The Republic of Kenya

Kenya Forest Service

Capacity Development Project for Sustainable Forest Management in the Republic of Kenya

（REDD+ Readiness Component）

Component Completion Report
(June 2016 – October 2021)

November 2021

Japan International Cooperation Agency

Asia Air Survey Company Limited

Pasco Corporation

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Readiness for REDD+ component in the Capacity Development project for sustainable forest management in the republic of Kenya

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List of abbreviations

AAS	**Asia Air Survey Co., Ltd**
AD	Activity Data
ASALs	Arid and Semiarid Lands
AR-CDM	Afforestation and reforestation - Clean Development Mechanism
AWF	African Wildlife Foundation
CADEP-SFM	Capacity Development Project for Sustainable Forest Management in the Republic of Kenya
CBO	Community Based Organization
CFA	Community Forest Association
COP	Conference of Parties
C/P	Counterpart
DAC	Development Assistance Committee
DB	Data Base
DRSRS	Directorate of Resource Survey and Remote Sensing
EF	Emission Factor
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FIP	Forest Information Platform
FMIS	Forest Management Inventory System
FRA	Forest Resources Assessment
FREL	Forest Reference Emission level
FRL	Forest Reference Level
GCF	Green Climate Fund
GEO GFOI	Group on Earth Observations Global Forest Observation Initiative
GHG	Green House Gas
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
IC-FRA	Improving Capacity for Forest Resource Assessment
INRA	Integrated Natural Resources Assessment
IPCC	Intergovernmental Panel on Climate Change
JAXA	Japan Aerospace Exploration Agency
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
JICS	Japan International Cooperation System
JJ-FAST	JICA-JAXA Forest Early Warning System in the Tropics
JOFCA	Japan and Overseas Forestry Consultants Associate
KEFRI	Kenya Forest Research Institute
KFS	Kenya Forest Service
KFIS	Kenya Forest Information System

KWS	Kenya Wildlife Service
MENR	Ministry of Environment and Natural Resources
MODIS	Moderate Resolution Imaging Spectroradiometer
MoEF	Ministry of Environment and Forestry
MRV	Measurement Reporting Verification
NDC	Nationally Determined Contribution
NFI	National Forest Inventory
NGO	Non-Governmental Organizations
NRCO	National REDD+ Coordination Office
NRS	National REDD+ Strategy
NRSC	National REDD+ Steering Committee
NRTFAS	Near Real Time Forest Alert System
NFMS	National Forest Monitoring System
Off-JT	Off the Job Training
OJT	On the Job Training
OTN	Oracle Technology Network
PaMs	Policy and Measures
PD	Project Document
PDA	Personal Digital Assistant
PDCA	Plan-Do-Check-Action
PHP	Hypertext Preprocessor
PMU	Project Management Unit
PPT	Power Point
RCMRD	Regional Centre for Mapping of Resources for Development
RDBMS	Relational Data Base Management System
REDD+	Reducing Emissions from Deforestation and forest Degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RHEL	Red Hat Enterprise Linux
R-PP	Readiness Preparation Proposals
RS	Remote Sensing
SBSTA	Subsidiary Body for Scientific and Technological Advice
SG	Safeguards
SIS	Safeguards Information System
SLEEK	System for Land Based Emission Estimation in Kenya
SOK	Survey of Kenya
S/W	Software
TA	Technical Assessment
TWG	Technical Working Group
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-REDD	United Nations collaborative initiative on Reducing Emissions from Deforestation

	and forest Degradation
USGS	United States Geological Survey
WB	World Bank
WS	Workshop
WWF	World Wide Fund for Nature

Executive Summary

The main activities of the REDD+ Readiness Component (hereinafter referred to as “the Component”), which is Component 3 in the Capacity Development Project for Sustainable Forest Management in the Republic of Kenya (hereinafter referred to as “the Project”), are to support Kenya for developing its National Forest Monitoring System (NFMS) and Forest Reference Level (FRL), which are two of the four (4) requirements for accessing result-based payments through “Reducing Emissions from Deforestation and forest Degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+)” implementation. Under the Component, a series of discussions was held with a large number of stakeholders through the holding of REDD+ Technical Working Group (TWG) meetings and stakeholder workshops, and Kenya’s NFMS and FRL were developed on this basis, then FRL was submitted to United Nations Framework Convention on Climate Change (UNFCCC). In addition, activities targeting the creation of various types of maps as well as Measurement Reporting Verification (MRV) -related trainings were implemented.

Kenya’s NFMS aims to: 1) Collect and store accurate and transparent data and information on forest management; 2) Share the necessary information with forest stakeholders in order to contribute to sustainable forest management, and 3) Use the information for reporting under international obligations.

In order to achieve these objectives, Kenya’s NFMS consists of two functions which are the monitoring function and the data management function. The former includes the monitoring of 1) forest cover and forest cover change (for Activity Data), 2) forest carbon stock (for Emission Factors), 3) near-real-time forest cover change, 4) policies and measures, 5) biodiversity, and 6) REDD+ and Afforestation and reforestation - Clean Development Mechanism (A/R CDM) Projects.

For its part, the Forest Information Platform (FIP) developed under the Component plays the role of data management function in the NFMS. The FIP consists of 8 components: 1) FRLs, 2) MRV, 3) Safeguards Information System, 4) Forest Cover Change Monitoring, 5) National REDD+ Strategy and Related Information, 6) Forest Sector Administrative Information, 7) REDD+ & A/R CDM Project Information, and 8) Other Relevant Data. The FIP is a web portal intended to provide various forest-related information. Through the Project, the FIP was designed and implemented, and discussions were held on how to display various data including maps and documents effectively when using it.

Aiming at continuous implementation, operation and management of Kenya’s NFMS, the "NFMS Document ver.1" was elaborated. Among others, it describes the structure of the NFMS as well as the underlying methodologies to the monitoring and the data management functions.

Meanwhile, the FRL was constructed based on the following conditions:

Forest definition:	Minimum 15% canopy cover, minimum land area of 0.5 ha, and potential to reach a minimum height of 2 meters at maturity in situ. Perennial tree crops like coffee and tea are not considered as forests.
REDD+ activities:	1) Reducing emissions from deforestation, 2) Reducing emissions

	from forest degradation, 3) Sustainable management of forests, 4) Enhancement of forest carbon stocks
Carbon pools:	Above-ground biomass and Below-ground biomass
Scale:	National level
Greenhouse gases:	Carbon dioxide (CO_2) only
Reference years and period:	Period: 2002 – 2018, with 4 years intervals Reference years: 2002, 2006, 2010, 2014 and 2018
Activity data (AD):	AD are set by computing a change matrix derived from land cover/land use change maps (2002-2006, 2006-2010, 2010-2014, and 2014-2018) prepared under the System for Land-Based Emission Estimation in Kenya (SLEEK), while adjusting to the minimum area of forests (0.5 ha).
Emission Factors (EF):	EF are set using forest carbon stock data derived from the pilot forest inventory conducted under Improving Capacity for Forest Resource Assessment (IC-FRA) and Capacity Development Project for Sustainable Forest Management in the Republic of Kenya (CADEP-SFM) projects (there is no national forest inventory in Kenya to date), and using Intergovernmental Panel on Climate Change (IPCC) default values for the growth rate of each forest strata and the non-forest carbon stock.
Construction method of FRL:	Method based on average historical values of emissions estimated between 2002-2006, 2006-2010, 2010-2014, and 2014-2018.

The FRL report was prepared mainly based on the conditions listed above, and was submitted to the UNFCCC Secretariat on 6 January 2020. Then, the Technical Assessment (TA) was conducted remotely by the UNFCCC from 8 to 12 June. The modified FRL report reflecting the conclusions of the TA was eventually submitted to the Secretariat in August 2020.

According to the average annual historical emissions, Kenya's FRL is as shown below.

Forest Reference Level: 52,204,059 CO2t/year

Activities for creating various types of map related to the NFMS and the FRL undertaken under the Component include a process and result correctness assessment of the Land Cover/Land Use Map 2014, the preparation and improvement of guidance material for land cover/land use mapping taking into account said assessment outcomes, and assistance to the creation of the 2020 Land Cover/Land Use Map. Forest Cover/Land Use Change Maps based on the reference period and years were also created in order to set the FRL.

Furthermore, in order to reinforce capacities for NFMS implementation, a total of four MRV-related trainings were held under the Component. The first and second trainings were basic courses for a total of 54 Kenya Forest Service (KFS) staff who had no prior knowledge of REDD+. The third and fourth trainings were advanced courses for a total of 40 KFS staff selected among participants to the first and second trainings.

Finally, the following recommendations were made as regards REDD+ implementation and sustainable forest management in Kenya. Recommendations particularly focus on the operational aspects of the NFMS.

Aiming at Sustainable Forest Management and REDD+ implementation, it is imperative for Kenya to operationalize its NFMS based on the plans and methodologies defined in the NFMS document. As regards the forest monitoring aspect, Kenya possesses the technical capacity to create Land Cover/Land Use maps and to undertake a National Forest Inventory, which are the main components of the monitoring function in the NFMS. Therefore, the Government of Kenya should secure the necessary budget to pursue the biannual forest mapping, and should grant priority to implementing the National Forest Inventory (NFI).

Furthermore, there are some monitoring aspects where no concrete methodology has been effectively developed to date. These are monitoring of Policies and Measures (PaMs) and monitoring of Biodiversity. Further development of specific methods will be necessary.

Under the Component, the necessity, structure and role of the Upper Level Commission and of the Management Team within KFS for managing and operating the FIP have been discussed. The Management Team within KFS has been established, but due to the wide range of agencies involved in the FIP, the establishment of the Upper Level Commission has been delayed. Because data and information to be stored in the FIP can be utilized not only for REDD+ implementation but also for sustainable forest management in Kenya, the FIP should be fully operationalized. For that sake, the Management Team should start its operations, and the Upper Level Commission should be established as soon as possible through discussing with the stakeholders.

Furthermore, the current FRL report and NFMS document mention future improvements. Therefore, Kenya needs to improve FRL and NFMS document by ensuring the techniques and finance to conduct the improvements based on the results of the Component.

I Basic Information of the Project and Component

1 Country

Republic of Kenya

2 Title of the Project and Component

REDD+ Readiness Component (hereinafter referred to as “the Component”), the Capacity Development Project for Sustainable Forest Management in the Republic of Kenya (hereinafter referred to as “the Project”)

3 Duration of the Project (Planned and Actual)

12th July 2016 – 11th October 2021 (actual) (Including a four-month extension due to COVID-19)
(12th July 2016 - 11th June 2021 (planned))

4 Background (from Record of Discussions(R/D))

About 80% of Kenya consists of arid or semi-arid areas. According to the FRL report submitted to UNFCCC in January 2020, forests in 2018 make up approximately 5.8% of the country. The consumption of fuel wood and forest conversion for agricultural use are problems that continue to devastate the forest resources. Kenya, moreover, is thought to be potentially more susceptible to climate change, given its location in Sub-Saharan Africa. As such, promoting the REDD+ (Reducing Emissions of greenhouse gases from Deforestation and Forest Degradation) framework and developing capacity for sustainable forest management to increase the forest area and mitigate climate change are important development approaches for the country. In this context, the national government of Kenya set the goal of increasing the forest coverage rate from 7% (as measured in 2010) to 10% by 2030, in both Kenya’s national constitution established in 2010 and “Vision 2030,” a national development plan established in 2008.

Since the mid-1980s, Japan has assisted Kenya in the building of the Kenya Forest Research Institute (KEFRI) and has provided technical cooperation for KEFRI and the Kenya Forest Service (KFS) to support their efforts to promote social forestry and research and develop breeding for drought-tolerant varieties, etc. Considering these earlier supports and Japan’s achievements in providing assistance in the forest field, Kenya requested Japan to provide technical cooperation on capacity development for sustainable forest management.

Responding to the request, the Japan International Cooperation Agency (JICA) conducted a study in November 2015 for the detailed planning of the requested technical cooperation. As a result, JICA and the government of Kenya agreed to implement a project to develop the capacity of the central and county governments overseeing sustainable forest management and to contribute to sustainable forest management toward the goal of increasing Kenya’s forest coverage rate to 10%. The Project sets out to provide five types of assistance focused on Kenya’s forest and climate change: (1) policy support; (2) pilot implementation for developing an implementation model for a county government; (3) assisting REDD+ Readiness; (4) research on tree breeding; (5) regional cooperation (see Figure 4.1).

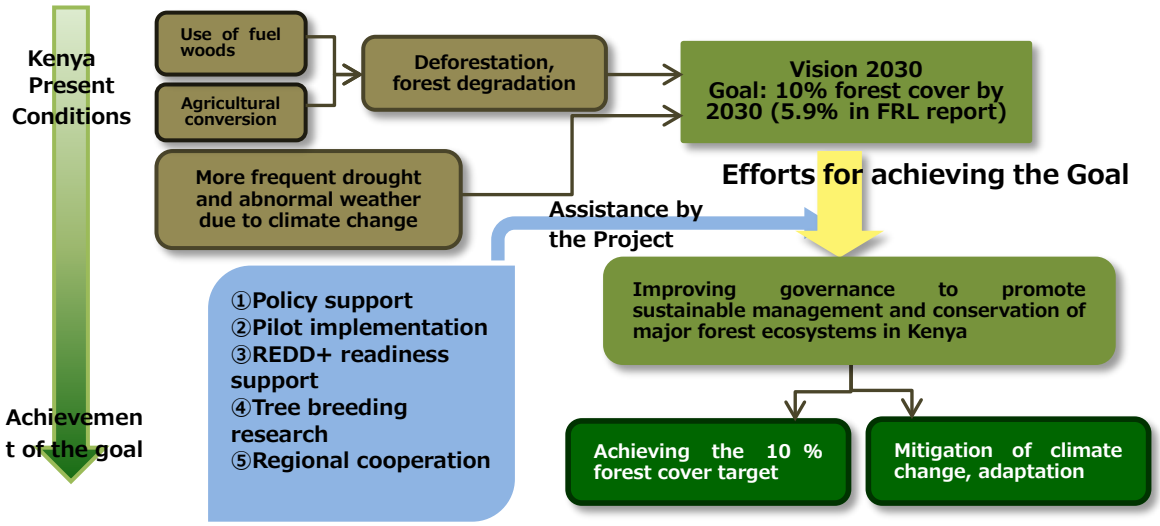


Figure 4.1 Roles of the Project

5 Overall Goal and Project Purpose (from Record of Discussions(R/D))

The Project aims to contribute to the promotion of sustainable forest management towards the achievement of Kenya's goal of increasing its forest coverage rate to 10%. In line with the background described in section 4, Table 5.1 below shows the Project Purpose, Overall Goal, and Outputs, as amended during the mid-term review implemented in February 2019.

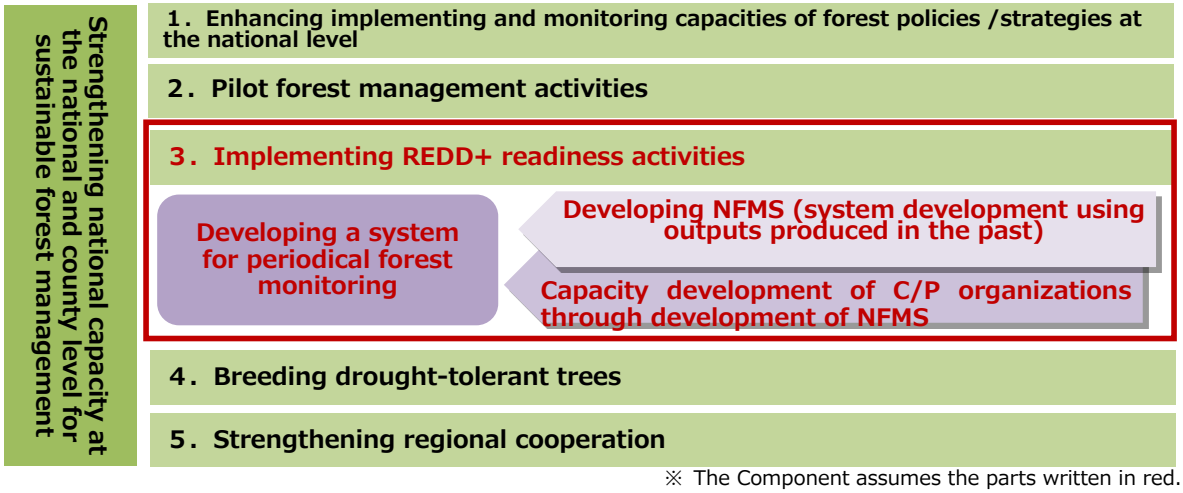
Table 5.1 Outputs and Objectives of the Project

Overall Goal	**Sustainable forest management is promoted in Kenya towards the national forest cover target of 10%**
Project Purpose	National capacity at the national and county level for sustainable forest management is strengthened.
Outputs	1. Implementing and monitoring capacities of forest-related policies/strategies at the national level are enhanced. 2. Capacities of public and private sectors, and NGOs/CBOs to promote tree growing in ASALs are enhanced through forestry extension activities. 3. Technical capacities for REDD+ readiness activities and forest monitoring for sustainable forest management in KFS are strengthened. 4. The capacity of breeding techniques for drought tolerant trees in KEFRI is improved. 5. Capacity of regional cooperation in KEFRI is intensified by promoting knowledge sharing and transfer of technologies for strengthening the resilience to climate change and drought in Sub-Saharan Africa.

The Project is to be achieved through activities carried out by long-term experts and activities for the Component carried out by the short-term expert team (hereinafter referred to as "the Team") together with the Kenyan Counterpart (C/P).

In the process of implementing the Project, the Component mainly engages in activities to assist REDD+

implementation in the readiness stage. The National Forest Monitoring System (NFMS) is developed effectively using the outputs produced by earlier projects funded by various donors including projects funded through Japanese cooperation, and domestic organizations in Kenya. Second, the Component will aid in capacity development for C/P organizations supported through the implementation of the Project. Finally, the Component seeks to develop a system for periodical forest monitoring. Figure 5.1 below shows the roles and objectives of the Component in the Project.



※ The Component assumes the parts written in red.

Figure 5.1 Roles and objectives of the Component in the Project

6 Implementing Agency

Kenya Forest Service (KFS)

II Results of the Componen

1 Results of the Component

1.1 Input by the Japanese side (Planned and Actual)

1.1.1 Input of Short-Term Japanese Experts

The track records of input of Japanese experts are shown in Table 1.1.1.1.

Table 1.1.1.1 Input of Japanese experts (July 2019 – June 2020)

Name	Organization	Expertise	M/M in Kenya	M/M in Japan
Kazuhisa KATO	JOFCA / AAS	Leader/National Forest Monitoring System (NFMS)/Measurement Reporting & Verification (MRV)	13.46	3.69
Kei SATO	PASCO	Forest remote sensing/GIS	14.33	1.75
Kazuhiro YAMASHITA / Kazuhisa KATO	JOFCA / AAS	FRL	6.83	2.70
Kouhei YAMAMOTO / Shintaro ISIZUKA	PASCO	Data base/Data base (1)	5.63	0.60
Kenji SHINDO	PASCO	Data base (2)	0.70	0.00
Akinobu SEMBO	PASCO	Data base (3)	4.50	2.32
Sahori FUJIMURA	JOFCA / AAS	Forest remote sensing/GIS assistant	1.70	0.00
Yoshihiko SATO	JOFCA / AAS	NFMS (2)/FRL (2)/Forest remote sensing/GIS assistant	10.77	3.30
Sachiko TAKINAGA	JOFCA / AAS	Coordinator	1.10	0.00
Total			**62.51**	**14.36**

1.1.2 Input of Equipment and Materials

The record of input of equipment and materials is shown in Table 1.1.2.1.

Table 1.1.2.1 Input of equipment and materials

(Gray: Procured by JICA Kenya office)

No.	Name of Equipment	Specification	Manufacturer	Q'ty	Situation
1	GIS cloud server software	ArcGIS Online Organization Plan Level 2 + additional 14 named user-3years	ESRI	1	Delivered in July 2018
2	Remote sensing software No.1 for desktop	ERDAS IMAGINE 2016 version	ERDAS	2	Delivered in Jan 2017
3	Maintenance for Remote sensing software No.1	1-year maintenance	ERDAS	2	Delivered in Jan 2017

No.	Name of Equipment	Specification	Manufacturer	Q'ty	Situation
4	Media Kit with Shipping and handling	Media Kit for install software, and shipping with handling	ERDAS	1	Delivered in Jan 2017
5	Remote sensing software No.1 for desktop	ERDAS IMAGINE 2016 version	ERDAS	1	Delivered in July 2018
6	Maintenance for Remote sensing software No.1	1-year maintenance	ERDAS	1	Delivered in June 2018
7	Media Kit with Shipping and handling	Media Kit for install software, and shipping with handling	ERDAS	1	Delivered in July 2018
8	Maintenance for Remote sensing software No.1	1-year maintenance	ERDAS	2	Delivered in July 2018
9	Remote sensing software No.2 for desktop	eCognition 9.2 Developer Included 1-year maintenance	Trimble	1	Delivered in Mar 2017
10	GIS software for desktop	ArcGIS for desktop advanced 10.5 with spatial analyst, 3D analyst, geostatistics analyst, publisher	ESRI	1	Delivered in Jan 2017
11	Maintenance for GIS software for desktop	1-year maintenance for ArcGIS desktop advanced	ESRI	1	Delivered in July 2018
12	GIS software for desktop	ArcGIS for desktop standard 10.5 with spatial analyst, 3D analyst, geostatistics analyst, publisher	ESRI	1	Delivered in Jan 2017
13	GIS software for desktop	ArcGIS for desktop standard 10.5 with spatial analyst, 3D analyst, geostatistics analyst, publisher	ESRI	2	Delivered in July 2018
14	Maintenance for GIS software for desktop	1-year maintenance for ArcGIS desktop standard	ESRI	1	Delivered in July 2018
15	Workstation	OS: Windows 10 Pro Edition 64 bit (English)CPU: Intel® Xeon® Processer ES-1620, 3.7GHz Turbo or higher, 12M L3, 5.86GT/s or higher Memory: 16 GB or moreHardDisk: at least 2TB totally, SATA (No RAID) or moreDVD Super Multi DriveGraphic Card: 1G NVIDIA Quadro K600 (1DP and 1DVI) (1DP-DVI and 1DVI-VGA adapter) or higherWireless network USB adopter (support 11n/11a/11g/11b)29inch Wide MonitorMicrosoft Office 2016 (Home & Business)Security software (24 months)System Recovery mediaAuto Ranging (100V- 240V)UPS 650 (650VA - 400 Watts), Input 230V / Output 230Vat least one year warranty	HP	3	Delivered in Jan 2017

No.	Name of Equipment	Specification	Manufacturer	Q'ty	Situation
16	Workstation	OS: Windows 10 Pro Edition 64 bit (English) CPU: Intel® Xeon® Processer ES-1620, 3.7GHz Turbo or higher, 12M L3, 5.86GT/s or higher Memory: 16 GB or more HardDisk: at least 2TB totally, SATA (No RAID) or more DVD Super Multi Drive Graphic Card: 1G NVIDIA Quadro K600 (1DP and 1DVI) (1DP-DVI and 1DVI-VGA adapter) or higher Wireless network USB adopter (support 11n/11a/11g/11b) 29inch Wide Monitor Microsoft Office 2016 (Home & Business) Security software (24 months) System Recovery media Auto Ranging (100V- 240V) UPS 650 (650VA - 400 Watts), Input 230V / Output 230V at least one year warranty	HP	3	Delivered in July 2018
17	Handy GPS	- Capture more positions and increased accuracy in tough GNSS environments - Compatible with existing and planned GNSS constellations to maximize - GNSS Systems: GPS, GLONASS, Galileo, BeiDou, QZSS - SBAS: WAAS, EGNOS, MASAS, GAGAN, SBAS+ - DGNSS accuracy: Horizontal 1cm to 100cm, Vertical 1.5cm to 100cm	Trimble	4	Delivered in Jan 2018
18	Large-format printer	HP DesignJet T3500 production printer A0 with Scanner	HP	1	Delivered in Sep 2019
19	Business printer	HP color LaserJet enterprise mfp m 577dn (b5146a)	HP	1	Delivered in Sep 2019
20	survey 123 for mobile mapping	subscription for 5 years	ESRI	14	Delivered in July 2018
21	Mobile mapping devices	7inch tablet with WiFI and socket for SIM card	Samsung Galaxy Tab	5	Delivered in July 2018
22	GPS Camera	16 mega pixcel Optical 4 x zoom, Digital 7.2 x zoom (Combine 28.8 x zoom) Still image:JPEG(Exif Ver.2.3,DCF2.0,DPOF) Movie:MOV form(H.264/AVC,IMA-ADPCM sound(monaural) media:SD memory card,SDHC memorycard,SDXC memory card GPS English Instruction Manual Universal Power Supply at least one year warranty	RICHO	2	Delivered in Dec 2017
23	Laptops	HP 17.3 touch screen, Intel core i7, 16GB memory, ITB Hard Drive windows 10 Microsoft Office 2016 (Home & Business)	HP	2	Delivered in Sep 2019
24	Laminating machine	double-sided A0 size Laminator, Auto Removing film reqinding	Model: SG-1100s Brand: CIGO	1	Delivered in Oct 2019

No.	Name of Equipment	Specification	Manufacturer	Q'ty	Situation
		paper, 600x300/min, Max Lamination width 1100mm			
25	Database server software	SQL SERVER + 5 USER CALS	Microsoft	2	Delivered in July 2018
26	Geo-information data base software with spatial data management	ArcGIS for Server Enterprise Standard, Portal for ArcGIS Level1	ESRI	1	Delivered in July 2018
27	Image server software	ArcGIS Image Extension for Server Enterprise	ESRI	1	Delivered in July 2018
28	Geo-information data base server	CPU: Intel® Xeon®E5-2640 v4 2.4GHz for 10 core, Memory: 32 GB HardDisk: 8 x SAS 3.84TB, or more, RAID 6 Rack type 2U server * Including Vmware vSphere Standard	HP	2	Delivered in July 2018
29	Data storage server	CPU: 1 x Intel® Xeon® E5-26xx v3 series, 1.9GHz, or more Memory 32 GBHardDisk: 24 x SAS 2TB or more, RAID 6with necessary software if need itRack type 2U server	HP	1	Delivered in July 2018
30	Anti-virus software	Security software (48 months for server)	Kaspersky	5	Delivered in July 2018
31	Rack for servers & Customized Accessories	Rack for servers ・Size: 600 x 1075mm ・Mount: 42U	HP	1	Delivered in July 2018
32	Windows server 2012 r2 software license or updated one	Windows server 2012 r2 software license	Microsoft	4	Delivered in July 2018
33	UPS	Schneider Electric Smart-UPS XL 3000VA Rack Mount 200V	APC	2	Delivered in July 2018
34	L3 Switching Hub	WS-C3650-24TS-L Rack mount Type Auto Ranging (100V- 240V) at least one year warranty	Cisco	1	Delivered in July 2018
35	Business printer for the Team			1	Delivered in July 2017
36	Laptops for the Team			1	Delivered in July 2017
37	Integration and configuration for servers & workstation, etc.	Integration of H/W and configuration for software		1	Delivered in July 2018
38	Back-up Device	DLT (Digital Linear Tape) Device, Software for backup and DLT 20 tapes &Media Tape	HPE	1	Delivered in July 2018

1.2 Input by the Kenyan side (Planned and Actual)

Counterparts from Government of Kenya are shown in Table 1.2.1.

Table 1.2.1 Counterparts list of REDD+ Readiness in CADEP-SFM

No.	Name		Designation / Position	Institution
1	Mr. Emilio	Mugo	Chief Conservator of Forests	KFS
2	Mr. Julius	Kamau	Chief Conservator of Forests (after 2019)	

No.	Name		Designation / Position	Institution
1	Mr. Peter	Nduati	Component 2 & 3 Component Manager	
2	Mr. Geroge	Tarus	Conservator of Forests	
3	Mr. Peter	Sirayo	Assistant Conservator of Forests	
4	Ms. Faith	Muturi	Chief GIS and Remote Sensing Officer	
5	Mr. Richard	Mwangi	GIS and Remote Sensing Officer	
6	Ms. Divinah	Nyasaka	ICT officer	

1.3 Activities (Planned and Actual)

1.3.1 Overall Activity

(1) Preparation of Work Plan

The draft Work Plan was prepared to clarify the basic concepts for the implementation of the Work at the each initial period. Then, the draft Work Plan was be finalized based on the comments from JICA. After dispatched to Kenya, the draft Work Plan was explained to long term expert of JICA, the staff of JICA Kenya office and Kenyan side (at 1st period), for getting approval. Table 1.3.1.1 shows the submission time for each period.

Table 1.3.1.1 The work plan for each period and the submission time

Period	Submission time	Duration	Note
All	June 2016	June 2016 - July 2021	In English
1st	June 2016	June 2016 – February 2018	In Japanese
2nd	April 2018	April 2018 – August 2019	In Japanese
3rd	September 2019	September 2019 – October 2021	In Japanese

From 2nd to 5th year, the results of the previous year's implementation were reviewed with the C/P in July of each year, and the basic concepts for the next implementation were reported into an Activity Plan, which was submitted to JICA and C/P with the progress report. Table 1.3.1.2 shows the submission period for each year.

Table 1.3.1.2 Submission of Progress report and Activity Plan

Year	Submission time
2nd	July 2017
3rd	July 2018
4th	July 2019
5th	July 2020

(2) Meetings Held/Attended

The team attended and/or held the Joint Coordinating Committee (JCC) and Project Management Unit

(PMU) meetings to manage the overall progress of the project, as well as REDD+ Technical Working Group (TWG) meeting on the component activity, and made to discuss with the stakeholders. The attending and holding meetings are listed in Table 1.3.1.3.

Table 1.3.1.3 List of meetings held / attended

Date	Venue	Meeting
16 July 2016	KFS boardroom, Nairobi	Inception Meeting for REDD+ Readiness Component
3rd October 2016	NSSF Building, Nairobi	1st PMU meeting
10th October 2016	KFS boarding room, Nairobi	Internal meeting of REDD+
13th October 2016	NSSF Building, Nairobi	2nd PMU meeting
24th and 25th November 2016	Blue Post Hotel, Thika	REDD+ TWG meeting
28th and 29th March 2017	Masada Hotel, Naivasha	Stakeholder'k WorkShop
28th June 2017	KFS boardroom, Nairobi	REDD+ TWG meeting
4th July 2017	NSSF Building, Nairobi	4th PMU meeting
27th November 2017	NSSF Building, Nairobi	5th PMU meeting
29th and 30th November 2017	MASADA Hotel, Naivasha	REDD+ TWG meeting
1st December, 2017	MASADA Hotel, Naivasha	Stakeholders' WorkShop
5th December 2017	NSSF Building, Nairobi	2nd JCC
26th June 2018	Crown Plaza Hotel, Nairobi	1st CADEP Interaction Workshop
19th July 2018	NHIF Building, Nairobi	3rd JCC
20th and 21st September 2018	Lake Naivasha Resort, Naivasha	REDD+ TWG meeting
21st February 2019	NHIF Building, Nairobi	4th JCC
23rd May 2019	NHIF Building, Nairobi	8th PMUt meeting
16th and 17th July 2019	Lake Naivasha Resort, Naivasha	REDD+ TWG meeting
21st to 24th July 2019	KEFRI Kitui center, Kitui and Embu	2nd Interaction Workshop
9th and 10th December 2019	Lake Naivasha Resort, Naivasha	REDD+ TWG meeting and stakeholders' workshop
28th January 2020	NHIF Building, Nairobi	5th JCC
26th January 2021	NHIF Building, Nairobi	9th PMU meeting
1st and 2nd July 2021	MASADA Hotel, Naivasha	REDD+ TWG meeting
3rd September 2021	Online	10th PMU meeting
14th September 2021	Online	6th JCC
4th October 2021	Utali Hotel, Nairobi	REDD+ TWG meeting

The summaries of the meetings related to the component activity are shown as below.

