Framework for National Forest Monitoring System

2018

Ghana Forestry Commission

Forestry Commission

Content

1.Introduction

1.1 Background

REDD+ is a forest mitigation strategy for forest-rich developing nations. Ghana has been active in the REDD+ space when it was first introduced in 2008. Since then, the REDD+ programme has evolved from the readiness stage, where the overall policy and governance arrangements developed under Forest Carbon Partnership Facility (FCPF). The REDD+ readiness processes sets out the woodwork for the demonstration and the result-based payment stages to kick-in. The roll-out of the Forest Investment Programme (FIP) and Dedicated Grant Mechanism (DGM) is to prepare the grounds for the full take-off of results-based payment (RRP) REDD+. During the RRP stage, the implementation of the REDD+ scheme, with the involvement of private sector, will be beneficial to forest management, sustainable development and reducing greenhouse gases.

Forest Reference Level (FRL) and National Forest Monitoring System (NFMS) are integral element results-based REDD+ schemes (UNFCCC 2014, 11/CP.19). Generally speaking, the aim of establishing FRL is to construct a baseline upon which the information, generated through NFMS on effectiveness and the benefits from REDD+ interventions would be measured against. The benefits are in the areas of GHG emission reductions, ensuring environmental integrity and social safeguards. FRL and NFMS are essential tools for demonstrating transparency and accountability credentials of Ghana's REDD+ scheme. Nevertheless, both of them have not received equal attention at the national level. The development FRL was finalised in 2016 after which it is being subjected to Technical Assessment (TA) within the UNFCCC process. The TA process is over and the final version of the Technical Assessment Report is yet to be officially published. The publication of the FRL marks the official approval of Ghana's emission on which to measure REDD+ performance against. On the other hand, not much concrete efforts have been made on NFMS.

Mostly, only a few of pockets of NFMS works exist within government and other players in the REDD+ industry. Therefore, the Forestry Commission has initiated to establish and operationalise an integrated NFMS as an information management hub of its results-based REDD+ programme. The strategy of establishing Ghana's NFMS is not to start afresh as if nothing is in place on REDD+ information management but to build on existing systems. Another strategy is to design an NFMS to enable the different assessment options of land-cover category and Social/Environmental Safeguards at the national, jurisdictional and project levels. The design of the NFMS would also be flexible and foster continuous improvements in the functionality in phased-approach. So, the first step in the design of the NFMS is to conduct a review into the existing NFMS initiatives to understand how it is working and the opportunity for entry points.

1.2 Review of existing NMFS initiatives

1.2.1 Mapping capabilities and Emission factor datasets

Even though the strategy for developing the NFMS is to build on existing related systems, it is important to recognise that the existing national forest monitoring platforms are at different development stages and has a special focus. For example, in the recent past, a number of donors have collaborated with the Forestry Commission's Resource Management Support Centre (RMSC) to establish a spatial infrastructure for forest monitoring. But broadly, the RMSC spatial infrastructure focuses on monitoring forest areas other than the entire landscape. Through the Forest Preservation Programme (FPP), RMSC was equipped to enhance its forestry monitoring capacity. The Remote Sensing/GIS Unit of the RMSC was supplied GIS equipment and software and was followed up with training. So, the RMSC as the mapping wing of the Forestry Commission has the capacity to adequately map the dynamics in Forest Reserves areas. They have GIS layers of the Forest Reserve boundaries, yield maps and land-cover maps of selected forest reserves, years and regularly update them as and when resources are made available.

The RMSC has also been able to produce land-cover maps for 1990, 2000, 2012, 2015 and currently working on one for 2017. Even though these maps can be used to generate deforestation and individual maps are not updated regularly so as to get new deforestation rates. Presently, the RMSC the land-cover maps are based on the six IPCC classes, of which only forestland category has been sub-divided into closed forest and open-forest. The rest do not have further divisions. Besides, on the currently available maps, tree crops are not separated from other vegetation for a number of reasons. A classic case example is the ability to isolate cocoa from natural forest. At this stage, the technological challenge of not aptly delineating cocoa from the forest is due to the limitation of optical-based remote sensing images to detect cocoa due to the double-canopy structure. As a result, during mapping, tree crops (like matured agroforest cocoa plantation), especially those that have similar spectral characteristics as the natural forest, are bunched into open forest areas. With this practice, it is not possible to associate deforestation with the expanding cocoa farm because they not isolated from other vegetation.

Biomass can be generated using remote sensing and field-based approach. Around 2011, the first the biomass map NCRC produced was satellite-based but since then the biomass has not been updated. The updates would require getting a new satellite and fresh ground-truth dataset. Again during the forest preservation programme, the RMSC led a team to undertake a comprehensive assessment of biomass inventory in the dominant IPCC land-categories in 2013. Since then the carbon stocks figures have not been updated even though some permanent sampling plot (PSPs) have been established in the forest reserve in the early 80s. Looking at the current state of the way biomass dataset is collected it is evident that the whole

Forest Inventory architecture needs another relook in terms of its coverage and the way data is managed. The reason is that at the time the network of permanent sampling plots was established the attention was more on gathering yield and volume data to inform timber utilisation planning. Nowadays, forestry inventory is a critical data source for carbon stocks assessment. In order to make the existing Forest inventory system relevant to the NFMS, the current structure needs serious reforms. The old PSPs need to be revived and new ones must be established. The sampling frequency of the PSPs must be regular and has a well-managed database. Apart from the Forestry Commission, most of the players in the Cocoa industry have some form of monitoring system in place. The Ghana Cocoa Board already have GIS platform that host majority of the spatial and attribute data on cocoa farms even though that dataset is not publicly available. Not only are the data on cocoa farms and the area change valuable to the NFMS but the GIS system they are hosted in can be an integral part of the whole NFMS architecture. Another important feature of the existing land-cover mapping, majority of them are prepared through one off exercise under projects. There is no consistent monitoring and updates of the existing land-cover maps. Some of the dataset generation under the existing NFMS is redundant and little value-addition. Table 1 presents an overview of some selected NFMS systems.

Table 1: Overview of functionalities of existing NFMS

Existing NFMS system	Institutional owners	Data Supply /Data system	Remarks/Status	Link to specific component of NFMS
National Forestry Inventory System	Forestry Commission (Production Unit of the RMSC)	• Permanent Sampling Plots (PSPs) • Biomass and Biomass Growth Dataset	• Spatial coverage of PSPs limited to Forest Reserves. • Regular monitoring of biomass has ceased and no longer useful due to the poor state of the PSPs • Data storage and format need to be clarified. • PSPs dataset do not cover all the carbon pools. • There are plans to revive and expand PSPs.	NFMS Component: GHG Inventory. Indicator: Emission/Removal Factors.
	Forest Services Division, FC	• Forestry plantation areas, average heights, DBH, survival survey, stocking.	• Focused on on-reserve areas with planted forest across the country • Annual Published of National Forest Plantation Development Programme.	
Land use/cover mapping	Forestry Commission (GIS/Remote Sensing Unit of the RMSC)	• GIS layers of all forest/wildlife reserve boundaries. • Land cover maps (1990, 2000, 2010, 2012, 2015).	• GIS layers are used to produce timber yield maps and for regular updates. • GIS layers are also used to inform the development of forest management plans • Land cover map were produced in a one off exercise during FPP and during the preparation of the FRL. • In the current land cover map, tree crops (cocoa, rubbers, citrus, etc.) are not spatially isolated. It is been bunched into the forest category.	NFMS Component: GHG Inventory Indicator: Activity Data

