
Existence of country-specific SOM & Capacity	None
QA/QC	None described
Capacity Development plan	Within UN REDD Programme capacity building has been undertaken.

<b>RS_GIS</b>	<b>Information obtained(Nigeria</b>
Institutional arrangements	The lead institution for remote satellite land monitoring system is the (NASRDA) mandated by the National Space Research and Development Agency Act, 2010
Institutional Functioning/management	Other Institutions include National Centre for Remote Sensing (NCRS), JOS; and Centre for Space Science & Technology Education (CSSTE), ILE-IFE; Also The Forestry Geographic Information System (FGIS) Unit works in collaboration with the NASRDA. The GIS Laboratory at CRS.
Financial Autonomy	The NASRDA, FGIS receive allocations from the Federal Government, although not insufficient for their operations. The RS/GIS Laboratory in CRS is supported by the UNREDD Programme.
Human Capacity	Sufficient human capacity in the area of remote sensing and GIS in NARSDA; with more than 4 PhD holders in RS/GIS/Environmental mgt. The Forestry Department's RS/GIS Unit has one MSc, one PGD and three BScs while the RS/GIS Laboratory in Cross River State has one MSC, Two BScs and four technicians. Several staffs in University institutions with RS/GIS labs. at NCRS, JOS; and CSSTE, IFE
Available data/information	
Infrastructure (equipment/laboratories)	NARSDA, has A0 plotter, over 20 computers/laptops, 1 A0 scanner, and Landsat imagery (Landsat, SPOT, NigeriaSat,), and software including open source software (QGIS, ILWIS).
Awareness of free satellite imagery	Yes, aware of the availability of free Landsat Imagery
Awareness of open source software for RS/GIS	Aware of open source GIS software (QGIS. ILWIS)
Existence of adequate Internet downloading facilities	Has sufficient band wide for satellite imagery downloads
Data management and archiving	NASRDA has an archiving system, at the ICT Department as well as on a Ground Station Facility
Existence of studies on land use change analysis	Yes, Drivers of deforestation and several sample based land use studies (cf. review for UN REDD Programme)
Knowledge of Image analysis /processing for land use change studies	Yes, sufficient knowledge of image processing and interpretation
Approach to land use change detection "wall-to-wall" or sample-based	Used approaches 1, 2 and 3
QA/QC	
Capacity Development plan	Capacity development has been implemented within the UN REDD Programme

<b>GHG Inventory</b>	<b>Information obtained(Nigeria)</b>
<b>Institutional arrangements &amp; permanence</b>	The lead agency for GHG is the Department of Climate Change (DCC), mandated by the National Climate Change Policy Document. The Federal Department of Forestry (FDF) is responsible for GHG Inventory for the LULUCF sector, mandated by the National Forest Policy Act, , and jointly undertakes it with the National REDD+ Secretariat.
<b>Institutional Functioning/ management</b>	The Department of Climate Change (DCC) is responsible for compilation and submission of of both the NC and BUR to the UNFCCC, and depends on Federal Department of Forestry (FDF) for information on the LULUCF sector
<b>Financial Autonomy</b>	Agency has insufficient funds and lack budgetary autonomy
<b>Human Capacity</b>	3 staffs with MSc and 2 staffs trained and received technical capabilities and in-depth knowledge on the generation of a National GHG inventory and the calculation of emissions and removals estimations for AFOLU sector through course of the “Capacity Building for REDD+ II” project (CD-REDD II)
<b>Available data/information</b>	
<b>Infrastructure (equipment /laboratories)</b>	2 Computers, 1 Printer, 1 Server and IPCC Software
<b>Data management and archiving</b>	No existing data management and archiving system but indicates that the National GHG Inventory System (NGIS) will provide a sustainable system to collect, archive and process data for National GHG Inventories as well as data storage and retrieval system
<b>Key Category Analysis</b>	Key category analysis undertaken at Tier 1 level. Qualitative method
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Not mentioned
<b>QA/QC</b>	None indicated
<b>Capacity Development plan</b>	Not mentioned