1) Stakeholder's Workshop

Date	16 July 2016	Place	CANTEEN HALL Headquarter, KFS
Name of Meeting	Inception Meeting for REDD+ Readiness Component	Organizing or Participating	Organized by the Component and KFS
Participants	TWG member, Donors, JICA member, etc., 39 members (See Appendix 1)		
Contents	Explain and discuss the contents of work plan of the REDD+ Readiness Component		
Results	The Team explained about the work plan of the component to the Kenyan side members and the work plan was agreed upon.(See Appendix 1)		

Date	28th -29th March, 2017	Place	Masada Hotel Naivasha
Name of Meeting	Stakeholder's Workshop	Organizing or Participating	Organized by the Component and KFS
Participants	TWG members, Donors, JICA members, etc., 34 members (See Appendix 2)		
Contents	・Confirmation of setting method of AD and EF ・NFMS document ・Calculation method of carbon stock/ha of each forest type. ・Teir1 data and country data ・Reference period and data point ・Soil carbon pool		
Results	Tasks for the development of NFMS and FREL and steps for each process were shared and sorted between stakeholders. (See Appendix 2)		

Date	1st December, 2017	Place	MASADA hotel Naivasha
Name of meeting	Stakeholder's Workshop for FRL submission	Organizing or participating	Organized by the Component and KFS
Participants	TWG member, Donors, JICA member, etc., 36members. Details on Appendix 3		
Contents	・ FRL setting: Report of AD, EF, National circumstances and Carbon Emission ・ Development of NFMS and FIP		
Results	In order to submit the FRL report to the UNFCCC, the results of the study on the setting of FRL so far were reported to the stakeholders and discussed. Details on Appendix 3		

Date	9th and 10th December 2019	Place	Lake Naivasha Resort, Naivasha
Name of meeting	REDD+ TWG meeting and stakeholders' workshop	Organizing or Participating	Organized by the Component, CADEP-SFM, UNDP and KFS
Participants	TWG member, Donors, JICA member, etc., 24 members. Details on Appendix 4		
Contents	・ Discussion for Further Improvement of FRL ・ Work Plan for further improvement of FRL development and submission to UNFCCC.		
Results	FRL setting and FRL uncertainty were improved based on the referenced period and interval: 2002-2018, 4-year intervals. The revised FRL report and progress of submission were discussed. Details on Appendix 4		

2) REDD+ Technical Working Group (TWG) meeting

Date	24th -25th November 2016	Place	Blue Post Hotel
Name of Meeting	REDD+ TWG meeting on development of FRL and NFMS for REDD+	Organizing or Participating	Organized by KFS Participation (Mr. Kei Sato)
Participants	TWG member, JICA member, etc., 22 members. Details on Appendix 5		
Contents	・Policy discussion on how to establish the FRL ・Presentation on the process of developing the 2014 national forest and land cover map and change detection ・Presentation, discussion and decision on the 2014 forest cover change detection and statistics ・Presentation of forest cover changes(Deforestation, forest degradation and enhancement)		
Results	・FRL is to be developed at the national level. Setting of jurisdictional versus national FRL will be discussed next TWG meeting. ・Soil carbon data is lacking so it is necessary to conduct a study. ・Land use-land cover map will be developed using supervised classification and Conditional Probability Network. Details on Appendix 5		

Date	28th June, 2017	Place	CANTEEN HALL Headquarter, KFS
Name of Meeting	REDD+ TWG meeting on development of FRL for REDD+	Organizer	The Component and KFS
Participants	TWG members, JICA members etc., 28 members. Details on Appendix 6		
Contents	・FRL setting(Outline of FRL and Setting of AD, EF and other requirements) ・FRL documentation ・System for Forest Information Platform		
Results	Decision making on requirements for FRL setting has been done except national circumstance. Details on Appendix 6		

Date	29th – 30th November 2017	Place	MASADA Hotel Naivasha
Name of meeting	REDD+ TWG meeting for FRL submission	Organizer	The Component and KFS
Participants	TWG members, JICA member, etc., 28members. Details on Appendix 7		
Contents	・ FRL setting. Reset the reference time period ・ Report of the land cover / land use change analysis ・ Report of examination of National circumstances ・ Development of NFMS		
Results	The reference time and period were reset due to consideration of GCF scorecard for result based payment. The confirmation and approval of AD, EF, and Carbon Emission which was calculated by the method based on decisions of the meeting was done. For NFMS, the purpose and function were agreed on in principle. Details on Appendix 7		

Date	20th and 21st September 2018	Place	Lake Naivasha Resort, Naivasha
Name of meeting	REDD+ TWG meeting for development of FRL	Organizer	The Component and KFS
Participants	TWG member, Donors, JICA member, etc., 24 members. Details on Appendix 8		
Contents	・ Discussion for Further Improvement of FRL ・ Work Plan for further improvement of FRL development. ・ Current Status of NFMS ・ Way forward on development of NFMS		
Results	Based on the comment from peer-review, FRL setting and FRL uncertainty were discussed for development of the FRL report. EF setting was decided to study the condition related EF by Kenyan expert in forestry. For NFMS, the draft, ver.0 was shared and discussed. Details on Appendix 8		

Date	16th and 17th July 2019	Place	Lake Naivasha Resort, Naivasha
Name of meeting	REDD+ TWG meeting for development of FRL	Organizer	The Component and KFS
Participants	The TWG members, Donors, JICA members, etc., 24 members. Details on Appendix 9		
Contents	・ Discussion for Further Improvement of FRL ・ Work Plan for further improvement of FRL development and submission to UNFCCC.		
Results	Based on the comment from peer-review, FRL setting and FRL uncertainty were improved. The revised FRL report and further improvement such as reference period and time series analysis, were discussed. Details on Appendix 9		

Date	1st and 2nd July 2021	Venue	Masada Hotel, Nairobi
Name of meeting	REDD+ TWG meeting for development of NFMS	Organizer	The Component and KFS
Participants	The TWG members, Donors, JICA members, etc., 33members. Details on Appendix 10		
Contents	・ Discussion for the drafting work and further improvement of NFMS		
Results	・ On the development of NFMS, the draft document of NFMS was shared and the work of future improvement was discussed. Details on Appendix 10		

Date	4th October 2021	Venue	Utali Hotel, Nairobi
Name of meeting	REDD+ TWG meeting for development of NFMS	Organizer	The Component and KFS
Participants	The TWG members, Donors, JICA members, etc., 14members. Details on Appendix 11		
Contents	・ To share the document of NFMS and to finalize		
Results	The draft NFMS document Ver.1 was shared. The details of monitoring functions were discussed, and it was decided to finalize the NFMS after the revise work on some parts. Details on Appendix 11		

3) Internal meeting of REDD+

Date	10th October 2016	Place	KFS boardroom, Nairobi
Name of Meeting	Internal meeting of REDD+	Organizer	The Component and KFS
Participants	KFS members and JICA members, 12 members (See Appendix 12 memo of FRL meeting)		
Contents	・Confirmation of AD and EF taking into account the feasibility and practicability to generate data of AD and EF.		
Results	To calculate the EF by adjusting to SLEEK map stratification, additional forest inventory which was implemented with JICA's support. But the additional forest inventory didn't cover the whole country, it was implemented as pre-inventory. Details on Appendix 12		

(3) Monitoring

Based on the JICA's working guidance, monitoring was made with C/P every six months by use of monitoring sheet. The monitoring described into a monitoring sheet were submitted to JICA through the project. Table 1.3.1.4 shows the period covered by each monitoring sheet and the attached documents.

Table 1.3.1.4 Number of version and period for monitoring sheet

Version	Period
Ver.00	January – June 2016
Ver.01	July – December 2016
Ver.02	January – June 2017
Ver.03	July – December 2017
Ver.04	January – June 2018
Ver.05	July – December 2018
Ver.06	January – June 2019
Ver.07	July – December 2019
Ver.08	January – June 2020
Ver.09	July – December 2020
Ver.10	January – June 2021

(4) Preparing Progress Report

The progress report was prepared in cooperation with C/P by June every year and submitted to JICA and C/P. The format of progress report followed the format of monitoring sheet. In addition, the draft work plan mentioning concrete activities in the next year was included in the progress report.

(5) Equipment Procurement

In this project, the equipment and materials shown in Table 1.1.2.1 were procured based on the "Procurement and Management Guideline for the Equipment in the outsource contract (2014 April)". At the confirmation of the current status of the C/P in advance, the component considered the compatibility and affinity with the related equipment used by the C/P, as well as the ease of maintenance

and sustainability of the equipment. The confirmed draft of equipment list was submitted to JICA, and it was confirmed based on discussion with JICA.
In addition, for the equipment to be procured by JICA office in Kenya, as shown in Table 1.1.2.1, the status of C/P was also confirmed and the quantity to be used was decided after consultation with JICA. The procurement tender document, draft of contract and order, equipment specification and estimation for budget with reference quotation was prepared, and evaluation of the proposal in tender and inspection of procured goods was conducted for supporting JICA Kenya office.

(6) Activity of Public Relations

The activities of the component were reported in a newsletter on the website of C/P and on the website of JICA in order to promote awareness of the REDD+ readiness in Kenya.

KFS: Kenya Forest Service - JICA set to support Kenya in REDD+ Readiness activities
(http://kenyaforestservice.org/index.php?option=com_content&view=article&id=499:jica-set-to-support-kenya-in-redd-readiness-activities&catid=81:news&Itemid=538)

- ✓ JICA set to support Kenya in REDD+ Readiness activities

JICA: https://www.jica.go.jp/project/kenya/014/news/index.html

- ✓ 1st MRV training, November 2017
- ✓ REDD+ TWG meeting and Stakeholder's Workshop, November 2017
- ✓ 2nd MRV training, July 2018
- ✓ 3rd MRV training, March 2020
- ✓ Submission of FRL report to UNFCCC, May 2021
- ✓ REDD+ TWG meeting for development of NFMS, July2021
- ✓ 4th MRV training, July 2021

As for the activities related to FRL, the FRL report was submitted to the UNFCCC and posted on the website of UNFCCC for dissemination.
UNFCCC: Submissions - REDD+ (unfccc.int)
(https://redd.unfccc.int/submissions.html?country=ken)

1.3.2 Activity on the National Forest Monitoring System and the Forest Information Platform

(1) Development of National Forest Monitoring System

The C/P and the Team had worked on the development of NFMS, which is one of the four requirements for the result payment in REDD+ (NRS, FRL, SIS and NFMS). Through the REDD+ TWG meetings and other activities to build consensus among relevant stakeholders, NFMS in Kenya has been finalized as NFMS document Ver. 1.0 (October 2021). The activities related to the development of NFMS are described below and the NFMS document Ver. 1.0 in Kenya was finalized.

1) Requirement for NFMS in Kenya

In the development of NFMS, the requirements indicated in UNFCCC (Figure 1.3.2.1) were presented,

and the monitoring items to be addressed in the NFMS were discussed. Through the C/P and stakeholder consultations, Kenyan stakeholders requested inclusion of PaMs, biodiversity, registration of forest carbon related projects such as REDD+ and AR-CDM for the monitoring items in NFMS, which were not originally scoped. The component then proceeded with the development of NFMS with these items included.

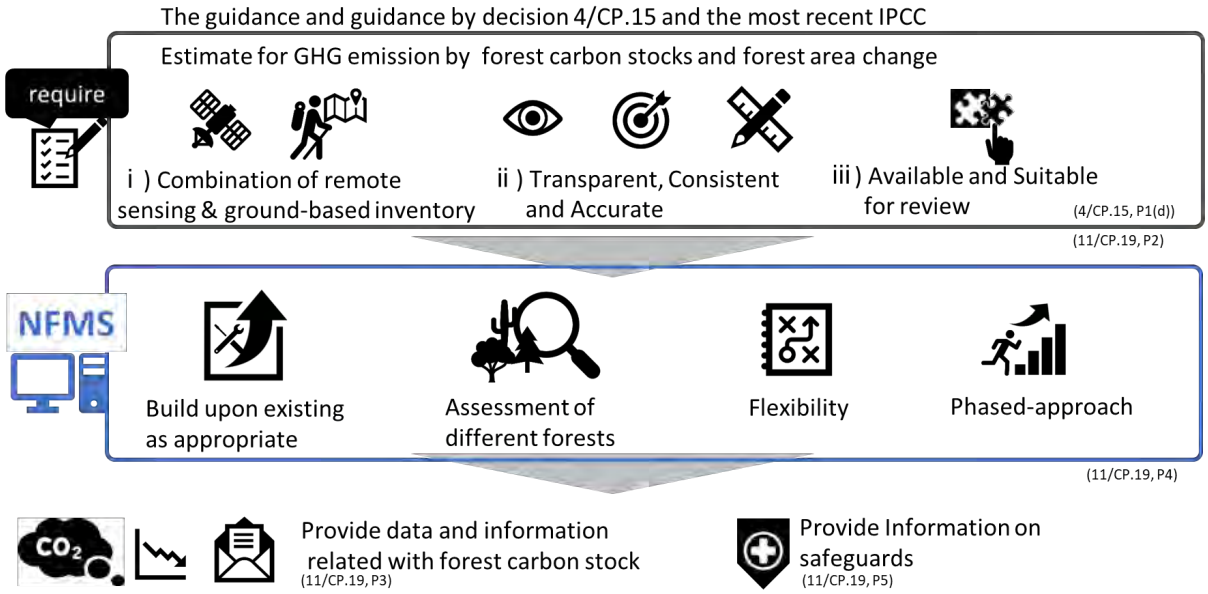


Figure 1.3.2.1 Requirements for NFMS in UNFCCC decision

In the development of NFMS, efforts were made to ensure consistency in REDD+ outlines and to avoid duplication of support by sharing information with relevant organizations and donors in Kenya.

In September 2019, consultations were held with United Nations Development Programme (UNDP), which supports the development of NRS and SIS using Forest Carbon Partnership Facility (FCPF) Readiness Fund in Kenya. PaMs and Biodiversity monitoring in NFMS are relevant to NRS and SIS respectively. In the meeting, the development progress of NFMS by the Component, and NRS and SIS by UNDP were shared with each other, and it was confirmed that the information sharing would be continued in the future.

2) Information Collection on NFMS

In regard to the development of the NFMS, relevant documents in Kenya, regulations and manuals issued by international organizations, etc. were collected and organized (Table 1.3.2.1).

Table 1.3.2.1 Information collected for NFMS development

Information	Organization	The data of issue	Contents
Roadmap for the establishment of Forest Reference Levels and the National Forest Monitoring System	UN-REDD/FAO, UNDP, UNEP, KFS	2017	Road Map for development of NFMS and setting FRL in Kenya
Report on National Forest Resource Mapping and	JICS、KFS	2013 (Project duration 2010-	Development of land cover map, land cover change map and forest

Information	Organization	The data of issue	Contents
Capacity Development for the Republic of Kenya		2013)	cover map by Japanese Program Grant Aid for Environment and Climate Change "the forest Preservation Program"
Manuals which were developed by IC-FRA (Improved Capacity in Forest Resource Assessment)	Government of Finland, KFS	2013	Designing of the national forest inventory methodology for development of EF in Kenya
SLEEK(System for Land-based Emissions Estimation in Kenya) program	Clinton Foundation, DRSRS	2016	Development of AD in Kenya
REDD+ Readiness Preparation Proposal(R-PP)	FCPF World bank KFS	June 2016	Preparation of R-PP (Readiness Preparation Proposal)
National Forest Monitoring Systems: Monitoring and Measurement, Reporting and Verification (M & MRV) in the context of REDD+ Activities	UN-REDD	2013	Guideline for the development of National Forest Monitoring System
Action Plan for the Implementation of the National Forest Monitoring System of Pakistan draft report	Pakistan, UN-REDD, WWF	August 2015	Action plan for the implementation of NFMS in Pakistan supported by UN-REDD+ and WWF
Decision booklet REDD+	FFPRI	February 2016	COP decision including the definition of NFMS
REDD-plus COOKBOOK (ANNEX Research Manual)	FFPRI	2012	This Cookbook is an easy-to-understand technical manual which provide basic knowledge and technologies required for REDD-plus with the main focus on the forest carbon monitoring methods.

3) Development of NFMS

During the development of NFMS, the requirements for the development of NFMS in UNFCCC decision and the guidelines of United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (UN-REDD) were referred and discussions held with the C/P and members of the REDD+TWG, as well as with other donors at stakeholder workshops. Throughout these discussions, the basic guidelines for the development of NFMS were produced by the C/P and the team (Table 1.3.2.2), and the development of NFMS was facilitated. Figure 1.3.2.2 shows an image of the NFMS structure.

Table 1.3.2.2 Definition of NFMS in Kenya

Item	Contents
Purpose	1) To collect and stores the accurate and transparent data and information for the forest management, 2) To share the necessary information with the stakeholders to contribute to

Item	Contents
	implementation of REDD+ and sustainable forest management, 3) To use the information for reporting to international organizations and for accountability to other countries.
Basic condition	1) Forest definition : A minimum 15% canopy cover; minimum land area of 0.5 ha and potential to reach a minimum height of 2 meters at maturity in situ. Perennial tree crops like coffee and tea are not considered as forests. 2) REDD+ activity : 1. Reducing emissions from deforestation, 2. Reducing emissions from forest degradation, 3. Sustainable management of forests, 4. Enhancement of forest carbon stocks 3) Carbon pool : Above-ground biomass, Below-ground biomass 4) Scale : National 5) Green house gases : Only Carbon dioxide gas (CO2)
Structure	• Monitoring function Includes the monitoring functions below; ・ Forest area and forest area change (AD) ・ Carbon stock of forest (EF) ・ GHG emission of forest ・ PaMs ・ Biodiversity ・ REDD+ and AR-CDM Project for Registration • Data management function A database that stores information and data collected by the monitoring function and provides information for the implementation of forest management, including REDD+.
Documentation	For the continuous implementation, operation, and management of the NFMS, its objectives, structure, and details of each function had been documented.

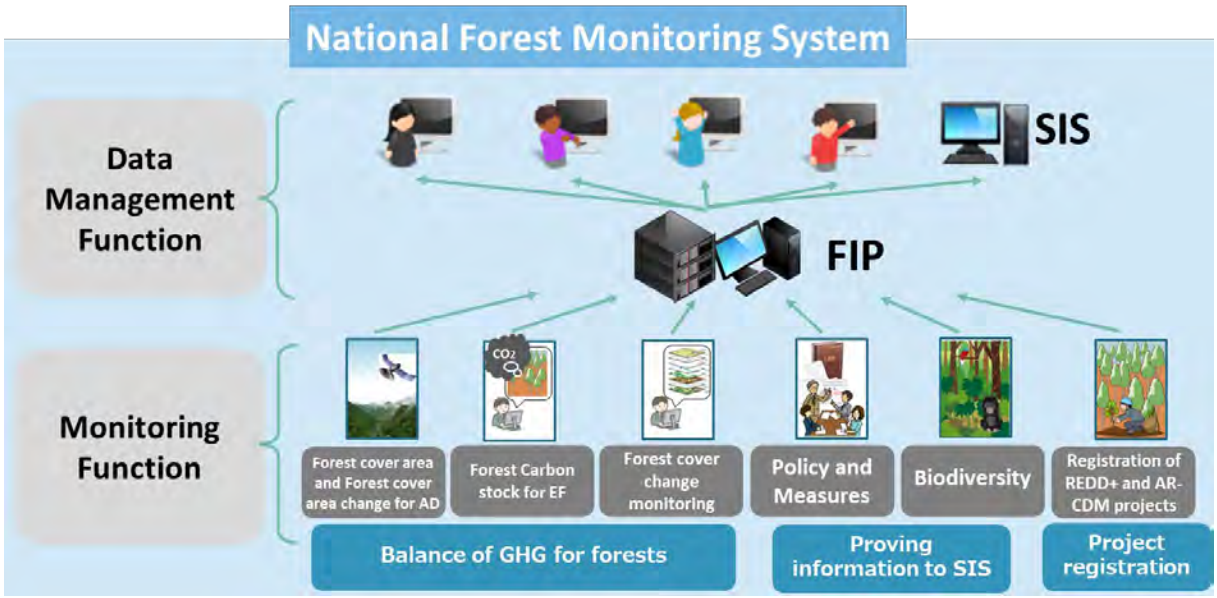


Figure 1.3.2.2 The image of NFMS design

The summary of the six monitoring items incorporated in NFMS are shown in Table 1.3.2.3.

Table 1.3.2.3 Item and data collection method in NFMS

Item	Basic design	Specific method
Forest area and forest area change (Activity Data)	Land Cover/ Land Use map which is developed by wall-to-wall based analysis using optical satellite image	【Analysis method】 Pixel-based classification 【LULC classes】 ・10 forest stratification (3 classes by ecological forest type x 3 classes by forest cover density in Natural forest, and Plantation) and 4 Non forest stratification 【Detection method】 Wall-to-wall based, Hybrid of supervised classification and Conditional Probability Network (CPN) based on 2014 land cover/land use map 【Representing AD approach】 IPCC Approach 3
Forest carbon stock per unit area (Emission Factor)	Implementation of National Forest Inventory	【Sampling design】 Stratified random sampling method: Random sampling by SLEEK stratification (10 forest types). Cluster locations are randomly selected by 1km * 1km grid points (1km2 grid). 【Cluster design】 ・Cluster design that 6 or 4 plots are set in each cluster has been proposed by IC-FRA, 【Shape of the plot】 ・Circle shape 【Survey items】 ・Species, DBH, Height and other necessary items such as disease information. 【Conversion to biomass】 ・Use allometric equations which are selected for each forest type. Otherwise, follow the FRL setting. 【Carbon fraction】 ・Apply default value of IPCC2006. Otherwise, follow the FRL setting.
Forest cover change monitoring	Existing deforestation detection system and field tool	Extraction of deforestation areas in Kenya using existing deforestation area detection systems (JJ-FAST and NRTFAS). In the identified deforestation areas, the area staff in charge will conduct field survey and report using field tools (Survey123).
PaMs	Monitoring based on the draft NRS	Monitoring indicators were provided for each of the strategic and investment areas agreed in the draft Kenya's NRS. Specific monitoring methods will be discussed in the future.
Biodiversity	Monitoring using the data of NFI	Monitoring using the field survey data in NFI Tree data: tree species, number of trees, DBH, height, information of disease and so on. Biodiversity: big mammals, other mammals, reptiles birds, insects and so on.
REDD+ and AR-CDM Project	Collecting information on REDD+ and AR-CDM projects in Kenya	To collecting information on each project, the project information and the project area are displayed in the GIS function of the FIP. Monitoring of project activities in Kenya and prevention of double payment of results due to reduction of carbon emission.

The outline of the monitoring method for each monitoring item is described below. For details of the monitoring method for each monitoring item, please refer to the NFMS document Ver1.

(a) Forest cover and Forest Cover Change Area (AD)

The method of creation for the land cover/land use map is to extract the forest area by filtering and

zoning process on the SLEEK map in accordance with the setting of FRL. The flow of land cover/land use mapping by SLEEK methodology is shown in Figure 1.3.2.3.

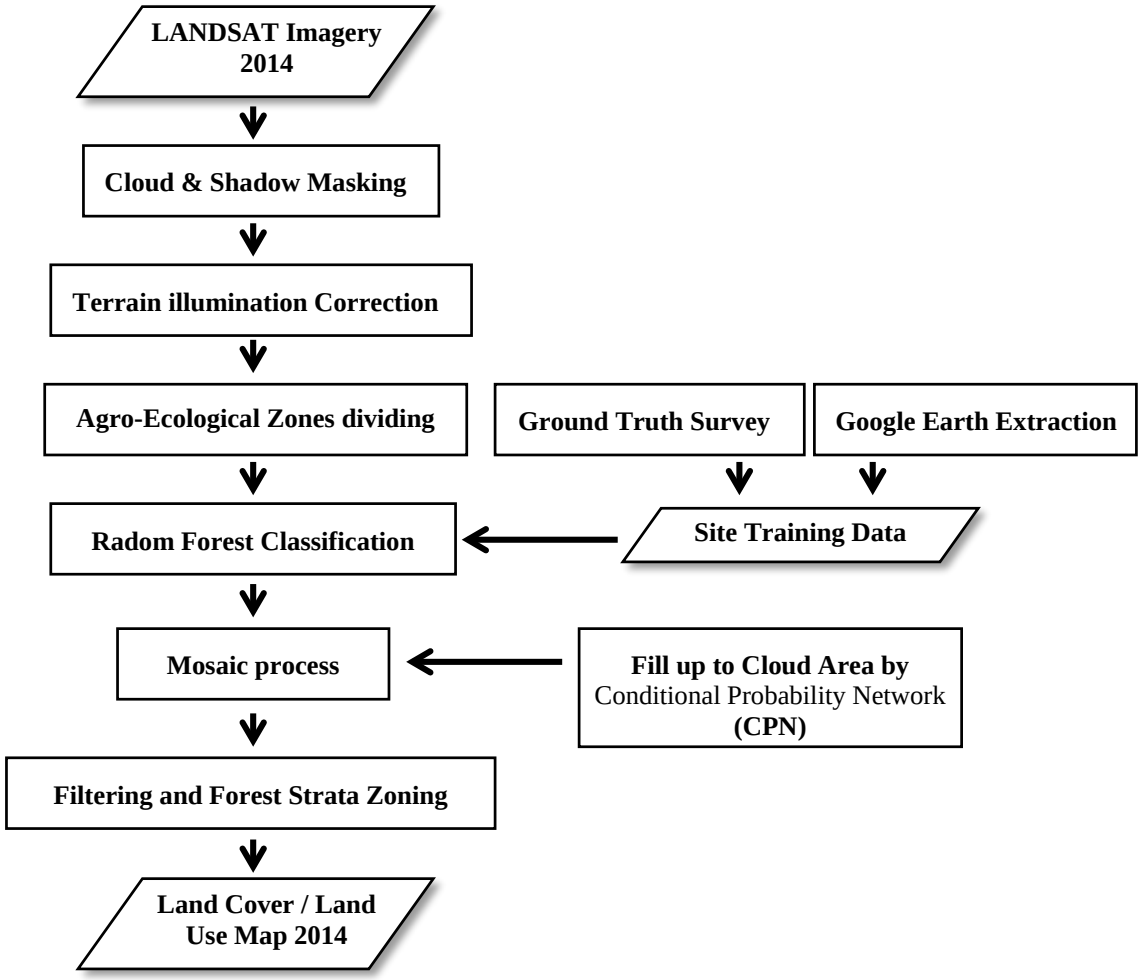


Figure 1.3.2.3 Flow chart of Land Cover / Land Use Map

The mosaicked and filled up image map is subjected to a filtering process to obtain the minimum map area and to meet the agreed forest definition for Kenya. To meet the forest definition, eight (8) neighbors filtering method is preferred and used for mapping. The method uses eight (8) direction searching and clumping as one connected forest as shown in Figure 1.3.2.4. Kenya defines a forest as having a minimum area of 0.5ha which is defined by approximately 6 pixels of 30m by 30m dimensions. Therefore a clumped forest of less than 6 pixels is eliminated.

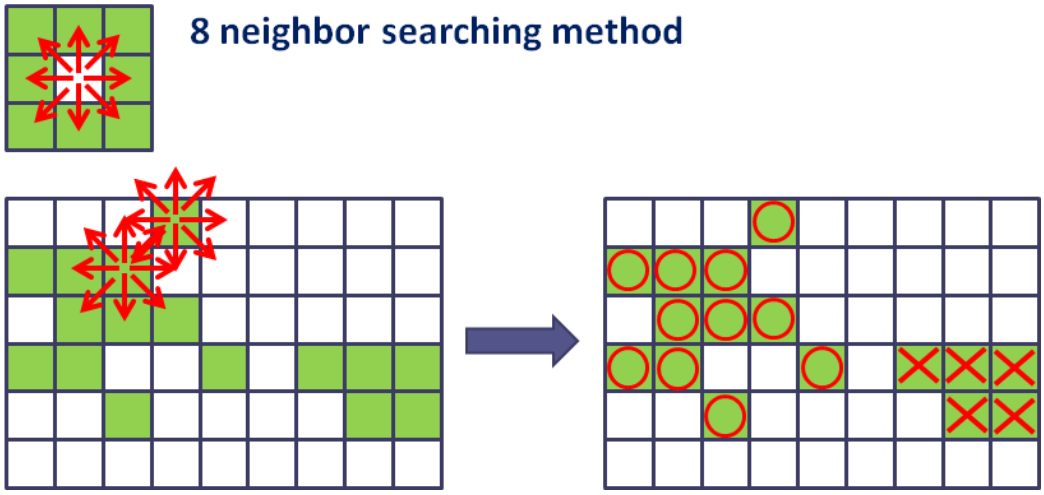


Figure 1.3.2.4 Eight (8) neighbors filtering

The filtered classification result map is zoned by forest stratification i.e. "mountainous forest and western tropical rainforest," "coastal forest and mangrove," "dry forest," and "plantation forest," as shown in Table 1.3.2.4.