			• Land-cover maps are not produced at regular interval. Funding for most of them are from Projects. • Plans to prepare a new Land cover map for 2017.	
	CERSGIS	• National land-cover map (2000). • Land cover maps prepared specifically for selected areas in the country. • Forest degradation maps for selected Forest Reserve (2018)	• Most land-use maps are produced on demand. • Limited in scale and focussed on specific areas of interest. • Forest degradation maps show extent of degradation but do not show the type of activity responsible for the degradation.	NFMS Component: GHG Inventory Indicator: Activity Data
Other GIS Layers	Forestry Commission (GIS/Remote Sensing Unit of the RMSC)	• Fires Affected Areas	Fire affected areas is non-spatial format. Affected area contained in the Annual Report on Monitoring and Evaluation of Wildfire Incidents across the country.	NFMS Component: GHG Inventory Indicator: Activity Data
	Lands Commission (Survey Department)	• National boundary Map • District boundary Map • River Map • Road Map • Settlement Map • Forest Reserve • Ecological Layers • Land-cover classification scheme	• All the maps are produced once but are seldom updated. • District boundary maps are updated when new Administrative areas are delineated. • There is no standard land-cover classification code.	NFMS Component: GHG Inventory, Social and Environmental Safeguards Indicator: Activity Data, Biodiversity, Water Quality
	Soil Research Institute, CSIR	• National soil map	• Existing national soil map are at “association classification” scale. • There are plans to update the National Soil Maps	NFMS Component: Social and Environmental Safeguards. Indicator: Soil Quality
	Cocobod	• Maps of cocoa growing areas. • Shapefile of individual cocoa farms.	• Maps of cocoa growing areas is available not updates. • Compilation of Shapefile of individual farms are still on-going.	NFMS Component: GHG Inventory Indicator: Activity Data
	Ghana Rubber Company Limited	Shapefile of GREL Plantation.	Unknown. Need to check from the institution	NFMS Component: GHG Inventory Indicator: Activity Data
	GPODC	Shapefile of GPODC Plantation.	Unknown. Need to check from the institution	NFMS Component: GHG Inventory Indicator: Activity Data
Data Management & Registry	University of Energy and Natural Resource	Base station for earth observation data	Unknown. Need to check from the institution	NFMS Component: GHG Inventory Indicator: Activity Data

	Forestry Commission , ICT (SIS Data)	• Depository of all REDD+ safeguard data • Interface for communicating feedback	Safeguard Information System (url – www.reddsis.fcghana.org) is still under development. Hope to be completed when fully populated with requisite safeguard data. Principles Criteria and indicators are being defined.	NFMS Component: Social and Environmental Safeguards Indicators: Resource use right, Participation and Cultural Heritage
	Forestry Commission , ICT and Climate Change Unit (Registry)	• Database of Emission transactions and cash flows. • Data on emission reduction at the jurisdictional scale.	Information /database system developed and shall be upgraded a REDD+ registry (https://www.ghanaredddatahub.org	NFMS Component: Registry Indicator: ERs, Non-ERs and Transactions
	Forestry Commission, Timber Validation Department	Wood tracking system which is a repository of data on (Tree information Form, Log Information, yield allocation, TUCs,) etc.	Wood tracking system is operational and will be used to issue FLEGT license to check the chain of custody of wood products.	NFMS Component: Registry Indicator: Non-ERs
	Environmental Protection Agency	• Provide data on economy-wide national GHG inventory, NDC, PAMs, Project Registry and GCF.	Fully deployed on the url: http://climatedatahubgh.com/gh/ Plan to upgrade to include tracking of actions in the Nationally Determined Contribution.	NFMS Component: Registry Indicator: ERs and Non-ERs
	Olam farmer information system	• Enable better understanding of farmer community to invest appropriately and measure improvements. • Promote traceability and transparency	Fully deployed on web address: "http://olamgroup.com/sustainability/ofis/	NFMS Component: Registry Indicator: ERs and Non-ERs
	World Resource Institute	• Global forest watch pro.	Under construction. Url www.proglobaloforestwatch.org	NFMS Component: Registry Indicator: ERs and Non-ERs
	Cocobod	Unknown. Need to check from the institution	Unknown. Need to check from the institution	NFMS Component: Registry Indicator: ERs and Non-ERs
	CERGIS/Parliament	E-mapping and monitoring system for development activities	http://ghemms.cersgis.org/map/	NFMS Component: Registry Indicator: Non-ERs
Manuals	FC, Climate Change	Using twelve Standard Operating Procedures to LULUCF Carbon Accounting	SOPs are adopted but not in operations	NFMS Component: GHG Inventory Indicator: Activity Data
		Ghana Forest Reference Level Guidance Document and Recommendation	Ghana Forest Reference Level Guidance Document and Recommendation in use.	NFMS Component: GHG Inventory Indicator: Activity Data
	FC, FSD	Manual of Procedures (MOP)	MOP for Forest Resource Management	NFMS Component: Social and Environmental Safeguards.

				Indicator: Biodiversity,
	EPA	GHG Inventory Manual and Uncertainty Management	In use for planning, implementation and management of national GHG inventory	NFMS Component: GHG Inventory Indicator: Activity Data & Emission Factors.
Social and Environmental Data	Ghana Statistical Service	Ghana Living Standard Survey (GLSS). Household, Poverty and Livelihood data nation-wide National Population Census Data	GLSS contains poverty and livelihood data at the household level is normally published at five-year interval. The seventh round of the GLSS7 is expected to be released by the end of 2018. National population census is published at roughly 10 year intervals.	NFMS Component: Social and Environmental Safeguards Indicators: Resource use right, Participation and Cultural Heritage
	EPA	Strategic Environment Assessment (SEA)	SEA is perfumed on selected policies, programmes and plans included REDD+ strategy. Administration of SEA is backed by NPDC Act.	NFMS Component: Social and Environmental Safeguards Indicators: Resource use right, Participation and Cultural Heritage, Biodiversity, Soil Quality, Water Quality
	EPA	State of the Ghana's Environment (SOE)	Published when EPA is able to secure funding. SOE give snapshot of current status of built and natural environments and provides outlook of Ghana's Environment in the coming years.	NFMS Component: Social and Environmental Safeguards Indicators: Resource use right, Participation and Cultural Heritage, Biodiversity, Soil Quality, Water Quality
International Reporting	EPA	Biennial Update Report (BUR) National Communication (NATCOM)	Climate report submitted to UNFCCC every 2 year (BUR) and every 4 year (NATCOM). Annex to BUR can be REDD+ technical Annex. REDD+ Safeguards information can be reported through NATCOMS. Ghana's Second BUR will be submitted to UNFCCC in 2018 Ghana's Fourth NATCOM will be submitted to UNFCCC in December, 2019	NFMS Component: GHG Inventory Indicator: Activity Data & Emission Factors. NFMS Component: Social and Environmental Safeguards
	FC, RMSC, FSD	Forest Resources Assessment (FAO)	Five reporting of status of forest resources, management and uses by the FAO. The process preparing the 2020 report has already started.	NFMS Component: GHG Inventory Indicator: Activity Data & Emission Factors.

1.2.2 Observations of the functionalities of existing NFMS

Given that the different aspects of NFMS exist in the various public and private organisations involved in REDD+, any national effort to establish an integrated NFMS must recognise the vast diversity in the way they operate, its scope and status and the level of complexities. The review of the technical and operational considerations of the existing NFSM systems can provide useful insights to inform the design and utility of the NFMS. After reviewing the existing NFMS platforms, their state, scope and operations, the following observations were made:

(a) Linking the operational NFMS elements to REDD+, national MRV system and international reporting is a critical synergy

- The National GHG inventory system led by the EPA has strong ties with the REDD+ FRL. Under the AFOLU sector, the dataset (activity data and emission factor) used in the Land have similarities with the REDD+ FRL except that the Land GHG inventory covered more activities. For example, while AFOLU relied on the areas and changes of the six IPPC land cover categories, the REDD+ focused on the dynamics of forest land alone. In the same vein, when it comes to the choice of emission/removal factors, while the Land inventory included that of both natural and planted forest, the FRL accounted for removals from the plantation. These and many, explain the fundamental differences in the historical national emissions/removals between Land and the FRL. Both the EPA and the Forestry Commission accept the need to iron out the differences in the land-cover maps and the Emissions or removal factors, to the extent possible, with the view to achieving a higher level of consistency.