## Sierra Leone

<b>NFI</b>	<b>Information obtained (Sierra Leone)</b>
Institutional arrangements	The Lead agency/unit for the NFI is the National Protected Area Authority (NPAA), mandated by the NPAA Act of Parliament
Institutional Functioning/management	No other institution indicated
Financial Autonomy	NPAA is newly created and ex it is expected to have financial autonomy
Human Capacity	No sufficient staff at NPAA. Same staff as for RS/GIS: the Head of NPAA (Dr. Kolleh Bangura: Environmental Mgt), Mrs Kate Garnet (Director: forester) and Mr Amos Diggay Kamara [The authority needs assistant in the training of personnel on the 2006 IPCC Inventory Guidelines]
<b>Infrastructure (equipment/laboratories)</b>	No equipment indicated
<b>Inventories undertaken</b>	609 fixed-area nested circular permanent sample plots (PSPs) have been established in the forest for monitoring changes in biomass
<b>Existence of PSPs/Status</b>	609 PSPs in Gola Rainforest National Park
<b>Variables measured for biomass/ carbon estimation*</b>	Dbh, ht, deadwood, biomass estimates
<b>Data management and archiving</b>	Data base on Excel
<b>NTFPs and Biodiversity Indicators</b>	None indicated
<b>Existence of country specific WD &amp; capacity</b>	None indicated
Existence of Country-specific Allometric equations & Capacity	None indicated
Existence of country-specific SOM & Capacity	None indicated
QA/QC	QA/QC done for Gola forest inventory
Capacity Development plan	

<b>RS_GIS</b>	<b>Information obtained(Sierra Leone)</b>
Institutional arrangements	The Lead agency/unit for Remote sensing/GIS is the Meteorological Department, mandated by The Met. Dep. Act of 1961
Institutional Functioning/management	
Financial Autonomy	No information provided
Human Capacity	No sufficiently trained staff. Staff include: Head of NPAA (Forestry/REDD+), Director (forester) and Asst. Director: Forester). No technical staff indicated 1 GIS Advisor
Available data/information	
Infrastructure (equipment/laboratories)	EUMETSAT/METEOSAT Satellite images of National Vegetation Index, Land area mapping of small water bodies and wide fires
Awareness of free satellite imagery	None indicated
Awareness of open source software for RS/GIS	None indicated
Existence of adequate Internet downloading facilities	None
Data management and archiving	None indicated
Existence of studies on land use change analysis	None indicated
Knowledge of Image analysis /processing for land use change studies	None indicated
Approach to land use change detection “wall-to-wall” or sample-based	Approach 1.
QA/QC	None indicaed

<b>GHG Inventory</b>	<b>Information obtained(Sierra Leone)</b>
<b>Institutional arrangements &amp; permanence</b>	There is no Lead agency/unit for the GHG Inventory for the LULUCF sector. Questionnaire indicates that there are plans to establish one [The <b>Ministry of Transport and Aviation</b> acts as the Focal Point for the United Nations Framework Convention on Climate Change (UNFCCC) and coordinates the activities of both the NPAA-SL, MLCPE and the EPA-SL during the compilation of the GHG inventory for the National Communications]
<b>Institutional Functioning/Mgt</b>	
<b>Financial Autonomy</b>	No financial autonomy
<b>Human Capacity</b>	No sufficiently trained staff. no sufficiently trained staffs at NPAA-SL. Three staffs mentioned: Head of NPAA, Director and Assistant Director. Two staffs are cited at the MLCPE: Director of Environment: and Deputy Director. And at EPA-SL two staffs are enlisted: Director and Assistant Director
<b>Available data/information</b>	
<b>Infrastructure (equipment /laboratories)</b>	NPAA-SL: Computers equipped with the GHG 1996 Inventory Software and GPS; MLCPE: Computers, GPS, Personnel; EPA-SL: Computers, GPS and Personnel
<b>Data management and archiving</b>	The Meteorological Dept. of the Ministry of Transport and Aviation, Ministry of Agriculture, Forestry and Food Security (MAFFS) Planning Division and Statistics Sierra Leone, share data with relevant organisations for the needed service delivery
<b>Key Category Analysis</b>	Not indicated
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	
<b>QA/QC</b>	
<b>Capacity Development plan</b>	