Table 1.3.2.4 Forest Stratum

Land Cover/Land Use category	Stratum 1	Stratum 2
Forest Land	Montane and Western Rain Forests	Dense (>65% Canopy)
		Moderate (40%-65% Canopy)
		Open Forest (15-40% Canopy)
	Costal and Mangroves Forests	Dense (>65% Canopy)
		Moderate (40%-65% Canopy)
		Open Forest (15-40% Canopy)
	Dryland Forests	Dense (>65% Canopy)
		Moderate (40%-65% Canopy)
		Open Forest (15-40% Canopy)
	Plantations Forests	-

By comparing two subsequent Land Cover/Land Use maps (e.g. for 2018-2022, 2026 as proposed in the FRL), extracts of land cover change areas can be made and their specific areas calculated as AD data. This creates a land cover/land use change map. The extracted change areas are then sorted out by using a Land Cover/Land Use Change Matrix as illustrated in Table 1.3.2.5. Calculations of change area are based on the forest strata (Montane and western rain forests and bamboo areas; Mangroves and coastal forests areas; Dryland forests areas and Plantation forest land zones) and their specific canopy closure (for Montane and western rain forests and bamboo, Mangroves and coastal forests and Dryland forests). The colours of each cell in Table 1.3.2.5 indicate following activities: red for deforestation, yellow for forest degradation, green for enhancement and blue for sustainable management of forest. Table 1.3.2.6 shows the example for 2014 – 2018 Land Cover / Land Use Change Area (ha)

Table 1.3.2.5 Matrix of Land Cover / Land Use Change and REDD+ activity in Kenya

Area in 20XX				Area in 20XX+(X)												
				Forest										Non Forest		
				Montane Forest/ Western Rain Forest/ Bamboo			Costal Forest and Mangroves			Dryland Forest			Plantation Forest	Crop Land	Grass land	Wet land	Settlement and Other land
				D	M	O	D	M	O	D	M	O					
Area in 20XX	Forest	Montane Forest/ Western Rain Forest/ Bamboo	D	n	dg	dg								df	df	df	df
			M	e	n	dg								df	df	df	df
			O	e	e	n								df	df	df	df
		Costal Forest and Mangroves	D				n	dg	dg					df	df	df	df
			M				e	n	dg					df	df	df	df
			O				e	e	n					df	df	df	df
		Dryland Forest	D							n	dg	dg		df	df	df	df
			M							e	n	dg		df	df	df	df
			O							e	e	n		df	df	df	df
		Plantation Forest											n	s	s	s	s
	Non Forest	Cropland		e	e	e	e	e	e	e	e	e	s	NA	NA	NA	NA
		Grass land		e	e	e	e	e	e	e	e	e	s	NA	NA	NA	NA
		Wetland		e	e	e	e	e	e	e	e	e	s	NA	NA	NA	NA
		Settlement and Other land		e	e	e	e	e	e	e	e	e	s	NA	NA	NA	NA

df Deforestation (F→NF)

dg Forest Degradation (F→F(Degraded))

e Enhancement (F→F(Improved) ,NF→F)

n No Change (F→F)

s Sustainable Management of Forest (F→NF, NF→F)

NA Not Available

Table 1.3.2.6 Area of Land Cover/Land Use change in 2014 – 2018 yr. (ha)

Forest strata			2018												
			Montane andwesternrain Forests and bamboo			Mangroves and coastal Forests			Dryland Forests			Plantation Forests	Crop land	Grass land	Wet land	Settlement & Otherland
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
2014	Montane and western rain forest and bamboo	Dense	834,862	49,209	19,734								88,835	91,840	416	821
		Moderate	40,248	83,235	12,899								11,406	53,825	78	33
		Open	9,843	10,324	26,260								6,435	51,566	10	25
	Mangroves and coastalforests	Dense				164,282	87,918	1,363					6,422	160,174	1,632	825
		Moderate				22,023	40,366	2,040					3,565	50,419	458	233
		Open				1,116	989	452					110	2,797	9	12
	Dryland Forests	Dense							344,985	97,928	42,170		24,559	455,918	3,874	2,307
		Moderate							57,877	60,223	33,164		4,763	127,932	1,229	1,018
		Open							21,221	20,412	66,984		4,012	185,783	1,445	4,274
	Plantation Forests											56,315	17,880	7,263	26	23
	Cropland		78,641	8,156	6,568	1,689	2,567	438	21,204	9,163	10,163	3,886				
	Grassland		85,367	48,885	38,956	76,856	82,563	13,417	377,850	207,559	158,441	4,834				
	Wetland		267	176	12	343	316	38	1,648	1,083	1,877	14				
	Settlement & Other land		866	107	1,702	398	470	15	1,667	2,424	3,279	6				

(b) Forest Carbon Stock (EF)

a) Sampling method for NFI

In Kenya, IC-FRA had established a national forest inventory survey methodology, but the methodology uses its own land classification. However, Kenya used the SLEEK-based forest classification in setting the FRL.

It was therefore necessary to re-examine the IC-FRA sampling design of the national forest inventory survey in the development of the NFMS. First, a comparison of the land classification of the IC-FRA and the forest classification based on SLEEK ecological zones is shown in Figure 1.3.2.5. The forest classification table based on SLEEK used in the FRL is also shown in Table 1.3.2.4. Based on the FRL setting, the sampling design using the forest classification based on SLEEK was developed and the method of calculating the required number of samples for the national forest inventory survey was examined.

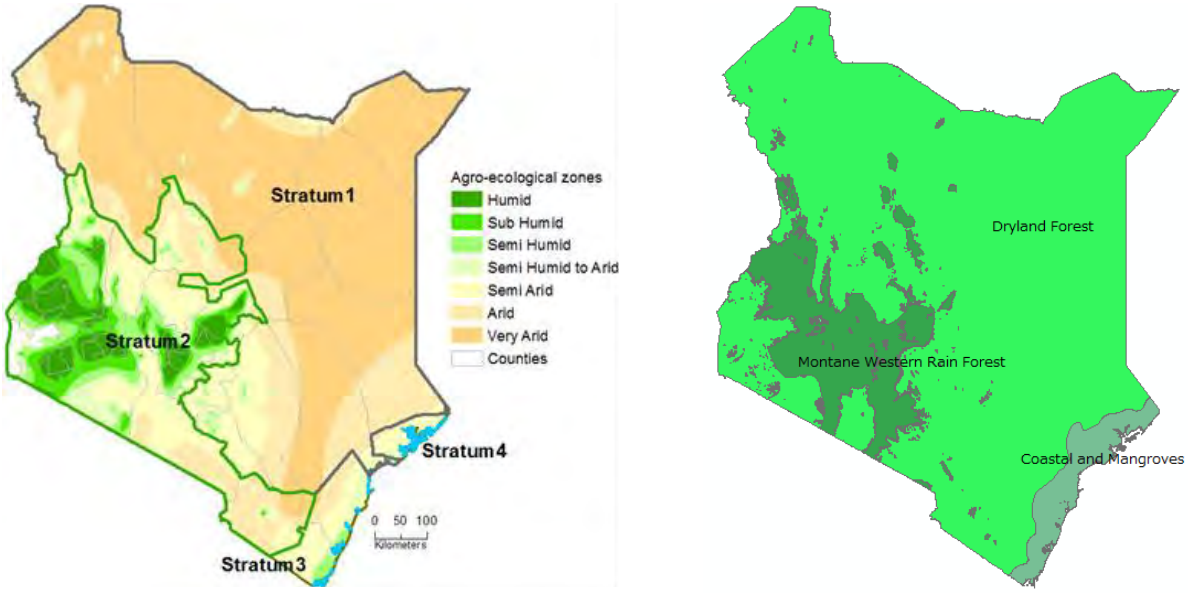


Figure 1.3.2.5 Comparison of land classification between IC-FRA and SLEEK

(Left: IC-FRA, Right: SLEEK)

For the setting of the required number of samples for NFI, the existing calculation method of IC-FRA was assessed and a new calculation method was examined. Through the assessment of IC-FRA calculation method, it was revealed that the optimal number of required samples was calculated by 500 simulations using the statistical software R based on the data combining i) the time required for past inventory surveys, ii) the average value and error rate of survey data, iii) Geographic Information System (GIS) data such as topography and so on. Since the R code for the simulation is not transferred to Kenya and it is difficult to update the basic data used in the simulation from i) to iii), it was considered difficult to recalculate the required number of samples using IC-FRA calculation method based on the SLEEK forest classification in FRL setting.

As an alternative, a methodological approach was considered to calculate the required number of samples based on the confidence interval of the sample distribution and the confidence coefficient

corresponding to the confidence interval, which are commonly used in the area of study and research (Equation 1). Equation 1 is estimated using the results of a pre-sample survey (mean and standard deviation). *n* is the required number of samples, *t0.05* is the confidence coefficient corresponding to the 95% confidence interval, *Cv* is the standard deviation of the prior sample survey results divided by the mean, and *e* is the target error rate.

$$n = \left(\frac{t_{0.05} * C_v}{e}\right)^2 \qquad \text{Equation 1}$$

Based on the pre inventory survey data used in setting FRL, the required number of samples n for each forest category was calculated with a confidence interval of 95% (confidence coefficient: 1.96) and a target error rate of 10% (n=1,227, Table 1.3.2.7). The minimum number of clusters per forest class is set at 30.. Therefore, if the calculated clusters of a given forest stratum is less than 30, the number of clusters in the actual NFI plan is set to be 30 for a class and/or forest stratum.

In the future, according to this required number, the actual survey clusters will be randomly set up from the intersections of the 1km grid of the entire country. In addition, 20% of *n* will be set as a supplementary sample cluster in case the actual survey cannot be conducted in the field due to land use change (e.g., conversion from forest to agricultural land) after the survey clusters of NFI are placed on the map. In addition, the cluster sampling method (6 or 4 plots per cluster) by IC-FRA has been adopted for NFI in Kenya, as this method enables efficient collection of sample data.

The results of the required sample number calculation will be applied as the required clusters. The cluster design, the number of plots and plot size, and the plot design for each forest stratum are shown in Figure 1.3.2.6, Table 1.3.2.8, and Figure 1.3.2.6Figure 1.3.2.7, respectively.

Table 1.3.2.7 Number of sampling clusters calculated for each forest class

Stratum		Pilot Inventory Data			*Cv*	*t0.05*	*e*	*n*
		Sampling No.	**Mean Biomass (t/ha)**	**Standard Deviation (t/ha)**				
Montane and western rain forests and bamboo	Dense	8	335.37	216.38	0.65	1.96	0.10	160
	Moderate	7	80.05	47.46	0.59	1.96	0.10	135
	Open	5	25.08	9.55	0.38	1.96	0.10	56
Costal &mangrove Forest	Dense	18	113.55	54.04	0.48	1.96	0.10	87
	Moderate	11	63.30	22.00	0.35	1.96	0.10	46
	Open	14	28.81	17.01	0.59	1.96	0.10	134
Dryland forests	Dense	7	54.31	41.10	0.76	1.96	0.10	220
	Moderate	8	44.19	19.21	0.43	1.96	0.10	73
	Open	7	18.26	8.82	0.48	1.96	0.10	90
Plantation forests	-	36	412.48	316.71	0.77	1.96	0.10	226
Total		121						1227

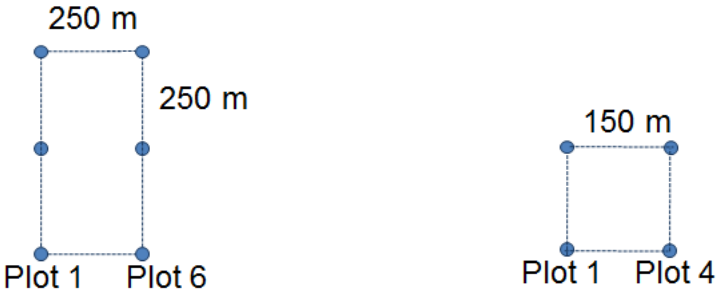


Figure 1.3.2.6 Cluster design

(Left: Montane and Western rain forest and bamboo, and Dryland forests, Right: Coastal and Mangrove forests, and Plantation forests)

Table 1.3.2.8 Number of plot in cluster and plot size

Forest stratum	Plot number in cluster	Plot size (radius meter)	Total plot area in cluster (m^2)
Montane and western rain forest	6	15	4,239
Coastal and mangrove forests	4	15	2,826
Dryland forests	6	20	7,536
Plantation forests	4	15	2,826

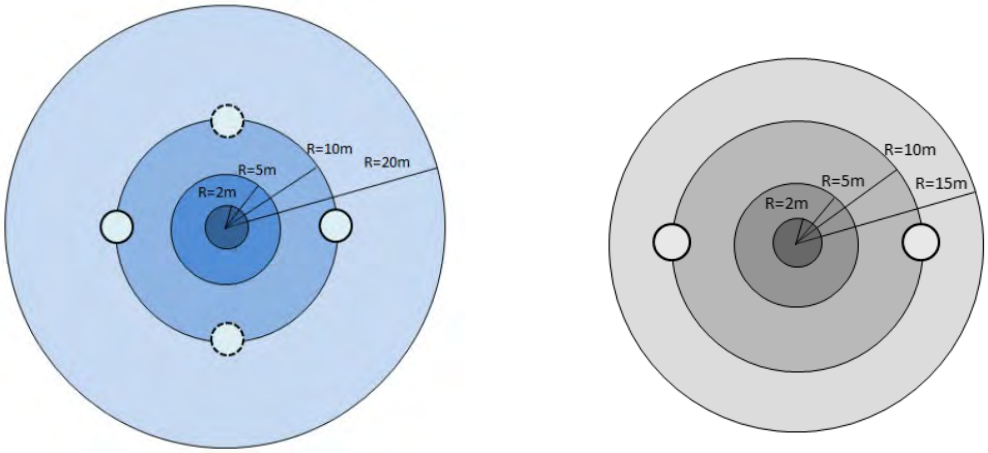


Figure 1.3.2.7 Plot design

(Left: Dryland forests, Right: Montane and western rain forest, Coastal and mangrove forests and Plantation forests

The target in plot survey is shown in Table 1.3.2.9.

Table 1.3.2.9 Condition for measurement

Measuring item	Size or location from centre of Sample plot	Data to record
Tree	Within 2m radius	DBH ≥2cm (seedlings)
	Within 5m radius	DBH ≥5cm (Saplings)
	Within 10m radius	DBH ≥10cm (poles)
	Within 20m radius (Dryland Forests Stratum)	DBH ≥20cm
	Within 15m radius (other than Dryland Forests Stratum)	
Shrubs	Within 15m radius	-
Tree regeneration	Two circular (1.5 m radius subplots) locating 10 meters from the sample plot centre.	Height ≥10cm, DBH ≤2cm
Dead wood	Within 15m radius (within 20m radius for Dryland forests)	Diameter ≥10cm
Stumps	Within 15m radius (Within 20m radius for Dryland forests)	Diameter ≥10cm
Bamboo	Within 10m radius	All bamboo shoots ≥1.3m
Climbers	Within 2m radius	DBH ≥2cm
	Within 5m radius	DBH ≥5cm

b) Conversion of the inventory data into carbon stock data

The method to conversion into biomass is the same as the method of conversion in FRL setting.

(c) Forest cover change monitoring

a) Detection of deforestation area using JJ-FAST and NRTFAS

For near real time forest cover change monitoring, the existing systems which are JICA-JAXA Forest Early Warning System in the Tropics (JJ-FAST) and Near Real Time Forest Alert System (NRTFAS) are used.

JJ-FAST is capable of detecting deforestation sites with size larger than 2 hectares. The target region of JJ-FAST includes 77 countries, covering almost the entire tropical forest belt. Employing the microwave remote sensing technology, detections can be made even under the thick cloud cover which is characteristic for tropical regions especially during the rainy seasons. The system detects deforestation approximately every 1.5 months by means of L-band Synthetic Aperture Radar data acquired by the PALSAR-2 sensor aboard JAXA's Advanced Land Observing Satellite 2 (ALOS-2) and provides the positioning information of detected sites to users free of charge via its web site.

In the NFMS of Kenya, FIP allows access to the deforestation information provided by JJ-FAST through FIP website.

NRTFAS for deforestation detection using the optical satellite (Sentinel 2) data has been implemented as a pilot project in the UK-sponsored Forest2020 project, covering eight counties in the North Rift region of

Kenya. The used Sentinel 2 satellite is a satellite launched and operated by the EU. Since it observes the earth with 10-day revisit and is operated by two twin satellites (Sentinel 2A and Sentinel 2B), high-frequency forest depletion monitoring is possible by observing once every 5 days. Deforestation areas detected by NRTFAS can be viewed through FIP website in NFMS, Kenya (Figure 1.3.2.8).

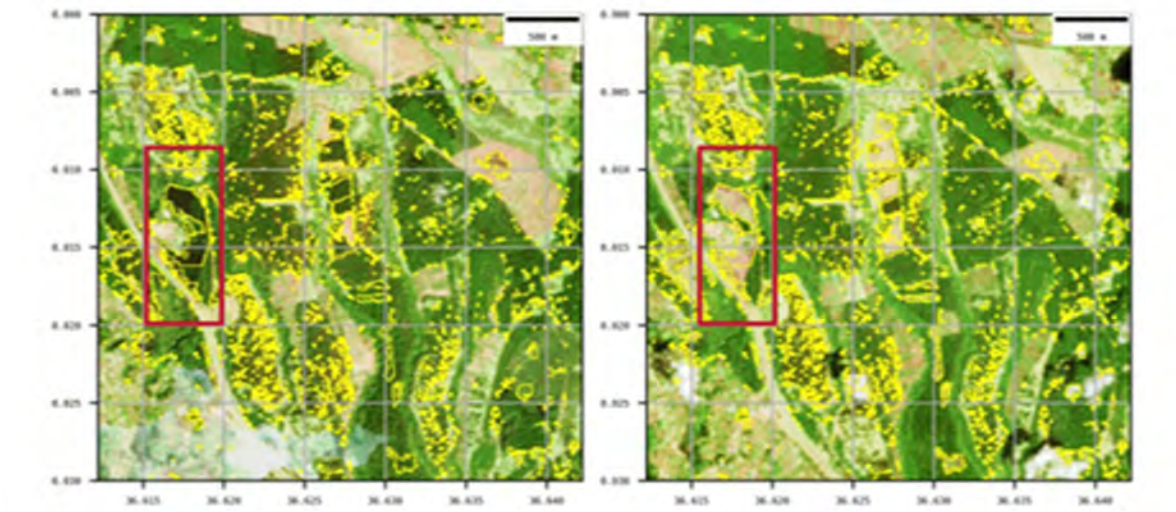


Figure 1.3.2.8 Detection of deforestation by NRTFAS (Left : before, Right : after)

b) Field report by grand truth using Survey123

The deforestation alert information detected by JJ-FAST and NRTFAS will be field-reported by KFS rangers who go to the site and use a mobile smartphone or tablet device equipped with an application that utilizes Survey123 (Figure 1.3.2.9).

In addition, when the rangers discover forest-related incidents such as deforestation and fire during patrol, or receive a report from the local residents, the rangers go to the site to report the situation from a smartphone or tablet terminal.

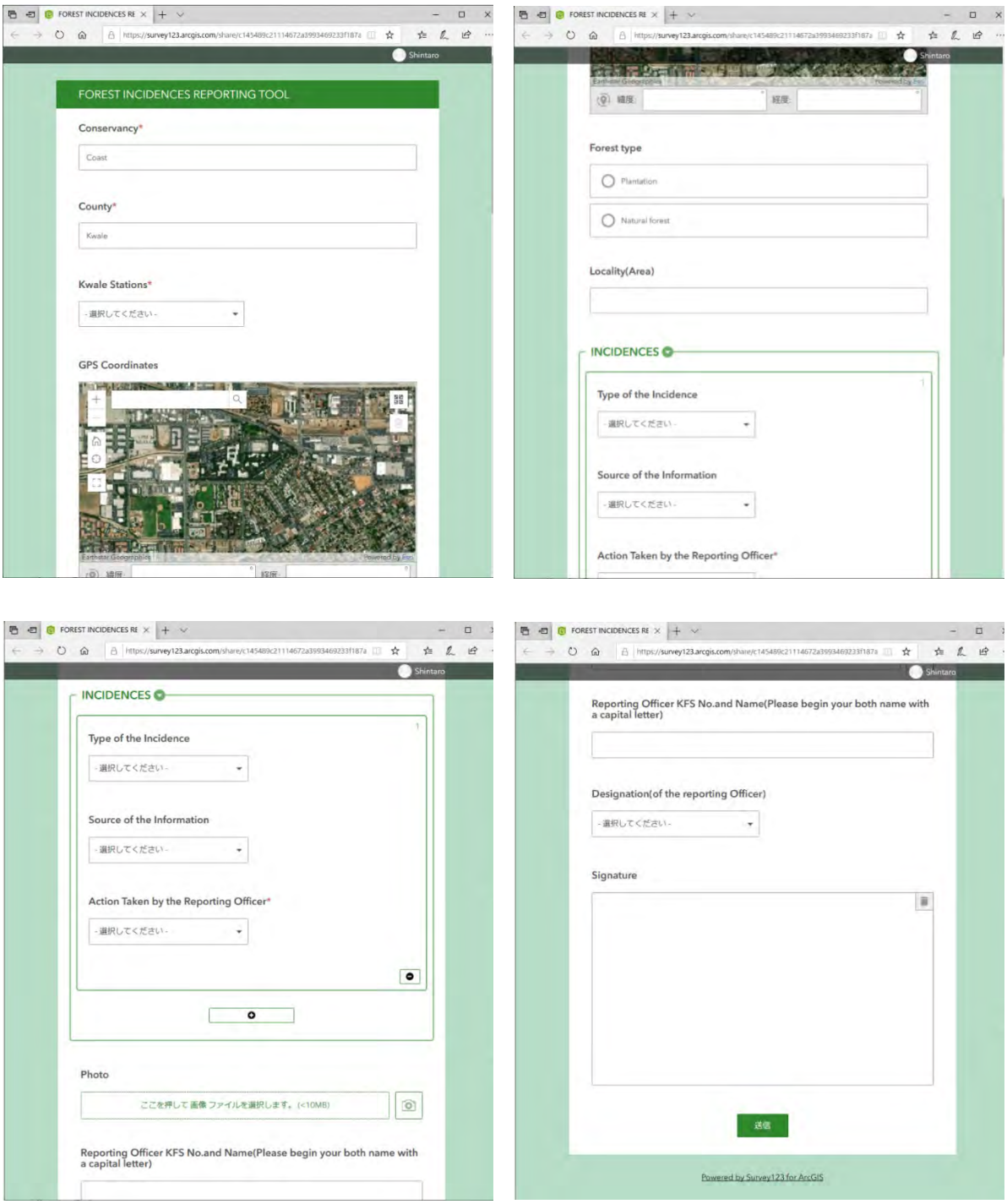


Figure 1.3.2.9 Survey123 survey form

(d) Policies and measures

It is recommended that monitoring of Policies and Measures (PaMs) under REDD+ be based on the National REDD+ Strategy (NRS), but NRS in Kenya is still under development as of October 2021. Therefore, NFMS which was finalized as of October 2021, has identified forest-related policies and set monitoring indicators based on the draft NRS as of October 2021. Specific monitoring methods will continued to be discussed in the future.

(e) Biodiversity

Two types of method were considered as the method of biodiversity monitoring in NFMS. The first approach is to use the results of existing or planned biodiversity surveys conducted by relevant organizations in Kenya. The second method is to design a new biodiversity monitoring method in the NFMS. Based on the C/P consultation, NFMS in Kenya chose the second method and adopted a biodiversity monitoring method based on the information collected by NFI. The number of tree species collected by NFI, the number of individuals by species, and the community occupancy rate of each individual can be used to evaluate the biodiversity of forest.

(f) REDD+ and AR – CDM projects

The Function of a REDD+ and AR-CDM project registration is to compile greenhouse gas reduction efforts in forests in Kenya and to prevent duplication of credits in emissions trading. This is also proposed in the National Strategy for REDD+. The collected information on each project will be posted in FIP website with location information using GIS function (see Figure 1.3.2.27), which is expected to ensure transparency of project management in Kenya.

4) Documentation of NFMS

For the continuous implementation, operation and management of the NFMS, the "NFMS Document" Ver. 1.0 was prepared with the table of contents shown in Table 1.3.2.10, which describes its structure and all methodologies for each of the monitoring functions and data management functions. The NFMS document in Kenya Ver. 1.0 was finalized through discussions at the REDD+ TWG meetings and distribution to relevant stakeholders to collect and reflect their opinions.

Table 1.3.2.10 Contents of NFMS document

Chapter	Contents	Sub-Title
Chapter 1	Background and Purpose of NFMS document	1.1 Background
		1.2 Milestones in Forest Sector Legal Legislation
		1.3 UNFCCC Requirements for NFMS
		1.4 The Purpose of the NFMS document
Chapter 2	Basic Considerations of Kenya's NFMS	2.1 Land use categorization
		2.2 Forest Definition
		2.3 Forest Stratification
		2.3.1 Montane and western rain forests
		2.3.2 Coastal and Mangrove Forests
		2.3.3 Dryland forests
		2.3.4 Plantation forests
		2.4 Carbon pools
		2.5 Scope gas
		2.6 REDD+ in Kenya
		2.6.1 Scale
		2.6.2 Selected REDD+ activity

Chapter	Contents	Sub-Title
		2.6.3 Definition of REDD+ activities
Chapter 3	Conceptual design of NFMS in Kenya	3.1 Introduction
		3.2 Composition of NFMS
		3.2.1 Monitoring function
		3.2.2 Data management function
		3.3 The Phased Approach to NFMS implementation
Chapter 4	Monitoring Function of the NFMS	4.1 Forest cover and forest cover change for AD
		4.1.1 Forest cover area based on SLEEK programme
		4.1.2 Forest cover change area based on Land cover / Land use change maps
		4.2 Forest Carbon Stock for Emission Factor
		4.2.1 National forest inventory
		4.2.2 Conversion of the inventory data into carbon stock data
		4.3 Forest cover change monitoring
		4.3.1 Detection of deforestation area using radar image (ALOS-2) by JICA-JAXA Forest Early Warning System in the Tropics（JJ-FAST）
		4.3.2 Detection of deforestation area using optical image (Sentinel 2) by NRTFAS
		4.3.3 Field report by ground truth using Survey 123
		4.4 Policies and Measures (PaMs)
		4.5 Biodiversity
		4.6 REDD+ and AR-CDM projects
Chapter 5	Data Management Function of the NFMS	5.1 Component and contents of the FIP
		5.2 Linkage with FMIS
		5.3 Operation of FIP
		5.3.1 Operational Structure
		5.3.2 Update of data and information
		5.3.3 Management of equipment and software
Chapter 6	Institutional arrangement for NFMS	6.1 Institutional arrangement for the monitoring function
		6.2 Institutional arrangement for data management function
Chapter 7	Calendar of NFMS	
Chapter 8	Future Improvement	8.1 Improvements in the NFMS based on proposals in the FRL
		8.2 Improvement on the NFMS based on Proposals from National REDD+ Strategy
		8.3 Participatory approach

(2) Design and Development of the Forest Information platform

1) Designing the Framework of Forest Information Platform

The Component designed system expansion for data interoperability which was examined over the existing database or the prospected information is expected to be added in the future. While designing the database, software was considered not only for the renewal but also replacement in order to ensure extensibility which will be required after the completion period of the Component.

The Component made a confirmation for the current status with survey of the existing database (DB) of KFIS (Kenya Forest Information System, Developed with “the Forest Preservation Programme” project (2010 to 2013, ODA Grants fund aid, Japan)) for the operation status of C/P and stakeholders.

(a) Survey of the existing database

The Component surveyed the condition of KFIS database and found that previous system had not been operated as frequent access and database update. According to an interview conducted with the C/P, there are two main reasons for this operation conditions.

The first reason is the replacement of main system in MITI MINGI MAISHA BORA Support to Forest Sector Reform in Kenya (MMMB) project which was donated by Finland. The role of KFIS became hosting the GIS server which stores the GIS database and the license server for the ArcGIS desktop and there is no update in relation to demand for the database.

The other reason is lack of human resources to maintain open source based server system structures. It was hard for the GIS division to maintain up-to-date open source knowledge by themselves because it is irrelevant for the main workflow for the division. For example resignation of the chief engineer made impacts for the technical transfer issues which are necessary for the server maintenance such as the database back up tasks, the plot field survey data collection support and patch file installation for the system, etc. Thus, the KFIS operation are not adequate in supporting a practical workflow of C/P.

The Component also researched other related projects donated by other countries for stakeholders of C/P. There are three major projects which are expected to be associated with FIP.

The first one is Forest Management Inventory System (FMIS) of MMMB. It has been implemented as a forest inventory management system amongst the MMMB’s five major components. Because it runs on the Oracle Relational Data Base Management System (RDBMS) database the data of inventories are registered and joined to the spatial feature data manually with QGIS which is open source based GIS software. FMIS contains 6,000 records of plantation sites which are managed by 65 stations and belong to 10 conservancies. The C/P expressed expectation on the FIP at the Technical Working Group which held in March 2017 in Naivasha as an integrated and unified platform for the FIP that should be able to refer the FMIS database to prevent the dissipating of information source.

The second is the expansion of the IC-FRA project. The ITCFRA was a prototype project from 2013 to 2015 supported by Finland for forest inventory survey and FRL. It introduced open source based software “Open Foris Collect” which is produced by Food and Agriculture Organization (FAO). The 250-plot data were registered during the prototype project period. Although KFIS equipped the import

program for the export files from Open Foris Collect, inventory section never utilized the program because of the major change of database design due to the reason that IC-FRA project increased survey items. While the additional pilot project of the FRL survey was in January 2017, new field survey tool has been discussed. Based on this discussion, the new system were required to implement the two aspects: One is the automatic generation process of record ID for adapting database and record registration. This functionality is one of the most crucial points to reduce the laborious work at the site and to ensure the qualities of inventory records. The other is facilitation with multimedia data sets, digital camera and Global Navigation Satellite System (GNSS) coordinates which are normally equipped on Personal Digital Assistant (PDA) and smart phone nowadays. These two functions were not implemented in the Open Foris Collect and these functions were considered as one of the critical point of FIP development.

Third is the SLEEK which aimed to support national report for the greenhouse gas emission and estimation, Planning and tracking for REDD+. This project is assumed from the inception stage because C/P is the one of the stakeholders of the project. C/P is concerned with and help to create the Land cover map from satellite imagery. The Component visited and interviewed SLEEK team to avoid duplication of the contents related to REDD+ which not only includes workflow and data but also system functionalities. Although the SLEEK system was expected to be released in late December 2016, the system capacity has resulted into a prototype under point of view for adaptation to the Kenyan specific natural conditions and the system sustainability with the possession of source code and manuals.

Based on the research of existing database, the Component created the requirements for developing and expanding the forest information system as following;

- Construct the forest information system based on the commercial GIS products which can get the support from vendor continuously, instead of using open source applications.
- Ability to link with GIS dataset of FMIS.
- Field survey tool should be worked on the PDA devices. The tool should generate the record ID automatically for adapting database and record registration. Also should be able to get the accurate position in the field with GNSS, etc.
- The system that can integrate and manage the various information related to REDD + including spatial information, which is the concept of the forest information platform.

(b) Designing Framework of the Forest Information Platform

Figure 1.3.2.10 below shows the draft image of the Forest Information Platform.