- The EPA has established a National Climate change data hub which recognises REDD+ as one the mitigation strategies in Ghana's NDC. This means that whatever REDD+ strategies will be implemented must be reflected in the national climate change data hub. Currently, climate change data hub does not a direct link with any of the existing REDD+ NFSM platform. Going forward, it would be necessary to infuse any future REDD+ NFSM into the climate change data hub. For the smooth transition occur, during the design of the NFSM real effort should be made to study the EPA data hub to find the best entry point for integration.

- According to the international MRV architecture, the FRL emissions and social and environmental safeguards information that will be generated from the NFSM can be reported to the international community through the regular preparation of the Biennial Update Report (BUR) as well as the National Communications. Ghana is yet to report the REDD+ technical information in any of the BURs but there are plans to do so in its subsequent BUR. Information on safeguard would be reported in the upcoming Fourth National Communication due in 2019. It is important to note that, when the NFMS becomes operational as it is being intended, it would be a major

source of REDD+ performance and safeguard information for the NATCOM and BUR reporting.

(b) *The existing national land-cover mapping capability must be strengthened*

Land-cover mapping in Ghana predates REDD+ scheme. The first-generation nation-wide land-cover map produced by CERSGIS and RMSC covered multiple years particularly from early 2000. Since then, through different initiatives, number land-cover maps at the national scale and area-specific have been done. In the recent past, the Forestry Commission has managed to produce five land-cover maps for 1990, 2000, 2010, 2012, and 2015 under the Forest Preservation Programme (FPP) and FCPF initiatives. Several projects and academic studies have also prepared land-cover maps. Most of these maps are area-specific are either single or several years (typically 3 years categorised into epoch) and are tailored to fit the objective of the study or project. Generally, the survey Department has the responsibility for land-cover mapping, it is not being able to exercise that function satisfactorily due to technical and financial hurdles. As results, most land-cover maps that are prepared in Ghana is not part of the regular duties of any institution but are produced as part of projects. Most of the maps produced under the project are demand-driven and its objectives are informed by the interest of the funders. The desired situation, however, is to have a single institution exercise the mandate of coordinating land-cover mapping according to international standards. And when the land-cover maps are produced it should regularly update which other users can adapt for specific mapping needs. Aforementioned will go a long way to reduce significantly reduced the high levels of uncertainties in different maps in the country. One other contributory factor is the lack of standardised land-cover classifications.

Broadly speaking, landscape mapping is faced with technical and technological challenges. The technical challenge is in two forms. One relates to the skill set to process non-optical (LIDAR or Radar) and hyperspectral images. Though over the last 2 decades, some appreciable levels of human capacities have been developed in the application of geospatial techniques, there is a need to strengthen the existing capacity to be able to effectively use emerging ways of applying geo-information data. For example, in recent times there has been high demand for good-quality data for monitoring biomass or even the preferable use of non-optical images to map out tree crops. But there are capacity gaps in that application of non-optical images for landscape mapping. The emerging use of non-optical products including LIDAR to monitor carbon stocks at varying mapping scales require further training in the use of radar and LIDAR. The geospatial infrastructure (hardware, software and storage) capacity greatly exist in the private sector for commercial purpose compared to the public sector. Hence there is a need to enhance the computational abilities of the ones that exist in the public sector. Most of the software is also proprietary and brings a heavy cost burden to users in the public service who use them for non-profit activities. One way to ensure sustainability in land-cover mapping is to develop the skills to adapt and use open-source spatial software applications.

On the technological side, the practice in the past has been to use free remote sensing data available in the right format and of good quality. However, the limited availability of such data due to cloud and haze effects and missing images has led time series gaps as well as the incompleteness of the spatial data. To overcome these challenges, in most land-cover mapping exercises the common practice is that remotely sensed images from different platforms/sensors are merged into a composite wall-to-wall data for developing national land-cover maps. This practice introduces inherent uncertainty in the land-cover mapping. Similarly, the creation of historical maps depends on LANDSAT data which since 2003 is plagued with scanline until for the middle 2000s when the new Landsat 8 was launched. In a time series analysis, when data in a preceding does not exist, the practice is to use alternative images with a different resolution which is resampled to be consistent with the initial data. All these problems have added to the integrity of the maps that are produced for forest and land cover monitoring, inventories etc. in the country.

The wall-to-wall approach has a spatial coverage advantage; it comes with some errors due to the heterogeneous nature of the Ghanaian landscape. Besides the complex nature of the landscape that makes wall-to-wall mapping at the national level difficult, putting together the logistical arrangement for the ground-truthing can be expensive and challenging. Probably the practical way to overcome this challenge is to start preparing sub-national (ecological zones, HIA or districts) maps and then work it up to the national level. The advantage of this strategy is that it can help to reduce uncertainties through the use of high-quality field data collected from the area of interest. In a nutshell, though the land-cover mapping in this country advanced over the years, there is the need to ensure stepwise and consistent improvement to access data and standards of practice. One of the ways to improve the quality of land-cover mapping is to begin to move to the sampling approach instead of the wall-to-wall method and further advance to use to open-source/web-based applications for real-time or near real-time monitoring. The practices are expected to contribute to making land-cover cost-effective and sustainable and make more relevant to the global trends. In the end, having an efficient land-cover mapping system will contribute to producing reliable land-cover maps for the GHG emission inventory.

(c) Need to enhance spatial data management

The main source of spatial data (satellite data) for land-use mapping is the publicly available Landsat, Modis and Aster archives and recently, sentinel from the European Space Agency. The rest are commercial products in the market that purchase for a specific exercise though most of them are not available to cover the entire country. However, there is no central depository in the country where all the publicly available global archive dataset can be accessed. The current is not good for sustainable land-cover mapping in the long-run. A data

panel/dashboard is needed on the global data sets (land-cover, fire products), proprietary and non-proprietary datasets. For starters, an excel template can develop to keep track of newly available data, the link and status/level of the data in the archives and the information of how and where the data is stored. Every quarter, a scan will be done on the global archives to find new available data sets. Inconsistencies in national and sub-national maps arise from situations where national maps do not exist or are available but with quality challenges. This situation leads to the proliferation of sub-national maps which are incomparable.

(d) More synergies in National REDD+, jurisdictional REDD+ (HIA), Private sector Initiatives

At the national level, REDD+ has progressed from the readiness phase to through demonstration to result based, however, the sub-national REDD+ has not progressed much. Lessons from the jurisdictional level are not readily available to inform national level REDD+ programming. This is because the jurisdictional level initiatives/programme are at early stages. There are other private sector companies involved in certification/reforestation programmes within the country. Lessons from Initiatives like Community Resource Management Areas (CREMAs), the fire volunteers, Globally Significant Biodiversity Areas, Cocobod artificial pollination, replacing of over aged/diseased cocoa farms can be useful to REDD+. All these initiatives are happening in the landscape though not directly under the REDD+ initiative. One of the objectives of the REDD+ is to facilitate coordination, collaboration and data sharing and lessons to the different initiatives. This can contribute to data sharing and harmonisation for the NFMS. For that level of engagement to occur, it will require consistent efforts to deliberate on their common needs and strategies towards achieving them. Therefore, one of the priority areas of the NFMS framework will be to propose data sharing protocols/ forms. The protocol must be designed in a flexible manner to allow for the diverse needs of the various partners.

(e) Facilitate data systems and exchanges

There are several existing systems in government and private sector at varying levels of development with a different focus. Some are online or offline, stand-alone and others are still under construction. Some are paper-based and even remain in the custody of individuals. These data systems are ad hoc and are project based resulting in an update and access challenges. Some of the systems host data that are in the activity domain while others have emission factors, social and environmental safeguards. Example Ghana statistic service produce on Ghana living standards households surveys every 5 years and which is publicly available. This can be influenced to benefit the social and environmental safeguards. FRA process though is established by the FAO; it strongly relies on publicly available land-cover datasets. The challenge is that the reports are available but the primary map data is not available. In the private sector, the data systems that are relevant to the NFMS exist yet they are not openly available to the public. So, the NFMS will consider exploring ways of brokering a new level of collaboration with the data providers while respecting data confidentiality.