## Togo

<b>NFI</b>	<b>Information obtained (Togo)</b>
Institutional arrangements	FEDOS and FDD of MERF are responsible for conducting forest inventories.
Institutional Functioning/management	RFD is responsible for evaluation of forest resources for wildlife monitoring...
Financial Autonomy	
Human Capacity	Expertise difficult to assess because there is no unit assigned to undertake NFI. FEDO and DRF staff includes foresters with experiences in forest inventories, field data collection, data processing, analysis and reporting. Staff training has been provided by Deutsche Forest Service GmbH (DFS) to 3 teams and since september 2015, data collection has been undertaken on about half of the 1000 plots envisaged. Only one of the team leaders is from MERF (other Expatriates??).
<b>Infrastructure (equipment/laboratories)</b>	GIZ ProREDD has procured equipment for NFI at MERF, including 2 \$x4 Vehicles, maps, NAVSTAR GPS 12 for location of field sample plots (GARMIN GPS 64 s), precision compasses and clinometers, (Suuntos: KB-14/360; Suunto PM-5/360 PC), distance measurement tapes, d-tapes, telescopic poles, cameras with GPS function (RICOH WG – 4), binoculars etc..
<b>Inventories undertaken</b>	GIZ ProREDD NFI being undertaken since September 2015. Stratified random sampling of 1000 PSPs.
<b>Existence of PSPs/Status</b>	1000 plots to be made permanent for eventual re-measurements
<b>Variables measured for biomass/ carbon estimation*</b>	ProREDD NFI will measure/assess dbh, tree height, volume of main stem, stem biomass, branch biomass, twigs and leaves, wood biomass for dead wood, ntfs and data to produce biodiversity indices.
<b>Data management and archiving</b>	ProREDD strives to identify an institution to be responsible for long term management of NFI and hence to host the database and archives of NFI. Data sharing mechanism (e.g. MoU) needs to be established between relevant institutions
<b>NTFPs and Biodiversity Indicators</b>	Not indicated
<b>Existence of country specific WD &amp; capacity</b>	Not indicated
Existence of Country-specific Allometric equations & Capacity	Not indicated
Existence of country-specific SOM & Capacity	Not indicated
QA/QC	Not indicated
Capacity Development plan	Not indicated

<b>RS_GIS</b>	<b>Information obtained(Togo)</b>
Institutional arrangements	Several national institutions have been identified (see below) and will be coordinated by FEDOs in the implementation of national forest monitoring system
Institutional Functioning/management	Several GIS and RS institutions (e.g. FEDOS, ANGEL, FDD, Environment Directorate (DE)) under MERF “tutelage”) and DGC, LBEV, UL and NGOs have been identified as part of the monitoring system under ORDER No. 94/MERF, coordinated by FEDOS
Financial Autonomy	Lack of financial resources stated
Human Capacity	Satellite image processing and analysis skills are scattered in various institutions. Several capacity building projects (e.g. GIS by ITTO, GEOFORAFRI by IRD), ProREDD by GIZ) have helped enhanced capacities through training.
Available data/information	No satellite acquisition stations, difficulties downloading imagery.
Infrastructure (equipment/laboratories)	FEDOS is being supported by IMIS of ITTO project and GEOFORAFRI or IRD in the procurement of equipment, including 14 desktops, 2 laptops, 5 external hard drives, 8 licenses for MS Office 2010, 8 licenses for ENVI, 4 licenses for ArcGIS, 2 GPSs (Garmin), GPS Trumble Gino, 1 printer A0, 4 printers A4, 11 images RapidEye (2013/2014), 4 images SPOT 2014 and free Landsat images.
Awareness of free satellite imagery	Indicates the use of free Landsat imagery
Awareness of open source software for RS/GIS	Mentions need for QGIS and other open source software
Existence of adequate Internet downloading facilities	Difficulties downloading imagery at FEDOS
Data management and archiving	No centralized database for management and archiving of geo-spatial and satellite images.
Existence of studies on land use change analysis	Land use mapping and forest stratification undertaken within the ProREDD project for NFI using <i>RapidEye</i> high resolution imagery.
Knowledge of Image analysis /processing for land use change studies	Image processing skills were low in FEDOS in 2013 (GEOFORAFRI Assessment), but capacity building has been offered to 28 technicians from FEDOS. 4 Executives trained specifically on image processing using ENVI
Approach to land use change detection “wall-to-wall” or sample-based	Not indicated
QA/QC	Not indicated
Capacity Development plan	Not indicated

<b>GHG Inventory</b>	<b>Information obtained(Togo)</b>
<b>Institutional arrangements &amp; permanence</b>	DE of MERF is responsible for national communications to UNFCCC. A coordinator and financial and administrative assistant are responsible for coordinating the preparation of NC and transmission to UNFCCC. The unit provides planning and management of the process of compilation of GHG Inventory for all sectors.
<b>Institutional Functioning/ management</b>	During preparation of first three national communications, assistance was requested from University of Lome for its preparation. Hence no institutional continuity is ensured; but is however, underway, with formal assignment of roles and responsibilities for different sectors of the report.
<b>Financial Autonomy</b>	None
<b>Human Capacity</b>	Not indicated
<b>Available data/information</b>	Not indicated
<b>Infrastructure (equipment /laboratories)</b>	There is no lab, unit or database for the compilation of GHG - I process. They are specifically recruited consultants that develop national communications and manage data with their own equipment.
<b>Data management and archiving</b>	Not indicated
<b>Key Category Analysis</b>	Not indicated
<b>Knowledge in Compilation of AD &amp; EF for LULUCF sector</b>	Not indicated
<b>QA/QC</b>	Not indicated
<b>Capacity Development plan</b>	Not indicated