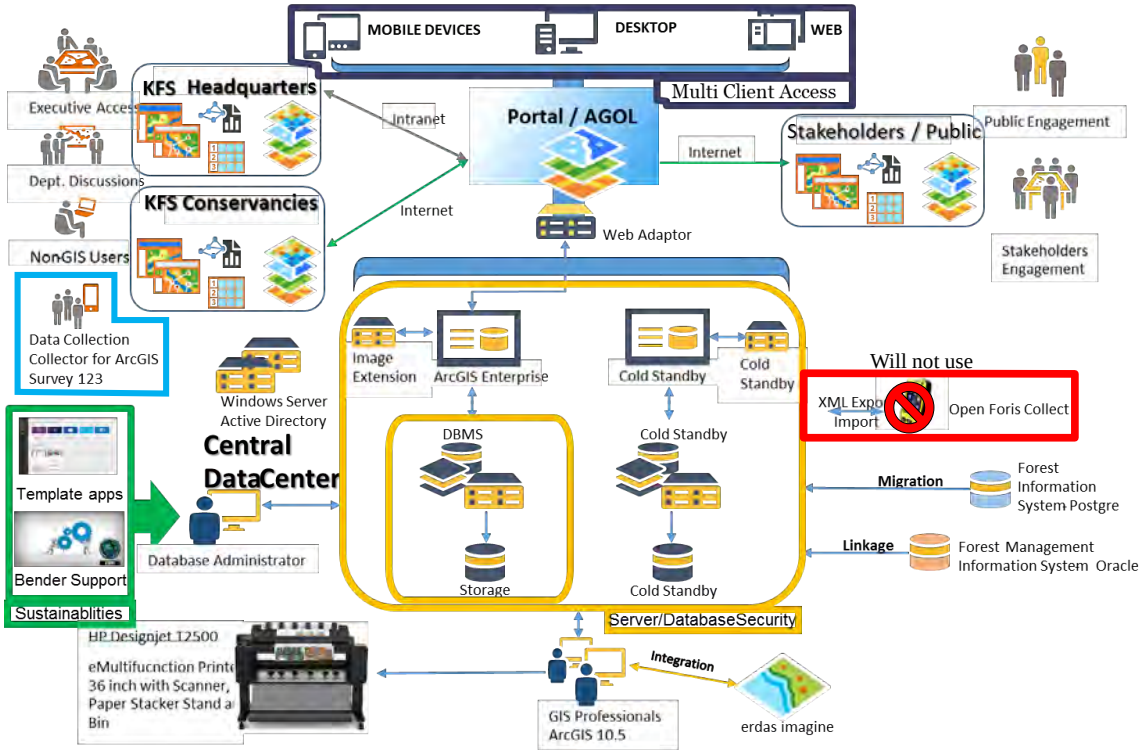


Figure 1.3.2.10 The draft image of the Forest Information Platform

The draft image has taken into account of the security and the sustainability for system operation. The database should be stored at the central DataCenter, and the storage system with RDBMS should be backed up and restored by backup devices and software. The hardware takes a redundant composition with utilization of existing server facilities because existing data sets should be moved to the FIP. Regarding the server software; ArcGIS Enterprise and MS-SQL server should be installed so that the portal sites are able to robustly serve the database contents not only to the HQ/Conservative offices but also to Field surveyors under the support of local benders. Moreover, to secure the information and contents of GIS database, the Component introduced cloud GIS services, ArcGIS Online as selected sets of the data contents for the limited user, such as SLEEK, KEFRI and Survey of Kenya (SOK), to manipulate GIS and Image data sources directly. Needless to say, KFS ordinal web pages are able to serve with the digital map data, such as land use and land cover data. Regarding external linkage systems, it is considered for the development as an additional item.

The concept Database design and detailed database design had been conducted after examination and consultation on additional development such as FMIS and Inventory database tools.

2) Development of Forest Information Platform

(a) Designing the Hardware

The FIP design is based on PC servers, storage, backup tape magazine drive, PC workstations and other peripherals. In addition to the newly procured hardware equipment, the existing hardware can be reused mainly as backup devices. This hardware consists of the following components shown as Table 1.3.2.11

Table 1.3.2.11 Components of the hardware

Item	Specification
New server: GIS server	- CPU: Intel® Xeon®E5-2640 v4 2.4GHz for 10 core, - Memory: 32 GB - HardDisk: 8 x SAS 3.84TB, or more, RAID 6 - Rack type 2U server * Including VMware vSphere Standard
New server: SQL database.	- CPU: Intel® Xeon®E5-2640 v4 2.4GHz for 10 core, - Memory: 32 GB - HardDisk: 8 x SAS 3.84TB, or more, RAID 6 - Rack type 2U server * Including VMware vSphere Standard
New data storage server	- CPU: 1 x Intel® Xeon® E5-26xx v3 series, 1.9GHz, or more - Memory: 32 GB - HardDisk: 24 x SAS 2TB or more, RAID 6 - Rack type 2U server
New Backup device HPE MSL2024 0-Drive Tape Library (AK379A)	- Support Tape: LTO-5, LTO-6,LTO-7 - Tape Slot: 24 - Capacity: 320TB (Compress) - Rack type 2U
New Backup device HPE MSL2024 0-Drive Tape Library (AK379A)	- Support Tape: LTO-5, LTO-6,LTO-7 - Tape Slot: 24 - Capacity: 320TB (Compress) - Rack type 2U
New PC workstation for image processing and GIS processing: x 6	- OS: Windows 10 Pro Edition 64 bit (English) - CPU: Intel® Xeon® Processer ES-1620, 3.7GHz Turbo or higher, 12M L3, 5.86GT/s or higher - Memory: 16 GB or more - HardDisk: at least 2TB totally, SATA (No RAID) or more - DVD Super Multi Drive - Graphic Card: 1G NVIDIA Quadro K600 (1DP and 1DVI) (1DP-DVI and 1DVI-VGA adapter) or higher - Wireless network USB adopter (support 11n/11a/11g/11b) - 29inch Wide Monitor - Microsoft Office 2016 (Home & Business) - Security software (24 months) - System Recovery media - Auto Ranging (100V- 240V) - UPS 650 (650VA - 400 Watts), Input 230V / Output 230V
New Laptop PC for Field survey: x 2	- OS: Windows 10 Pro Edition 64 bit (English) - CPU: Intel® Core i7® series Processer - Memory: 16 GB or more - HardDisk: at least 1TB

(b) Base Software Design

The FIP design is based on Commercial Software in order to have support from each vendor so that C/P can have an opportunity of training and support. The components which comprise the software architecture are shown in Table 1.3.2.12.

Table 1.3.2.12 Components which comprise the software architecture

Item	Specification
Geo-information database software with spatial data management	ESRI ArcGIS for Server Enterprise Standard, Portal for ArcGIS Level1
Image server software	ESRI ArcGIS image Extension for Server Enterprise
GIS Cloud server software	ESRI ArcGIS Online Organization Plan Level 1 + additional 5 named user
GIS software for Desktops for administrators	ESRI ArcGIS for desktop advanced 10.4 with spatial analyst, 3D analyst, geostatistics analyst, publisher
GIS software for Desktops for the operating engineer: x 3	ESRI ArcGIS for desktop standard 10.4 with spatial analyst, 3D analyst, geostatistics analyst, publisher
Remote sensing software for desktop	ERDAS IMAGINE 2016 version
Database Server Software	Microsoft SQL SERVER 2016 or Higher + 5 USER CALS

GIS Portal Module: This module provides the user interfaces for all GIS data use cases in FIP. This module consists of several sub-modules which include:

- Geo-information database software with spatial data management
- Image Server Software
- Database Server Software
- http server（existing web server of KFS or reconstruction with KFIS）

The module will be accessed as the main gateway for all internal GIS use in KFS. About Image server software, the module contributes by utilizing satellite imagery with the right to access and to generate the image cache which can be used at the site of field where access to the internet is not available.

GIS Cloud Module: This module provides the user interfaces for limited users of field inventory survey or stakeholders of C/P. It consists of several sub-modules including:

- GIS Cloud server software
- GIS software for Desktops for administrator
- GIS software for Desktops for the operating engineer

The module will be accessed by the named ArcGIS user licenses which are owned by stakeholders through ArcGIS online. Through this cloud services the registered named users are able to access the GIS dataset securely.

The other use for the management board is available for these cloud services. For example, the Operations Dashboard for ArcGIS generates analysis result with intuitive graphics use of the statistical analysis by the GIS software for Desktops (Figure 1.3.2.11).

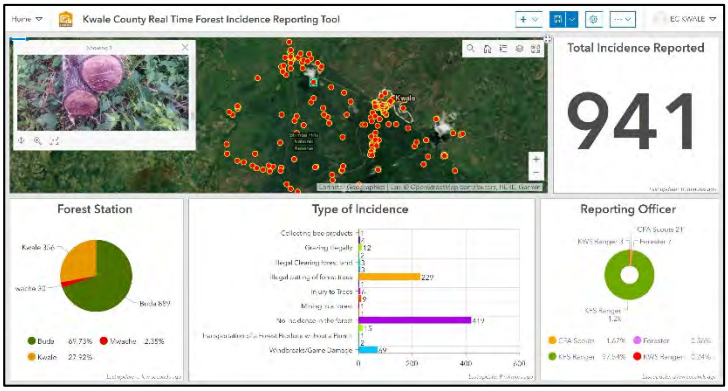


Figure 1.3.2.11 Operations Dashboard for ArcGIS

3) Designing the information security

The FIP design is based on the Information Security Policy of KFS. Since C/P takes Active Directory services as an authentication method to realize confidentiality, all the access are under control of the windows network domains. In order to secure other elements such as integrity every database should be backed up with the Digital Tape Loader so that database software will be able to verify the integrity of the data backup. As an availability aspect, all PC servers and workstations should be registered to the active directory repository so that at the service level every server process shall be monitored by the IT department of KFS. If a problem occurs on the server one of the existing servers should be connected and loaded as backup at that instance so that the FIP can continue to provide the services.

4) Designing Sitemap

The Component discussed with C/P at TWG meeting in December, 2017 and the eight (8) main components of FIP sitemap were decided. And based on this, the Component designed the outline of sitemap as follow;

(a) Eight main components and its content (Figure 1.3.2.12, Table 1.3.2.13, Table 1.3.2.14).

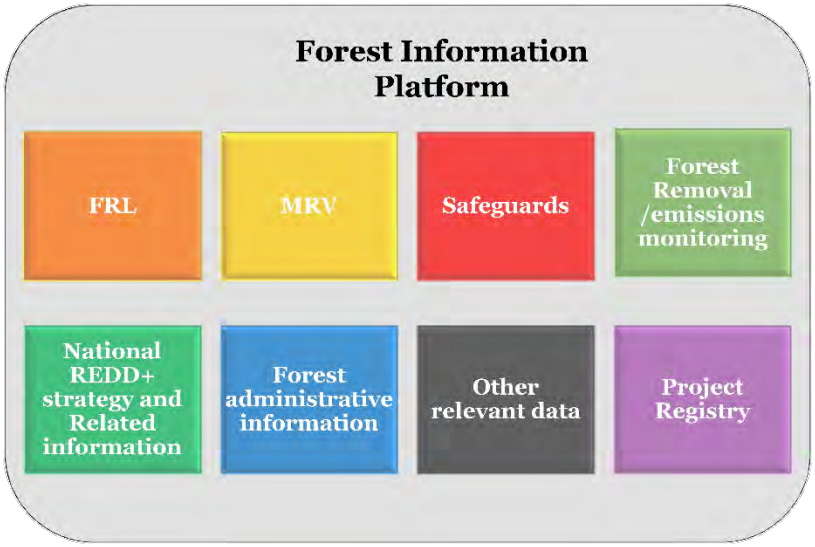


Figure 1.3.2.12 Eight components of FIP (1st version)

Table 1.3.2.13 Outline of each contents (1st Version)

Target Information	Outline of Functions
FRLs	• FRLs to quantify the emissions reduction to be achieved through the REDD+ activities is shown. • All the elements relating to the activity data, emission factors and estimations used for setting FREL/FRL are clearly shown.
MRV	• Concept and plans indicating what and how to measure, report and verify in Mozambique with respect to REDD+ are shown.
Safeguards Information System	• Information as to how safeguards were handled and respected through the REDD+ activities is provided through the safeguard information system.
Forest Removal/emissions monitoring	• Trends of forest cover change and carbon stock removal and emissions are shown.
National REDD+ Strategy and Related Information	• Information concerning the National REDD+ Strategy is provided. • Driving forces of forest logging and degradation are shown quantitatively. • Quantitative evaluation of the policy, strategy and measures (PaMs) is shown.
Forest Sector Administrative information	• Forest growth and concession information are provided. • Information necessary for the REDD+ Project implementers and investors to determine the feasibility of PDD before the submission is provided as REDD+ registry.

Target Information	Outline of Functions
Other Relevant Data	• Other Relevant Data are provided.
Project Registry	• Projects area and information related to REDD+ and A/R CDM are shown as map and attribute.

Table 1.3.2.14 Contents of FIP (1st Version)

Component	Information to be operated in the data management system
FRLs	FRELs/FRLs Evidence of formulation of FRELs/FRLs Activity data Forest cover Forest cover/land use map of the historical reference years Emission factor Forest inventory survey Biomass information Emission estimate National-circumstances Useful Information for FREL/FRL
MRV	MRV concept Measured data from Measurement system Reports from Reporting system Verification results from Verification system
Safeguards Information System	Safeguard information
Forest Removal/emissions monitoring	Forest cover change Semi-real time deforestation monitoring Carbon stock removal and emissions
National REDD+ Strategy and Related Information	National REDD+ strategy National REDD+ strategy Law related REDD+ Driving forces of deforestation and forest degradation PaMs
Forest Sector Administrative Information	Forest administration and REDD+ Legal jurisdiction of Forest Management National Responsibilities with respect of REDD+ Forest concession

Other Relevant Data	Cities and Towns, River, Meteorological station, Road, Mining Concession, Land Units/Land Systems/Land Regions, Agra-ecological zone, Soil, Elevation, Other REDD+ Project
Project Registry	Document Map

(b) Type of contents

The information type of contents are categorized in 4 (Table 1.3.2.15).

Table 1.3.2.15 Type of contents

Content Type	Remark
Description	Explanation of contents.
GIS data	Spatial dataset. Display as map.
Table	Show the result of calculation and/or inventory.
Document	Document

(c) Access rights

The access rights for each content are categorized in 4 type of users (1. FIP Administrator, 2. KFS 3. Related Stakeholder, 4. General Citizen). Type of access rights of each persons are shown in Table 1.3.2.16. For example, the person who handle the GIS data are required the specialized knowledge and management rights for GIS and spatial dataset, therefor the access right of create and modification is only allowed to FIP Administrator and KFS officers.

Table 1.3.2.16 Access right matrix of contents type and persons

Contents Type	Access Right			
	FIP Administrator	KFS	Related Stakeholder	General Citizens
Description	Read/Create/Modify	Read	Read	Read
GIS Data	Read/Create/Modify	Read/Create/Modify	Read	Read
Table	Read/Create/Modify	Read/Create/Modify	Read	Read
Document	Read/Create/Modify	Read/Create/Modify	Read/Create/Modify	Read

(d) Design and implementation of the User Interface

The Component designed the FIP and implemented the portal site by developing the user interface with tab functions (Figure 1.3.2.13). Also, on the FIP sitemap, it enabled to provide not only GIS data but also word documents, PDF data, excel files or other web pages on FIP.

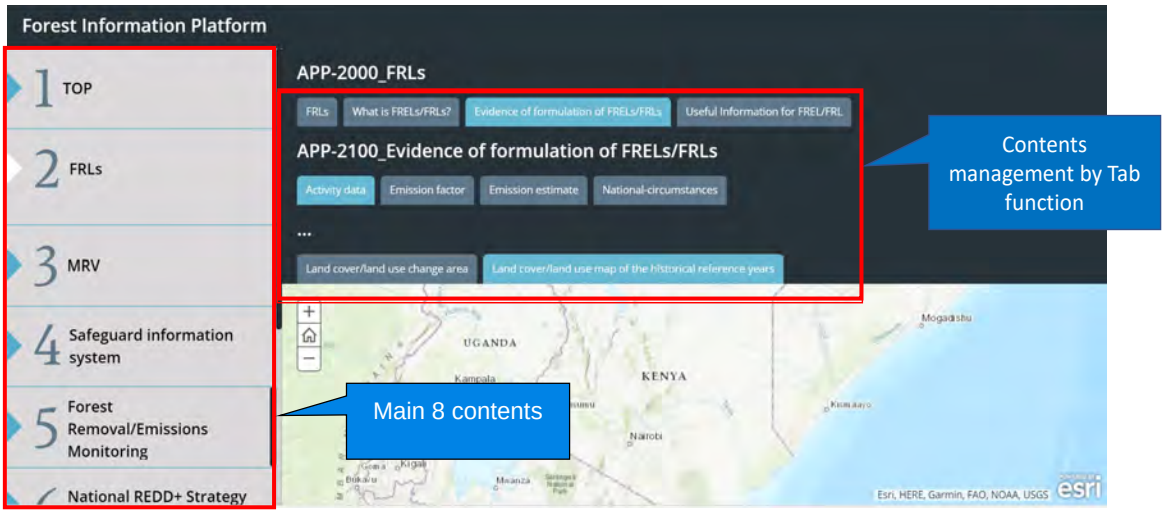


Figure 1.3.2.13 Tab function style UI

(e) Designing the field survey tools

The Component discussed with C/P and designed the field survey tool and collected data management tool. Field survey tool are based on Survey 123 / Collector for ArcGIS (ESRI) and the data management tool are based on ArcGIS online (ESRI). Survey 123 / Collector for ArcGIS can access to the global dataset such as satellite image and base map and it helps surveyors to locate the position and report the information to the management server. Moreover, combining and working with Survey 123 / Collector for ArcGIS and ArcGIS online, it makes easier to manage the collected data by administrators. Also the Component research the “Open Foris Collect” (existing survey tool) and its operation flow. Based on this research, the Component designed the new workflow with Survey 123 / Collector for ArcGIS and ArcGIS online (Figure 1.3.2.14).

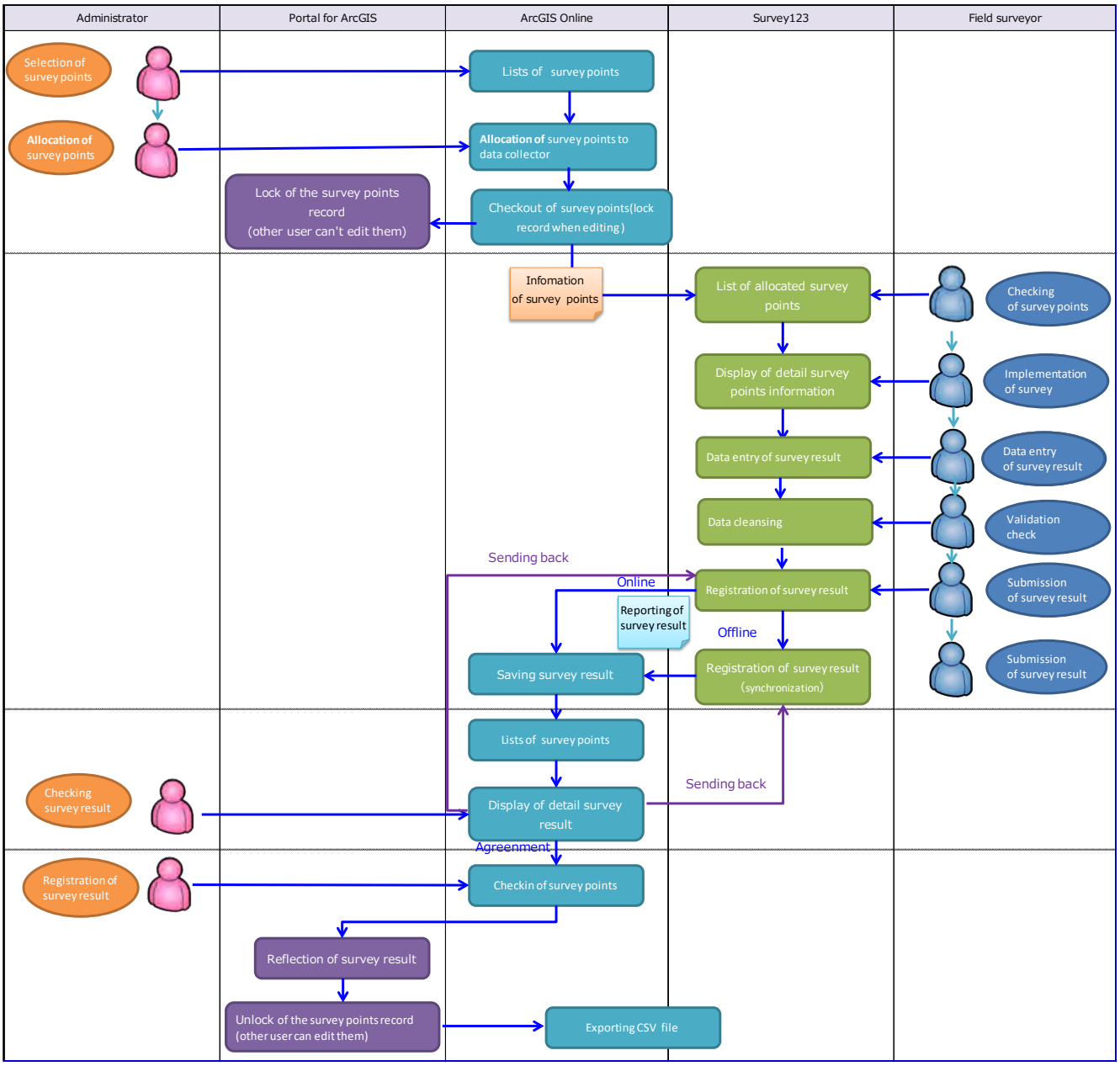


Figure 1.3.2.14 New inventory collection tool

Figure 1.3.2.15 shows the field survey tools, field survey functions are developed based on the Survey123 and collector for ArcGIS.

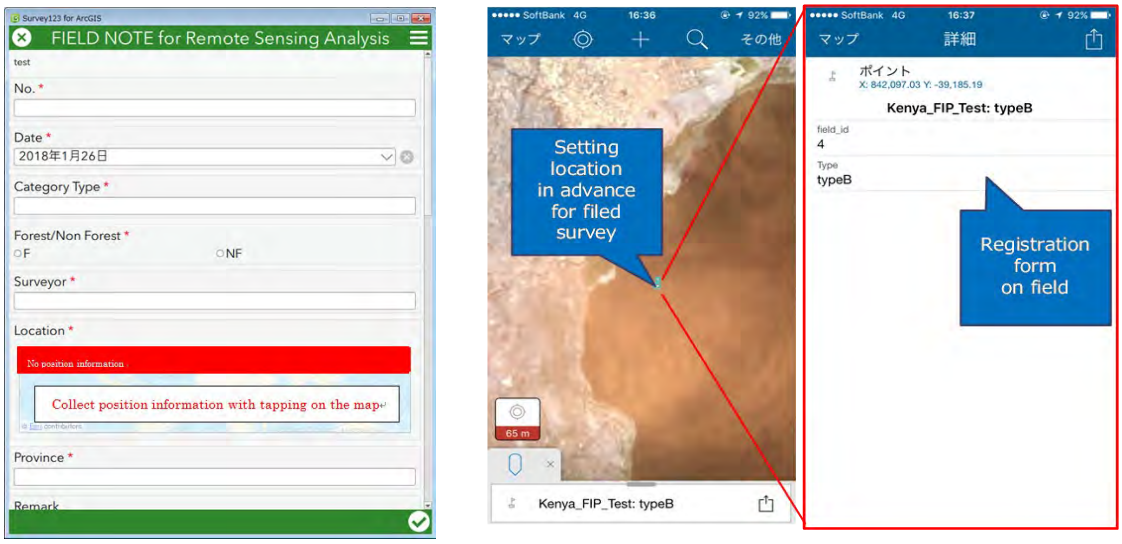


Figure 1.3.2.15 Field Survey tool (Survey 123 and Collector for ArcGIS)

(f) FMIS (Forest Management Inventory System) Linkage

Based on the discussion with system administrator of FMIS, the requirement to linkage from FMIS to FIP was sorted out. The component decided that while import FMIS GIS-data into FIP, the process do not provide the complicated validation check process. Because there are difference of data structure and format between FMIS and FIP, when the complicated validation check process are implemented, it will causes the difficulty of importing to FIP. The validation check should focus on only the structure of FMIS GIS-data. The linkage frequency is at most once a week. Figure 1.3.2.16 shows the work flow of FMIS Linkage process.

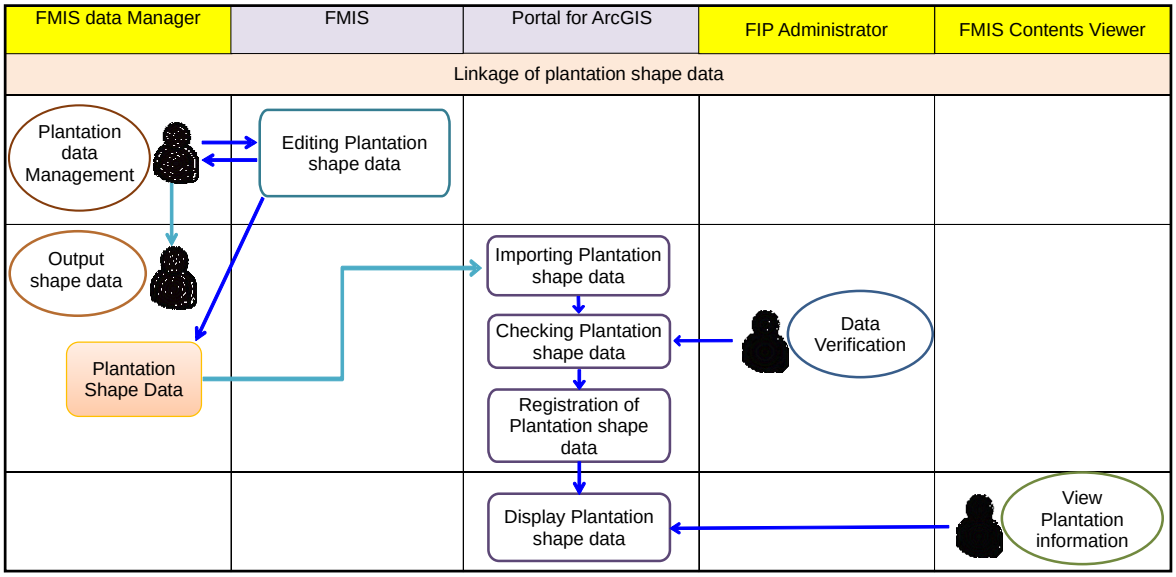


Figure 1.3.2.16 FMIS (Forest Management Inventory System) Linkage

Moreover, based on current FMIS GIS-data, the Component discussed with Kenya C/P which items to be made open to general citizens and sorted out the items for color coding of the maps. The yellow fillings on Table 1.3.2.17 below means non-open information to the general citizens, the blue fillings

mean open information and the green filling means the information for coloring of map.

Table 1.3.2.17 FMIS items for linkage to FIP

No	Field Name	Alias	Field type	Field Length	null	The meaning of field and data	note
1	FID	FID	OID	4	－	The serial number to specify each shape data	The number starts from [0]
2	Shape	Shape	Geometry	0	－	Shape type －"Polygon"	
3	OID1	OID1	Integer	9	－	Unknown.	All records are "0"
4	GEO_ID	GEO_ID	String	254	No	Unique number of UVIO system. It matches [SC_ID]	This information is not unique id as each shape data.
5	FMIS_QUANT	FMIS_QUANT	Double	19	－	Unknown	
6	Station	Station	String	254	No	Large division	
7	Block_Name	Block_Name	String	254	Yes	Middle division	
8	Block_ID	Block_ID	String	254	Yes	Ommited informaiton of [Block_Name]	It doesn't match [Block_Name]
9	Comp	Comp	Double	19	－	The branch number of [Block_ID]	
10	Sub_Comp	Sub_Comp	String	254	Yes	The branch number of [Comp]. The smallest unit of plantation	
11	SC_Code	SC_Code	String	254	Yes	Conbination information of [Comp]＋[Sub_Comp]	
12	SC_ID	SC_ID	String	254	Yes	Conbination information of [Block_ID]＋[SC_Code], Unique number of UVIO system. It matches [Geo_ID]	It doesn't match each [Block_ID] and [SC_Code] perfectly
13	Geo_Class	Geo_Class	String	254	Yes	The information of Indigenous Forest or not	All records are "Indigenous Forest" or "null"
14	GEO_C_CODE	GEO_C_CODE	String	254	Yes	Ommited writing of "Plantation"→"PLT"	All records are null or "0"
15	Geo_Group	Geo_Group	String	254	Yes	The information of Conservation or not	All records are "Conservation" or "null"
16	Geo_G_Code	Geo_G_Code	String	254	Yes	Ommited writing of [Geo_Group] "Conservation"→"Con"	It doesn't match [Geo_Group]
17	Species_1	Species_1	String	254	Yes	Species_class1.	How to write is not unified including mixing up Large and small letter of Alphabet or having a space in the first letter of a word
18	Year	Year	Double	19	－	Plantation year related to Species_class1.	Plantation year is displayed as A.D. but some case occures "0","10" "25" or "163".
19	Area_Ha	Area_Ha	Double	19	－	area of Species_class1 per/ha	
20	Land_Cover	Land_Cover	String	254	Yes	The classification of Forest Cover..	How to write is not unified including mixing up Large and small letter of Alphabet or having a space in the first letter of a word
21	Land_use	Land_use	Double	19	－	Land use	All records are "0"
22	Species_2	Species_2	String	254	Yes	Species_class2.	How to write is not unified including mixing up Large and small letter of Alphabet or having a space in the first letter of a word
23	Age	Age	Double	19	－	Stand age.	All records are "0"
24	Volume	Volume	Double	19	－	Tree volume from Inventory survey	All records are "0"
25	Label	Label	Double	19	－	Unknown.	All records are "0"
26	Year_	Year_	Double	19	－	Plantation year related to Species_class2.	All records are "0" except for 1 record
27	Area_1	Area_1	Double	19	－	area of Species_class2 per/ha	All records are "0"
28	Units	Units	Double	19	－	ha	All records are "0"
29	cat	cat	Double	19	－	Unknown.	All records are "0"

For public(including general citizen and related stakesholder)
Only KFS
The inforfomation for coloring on MAP

Figure 1.3.2.17 shows the result of GIS data linkage of FMIS and FIP.

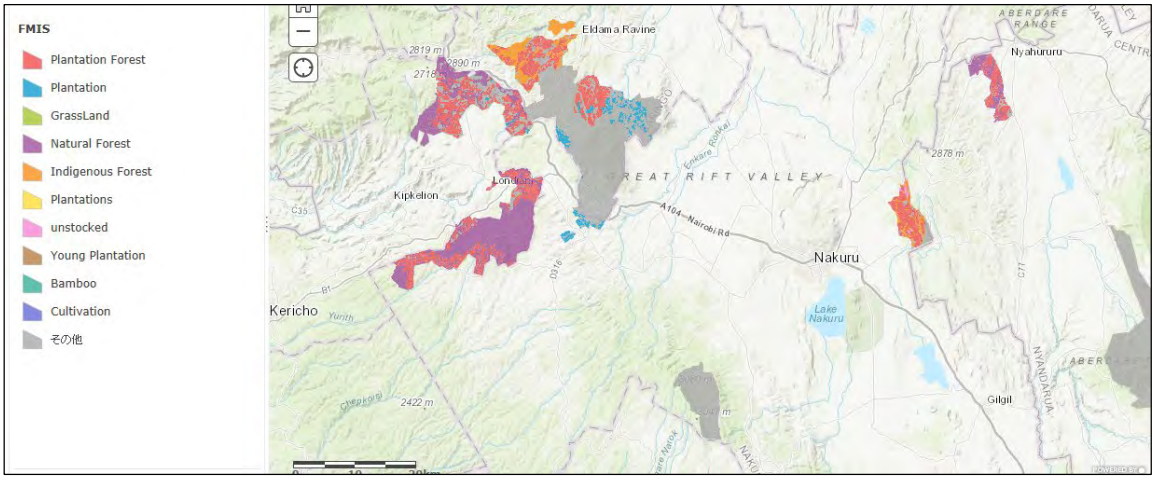


Figure 1.3.2.17 FMIS data on FIP

5) How Kenya can utilize the FIP

The FIP is a platform for Kenya's REDD+ implementation and provides access to the UNFCCC four requirements (FRL, NFMS, NRS and SIS) for receiving result-based payment. The platform also provides the results of future monitoring of CO2 emissions from Kenya's forests so that emission reductions can be calculated in comparison with the FRL, and information on REDD+ and A/R-CDM projects can be used to estimate emission reductions using a nested approach. The centralized storage and dissemination of REDD+-related materials/information/data in this way will support REDD+ activities in Kenya.