1.3. The scope of NFMS

As part of the REDD+ process, the FC is taking steps to establish NFMS. It is linking to the results based payment stage of the REDD+ process. The establishment of the NFMS is in two phases. The first phase will seek to consolidate the efforts to finalize the setting up of the existing elements of the NFMS in the country. In the second phase, the focus will be to harmonize all the components into a robust functional NFMS that is able to meet the following requirements: Regular tracking and reporting of GHG emission savings and social and environmental safeguards as a result of the implementation of REDD+ projects and Transparent communication of REDD+ transactions as well as financial flows. Once the NFMS system is fully deployed, at any point in time, Ghana will be in the position to show the overall benefits of REDD+ that is verifiable. Furthermore, the system will also support all related sectors by providing them with transparent and accurate information about resources under their jurisdiction. The system shall also provide relevant information for key stakeholders such as private cocoa sector companies, NGOs/CSOs. In addition, it will serve as an integral part of the AFOLU component of Ghana Climate Ambitious Reporting Programme (G-CARP).

Against the above background and in line with the objectives of the Partnership for Productivity, Protection, and Resilience in Cocoa Landscapes (3PRCL) project (a pilot under the GCFRP), a team was constituted to develop an NFMS framework for the country. The NFMS framework would thus serve as the blueprint for monitoring REDD+ activities, related initiatives into a one-stop-shop platform for all stakeholders. This framework will pave the way for further elaboration on how the framework would be implemented. Therefore, this framework is the first step in providing guidance as to how the NFMS will look like and its functionalities as well as the institutional and the requisite capacity needed to operationalise the system. Therefore, this NFMS framework document contains the initial discussions by the team and it is structured into 4 parts as follows:

- Part 1 - sets the scene by reviewing current systems existing in country.
- Part 2 - visualises the desired NFMS and its components after reviewing the existing systems by looking at the opportunities, challenges as well as the needs of stakeholders.
- Part 3 - contains the roll out strategies in a step wise manner per each component of the NFMS structure.
- Part 4 - contains the next steps which put forward specific activities to be followed in the immediate-long-term as well as the capacity and financial needs.

2. Setting up REDD+ NFMS

2.1 The approach

Back-casting approach was employed in defining the desirable NFMS and functionalities; and worked backward to determine the components, methods, and networks required to achieve a fully functional system that meet the demands of stakeholders. The envisaged system and its attributes were defined by reviewing existing global online platforms and published reports to gain insights into the elements of the NFMS and the challenges/gaps/barriers. The design structure of the existing platforms was reviewed for the missing functionalities of those platforms. The resulting NFMS thus draws on beneficial functions of existing platforms whilst accommodating the needs of both national and international stakeholders. A scan of the relevant existing systems in-country was done. Existing data and MRV related systems in Forestry Commission (FC), EPA (G-CARP) and the need to look at the cocoa certification systems. Based on that, a design structure of the envisaged Ghana's NFMS was developed taking into account its functionalities as well as the gaps, the reporting requirements, and the multiple user needs. The rollout of the system will follow a progressive approach beginning consistent stepwise and recommendations on the next steps

2.2. The Proposed design of the NFMS

The NFMS is envisioned to have 3 main components namely; GHG Inventory, Environment and Social safeguards and the Registry subsystems (Figure 1). Each of these sub-systems is made up of the integration of many standalone data units as well as mini systems. The data collected from the components are then stored in a centralised data hub which would be displayed through a web portal. The centralised storage will be updated as and when new data is available. The web portal will provide information on REDD+ and related activities to the general public online, while key stakeholders will have access to more detailed information and data per their access rights. Depending on the specific needs, reports and regular publications shall also be generated from the centralised database system. The publications will be synced with the reporting periods of the FC, as well as that of the BURs and NATCOMs.

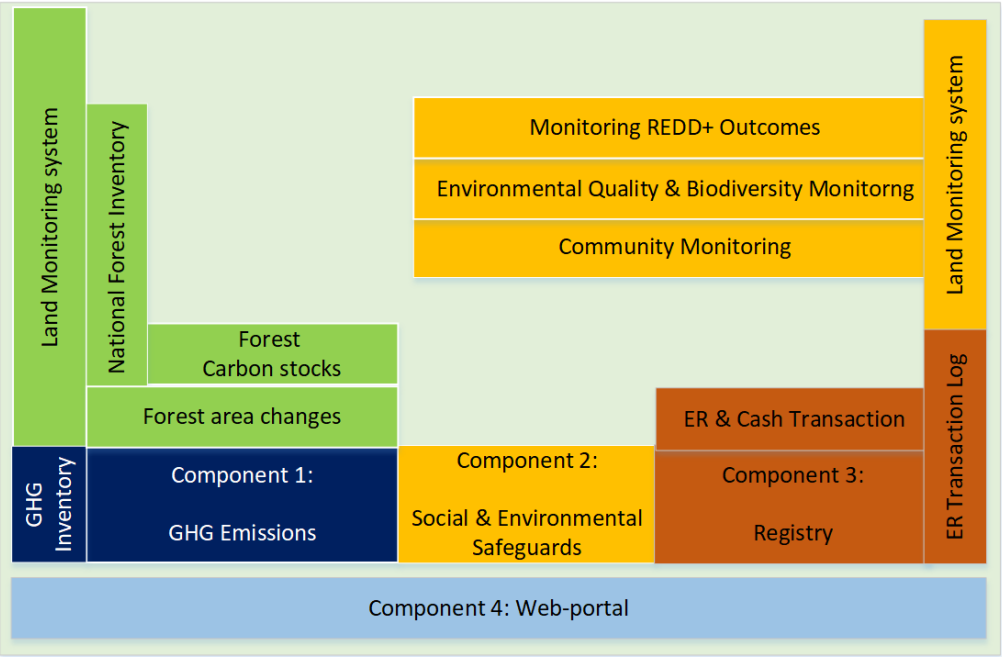

Figure 1: Overview of the elements of the proposed REDD+ NFMS

2.3. Components of the NFM System

The components of the NFMS are GHG Inventory, Environment and Social safeguards and the Registry subsystems. Figure 2 shows how the components are connected to each other. The NFM is system will serve as the central REDD+ information management system that will receive spatial and statistical dataset from multiple sources. It will also allow intended users to plug in to have access to the front and back-end of the database. The spatial data will be generated through land monitoring and national forest inventory systems to generate regular updates of data on forest area and carbon stocks changes. At the initial phase, the spatial data on baseline and monitoring will be generated outside the NFMS and subsequently transferred into it. So for example, in the early stages of the NFMS, it would not be possible to monitor deforestation real-time and published the map web server on the fly. Such data would rather be several months old before it published online. The challenge is that the current NFMS cannot be designed to publish real-time dynamic deforestation maps for the whole country but may probably be possible is to have a near real-time monitoring at the HIA level. The NFMS will also host Environmental and Social Safeguard (EaSS) data. The EaSS data will mainly come from the community, environment quality and REDD+ outcome monitoring in the HIAs using agreed core indicators. Additional EaSS data from national and international sources can complement the HIA data.

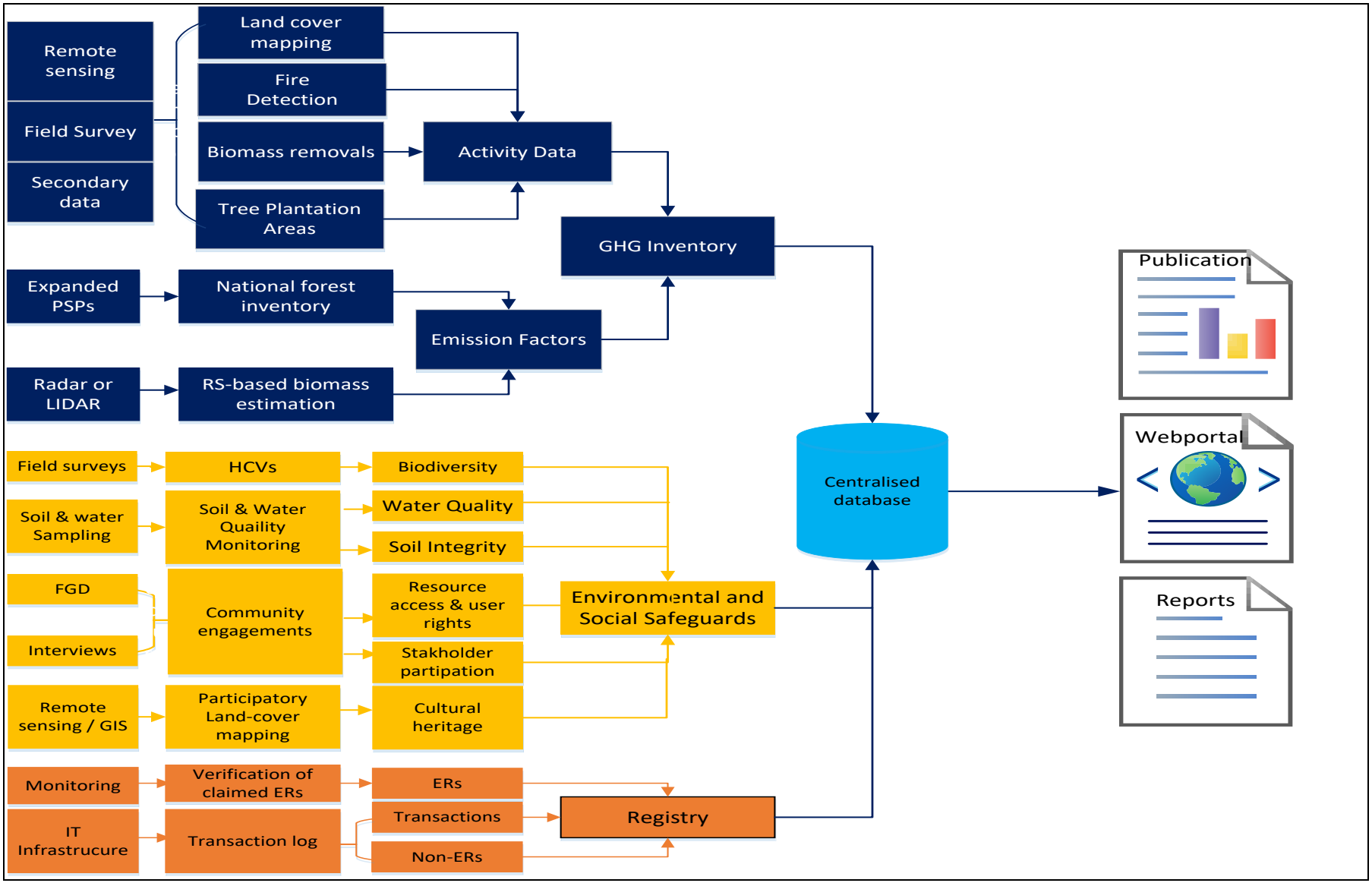
Remote sensing
Field Survey
Secondary data
Land cover mapping
Fire Detection
Biomass removals
Tree Plantation Areas
Activity Data
GHG Inventory
Expanded PSPs
National forest inventory
Emission Factors
Radar or LIDAR
RS-based biomass estimation
Field surveys
HCVs
Biodiversity
Soil & water Sampling
Soil & Water Quaility Monitoring
Water Quality
Soil Integrity
FGD
Interviews
Community engagements
Resource access & user rights
Stakholder partipation
Environmental and Social Safeguards
Remote sensing / GIS
Participatory Land-cover mapping
Cultural heritage
Monitoring
Verification of claimed ERs
ERs
IT Infrastrucure
Transaction log
Transactions
Non-ERs
Registry
Centralised database
Publication
Webportal
Reports

Figure 2: Schematic diagram of the proposed REDD+ showing the key components are functionally interrelated

2.3.1 Component 1: GHG Inventory

The GHG inventory subsystem is the component will host information on greenhouse gas emissions from forest and related land-cover types. It will thrive on other systems that generate activity data and emission factors which are the prerequisites for the computation of emissions. The source of the activity data is mainly the land category areas and their changes. This will involve interpretation of remotely sensed data into land categories and area estimations. Emission factors, on the other hand, are generated through both field-based forest inventory and remote sensing based biomass estimations for the emission factors.

2.3.1.1. Activity data

Activity data involves the estimation of land category areas from satellite images. The recent IPCC guidelines as well as the Standard Operating Procedures developed by the climate change department of the Forestry Commission provides guidelines on the estimation of these activity data. Thus, all land based maps that have different land categories will be reclassified to match those in the IPCC guidelines. The land representations are mainly used to track the changes and transfers of changes within the classified image:

- Forest (Closed forest is > 60% canopy cover & open forest is >15 <60 canopy cover)
- Non-forest
- Afforestation/reforestation
- Forest management

In view of the cost involved in the regular data collection and the recommended 2 year monitoring cycle in the REDD+ strategy, the frequency of collection of activity will be done biennially using virtual and field data methods. Both methods shall be complementary and will be interchanged in every monitoring cycle. The plan is to apply the virtual monitoring every other year then the intervening years will be the combination of the 2 (full-scale monitoring).

Virtual Monitoring

The virtual monitoring option will rely on secondary spatial and attribute data from both national and international sources such as land-cover maps for land-area estimation; MODIS active fire data and Landsat Thermal Band for burnt area estimation and Timber Export Values and volume figures biomass removals estimation. The virtual activity data collection will be done by reviewing available data sources in order to determine the status (updated /not updated, free etc) of the data. Land-cover maps/fire data would subsequently be updated based on the results of the review. Spot verifications would be undertaken to complement the virtual updates. This would be done every two years. Web applications such as Google Earth and collect Earth have datasets of multiple platforms and hence have high temporal resolution. With this the, virtual monitoring will also rely on new updates from such web applications. Relevant data sets from Research findings and projects will be relied on.

Format for undertaken this exercise is indicated below (Table 2)

Table 2: Sample of virtual data template

Data	Source	Status	access	Downloaded (Y/N)

Full Scale Monitoring

Full scale monitoring comprises of all monitoring activities undertaken under the virtual monitoring in addition to detailed field data collection campaigns to generate activity data. In practice, this approach of joint field sampling and web-based data collection will be deployed every 4 years.

Table 3: Activity data template

Activity	Data type	Data format	Data source	Frequency	Remarks
Virtual	annual and historical forest area changes	Classified raster images	Forestry Commission (RMSC)	Project driven	
	annual and historical burnt forest area				
	active forest fires		MODIS burned area product		
	annual and historical extension of degraded forest				
	annual forest area under logging activities				
	forest area under conservation schemes				

2.3.1.2. Emission/ removal factors

This refers to the rate at which GHG is released or absorbed as of anthropogenic activities in the forest sector. In the forestry sector, emission/removal factors are collected through conventional forest inventory and remote sensing. The collection and the use will follow both the IPCC guidelines, Manual of Procedures as well as the Standard Operating Procedures (Number 8) developed by the Forestry Commission. The National Forest Inventories is the main source for collection of Emission/ removal factors such as forest carbon stocks. The However, the system is fraught with some weakness. These include the following:

- Outdated and not regularly updated
- Spatial coverage of PSPs limited to Forest Reserves.
- Regular monitoring of biomass has ceased and no longer useful due to the poor state of the PSPs
- Data storage systems available lack metadata which explains the format

- PSPs dataset do not cover all the carbon pools such as dead woods etc.

Beyond the PSPs, in 2012, there was a comprehensive assessment of forest carbon stocks across the country under the Forest Preservation Project (FPP) and was used in the Forest Reference Level computations. In this framework, the plan is to revive existing forest inventory structures. Findings from research works shall also be used.