- The FIP automatically indicates deforestation areas of 2 ha or more detected by JJ-FAST, which is updated every 1.5 months when the deforestation areas are detected, the field officers are communicated for them to check the causes of deforestation and, if necessary, to consider measures to prevent and address deforestation.
- A system for automatically calculating stand volume and CO2 stock amount per hectare by each forest type based on the results of forest inventories was established in the FIP. This data can be used not only for REDD+ MRV, but also for setting target stand volume for each forest type, estimating allowable cutting volume, and estimating annual growth rates for each forest type. Furthermore, these data can be used to develop sustainable forest management plans.
- The latest land cover/land use maps and land cover/land use change maps are stored in the FIP and can be used to plan the selection of area for plantations and/or forest restoration.
- The FIP contains the training materials and participant lists of the MRV trainings implemented by CADEP. In addition to the MRV trainings, the FIP will also contain lists of personnel and materials related to REDD+ activities including other trainings to be held in Kenya in the future, which will help to promote sustainable REDD+ activities in Kenya.

(3) Installation of the Forest Information Platform

Based on the decided specifications, hardware and software were procured and installed by Innnovine Ltd, Shonitel Ltd and ESRI in July 2018. Figure 1.3.2.18 shows the design of the server structure of FIP. Based on this structure, the team confirmed the installation and setup of software and hardware by these companies.

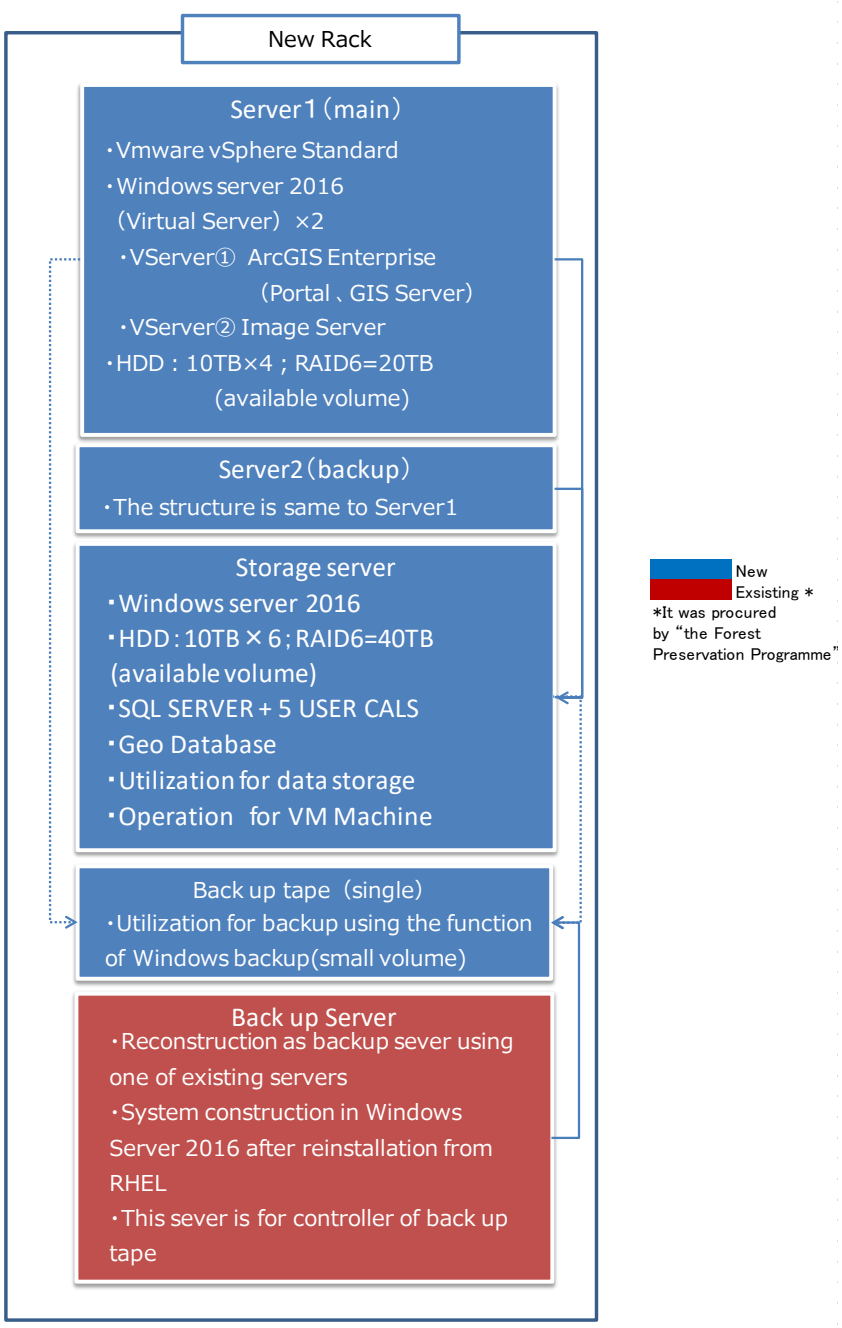


Figure 1.3.2.18 Server structure and installed software

Figure 1.3.2.19 and Figure 1.3.2.20 shows the physical layout of new and old server in KFS server room.

42	
41	
40	
39	
38	
37	
36	
35	
34	
33	
32	
31	
30	
29	
28	
27	
26	
25	L3 Switching HUB
24	DELL PowerEdge R710 *1
23	(Backup Server)
22	
21	
20	KVM Console , KVM Switch
19	HP ProLiant DL380 Gen9
18	[Server1;main]
17	HP ProLiant DL380 Gen9
16	[Server2;backup]
15	HP ProLiant DL380 Gen9
14	[Storage Server]
13	
12	
11	
10	LTO-5 ULTRIUM 3000 *2
9	[Back-up Device（Single）]
8	
7	DELL PowerVault TL4000 *1
6	[Back-up Device（Multi）]
5	
4	APC Smart-UPS RT 3000
3	[UPS1]
2	APC Smart-UPS RT 3000
1	[UPS1]

*1 Old hardware (moved from old rack)

*2 Old hardware (not working)

Figure 1.3.2.19 New server rack layout

42	
41	
40	L3 Switching HUB
39	
38	
37	
36	
35	
34	
33	
32	
31	
30	
29	
28	KVM Console , KVM Switch
27	DELL PowerEdge R710 (ArcGIS Server)
26	
25	DELL PowerEdge R710 *1 (Web Server)
24	
23	DELL PowerEdge R710 (Backup Server)
22	
21	DELL PowerEdge R710 (Database)
20	
19	DELL PowerVault MD3200 (Backup Server)
18	
17	DELL PowerVault MD3200 (Backup Server)
16	
15	
14	
13	
12	DELL PowerVault TL4000 *1 [Back-up Device（Multi）]
11	
10	
9	
8	
7	APC Smart-UPS RT 8000
6	
5	
4	Battery Pack
3	
2	
1	

*1 Moved to new rack

Figure 1.3.2.20 Old server rack layout

(4) Making a Test of Installation of the Forest Information Platform through OJT

After the installation of the FIP, a test operation of FIP was performed by On the Job Training (OJT) in July and October 2018. Regarding the field survey tools of FIP, test operations of Survey123 and Collector for ArcGIS were conducted in October 2018.

For the test operation, the Component prepared four materials including guideline, operation manuals and training materials of FIP and field survey tools as described in the following Table 1.3.2.18.

Table 1.3.2.18 Training materials

No.	Document name	Note
1	How to construct and edit FIP	Explanation of updating data or editing the seeing of FIP
2	Server operation of FIP	Explanation of server structure, operation and maintenance
3	Collector for ArcGIS for KFS	How to make survey form or input result by Collector for ArcGIS
4	Survey 123 for KFS	How to make survey form or input result by Survey 123

By referring above documents, the Component implemented the training for KFS according to the following Table 1.3.2.19.

Table 1.3.2.19 Training schedule of FIP and field survey

Training name	Contents	Type	Date
System Administrator training of FIP	How to manage the server and contents or data of FIP	Individual	12th Jul., 19th Oct., 2018
		Group	11th Oct., 2018
Field survey training (Survey 213 and Collector for ArcGIS)	How to make the field survey form, input data and management the collected data	Individual	3rd, 4th, 8th, 9th, 12th, 17th, Oct., 2018
		Group	15th, 16th, Oct., 2018

(5) Operating the Forest Information Platform with Improvement Based on the Review

After the installation of FIP, the Component had continued to consider the effective display method of the various data including maps, document or URL link on FIP.

1) Contents update

(a) Modification of the main eight components of FIP

In the course of content review and discussion, some contents were moved / joined to other sections. The main eight components of FIP were updated as the result of this modification. For example, “Forest Carbon Stock Removal and Emissions” page was moved from “Forest Removal/Emissions Monitoring” to “MRV”. As a result of this move, the “Forest Removal/Emissions Monitoring” component is focused to the contents of forest cover change monitoring. Therefor the component name was changed to “Forest Cover Change Monitoring” (Figure 1.3.2.21).

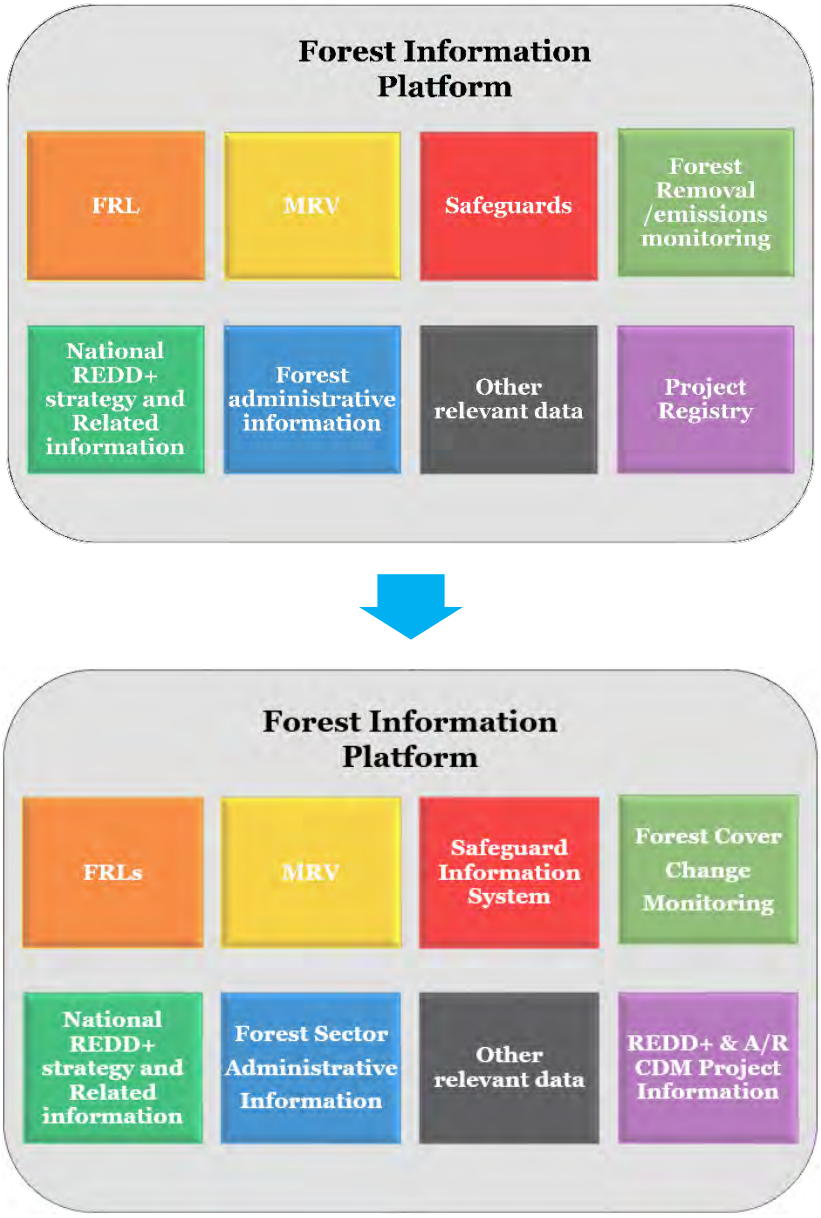


Figure 1.3.2.21 Modified eight components

Table 1.3.2.20 shows the modified outline.

Table 1.3.2.20 Modified outline

Target Information	Outline of Functions
FRLs	• FRLs to quantify the emissions reduction to be achieved through the REDD+ activities is shown. • All the elements relating to the activity data, emission factors and estimations used for setting FREL/FRL are clearly shown.
MRV	• Concept and plans indicating what and how to measure, report and verify in Kenya with respect to REDD+ are shown.

Target Information	Outline of Functions
	• Monitoring results of AD by land cover/land use change, EF by forest inventory, and carbon stock removal and emissions are shown.
Safeguards Information System	• Information as to how safeguards were handled and respected through the REDD+ activities is provided through the safeguard information system.
Forest cover change monitoring	• Near real time deforestation area provided by JJ FAST and NRTFAS are shown. • Field survey information of detected deforestation area are shown.
National REDD+ Strategy and Related Information	• Information concerning the National REDD+ Strategy is provided. • Driving forces of forest logging and degradation are shown quantitatively. • Quantitative evaluation of the policy, strategy and measures (PaMs) is shown.
Forest Sector Administrative information	• Forest growth and concession information are provided. • Information necessary for the REDD+ Project implementers and investors to determine the feasibility of PDD before the submission is provided as REDD+ registry.
Other Relevant Data	• Other Relevant Data are provided.
REDD+ & A/R CDM Project Information	• Projects area and information related to REDD+ and A/R CDM are shown as map and attribute.

Based on this modification, the Components update, add, remove and move the contents of FIP (Table 1.3.2.21).

Table 1.3.2.21 Modified FIP contents

Component	Information to be operated in the data management system
FRLs	What is FRLs? Kenya FRL Kenya FRL Dec. 2019 Kenya FRL Aug. 2020 Evidence of formulation of FRELs/FRLs Activity data Land cover / land use change table Land cover / land use change map Land cover/land use map of the historical reference years Emission factor Forest inventory survey Biomass conversion information

Component	Information to be operated in the data management system
	Emission estimate
MRV	What is MRV? Measurement system Monitoring Activity data Land cover / land use change table Land cover / land use change map Land cover/land use map of the historical reference years Emission factor Forest inventory survey Biomass conversion information Forest carbon stock removal and emissions Reports from Reporting system Verification system MRV Training Community Monitoring of Forest
Safeguards Information System	Safeguard information
Forest cover change monitoring	JJ-FAST NRTFAS Field Survey Report
National REDD+ Strategy and Related Information	National REDD+ strategy Legislation and strategy related REDD+ Other information related REDD+ in Kenya Conventions related climate change ratified
Forest Sector Administrative Information	Forest related organization chart Legal jurisdiction of Forest Management
Other Relevant Data	Relevant information Information on protected areas including national parks Demographic information including ethnic communities Forest and Landscape Restoration EOLAB Other related maps Soil maps Precipitation map Temperature map Landuse 2010

Component	Information to be operated in the data management system
	FMS Forest Fires Glossary
REDD+ & A/R CDM Project Information	REDD+ & A/R CDM Project Information

(b) Updating the list of legal documents and information

To update the contents of FIP, the Component searched and collected the documents of REDD+ related information, legal documents of forest administration. The Component confirmed the information and selected the contents to be posted to the FIP, and examined the location of the information. The items of legal documents and information are shown in Table 1.3.2.22.

Table 1.3.2.22 List of legal documents and information

Legislation and strategy related REDD+	Acts	Environmental management and coordination (amendment) act, 2015
		Climate change act, 2016
		Community land act, 2016
	Strategies	Green economy strategy and implementation plan (2016-2030)
		National forest programme 2016-2030
		Any strategies for climate change Adaptation
	Policies	National Environment policy, 2013
		Landuse policy
		Any policies for climate change Adaptation
Other information related REDD+ in Kenya	Water	The water act, 2016
	Agriculture	Agriculture, Fisheries and food authority act, 2013
	Driving Force	
Conventions on climate change ratified	Web Link	UNFCC (https://unfccc.int/)
		REDD+ Web platform (https://redd.unfccc.int/)
	Documents	UNFCC
		Paris Agreement
		Kyoto Protocol

(c) PDF hyper link

To realize management of documents on FIP, the Component 3 uploaded PDF file into FIP and used the function of hyperlink as following Figure 1.3.2.22. This helps the FIP administrator to provide the list/table type page easily.

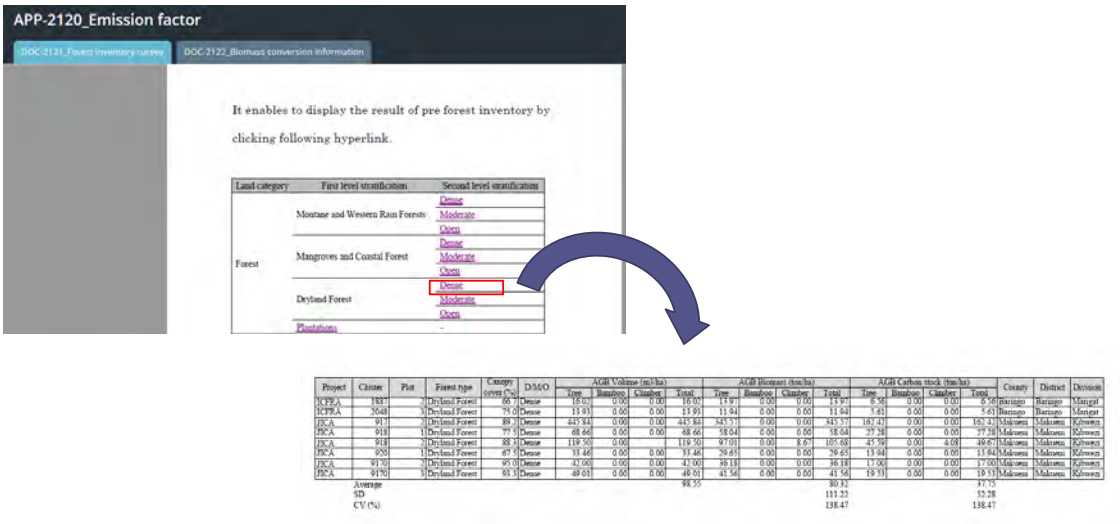


Figure 1.3.2.22 Embed the hyperlink in PDF file

(d) Updating the information on the FRL Report

The information on the FRL submitted to the UNFCCC in January 2020 was uploaded. In connection with this update, following contents of FIP were updated (Figure 1.3.2.23);

- FRL Report
- Land cover / Land use change map (2002-2006, 2006-2010, 2010-2014, 2014-2018)
- Land cover / Land use map (2002, 2006, 2010, 2014, 2018).

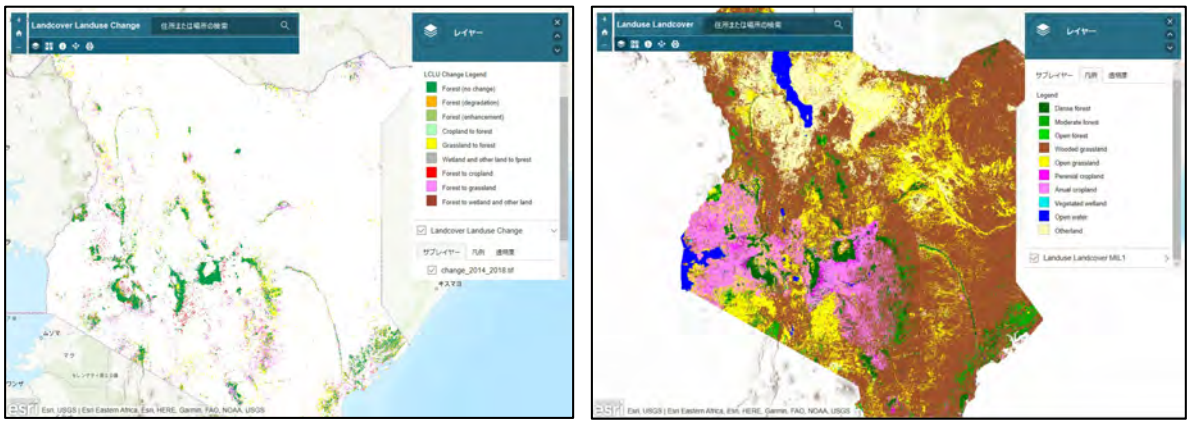


Figure 1.3.2.23 Land cover/Land use change map (left) and Land cover/Land use map (right)

2) Adopting ArcGIS Pro for FIP contents management

To realize management of map data on FIP, the Component adopted ArcGIS Pro for uploading data into FIP.

(a) Multiple data drawing

Adopting ArcGIS Pro, it enables to display multiple map data on FIP. Figure 1.3.2.24 shows the example of the multiple maps on same display by checkbox toggle. The former shows Land Use / Land Cover change map from 2010 to 2014 and the latter is switched to Land Use / Land Cover change map from

2014 to 2018.

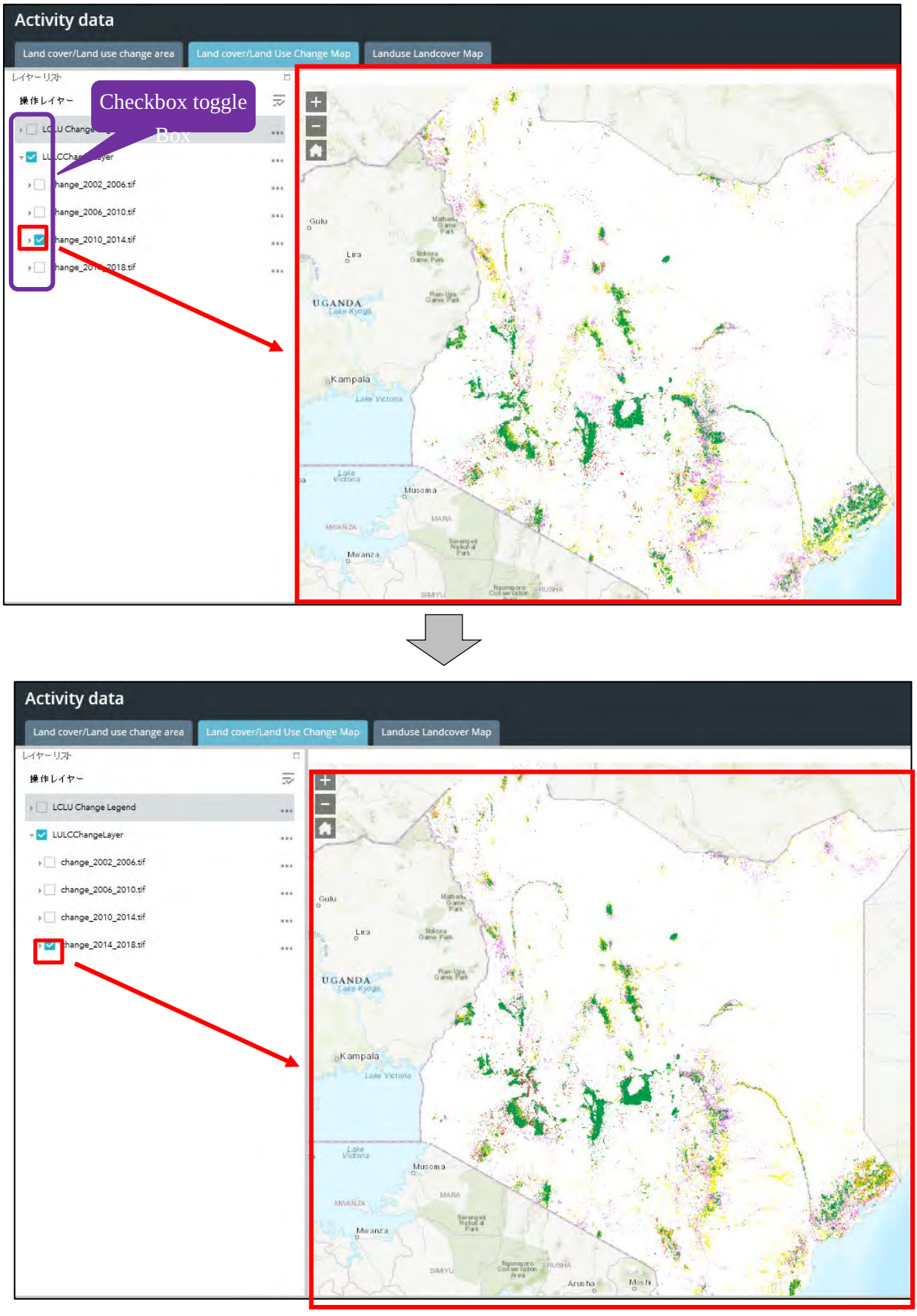


Figure 1.3.2.24 Draw multiple map data (Draw selected map by user)

(b) Direct Server data update

Figure 1.3.2.25 shows previous work of update and the data addition to FIP server. FIP administrator updates and creates the data in their local environment and upload the data to FIP through the ArcGIS online interface. Also manage the cartographic (symbol, color, etc.) parameters with the ArcGIS online interface.

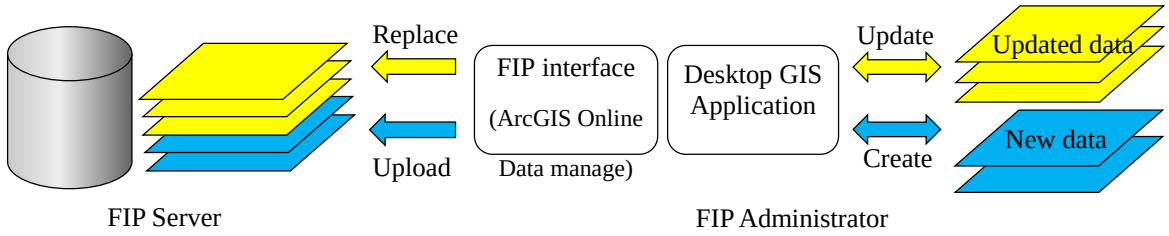


Figure 1.3.2.25 Data add/update process (previous)

Figure 1.3.2.26 shows the same process (data update/create) with ArcGIS Pro. ArcGIS Pro can access to the server dataset directory and modify the data set and manage the cartographic setting. FIP administrator can handle the server data set as if they are stored in administrator's local environment. Moreover, about the new data, data creation is a same process of the previous one. However administrator can set the cartographic parameters of new data with ArcGIS Pro and upload to FIP server directory from ArcGIS Pro. This will reduce the task of FIP server data management for FIP Administrator.