Forest Inventory

Accurate plot measurement data is needed in deriving forest carbon pools per broad forest classes (strata). These forest carbon pools are namely above-ground (trees), below-ground (root system), Deadwood, soil, litter and non-tree carbon pools. Field-based forest inventory in Ghana has been done traditionally by sending teams to the field to engage in rigorous measurements of tree parameters such height, diameter at breast height (DBH), species of tree etc. the carbon pools are also calculated per the forest type (closed and open forest) and ecological zone as the stocks differ per zone.

Using Remote sensing for emission factors estimation

Estimation of carbon stocks/emission factors has traditionally been done in Ghana through field-based inventory. Tree parameters such as height, diameter at breast height (DBH), species of tree etc. are collected during field inventory for establishing allometric equations, carbon stocks etc. The field-based requires more man hours and costly too. With technological advancement, remote sensing techniques are increasingly being used to estimate landscape carbon density and carbon stocks. Forest height, forest greenness, canopy attributes, or other biophysical parameters can be measured using both active and passive sensors remote sensing methods for the estimation of aboveground biomass stocks by measuring. Ghana intends using such new remote sensing technologies such as the Airborne or space borne LIDAR sensors to directly measure forest height in closed canopy forests which correlates to AGB of various forest types and or Radar data to map low-density woodlands and agricultural landscapes for emission factors.

Fine (<1 m) resolution satellite data can be used to directly measure crown attributes of individual trees in open forests or in non-forest land covers after which the above-ground biomass (AGB) of these individual trees can be determined through allometric relationships between crown characteristics and AGB to map landscape Carbon. Low (200 m) or moderate (30 m) resolution satellite data can be used to measure the fractional cover of large-scale closed canopy forests and then correlated with ground measurements of forest carbon density to map carbon stocks across large area landscapes. For this to be possible in Ghana, the procurement of such fine resolution satellite images need to be integrated well into the NFMS architecture and financing scheme as well as provision for the development of human capacities in the analysis software that will be used in processing the images. Collaborative efforts from the various institutions as identified in the list of existing NFMS structure (UNER,

CERSGIS, RMSC etc) that have mandates or work on satellite images will be key in providing an accurate estimation of carbon stocks based on remote sensing.

2.3.2 Component 2: Social and Environmental Safeguards

Ghana has carried out a Strategic Environmental and Social Assessment (SESA). The SESA synthesized national and institutional sustainability policies, plans and strategies and also addressed World Bank Safeguards Operational Policies. SESA identified the relationship between national policies, laws and their effects on the proposed REDD+ interventions. The SESA process led to the production of an Environmental and Social Management Framework (ESMF) which contributes to the smooth implementation of interventions by providing guidelines to mitigate all anticipated adverse impacts during the planning and implementation of various projects/programmes in Ghana. Key documents that have also been produced out of the SESA process in Ghana are: Resettlement Policy Framework (RPF), the Pest Management Plan and the Process Framework for stakeholder engagement.

Ghana is defining its Country Approach to Safeguards (CAS) and developing a Safeguards Information System (SIS). A legal analysis has been conducted on each of the Cancun safeguards outlining what is on paper and what is being practiced, the gaps with respect to Policies, Laws, and Regulations (PLRs) on paper and practice and recommendations for addressing the gaps. The results of the legal analysis and of the SESA identified legislative and policy gaps which will require reforms. Ghana's SIS will provide information on how jurisdictional projects/programmes address safeguards. The SIS will contain indicators for monitoring the compliance on the World Bank Safeguards, Cancun safeguards, and other Donor safeguards requirements, Feedback and Grievance Redress Mechanism (FGRM), benefit sharing, co-benefits, etc. An online web platform has been developed to host Ghana's REDD+ SIS. There is work currently on-going by members of the Safeguards Sub-working group to define Principles, Criteria, and Indicators (PCIs) and also gather socio-economic data on livelihood, etc. within the Ghana Cocoa Forest REDD+ Programme area GCFRP, the premiere jurisdictional Programme of Ghana). This data will be populated onto the web platform. Ghana envisages having a fully functional SIS before the end of the year 2018. Ghana's SIS web address is www.reddsis.fcghana.org.

2.3.2.1 Community, social and policy monitoring

Ghana has carried out a Strategic Environmental and Social Assessment (SESA). The SESA synthesised national and institutional sustainability policies, plans and strategies and also addressed World Bank Safeguards Operational Policies. SESA identified the relationship between national policies, laws and their effects on the proposed REDD+ interventions. The SESA process led to the production of an Environmental and Social Management Framework (ESMF) which contributes to the smooth implementation of interventions by providing guidelines to mitigate all anticipated adverse impacts during the planning and implementation of various projects/programmes in Ghana. Key documents that have also been produced out of the SESA process in Ghana are the Resettlement Policy Framework (RPF), the Pest Management Plan and the Process Framework for stakeholder engagement.

The efforts to domesticate or implement the principles articulated in the Cancun framework is the first step towards the establishment of the community social and policy monitoring framework. The next stage will involve the collection of social and environmental indicators in the programme areas to populate the SIS. The nature and form of tracking the social and environmental indicators must be determined by the stakeholders in the programme area through a consultative process. Beyond the HIAs or the programme areas, it will be important to collaborate with other state and non- state to collate official secondary data. The district assemblies will be one such stakeholder. When the DAs are developing their medium-term plans, they undertake socio-economic baseline studies to inform the development priorities of the district. The information contained in the medium term plans can contribute to the monitoring of the social and environmental safeguards. The Ghana district website is one source of information that can also be used for monitoring socio-economic safeguards. In this regard, the FC and its actors must strengthen the existing collaboration with the DAs when it comes to the collection of the safeguards data. There are also opportunities to collaborate with national institutions that are responsible for the regular publication of socio-economic data. Ghana statistical service produces Households and population data. Data (Gender-based indicators, Livelihoods, and income, Energy cooking patterns, Migration) from this report can be useful for the monitoring of the environment and social safeguards. Relevant portions of the data should contribute to the regular update of the SIS.

2.3.2.2 Monitoring of environmental integrity

The key indicators which shall be measured for Ghana's NFMS are biodiversity, water quality, soil integrity, resource access or user rights, stakeholder participation and cultural heritage. The data, methods and indicative periods for the indicators are indicated in table 4 below.

Table 4: Suggested data, method and indicative period for monitoring environmental integrity

Component	Indicator	Method	Data	Verifiers	Period
Environmental safeguard	Biodiversity	Surveys	High Conservation Value	Report	Prior to the project
	Water Quality	Water Sampling	Water Quality Monitoring	Report	Prior to the project/ Annually thereafter
	Water Quality	Soil Sampling	Soil Quality Monitoring	Report	Prior to the project/ Biennially thereafter
Social Safeguard	Resource Access & User Rights	Focus Group Discussion/Interviews, Free Prior & informed Consent	Community Engagements	No of Women engaged, No of	Prior to Project/ Biannual
	Stakeholder Participation				
	Cultural Heritage	Remote Sensing /GIS/ field Survey	Participatory Land cover mapping		Prior to Project / Annually thereafter

Data gathered by the methods enumerated above would be complemented by Ghana Living Standard Survey, National Population Census Data, Strategic Environment Assessment and State of the Environment reports produced by the Ghana Statistical Service and the Environmental Protection Agency respectively.

2.3.2.3 REDD+ Outcomes

This will involve and Monitoring and evaluation to assess the extent of the implementation of the REDD+ interventions. The idea is that, during the implementation period, the FC should be able to have a good picture of the status, successes and the challenges of the REDD+ programme. At any point in time, the monitoring of the REDD+ outcomes, the FC will know the beneficiaries, their location, the key barriers, the effectiveness of the REDD+ feedback and Redress Mechanism, the number of policy initiatives that have been adopted due to the REDD+ programme, the investment made and the contribution of the REDD+ to the improvement of the communities involved in REDD+ in the HIAs, and the extent to which REDD+ is promoting sustainable forest management. All these will feed into the strategic assessment of the outcomes of REDD+

2.3.3. Component 3: Registry

The registry sub-system of the proposed NFMS is a database that will track Emission Reductions (ERs), emission reduction sources, and financial flows as well as non ER benefits associated with efforts that seek to cut emissions in the country. The registry will facilitate accountability in REDD+ financial investments, ER accruals, sales and details of buyers. The main data logged in the registry will comprise of ER programs initiated in-country, their locations and the expected ERs. Cumulated ERs certified over the years will be tracked in addition to the distributions. Non-ER benefits such as improved forest governance systems, ecosystem services enhancements, climate change adaptation, livelihoods and supported social and cultural values are important contributions worth tracking. This will assess the direct and indirect impacts of REDD+ initiatives on fringe communities. It is important to note that different REDD+ initiatives produce different non ER benefits. The aggregated transactions of the standalone registry will be displayed on the NFMS. In order to update the registry, the NRS as the in country REDD+ coordinators will agree on a regular reporting schedule using a predefined template.

2.3.4 Component 4: Storage and Web Portal

2.3.4.1 Centralised Database

Inspite of substantial amount of data collected in the field and the work done by several national institutions, weaknesses remain to ensure that data are integrated and harmonized in a robust database. The National Forest Management System among other things will establish a centralised and secured database containing existing information (e.g. remote sensing and field data) related to forest resources. All the data gathered, procured, processed

and analysed will be part of the main centralised database including activity data from Satellite Land Monitoring Systems, Emission Factor from National Forest Inventories and emissions/removals from GHG inventory.

The data to be stored in the centralised database will come from different sources (institutions). There is therefore the need to harmonise the datasets to ensure consistency and also avoid data redundancies and duplication. It also critical to agree among stakeholders and data custodians on data formats to be stored in the database. This will facility data sharing among stakeholders. A well-defined data and information-sharing policy shall be developed to meet the needs of different parties. The policy may introduce restrictions in line with national interests and legislation. The NFMS shall be accessible to different users, either as original or as aggregated data sets depending on access rights. Defining a data policy that regulates access to national forest monitoring data sets or sub-sets also means that long-term data storage and management need to be secured.

2.3.4.2 Web portal

The Web-portal will be used to disseminate information on REDD+ and related activities to users, both national and international stakeholders, etc. For ensuring the transparency of Ghana's REDD+ process. The Web-Portal will be the information/data dissemination interface between the NFMS and Users. The Forest Monitoring System Web-Portal will be developed by the Forestry Commission (FC) of Ghana. Other Government Institutions and Private Sectors Institutions (EPA, GLSS, Lands Commission, Survey Department, Forests Services Division, RMSC, Soil Research Institute, CSIR, ICT Department of FC, Cocobod, GPODC, CERSGIS, etc.) who are data custodians will be responsible for providing the necessary data needed for the web-portal. The web-portal will be managed by Forestry Commission. Within the FC, the administration of the database will be jointly managed by the ICT and the CCD. the ICT Department shall be responsible for the backend management of the portal which will include creation of users, roles and access rights as well as data backups and general infrastructure management. In addition, the ICT will be responsible for the final vetting and uploading of data. The NRS shall be responsible for the content management of data and feedbacks from users.

Data from the centralised database of National Forest Monitoring System Web-Portal shall be viewed online. Provision will be made for data download through the portal. However, download links of some datasets will be directed to the original data providers or data custodians depending on the data sharing restrictions. The National Forest Monitoring System Web Portal will broadly have seven thematic menu tabs as shown in Figure 3 namely: (1) Base layers, (2) Administrative areas; (3) Forestry, (4) Other layers, (5) Land use/cover maps, (6) Registry and Transaction Log and (7) Environmental and Social Safeguards. Each of the thematic menu tabs shall contain other related layers as provided by the relevant Agencies

(data custodians) based on the institutional arrangement within the NFMS. Some of data layers will be spatial and others non spatial.

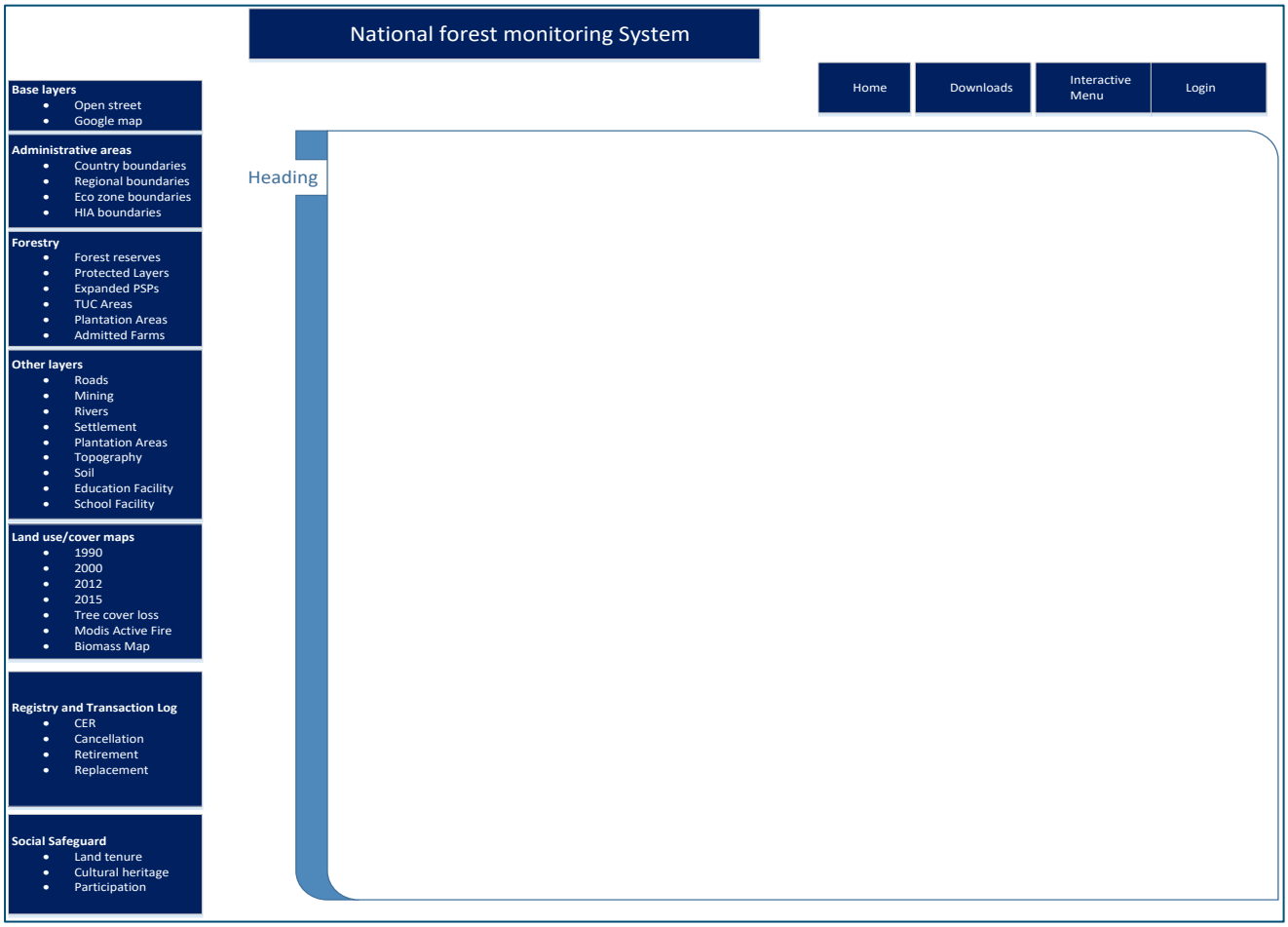

Figure 3: Snapshot of the design of the NFMS web-portal

3. Roll-out strategy of the REDD+ NFMS

Looking at the large amount of work that need to be done before the REDD+ NFMS becomes fully operational it is important to come up with clear plan to guide how it is rolled-out. Basically the roll-out strategy will address issue on implementation milestones, institutional arrangement, financial, capacity and technological requirements that are needed to set up the NFMS and put it to use in a given period of time. In this regard, the roll-out of the NFMS will be in three phases and in every phase three fundamental element would be addressed. These are: (a) strong institutional framework, (b) cost and mobilising finance and (c) capacity requirements.