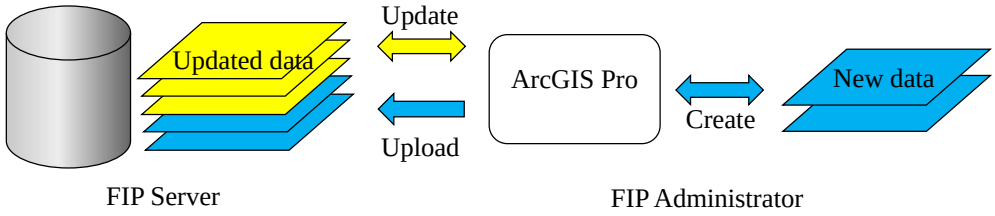
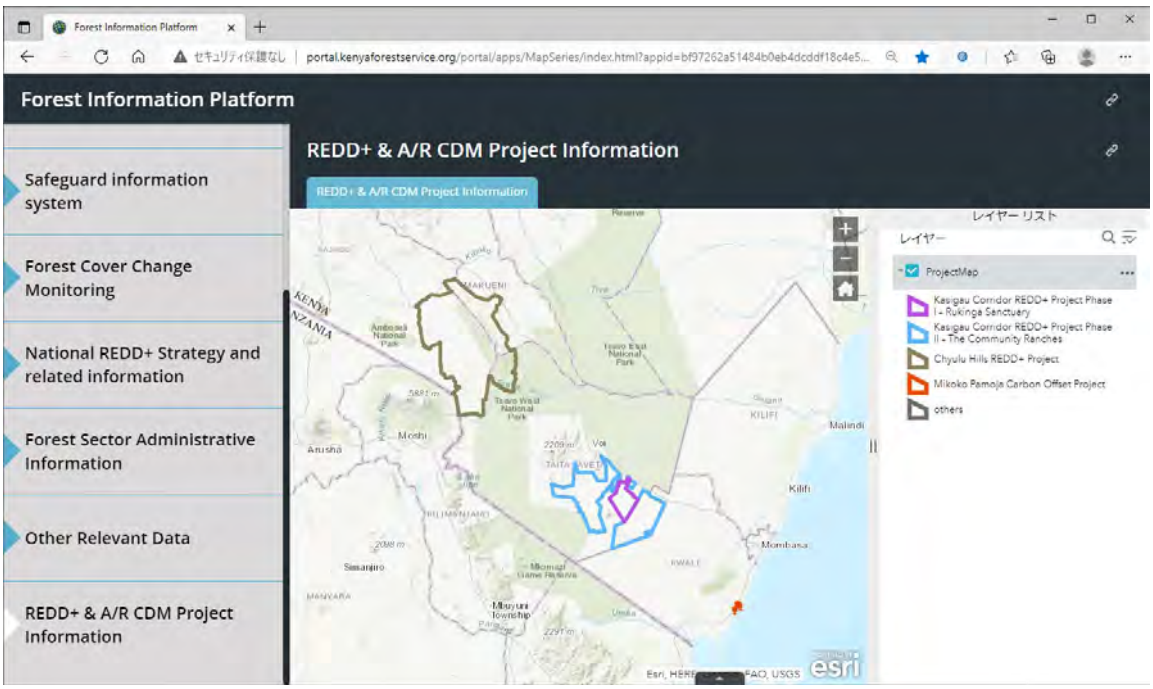
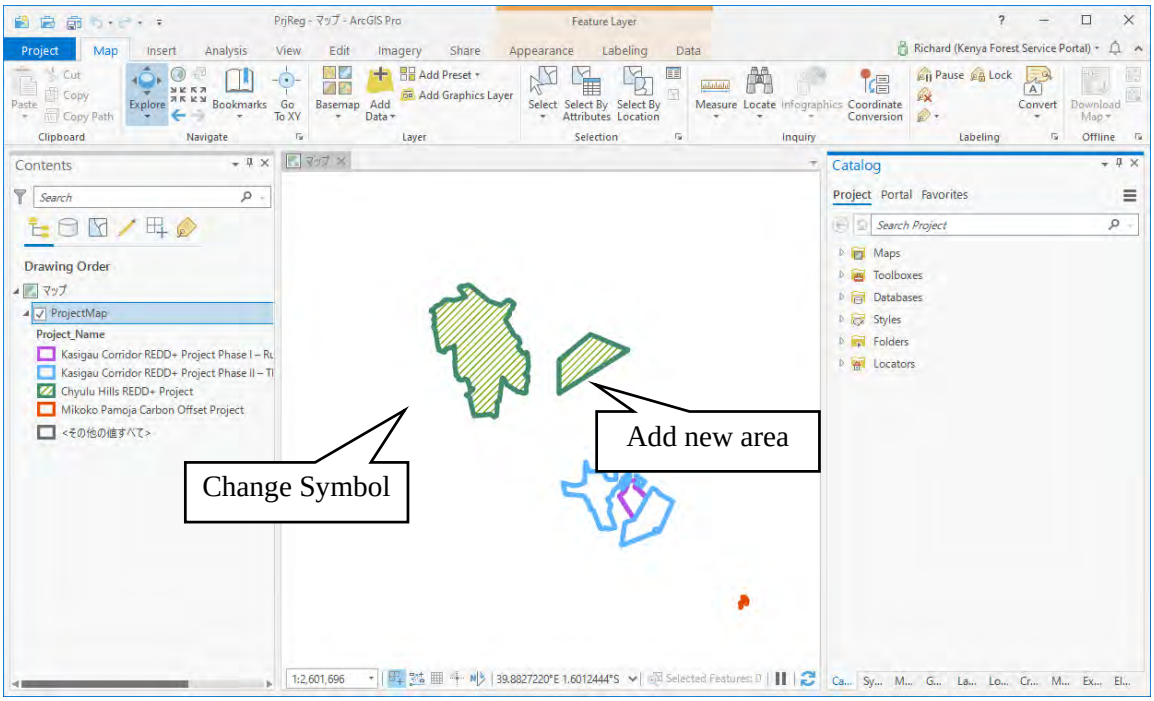


Figure 1.3.2.26 Data add/update process (with ArcGIS Pro)

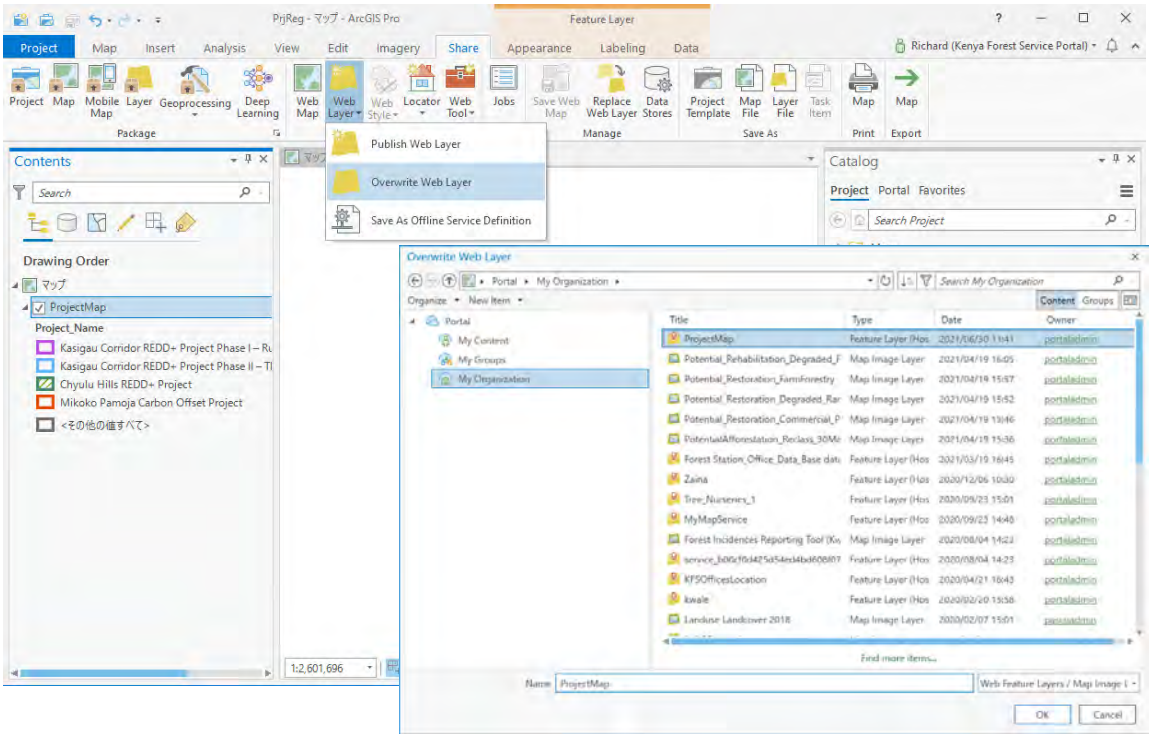
Figure 1.3.2.27 shows how to update data and information on FIP from local GIS application.



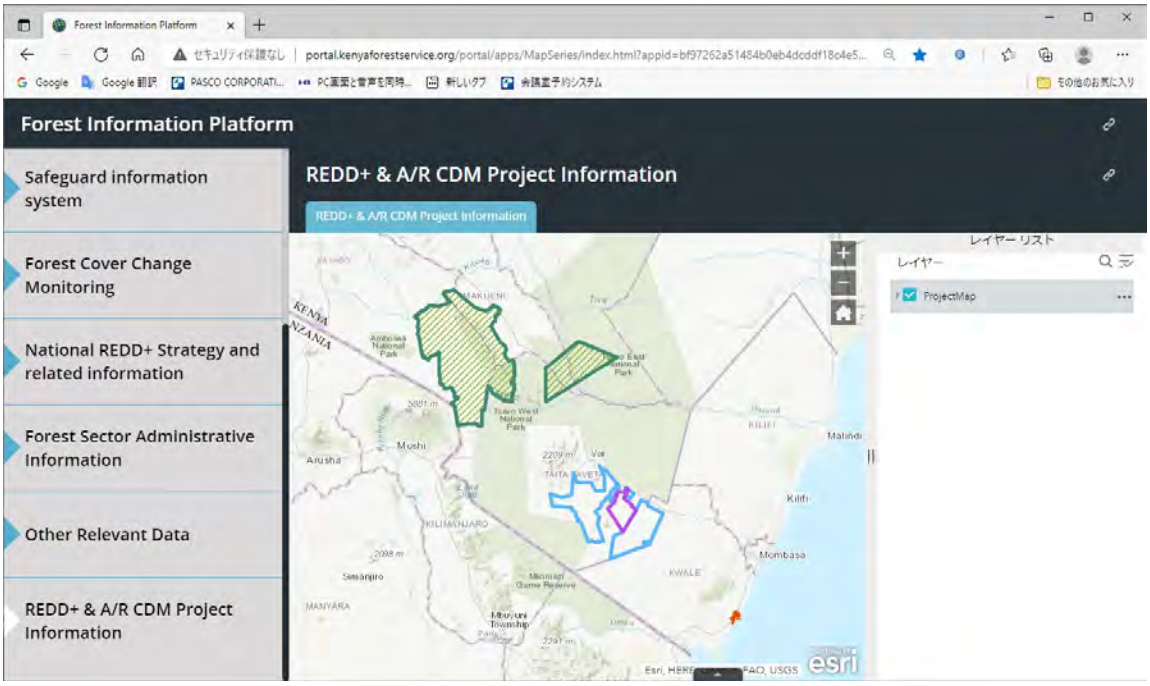
i) Current REDD+ Project Map (FIP)



ii) Import the data from FIP, then change the symbol and add new area with ArcGIS Pro (administrator's local PC).



iii) Overwrite the REDD+ Project map (FIP) with new symbol and updated data.



iv) FIP Contents are updated. No need to touch the FIP from online administrator menu.

Figure 1.3.2.27 How to update data and information on FIP

3) User Interface update

(a) Combined with contents table and tab function

The Component continued to improve the web page user interface. Previous FIP had the hierarchical tab style only. This method is suitable for the user to understand the hierarchical level, however has disadvantage that the screen becomes narrower at lower levels (Figure 1.3.2.28).

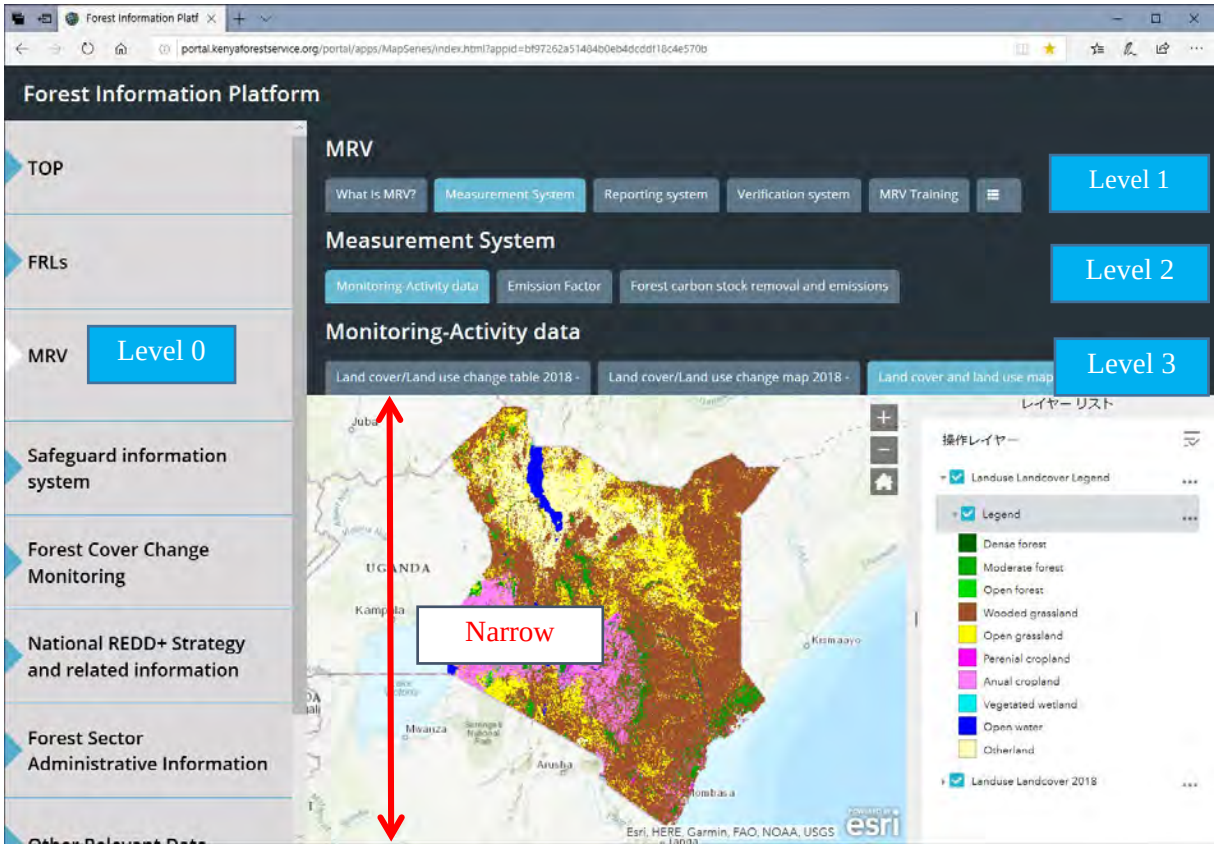


Figure 1.3.2.28 Narrow display area of deep level

To avoid this problem, the Component researched how to modify the user interface. One of solutions was to merge level1 into level0. As the result of this modification, lower level area could be displayed wider than before (Figure 1.3.2.29).

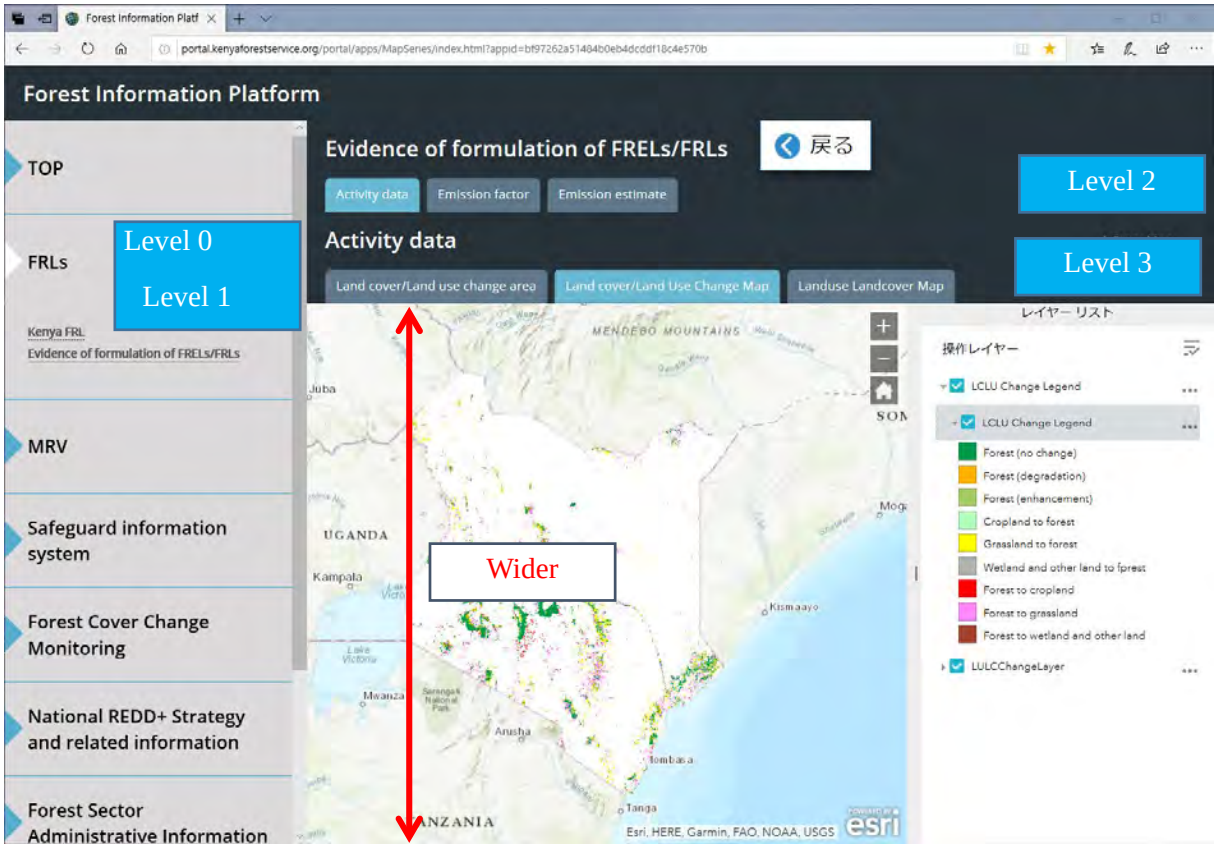


Figure 1.3.2.29 Wider display area after the modification

About the latest interface of FIP, contents tabs had been moved to left side (contents table) and only lowest level of tab function are displayed in the main field (Figure 1.3.2.30).

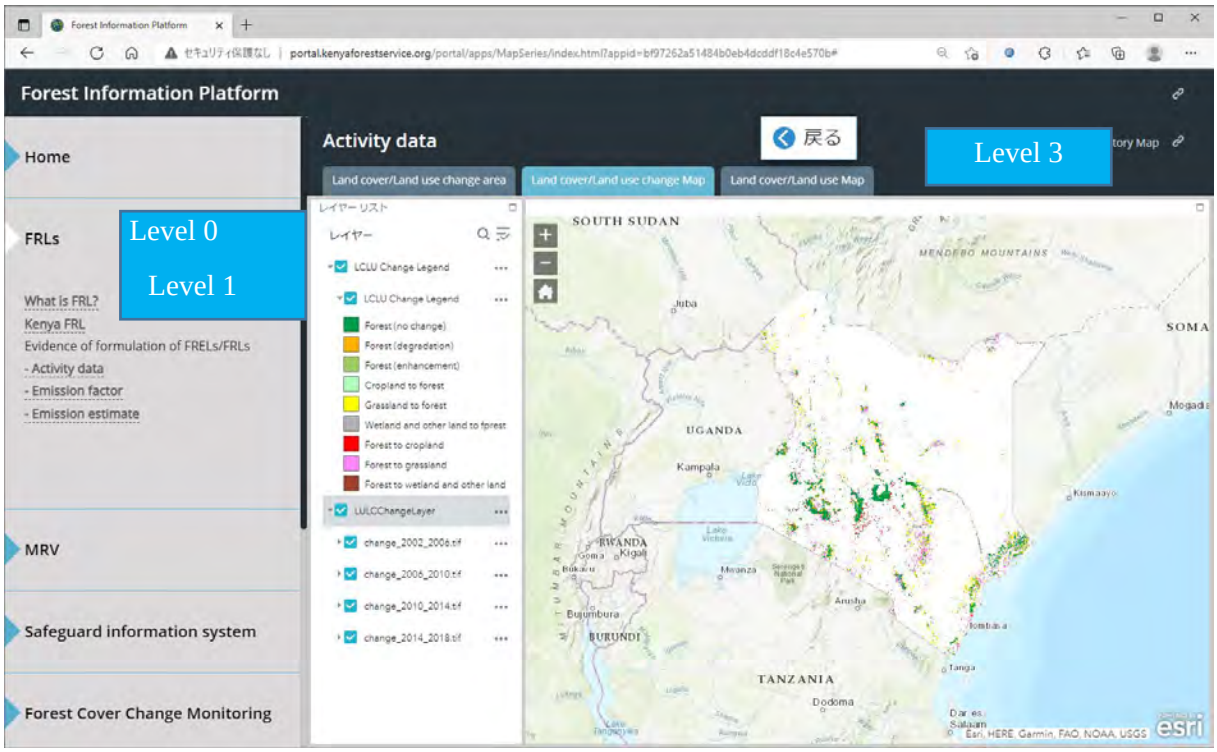
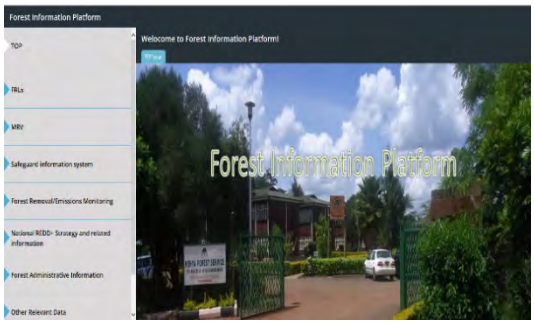


Figure 1.3.2.30 Latest interface of FIP (Sep, 2021)

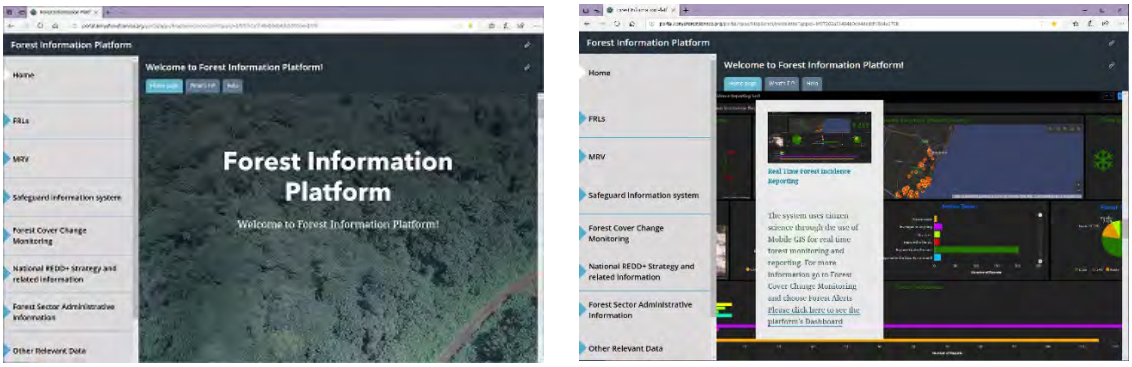
(b) Updating the base software and improvement of the user interface (dynamic HTML)

The base software of FIP has been updated from ArcGIS 10.7 to 10.8. ArcGIS 10.8 can handle the scripts of dynamic HTML like JavaScript for web site. Working with the dynamic HTML, web site can handle the advanced contents like an animation, slideshow, database management system and other rich contents.

Figure 1.3.2.31 shows the update of top page of FIP. The previous top page was just displaying a single image. However, after the update of base software, top page was modified and shows the multiple documents and images like a slideshow.



Previous top page (just single image)



New top page (slideshow like interface)

Figure 1.3.2.31 Modification of Top page

The Component suggested to use dynamic HTML for FIP modification. For the case of using dynamic HTML, Figure 1.3.2.32 shows the process of dynamic creation of the data table view. In this case, table data is stored as a csv file. When the user access to this page, script (JavaScript) reads the csv file and creates the web page (html) dynamically. When the csv file is modified, web site is also updated automatically. Site administrator does not need to modify the web page itself but only to update the csv file. This will reduce the cost of web site and contents management.

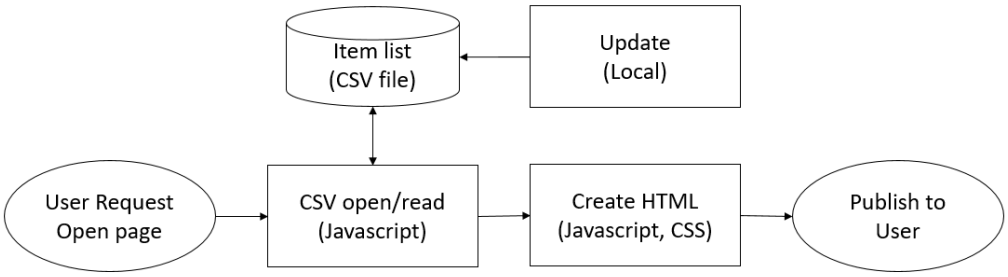


Figure 1.3.2.32 Process of dynamic HTML creation

For example, “National REDD+ Strategy” page stores the list of Acts, Strategies, Policies and other information. When the new item is added, administrator should (1) update the web page document file, (2) convert the document to PDF file and (3) upload the PDF to FIP. However, when using the dynamic HTML, administrator’s task is just update the list file (csv file; step1) and steps2 and 3 are not required

4) Document update

Based on the update of FIP management, the Component revised some manuals as follows (Table 1.3.2.23).

Table 1.3.2.23 Revised manuals

Manual name	New / Updated	Contents
Create the Web Map with ArcGIS Pro	New	How to upload GIS data by ArcGIS Pro on FIP
The manual of how to construct and edit FIP	Updated	How to create or edit contents of FIP Updated contents: How to use some templates related to Map display, which enables to display multiple map data or upload map data which is owned by users.

5) Customizing Survey 123 for NFI

The Component created the prototype of field survey tool for NFI based on the Survey 123. Through the forest inventory practice in the MRV training, the Component tested the usability of interface of inventory data (GPS location, Species, Diameter at Breast Height (DBH), etc.) inputting, form layout and so on. The survey items in this prototype were selected from the IC-FRA manual and implemented as a Survey 123 functions, and survey tool was used with mobile tablet. Table 1.3.2.24 and Figure 1.3.2.33 shows the implemented survey items and interface of this tool. Also through the discussion with C/P, survey 123 covers the requirement of field survey, then Collector for ArcGIS was not utilized for this survey.

Table 1.3.2.24 Survey item list

Item		Contents
Group ID		Survey Group ID
Date		Date / Time of Survey
GPS Coordination		GPS location of Center of the Plot
Cluster No.		Number of survey cluster
Plot No.		Plot number
County Name		County name (“Nakuru” at this time）
Canopy Cover		Rate of canopy Cover（Percentage, Measured with Densiometer）
	Center	Rate of canopy Cover (Center)
	North	Rate of canopy Cover (15m from center to north)
	South	Rate of canopy Cover (15m from center to south)
	East	Rate of canopy Cover (15m from center to east)
	West	Rate of canopy Cover (15m from center to west)
Trees		Tree inventory (All trees)
	Radius(DBH)	Distance from center（0m - 2m, 2m - 5m, 5m - 10m, 10 m- 15m)
	Tree No.	Tree number (Sequential)
	Stem No.	Stem number (Forked tree)
	Species Name	Species (Select from list)
	Any Other Species	Species (Not in the list)
	DBH	Diameter (mm, 130cm height from ground)
	Height	Tree Height (m, Every 5 trees)

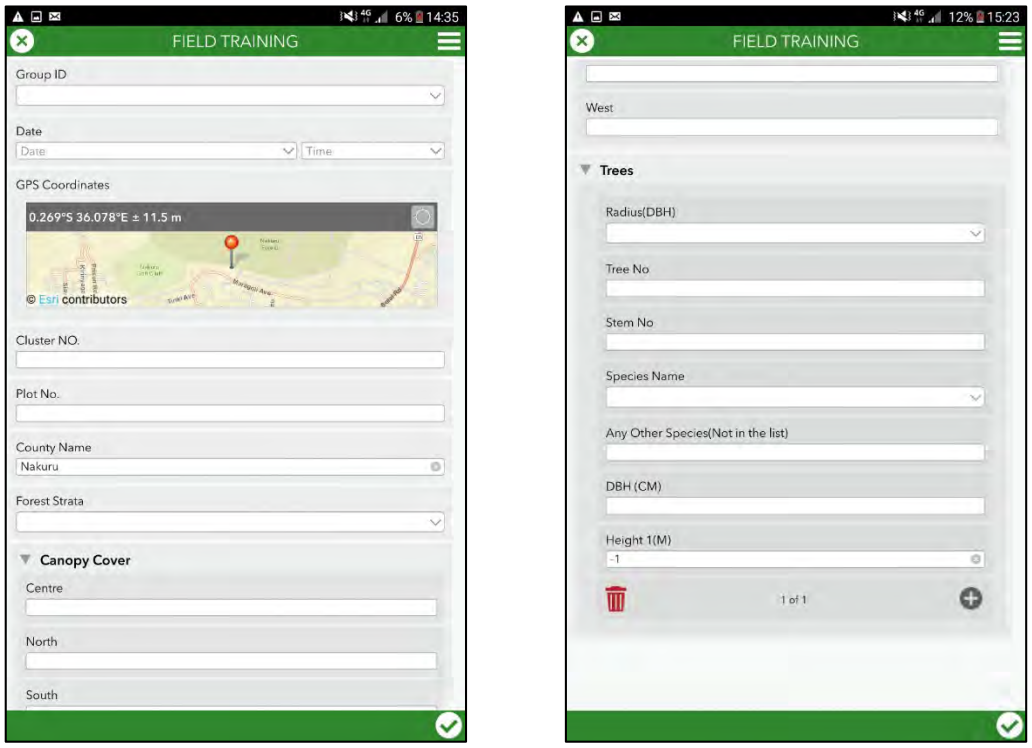


Figure 1.3.2.33 Survey form (Survey123)

Field survey tool are tested in the MRV training (Jan 2020 and Jul 2021, KFS forest in Nakuru). Figure 1.3.2.34 shows the field survey with field survey tool in MRV training Jan 2020. Trainee records the inventory information with field survey tools. The field survey data was stored in ArcGIS online server (Figure 1.3.2.35). The plot center is stored as point data and surveyed tree data is stored as table format. Administrator will do the analysis based on these surveyed dataset (Figure 1.3.2.36).

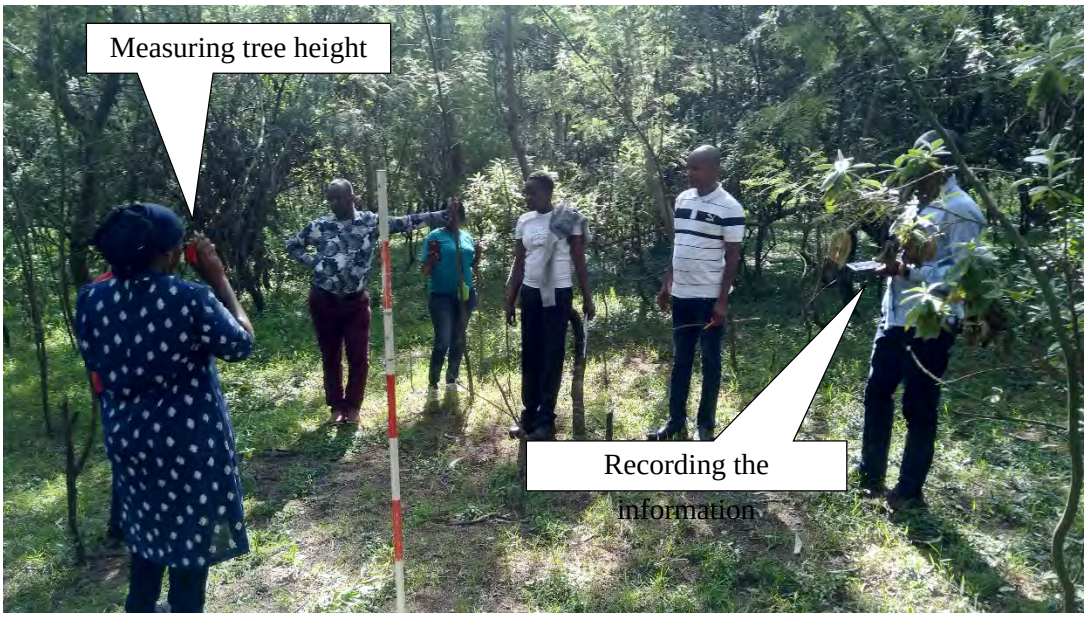


Figure 1.3.2.34 Working with field survey tool (MRV Training, Jan., 2020)

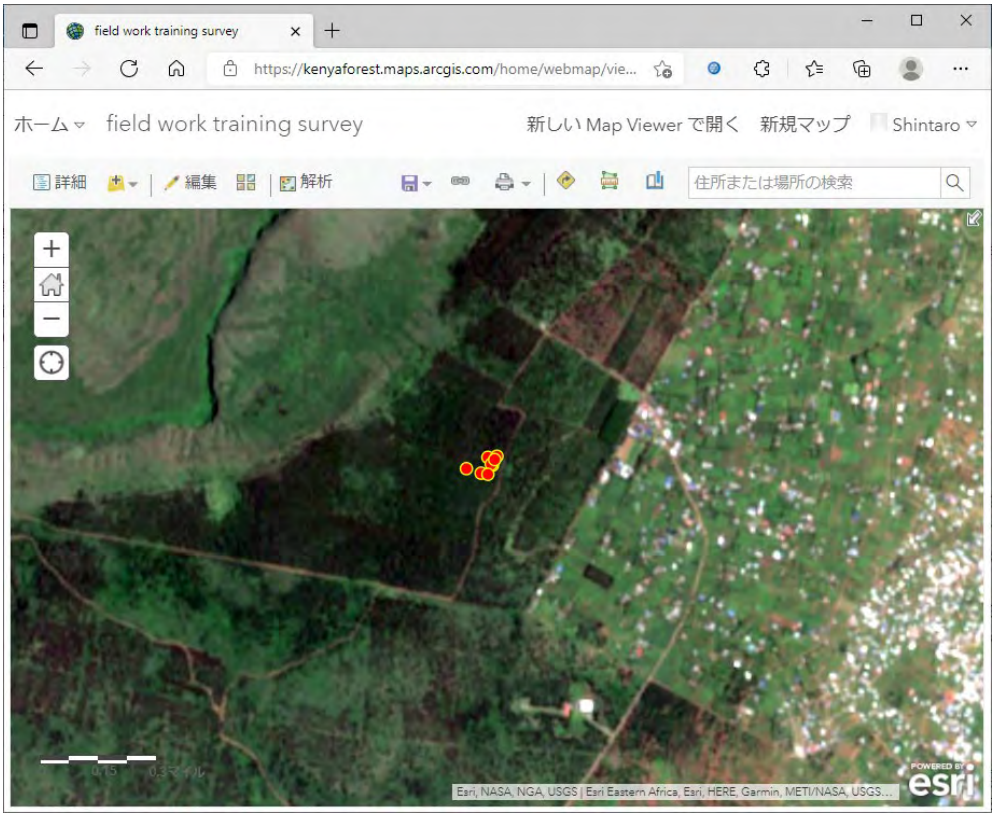


Figure 1.3.2.35 Plot center (stored in ArcGIS Online)

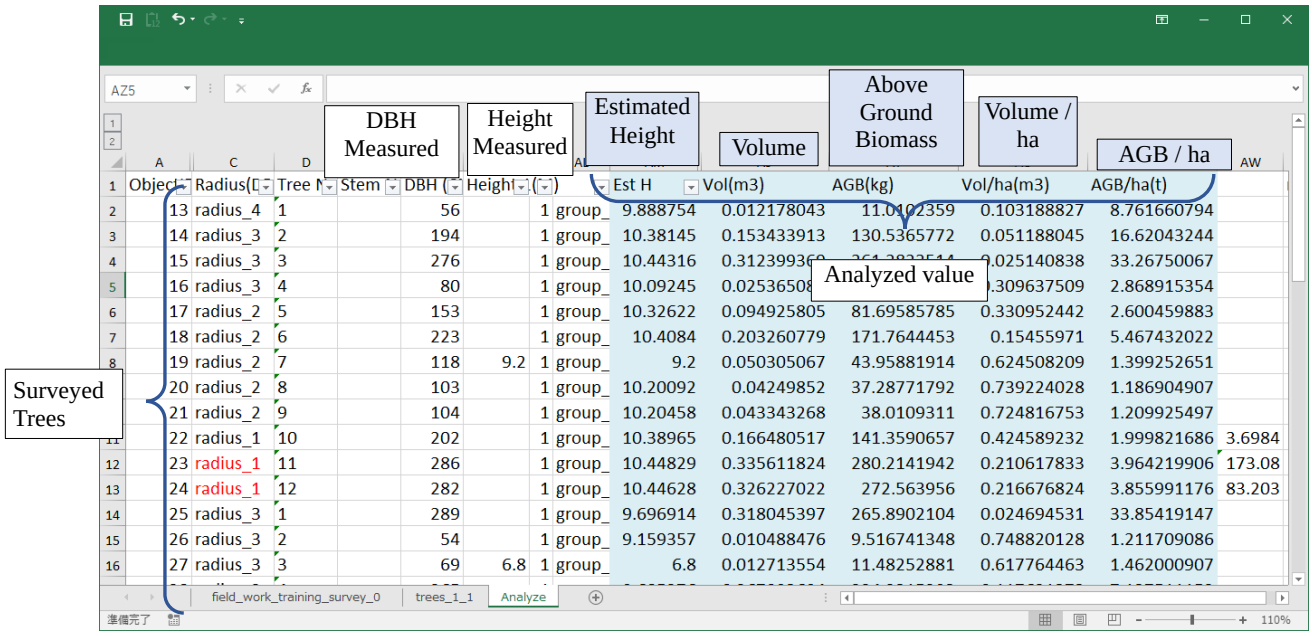


Figure 1.3.2.36 Result of analysis

6) Additional tools

(a) Biomass calculation tool

The Component planned, designed and developed the additional tool of the arithmetic program for automatically calculating volume and carbon amount using data of plot survey on the assumption of future implementation of NFI. Input data are collected with the Survey 123 application which will be utilized for the future NFI will be used for the calculating volume and carbon amount. Figure 1.3.2.37 shows the framework of biomass calculation tool.

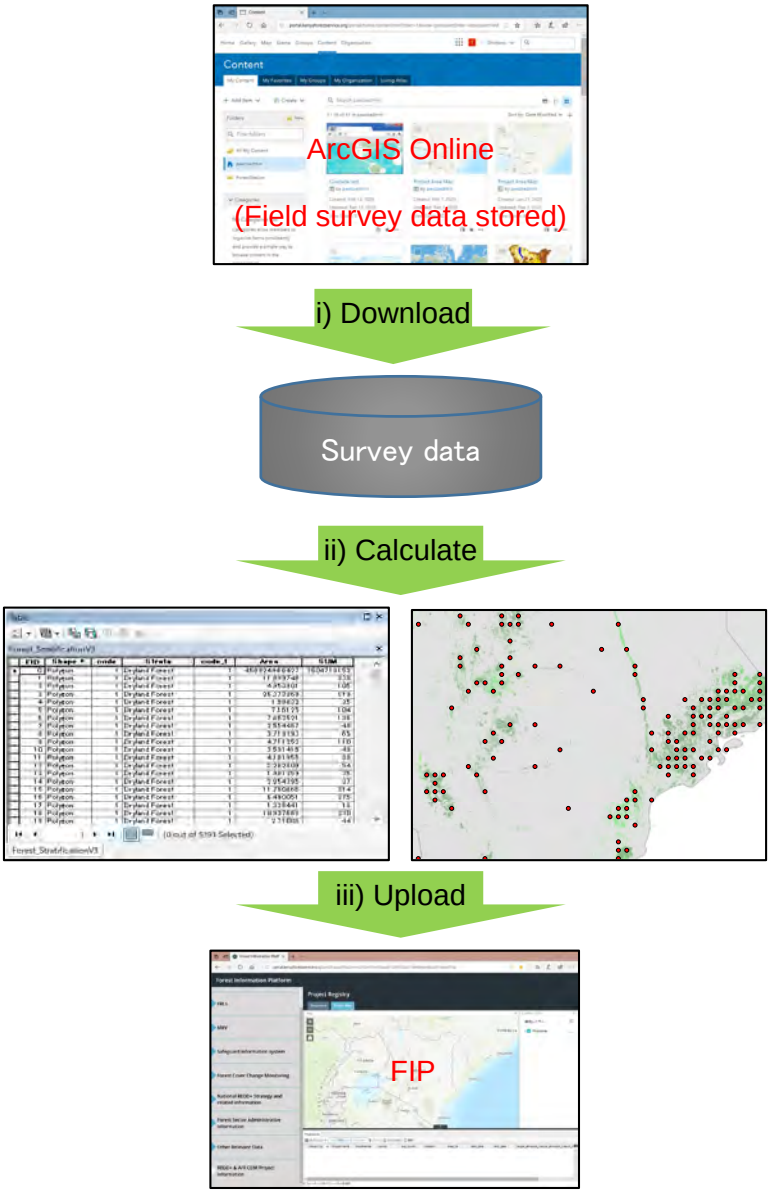


Figure 1.3.2.37 Workflow of Biomass calculation tool

i) Download: Download the field collected data (by Survey 123) from portal site by script.

ii) Calculate: Perform calculation of the downloaded data. Following shows the considering items for calculation;

- Volume of trees and biomass tons and carbon amount of Above Ground Biomass (AGB) and Below Ground Biomass (BGB) in each forest strata (total, per hectare).
- Volume of trees, biomass tons and carbon amount of AGB and BGB in each major species (total, per hectare).

iii) Upload: Calculated data will be stored as the location of plot point and its attributes (number of trees, statistics, etc.) and upload to the FIP (Original data is also uploaded to FIP, however it will be closed to public).

Figure 1.3.2.38 shows the image of calculation result.

Forest strata	Canopy Cover	ABG	BGB	TOTAL		
		Biomass Tonnes/ha)[9]	Biomass Tonnes/ha)[9]	Biomass (Tonnes/ha)[10]	Carbon (Tonnes/ha)[11]	CO_2 (Tonnes/ha)[12]
Montane & Western Rain	Dense	244.80	90.57	335.37	157.62	577.95
	Moderate	58.43	21.62	80.05	37.62	137.96
	Open	18.31	6.77	25.08	11.79	43.23
Coastal & Mangrove	Dense	94.63	18.93	113.55	53.37	195.69
	Moderate	52.75	10.55	63.30	29.75	109.08
	Open	24.01	4.80	28.81	13.54	49.64
Dryland	Dense	42.43	11.88	54.31	25.53	93.60
	Moderate	34.52	9.67	44.19	20.77	76.15
	Open	14.26	3.99	18.26	8.58	31.47
Plantation		324.79	87.69	412.48	193.87	710.84
Cropland Wetland &Settlements/ Otheralands		0	0	0	0[13]	0
Grassland				8.7[14]	4.09	14.99

Ranking	Scientific name	Total stem volume (m3)	(%)
1	Colophospermum mopane	36,460,718	26.818
2	Androstachys johnsonii	19,251,783	14.161
3	Guibourtia conjugata	15,359,190	11.297
4	Sclerocarya birrea	8,255,767	6.072
6	Acacia nigrescens	4,365,117	3.211
7	Spirostachys africana	4,292,102	3.157
9	Xeroderris stuhlmannii	2,300,971	1.692
5	Acacia sp.	5,261,411	3.870
8	Combretum apiculatum	2,588,616	1.904
10	Strychnos madagascariensis	2,187,353	1.609

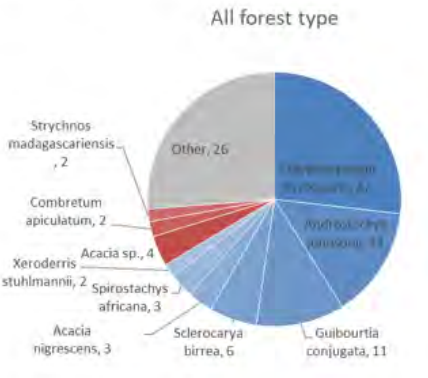


Figure 1.3.2.38 Image of calculation result

This tool has been implemented as a custom tool of ArcGIS and coded with “Python script” and implemented as an ArcGIS plug-in tool (Figure 1.3.2.39).

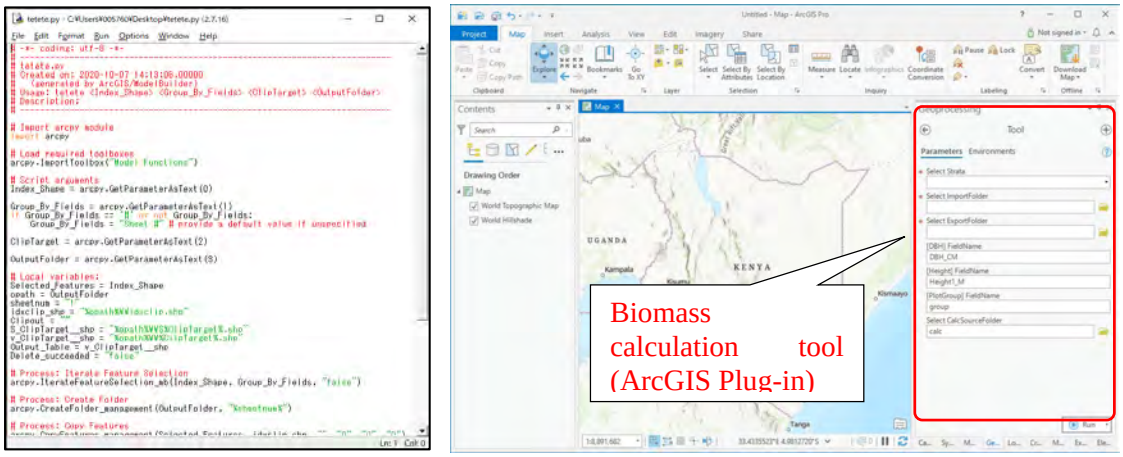


Figure 1.3.2.39 Python script and running the tool as ArcGIS plug-in

(b) Data retrieval tool for JJ-FAST

The Component also planned, designed and developed the additional tool of the semi-automatic JJ-FAST data fetching, modeling and uploading tool as the ArcGIS plugin. Figure 1.3.2.40 shows the framework data capture of JJ-FAST.

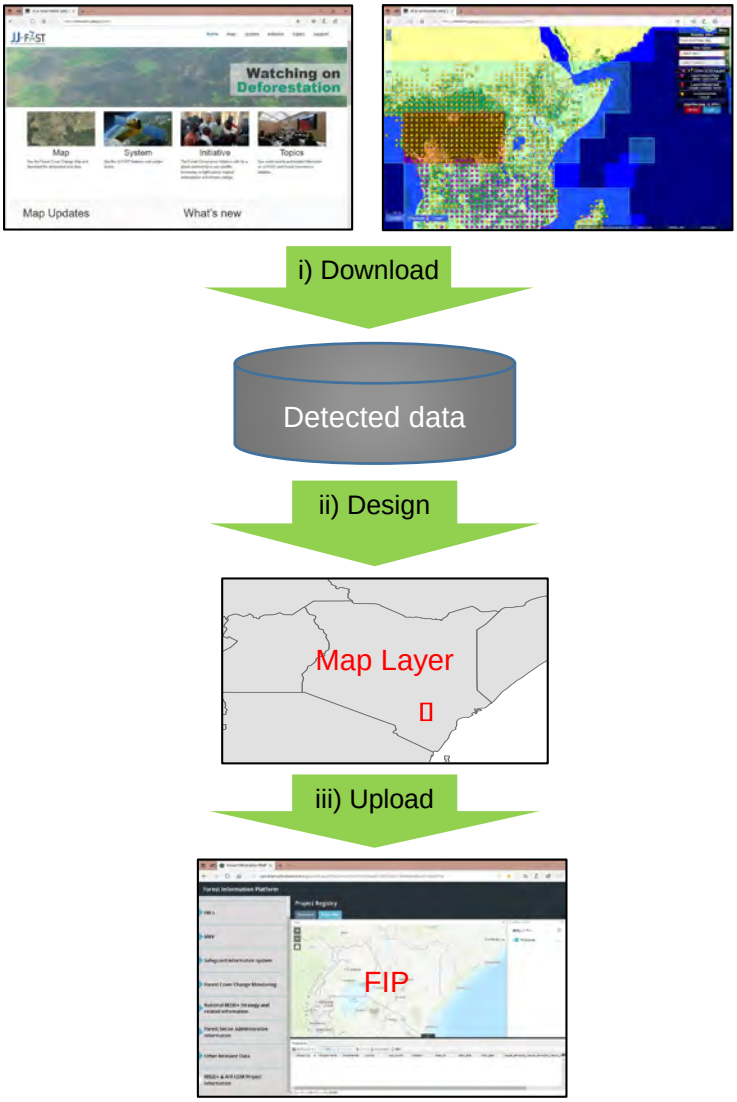


Figure 1.3.2.40 Framework of Data retrieval tool for JJ-FAST

i) Download: Access to the JJ-FAST web site and fetch the monitoring data from JJ-FAST by script (JJ-FAST web site allows to users to access the data stored directory for download). JJ-FAST data has been stored as longitude / latitude block. Therefore, the data of Kenya is divided into about 70 blocks. This tool searches the data folder of all 70 blocks and download the data. And then, merge the all downloaded data into one geospatial data (Figure 1.3.2.41).

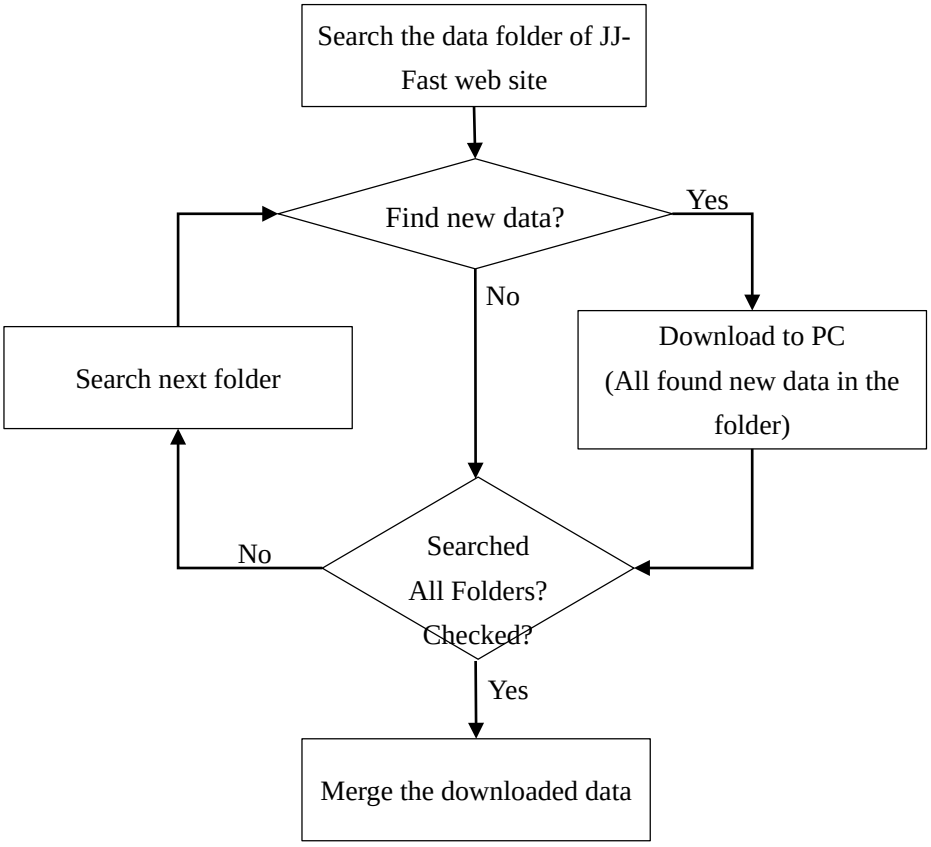


Figure 1.3.2.41 Data retrieval routine

ii) Design: Apply the layer symbol, scale, etc. to the JJ-FAST data by script and create the designed map layer.

iii) Upload: Upload the layer to FIP by script. Then user can see the JJ-FAST data as FIP map layer.

This tool has been implemented as a custom tool of ArcGIS and coded with “Python script”, same as biomass calculation tool.

Figure 1.3.2.42 shows the Data retrieval tool for JJ-FAST (ArcGIS plug-in) and collected data on ArcGIS.

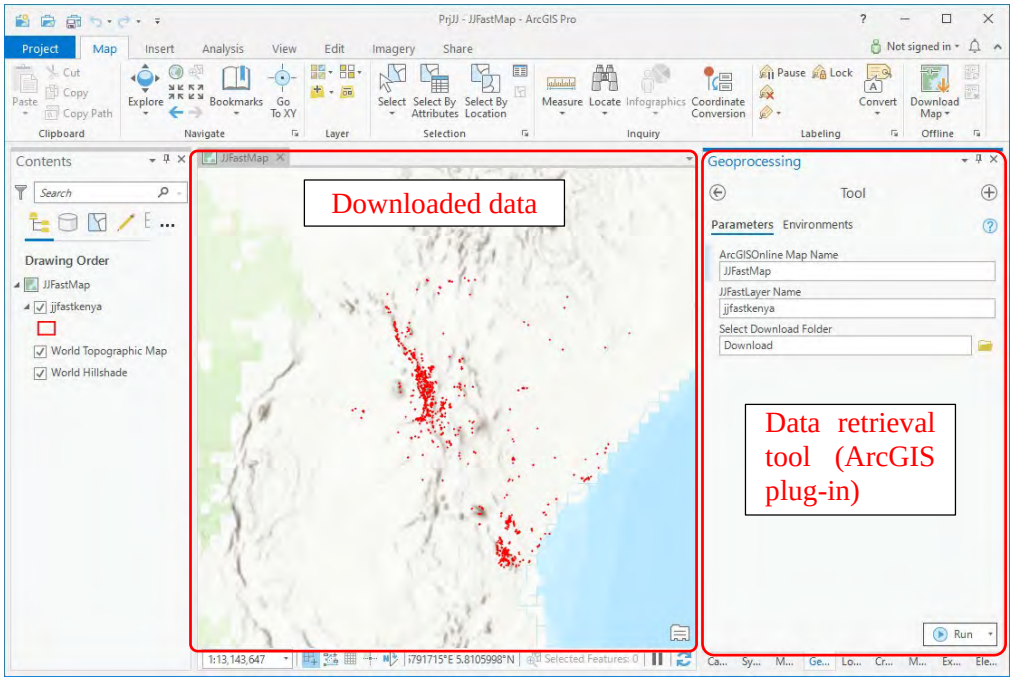


Figure 1.3.2.42 Data retrieval tool for JJ-FAST (ArcGIS plug-in) and collected data

(6) Development and Practice of Operation Method of Forest Information Platform

For the sustainable operation of FIP, the Component created a framework for data management and operations and it is described as follows. Additionally, the workflows for publishing contents were also considered.

1) Basic diagram of data flow

Figure 1.3.2.43 shows the basic diagram and data flow of FIP. From data preparation; such as Data Collection, Registration (left side) to publication for User (right side). To ensure smooth operation, technicians, IT systems and FIP operation and management section need to work together. In this case, it is necessary to establish a solid role and requirements.

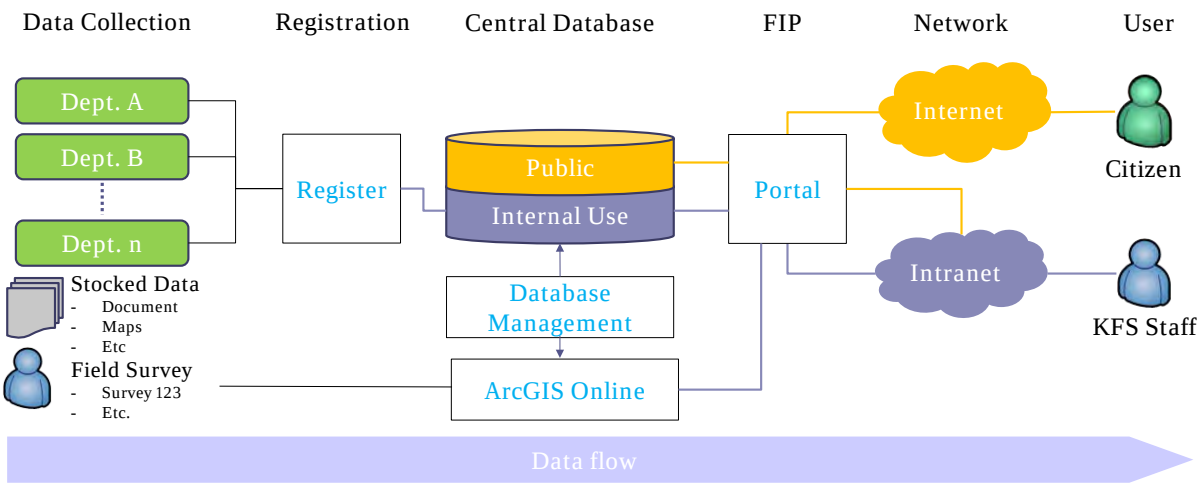


Figure 1.3.2.43 The structure of data management related to FIP

[Data Collection]

Research and Collect the data related to the FIP.

· Manage the requirement (Which department / section should be joined or want to join)

· Manage the dataset (What kind of data they have / should be registered to the Central Database)

· Create and provide the tools for data collection.

· Validation for collected data

· Training

[Registration]

Register the collected data to the Central Database

· Define the rules for registration (Access rights, Data verification, etc.)

· Provide the tools for data registration.

· Training

[Central Database]

Store the huge datasets for project

· Define the section for maintenance (Database, hardware, software)

· Training

[FIP]

Provides the information to public and internal

· Define the structure, operation and maintenance for FIP (hardware, software, portal site)

· Training

[Network]

Provides the project datasets to user

· Security management

· Service policy (24/7/365)

· Training

[Users]

Search and view the information on FIP

· Some data will be hidden from public user

· System administrator can access to the all data through the intranet or administrator menu

2) Institutional arrangement for operation and management

For sustainable operating and maintaining (O&M) of the FIP, two kinds of important matters are required. One is the institutional arrangement for O&M and the other one is the reliability of the contents. The Component prepared and suggested in the diagram which shows the role and responsibility for FIP management as shown in Figure 1.3.2.44 and discussed then with C/P. This management team within KFS requires in two fields. One is the forest and related information section (Portal management: Create and manage the contents of FIP) and the other one is IT section (IT management: Hardware and network maintenance, web page design, etc.).

In addition, upper level commission should be established when the FIP will begin to handle cross-organizational data in full-swing. The upper level commission will have the entire responsibility of the FIP. They should check and control the quality of the contents (e.g. validate the publication of contents) and discuss the policy of the FIP on the regular basis. Establishment of the upper level commission will take some time because all stakeholders should be able to participate to this commission. Therefore, the upper level commission will be established in the future.

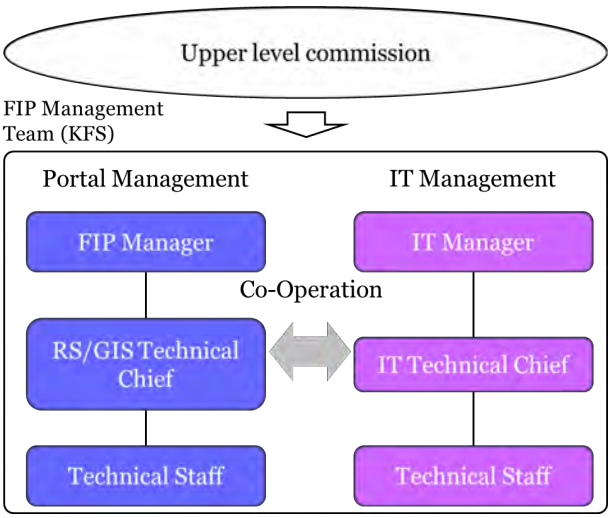


Figure 1.3.2.44 The framework of O&M for FIP

Below shows the responsibility of each role.

[Upper level commission]

- All stake holders of FIP
- Owning the total responsibility of the FIP.

[Portal Management]

FIP Manager

- Responsible person of the FIP operation
- Authorization of the proposal on FIP management from remote sensing (RS)/GIS technical chief

RS/GIS technical chief

- Manage the information (contents, quality, publish, etc.)
- Manage the RS/GIS application database and portal

Technical Staff

- Work with RS/GIS application database and portal

[IT Management]

IT Manager

- Responsible person of the IT

IT technical chief

- Manage the hardware, network, and basic software

Technical Staff

- Working with IT system

3) Reliability of the contents

About the reliability of the contents, Figure 1.3.2.45 shows the workflow of data publication and responsibility of each task.

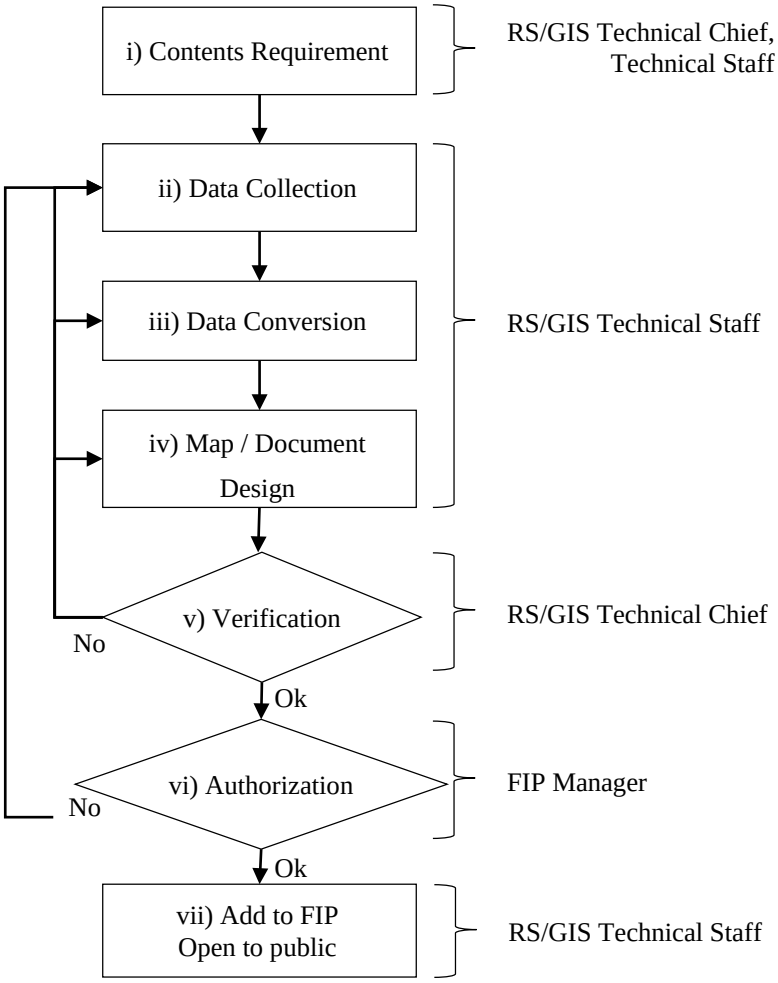


Figure 1.3.2.45 The workflow of contents publication

i) Contents Requirement

RS/GIS technical chief and staff (and related stakeholders) consider the providing contents and

required information.

ii) Data collection

RS/GIS technical staff research the required dataset and collect them.

iii) Data conversion

RS/GIS technical staff review the collected dataset and convert into spatial data/document when needed.

iv) Map / Document design

RS/GIS technical staff design the map and document for FIP.

v) Verification

RS/GIS technical chief validate the created contents. When the contents do not have enough quality for publishing, RS/GIS technical chief should reject it.

vi) Authorization

FIP Manager give the authorization to the contents.

vii) Add to FIP, Open to public

RS/GIS technical staff register the authorized contents and open to public.

1.3.3 Activity on Various Types of Map Creation

(1) Process Assessment for Correctness of Land Cover / Land Use Map 2014

The Land Cover / Land Use Map 2014 were created by technical remote sensing team through the SLEEK project. This project was supported by Clinton Foundation. The technical remote sensing team comprised members from KFS, DRSRS, SOK and Regional Centre for Mapping of Resources for Development (RCMRD).

The assessment process was conducted based on the technical document of SLEEK and hearing from technical remote sensing team the following points were considered:

i) Utilization of Earth Observation (EO) satellite imagery
ii) Preparation of image classification process
iii) Land cover class
iv) Image classification methodology

1) Utilization of Earth Observation (EO) satellite imagery

LANDSAT-8 EO satellite imagery was utilized, the satellite was launched on February 11, 2013 and sensor calibration was completed on April 11, 2013. LANDSAT-8 has Operational Land Imager (OLI) observation sensor which is almost similar to Enhanced Thematic Mapper Plus (ETM+) which is equipped on LANDSAT-7. LANDSAT-8 is one of the US LANDSAT series, and LANDSAT archive

image is the only image data source which meets the historical requirements to time series of Land Cover / Land Use Map for Land Cover Change and Land Use Change globally.