3.1 Phase 1 – Staging

Phase 1 will be for planning in order to get ready focusing on issues like data systems, capacity development, and institutional roles. The Forestry Commission will lead the process to first conduct capacity and technological needs assessment and on that basis formulate a concrete capacity and technology plan (CTP) for the NFMS. The priorities in the NFMS CTP must guide mobilising and sourcing of capacities and technology. As much as possible the Commission should widely consult the key stakeholder in the REDD+ to understand their needs and preferences so as to tailor the capacity and technological solutions. Once CTP is done, it should be followed by training and workshops to disseminate the feature and utility of the REDD+ NFMS and solicit feedback on the functionality of the system. Again during the staging, the overall institutional arrangement will be established and become operational. The establishment of the institutional arrangement will involve the following steps: (a) identification of institutions, (b) formation of teams, (c) defining roles and responsibilities and reporting lines and above all, (d) adopt a workable collaborative arrangement such as MoUs, agreement etc. The NFMS institutional arrangement will not be markedly different from the already existing structures under the REDD+ MRV. Rather emphasis must be given to strengthening the collaboration among the key stakeholders and where possible allow more sub-national actors to get involved in REDD+. As much as possible, the NFMS institutional arrangement takes existing partnerships to the next level or foster new ones where roles and data can be shared on regular basis.

In addition to defining the governance arrangement for the NFMS, it also important to stipulate a clear data handling and management procedures during the planning stage. This must include but not limited to the following suggested issues; (a) setting up the design of the NFMS, (b) establish network protocols, (c) develop data template and protocols, (d) procurement of IT infrastructure hardware/ software, acquisition of existing dataset and structure for regular updates, (e) conduct test run and stress test and (f) come up with strategies to for fixing of bugs

3.2 Phase 2: Deployment of NFMS and Monitoring of REDD+

After establishing the NFMS, test run it and conducted the stress test, the NFMS will be ready for deployment in phase 2. In this phase, the Forestry Commission must outdoor NFMS prototype at the national level and after three months the first sub-national NFMS will be rolled-out in a selected HIA. As much as possible, the operations and functionality of the forest monitoring system at the national and HIA levels should be in a seamless sync to the extent that data sharing would be easy. It is at this that actual data collection covering emission data i.e. activity data and emission factors which includes images, forestry inventory and socio-economic data for upload into the NFMS. The collected should have time stamps for baseline and monitoring. For instance, for satellite-derived dataset, if data is not available for the particular year of interest, multi-temporal base line should be set by using a two-year buffer range. When collecting data, it would be useful to prepare date template and protocol to standardise how data is collected, how data is evaluated or processed, documented and archived. These basic tenants of data handling must be respected across the entire chain of custody of data.

Once all dataset is properly collected, evaluated and labelled it will be ready for upload to the NFMS for visualisation. All baseline data must be populated first and uniquely identified then subsequently load up monitoring data per year. For activity data, the plan to update the land-cover maps every year for using the virtual approach and 4 years for the full-scale method. Any other relevant spatial dataset such as fire, carbon stock maps, Shapefile of forest reserves, tree plantation will be uploaded when they are available. One example is to link the published maps to the global web-platform like google earth and the global forest watch (https://www.globalforestwatch.org).

Currently, the available carbon stocks data were generated during the FPP project. The old data from the PSPS are not publicly available as at the time this report was prepared. So it will make sense to upload the existing carbon stocks data from the FPP inventory work and the biomass map. It will also be useful to tap into existing global biomass database such the IPCC emission factor database (https://www.ipcc-nggip.iges.or.jp/EFDB/main.php), IIASA's global forest database (http://www.iiasa.ac.at). After uploading the baseline and monitoring dataset anytime new ones are published in-country or at the international level it should reflect on the NFMS.

In the same vein, socio-economic and environmental safeguard data may come from multiple sources. There are those that will be generated directly from the HIA's annual or bi-quarterly. For the dataset other than the ones supplied from the HIA, the reporting timelines will depend on when that data owners publish. So at the initial stage, a lot data heavy lifting is required to collect relevant socio-economic from all identified sources. Timelines for subsequent update depends on when the data is made public.

The registry is the heartbeat of the NFMS since it going to host confidential emission transaction data. So the way transaction data is managed need a special attention in order to protect the integrity NFMS. When and how the registry data will be update be must left open for the REDD+ partners to decide. At this stage what is important is to assure all the actors that the REDD+ strategy will be managed in a transparency manner.

3.3 Phase 3: Updates and upgrades

A REDD+ information management hub, the NFMS should have realistic system maintenance and update protocol. The following general good practices for web-based data management system has been recommended:

- Annual Maintenance of the IT infrastructure
- Hardware upgrades should be carried out every 5 years
- System audit (templates, worksheets, relevance of web portal menus, information etc.) should be undertaken every 5 years
- Software upgrades as and when newer versions are available

4. Next steps for the NFMS Framework

4.1 Immediate to medium-term plans

- The development of a feasibility report that addresses detail out comprehensive cost and technical analysis based on the indicative budget estimates in this document is crucial in taking this work forward.

- Based on the recommendations on the institutional framework, come up with a workable institutional arrangement involving the key actors at the national and jurisdictional levels.

- Undertake a detailed capacity and technology needs to inform the resource mobilisation strategy.

- Develop a resource mobilisation strategy identifying all possible sources of funding and the strategies to assess the funds.

- Develop an NFMS manual containing the following: (a) Elaborate operations and maintenance instruction, (b) QA/QC protocol to be adopted by all the actors in the operationalisation of the NFMS and should contain a troubleshooting guidance and (c) Common data and file naming format

- Develop a standardised transaction logs guidance book to be gradually implemented as the REDD+ transaction increases. The guidance document should clearly address issues like serial numbering, where to store, what to disclose and not in the transactions.

- Develop a prototype for a test run and stress test and

- Full deployment of the NFMS

4.2 Road-map for milestones

Ghana National Forest Monitoring System (NFMS) for REDD+

Project Lead: Forestry Commission

Budget: Estimated: $1,500,000.00 | Baseline: $0.00 | **Cost:** Estimated: $0.00 | Baseline: $0.00 | Actual: $0.00

WBS	Task Name	Resource Names	Start	Finish	Duration	Percent Complete
1	Conduct NFMS capacity and technology need assessment	Consultancy	Thu 31/Jan/19	Fri 29/Mar/19	42	0%
2	Establish Institutional arrangememnt	Manned hours for FC	Thu 09/May/19	Wed 19/Jun/19	30	0%
3	Development of NFMS data Protocols, Template and	Consultancy	Tue 02/Jul/19	Mon 09/Sep/19	50	0%
4	Procure of IT hardware and sofware	Competative bidding	Tue 01/Oct/19	Mon 17/Feb/20	100	0%
5	Install, test run and stress test the NFMS shell and when	Consultancy, Manned	Tue 07/Jan/20	Mon 17/Feb/20	30	0%
6	Organise a number of training programmes	Manned hours for FC ,	Tue 10/Sep/19	Mon 16/Sep/19	5	0%
7	Prepare detailed cost and technical feasibility report	Consultancy	Thu 04/Oct/18	Wed 12/Dec/18	50	0%
8	Develop NFMS institutional plan	Consultancy	Thu 11/Oct/18	Wed 07/Nov/18	20	0%
9	Prepare NFMS resource mobilisation plan and follow it	Consultancy	Thu 01/Nov/18	Wed 12/Dec/18	30	0%
	Develop standardised transaction log book	Consultancy	Thu 09/Jan/20	Wed 19/Feb/20	30	0%
	Fully deploy NFMS	Consultancy, Manned	Tue 04/Feb/20	Thu 02/Apr/20	43	0%
	Type here to add a new task