The OLI on LANDSAT-8 covers 185km as swath distance with 180km along track as single scene size, and acquires 30m x 30m pixel size as ground spatial resolution imagery. This ground spatial resolution satisfies 0.5ha as the Minimal Mapping Unit (MMU) which is important for forest definition.

For LANDSAT-8, each scene was utilized only for one year i.e. 2014 and parameters on cloud, season, haze, smoke and pollution were considered for selecting the scenes; Cloud cover was a major consideration. The aim of scene selection was to provide the maximum possible area for classification. Dry season images are preferred for classification purposes for better differentiating between trees, and grasses or crops. The selected scenes were mostly from dry season which are June, July, August, September, January and February and the result of the ratio of cloud gap as NO-DATA was 3.75% for the whole of Kenya. The selected imageries are shown in the following Table 1.3.3.1. Figure 1.3.3.1 is a sample of LANDSAT-8 imagery.

Table 1.3.3.1 Selected imageries for the Land Cover / Land Use Map 2014

2014 Mosaic (32 images were used: 32 dry & 2 wet)					
No	**Path**	**Row**	**Scene**	**Image ID**	**Season**
1	165	61	165061	LC81650612014189LGN00	Dry
2	165	62	165062	LC81650622014189LGN00	Dry
3	166	57	166057	LC81660572014004LGN00	Dry
4	166	58	166058	LC81660582014020LGN00	Dry
5	166	59	166059	LC81660592014004LGN00	Dry
6	166	60	166060	LC81660602014004LGN00	Dry
7	166	61	166061	LC81660612014196LGN00	Dry
8	166	62	166062	LC81660622014084LGN00 & LC81660622014196LGN00	Dry
9	166	63	166063	LC81660632014180LGN00	Dry
10	167	57	167057	LC81670572014011LGN00	Dry
11	167	58	167058	LC81670582014011LGN00	Dry
12	167	59	167059	LC81670592014267LGN00	Dry
13	167	60	167060	LC81670602014283LGN00	Wet
14	167	61	167061	LC81670612015014LGN00	Dry
15	167	62	167062	LC81670622014331LGN00	Wet
16	167	63	167063	LC81670632014059LGN00	Dry
17	168	57	168057	LC81680572014018LGN00	Dry
18	168	58	168058	LC81680582014034LGN00	Dry
19	168	59	168059	LC81680592014034LGN00	Dry
20	168	60	168060	LC81680602014258LGN00	Dry
21	168	61	168061	LC81680612014034LGN00	Dry
22	168	62	168062	LC81680622014034LGN00	Dry
23	169	57	169057	LC81690572014025LGN00	Dry

2014 Mosaic (32 images were used: 32 dry & 2 wet)					
No	**Path**	**Row**	**Scene**	**Image ID**	**Season**
24	169	58	169058	LC81690582014185LGN00	Dry
25	169	59	169059	LC81690592014025LGN00	Dry
26	169	60	169060	LC81690602014025LGN00	Dry
27	169	61	169061	LC81690612014025LGN00	Dry
28	170	56	170056	LC81700562014016LGN00	Dry
29	170	57	170057	LC81700572014032LGN00	Dry
30	170	58	170058	LC81700582014032LGN00	Dry
31	170	59	170059	LC81700592014032LGN00	Dry
32	170	60	170060	LC81700602014032LGN00	Dry
33	170	61	170061	LC81700612014256LGN00	Dry
34	171	57	171057	LC81710572014007LGN00	Dry

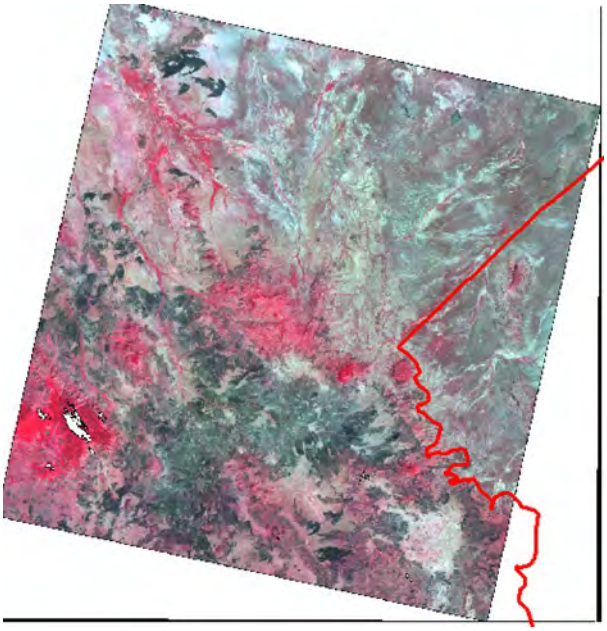


Figure 1.3.3.1 Example of LANDSAT-8 Imagery

2) Preparation of image classification process

The preparation of image classification considered the following processing items;

- ✓ Terrain illumination correction
- ✓ Removal of cloud and shadow cover area
- ✓ Image Segmentation

Terrain Illumination Correction

The technical remote sensing team considered image correction to avoid misclassification. The EO satellite imagery needs correction to illuminate value of pixel for removal of terrain effect. Terrain

illumination variations exist in imagery because there are variations in slope and aspect of the land which affect the amount of incident and reflected energy (light) from the surface. Therefore, terrain illumination correction was necessary for preparation of image classification process. Figure 1.3.3.2 below show images for before correction and after correction on illumination.

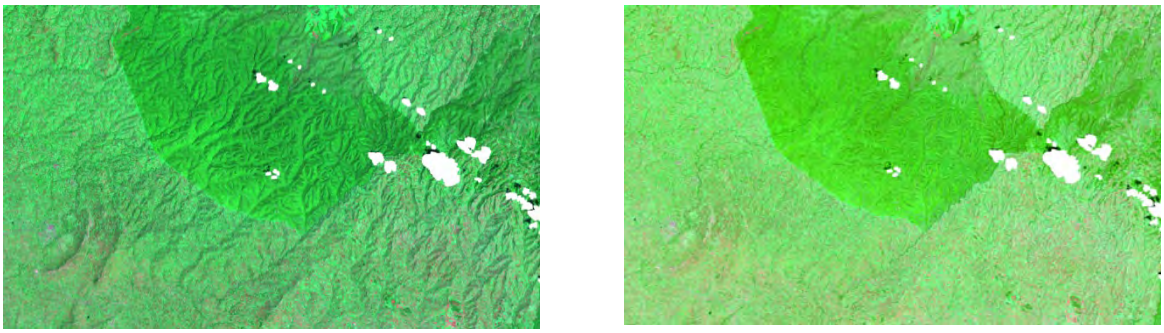


Figure 1.3.3.2 Left: Original imagery, Right: Imagery after correction

Removal of Cloud and Shadow Cover Area

Cloud covered area is an obstacle in utilization of optical imagery for image classification process. Cloud cover obscures land and makes the affected pixels unusable even for visual interpretation and/or classification. Thinner clouds, cloud shadow and haze affect digital reflectance from land cover and make quantitative processing impossible or inaccurate. Hence, minimizing cloud cover area was a major consideration in scene selection, but even the best selected scenes still had cloud cover and cloud shadow cover area. For this situation, cloud cover area on the imagery was removed before image classification process. The technical remote sensing team had conducted removal of cloud and shadow cover area based on masking methodology. The following Figure 1.3.3.3 shows cloud masking and area where cloud cover was removed.

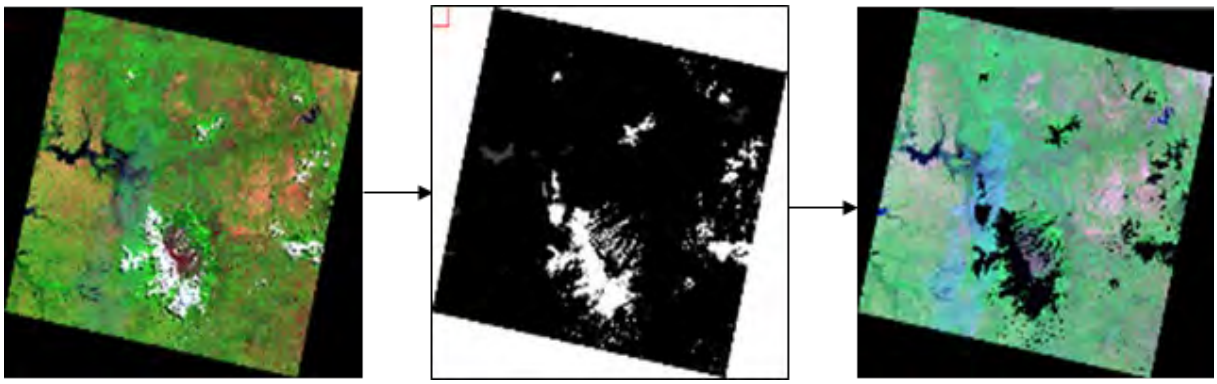


Figure 1.3.3.3 Process of masking and removal of cloud covers

Regarding the missing area on the satellite image from which the clouds have been removed, the missing area is supplemented by mosaicking the classification result on the image of different observation dates.

Image Segmentation

Land cover and land use vary tremendously across Kenya. Land cover ranges from dense forests to vast dry wooded grassland areas, also different types of cropland are found in the whole of Kenya. Therefore,

a single image classifier cannot accurately classify all these different land cover types simultaneously which would lead to misclassification. In order to avoid misclassification, the selected LANDSAT-8 imagery needs to be divided into some spectral groups of smaller zones in relation to the mix of land cover or similar strata of land cover.

Therefore, the remote sensing team refers to the Agro-Ecological Zone of Kenya, considers the spectral characteristics and land cover, divides the satellite images of each image according to their characteristics, and then performs image classification processing. If a large classification error is found, the division areas are integrated or changed, and image segmentation and image classification are processed again. The Agro-Ecological Zone is a zone map which was created by the Ministry of Agriculture in collaboration with the Kenya Meteorological Bureau, is shown in Figure 1.3.3.4. The following Figure 1.3.3.5 is original LANDSAT-8 imagery and example of the image segmentation.

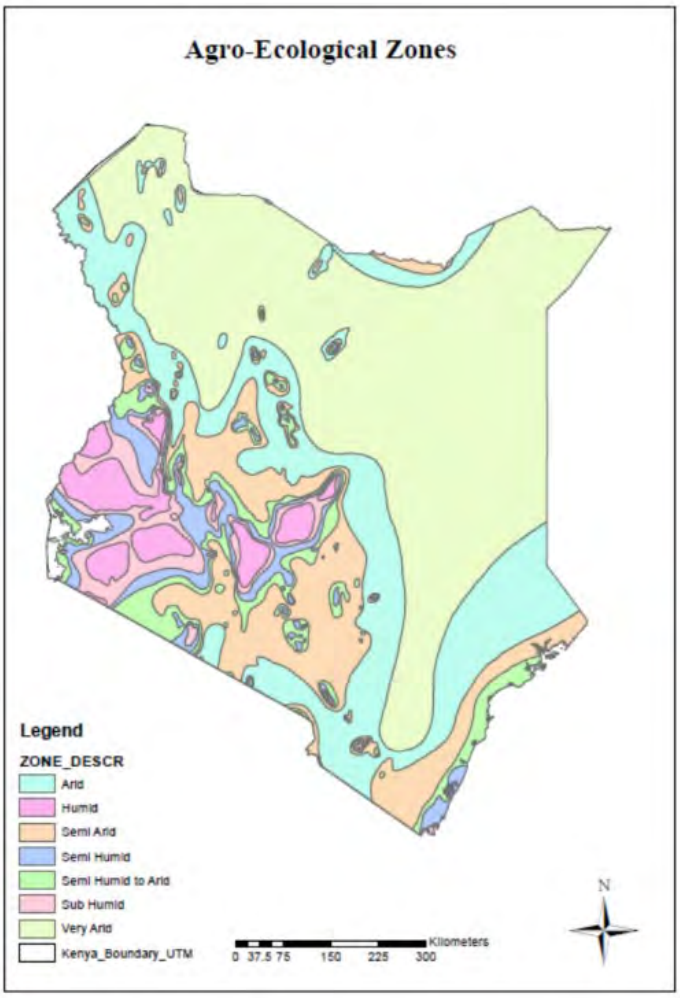


Figure 1.3.3.4 Zone map of the Agro-Ecological Zone

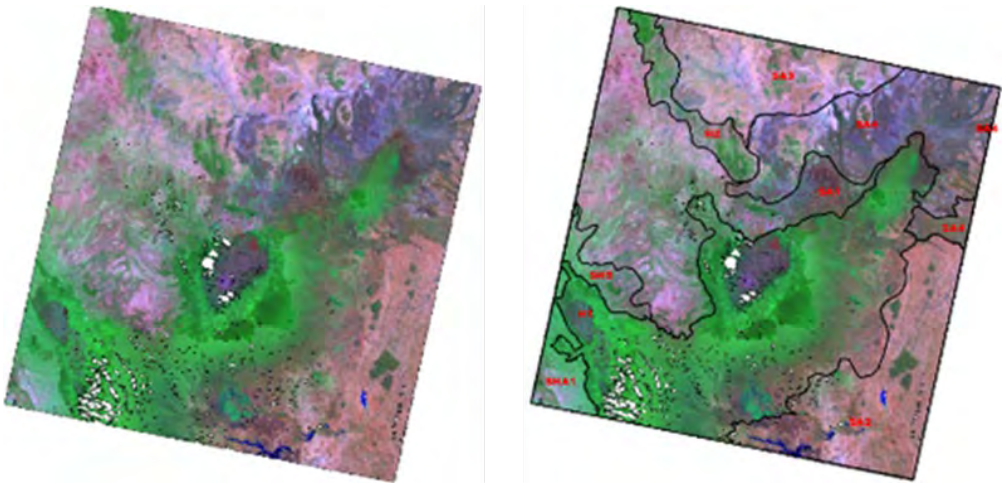


Figure 1.3.3.5 Left: Original Image, Right: Example of image segmentation

3) Land cover class

The defined land cover classes for the Land Cover / Land Use Map were followings.

1. Dense Forest (above 65%)
2. Moderate Forest (40 %< 65%)

3. Open Forest (15 %< 40%)
4. Annual Crops
5. Perennial Crops
6. Open Grasses
7. Wooded grass
8. Water body
9. Vegetated Wetland
10. Other

Those types consist of mixed land cover and land use. The land cover classes were dense forest, moderate forest, open forest, open grasses, wooded grass, water body, vegetated wetland and other. The land use classes were annual crops and perennial corps. The land use classes are normally difficult category to classify and therefore it has to be considered for image classification process. As mentioned above, for preparation of image classification, the technical remote sensing team divided the LANDSAT-8 imagery into sub-imageries based on Kenya's Agro-Ecological Zones.

4) Image classification methodology

There are mainly two approaches for image classification methodology. One is pixel based classification and the other is object based classification. The technical remote sensing team decided to apply the pixel based classification approach. The typical classification methods that are often used are as follows:

- ✓ Multi-Level Slice Classifier
- ✓ Decision Tree Classifier
- ✓ Minimum Distance Classifier
- ✓ Maximum Likelihood Classifier
- ✓ Fuzzy Theory Classifier
- ✓ Expert System Classifier
- ✓ Neural Network Classifier
- ✓ Others

The technical remote sensing team used machine learning algorithm which is called random forest with supervised classification for the Land Cover / Land Use Map 2014. This image classification methodology is suitable for land cover / land use classification and reduces computer processing time than other machine learning algorithms. In addition, removal of cloud cover area and dividing into sub-imagery is performed by decision tree classifier hence it is a typical methodology.

Consideration of each processes 1) to 4), therefore, the satellite image selection and image classification methods for creating the Land Cover / Land Use Map 2014 was an appropriate procedure that matched the classification class items. Moreover, this classification method could use the same site training data as long as there is no change of the land cover. And it also increases the classification accuracy by computer processing if continuing classification processing based on the same model. Manual processing is required for each process such as pre-processing, but since classification processing is an automatic classification by computer processing, compared to other methods that require interpretation, etc., it is possible to create land cover / land use map in a shorter time with fewer people at the national level. The method used in SLEEK can be said to be a sustainable method.

(2) Result Assessment for Correctness of Land Cover / Land Use Map 2014

The result assessment was conducted through ground truth survey from Sep 27th – Oct 8th, 2016. The survey points for verification was discussed with C/P and selected based on accessibility from areas of interest which are necessary confirmation area, possible misclassification area and unknown area. The selected points covered all land cover and land use classes, and classified forest class points were more than other classes. For accessibility, distance between road and points and distance from major town were considered. The distance from major town was not more than 20km so as to avoid contamination of verification point collection at field and excessive survey traveling time. The distance from road was not less than 50m and next point was not further than 1.5km from the same road for minimizing survey traveling time. The selected points on the Land Cover / Land Use Map are shown in the following Figure 1.3.3.6.

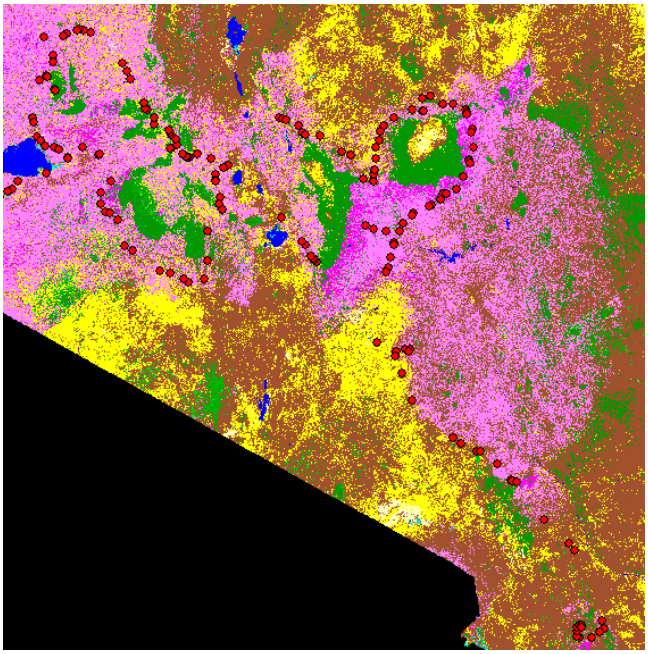


Figure 1.3.3.6 Land Cover / Land Use Map with survey points

This verification survey was conducted together with KFS's staff and stakeholders of SLEEK such as DRSRS, KEFRI, etc. The verification point was collected with photos and location information by use of handy GPS. Kenyan participants and verification survey schedule are shown in the following Table 1.3.3.2, Table 1.3.3.3 and Table 1.3.3.4 respectively.

Table 1.3.3.2 Kenyan participant group for verification survey

	Group 1	Group 2
Supervisor	Serah Kahuri	Faith Mutwiri
KFS	Eunice Maina	Kioko Nzioka
	Safi Ibrahim	Antony Ngari
	Jira Chimanyi	Eric Nganga (RCMRD)
Other institution	Tom Kemboi (AWF)	John Ngugi (KEFRI)
	Antony Macharia (SOK)	Merceline Ojwala (DRSRS)

Table 1.3.3.3 Survey schedule (Group1)

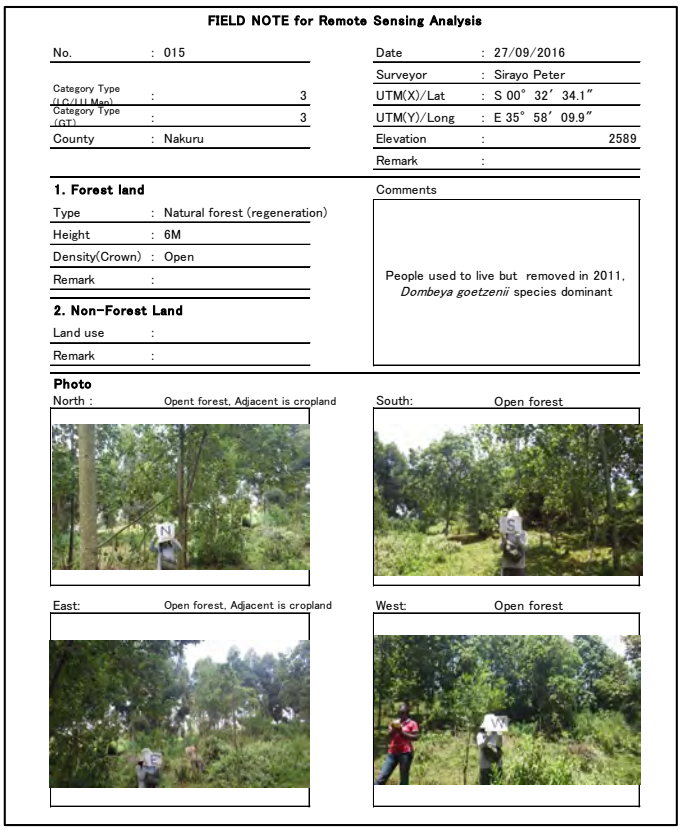
2016	Sep	26	MON	Field Survey (Nairobi - Kabarnet)
		27	TUE	Field Survey (Kabarnet - Timboiwa – Sacho – Tenges –Kabarnet)
		28	WED	Field Survey (Kabarnet – Kipcherera – Kapchekor – Tirimionin - Kabarnet)
		29	THU	Field Survey (Kabarnet – Chebloch – Biretwo – Tambach – Kessup – Iten - Eldoret)
		30	FRI	Field Survey (Eldoret –Kipkabus – Kaptagat - Eldoret)
	Oct	1	SAT	Field Survey (Eldoret – Soy – Kitale)
		2	SUN	Data arrangement / day off (Kitale)
		3	MON	Field Survey (Kitale - Kaptalelia – Cheptais - Kitale)
		4	TUE	Field Survey (Kitale – Kapenguria - Cherangani– Kitale)
		5	WED	Field Survey (Kitale – Lodwar)
		6	THU	Field Survey (Lodwar - Lodwar)
		7	FRI	Field Survey (Lodwar - Lodwar)
		8	SAT	Field Survey (Lodwar - Eldoret)
		9	SUN	Field Survey (Eldoret - Nairobi)

Table 1.3.3.4 Survey schedule (Group2)

2016	Sep	26	MON	Field Survey (Nairobi - kimende - Naivasha - Nakuru)
		27	TUE	Field Survey (Nakuru - Sobea - Mau Samit - Londiani - Molo - Elburgon - Njoro –Nakuru)
		28	WED	Field Survey (Nakuru - Total - Timboroa - Burnt Forest - Eldoret)
		29	THU	Field Survey (Eldoret - Turbo - Kipkaren - Webuye - Malava - Lubao(Kakamega Forest) - Mukumu - Maragori - Vihiga - Kiboswa - Kisumu)
		30	FRI	Field Survey (Kisumu - Ahero - Awach-Kendu Bay- Homa Bay - Kisumu)
		1	SAT	Field Survey (Kisumu -Ahero - Awasi-Kericho - Bomet - Narok - Mau Narok - Nakuru)
		2	SUN	Data arrangement / day off (Nakuru)
	Oct	3	MON	Field Survey (Nakuru - Nyahururu - Nyeri –Naro Moru - Nanyuki)
		4	TUE	Field Survey (Nanyuki - Timau - Meru - Chogoria - Chuka - Embu)
		5	WED	Field Survey (Embu –Kutus - Sagana –Muranga - Maragua - Thika)
		6	THU	Field Survey (Thika - Nairobi - Machakos - Salama - Kibwezi - Voi)
		7	FRI	Field Survey (Voi –Mwatate - Wundanyi - Voi)

		8	SAT	Field Survey (Voi - Nairobi)

The collected verification points were mentioned in the field note as shown in the following Figure 1.3.3.7. The field note also includes; date and time, location name, location information such as longitude / latitude, class type on the Land Cover / Land Use Map, class type at site and photos for 4 directions such as north, south, east and west.



FIELD NOTE for Remote Sensing Analysis

No.	: 015	Date	: 27/09/2016
		Surveyor	: Sirayo Peter
Category Type (LC/LU Map)	: 3	UTM(X)/Lat	: S 00° 32′ 34.1″
Category Type (GT)	: 3	UTM(Y)/Long	: E 35° 58′ 09.9″
County	: Nakuru	Elevation	: 2589
		Remark	:

1. Forest land

Type	: Natural forest (regeneration)
Height	: 6M
Density(Crown)	: Open
Remark	:

2. Non-Forest Land

Land use	:
Remark	:

Comments

People used to live but removed in 2011, *Dombeya goetzenii* species dominant

Photo

North : Opent forest, Adjacent is cropland

South: Open forest

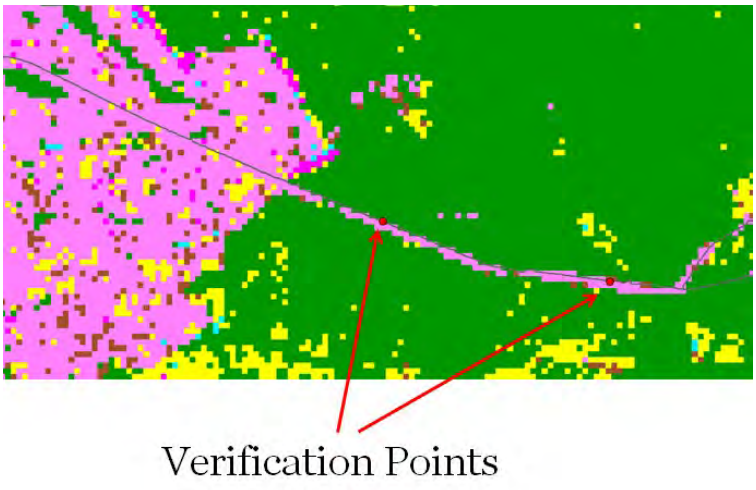
East: Open forest, Adjacent is cropland

West: Open forest

Figure 1.3.3.7 Example of Field Note

The Team collected 176 points during verification survey. For the forest, some verification points indicated misclassification to different canopy as dense especially for open and moderate. There was also misclassification between some croplands and grassland due to similar illumination of pixel value on the LANDSAT imagery. The following Figure 1.3.3.8 shows site survey. And, Figure 1.3.3.9 shows analysis of verification points on Land Cover / Land Use Map.

Figure 1.3.3.8 Photos of the Site Survey



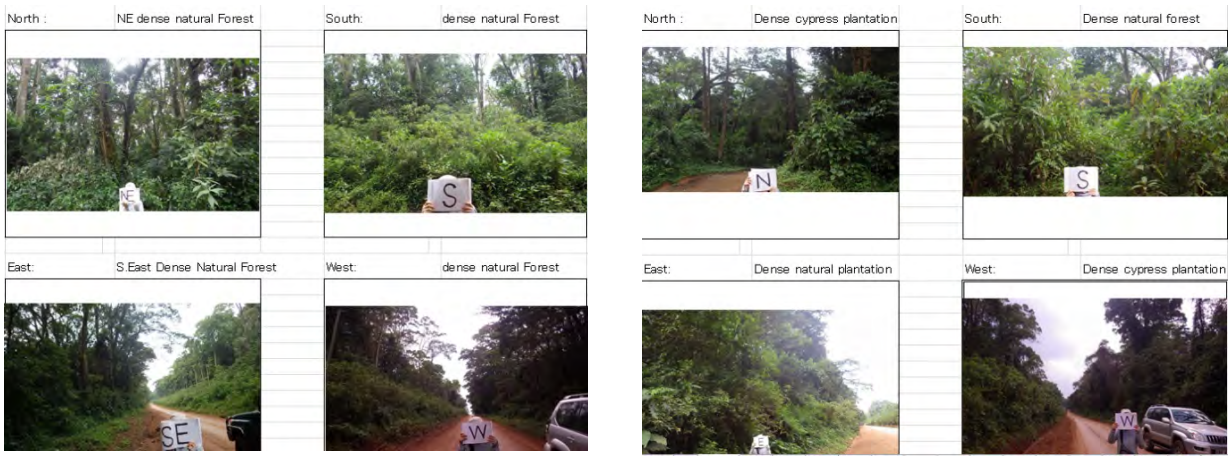


Figure 1.3.3.9 Analyzing of verification point on the Land Cover / Land Use Map and 4 direction photos

The collected verification points in the field note is attached as Appendix 13. This field note was utilized for reporting of assessment result.

(3) Report of Assessment Result

The assessment result was presented and reported at the Stakeholder consultation workshop and TWG meeting on March 28th and 29th, 2017. The methodology and process of SLEEK for Land Cover / Land Use Map was typical and thus adopted as the formal way since it was a reliable approach. For the classification of result assessment for correctness of Land Cover / Land Use Map, analysis was based on combination of the Component's verification points and SLEEK's points. The total number of verification points was 3,799 and the correctness result was overall accuracy 75.1 percentage which was taken as classification accuracy. Individual correctness result of class is shown in the following Table 1.3.3.5.

Table 1.3.3.5 Accuracy assessment result of Land Cover/Land Use Map

Class Name	Land Cover / Land Use	Number of correct	Accuracy
Dense Forest	312	239	76.6%
Moderate Forest	221	153	69.2%
Open Forest	150	97	64.7%
Wooded Grassland	984	761	77.3%
Open Grassland	581	406	69.9%
Perennial Cropland	205	165	80.5%
Annual Cropland	989	748	75.6%
Vegetated Wetland	95	70	73.7%
Open Water	47	40	85.1%
Other Land	215	174	80.9%
TOTAL	**3799**	**2853**	**75.1%**

(4) Preparation for land cover map creation guidance

Regarding the preparation of guidance materials for the Land Cover / Land Use Map 2020 creation, the method of creating the Land Cover / Land Use Map 2014 implemented in the SLEEK program will continue to be followed as a map creation method of Kenya. For this reason, the Component decided to prepare materials for guidance based on the Land Cover / Land Use Map creation method evaluated by the Component. In addition, the Kenyan side is also preparing a technical manual based on this method, and forest remote sensing / GIS experts in the Component also participated in the technical manual preparation meeting and provided input.

As for the prepared guidance materials for land cover / land use creation, since the trainees who participated in the land cover / land use creation in the pilot area do not have the basic knowledge of the

remote sensing, the material were designed not only for the explanation of the creation method but also to explain the basic remote sensing and role of Activity Data. The items of the created guidance materials are as follows (Details on Appendix 14).

- Role of Activity Data in REDD+
- Basic Remote Sensing and Image Processing
- About Filed Survey
- Selection of Satellite Image Data and Download
- Pre-processing for Image Classification Processing
- Site Training Data Creation Method and Image Classification Processing

Aside from the guidance materials, a technical manual was also created for the reference by KFS staff. The technical manual created by the Component follows the content reviewed at the technical manual creation meeting in which forest remote sensing / GIS experts also participated. In addition, the content was made simpler so as to specialize in land cover / land use map creation, and the composition and table of contents were made according to the creation process. In addition, the method for matching the land cover / land use map examined in the Component with the forest definition and forest 10 classification of Kenya was added to the technical manual. The details added will be described later in "(5) Improvement of Guidance Material of Land Cover / Land Use Map Creation".

(5) Improvement of Guidance Material of Land Cover / Land Use Map Creation

In Kenya, a time series land cover / land use map was created based on the land cover / land use map creation method used in the SLEEK program, and it was decided to create the AD to be used for FRL based on this time series land cover / land use map. In the time series land cover / land use map, the forest cover is actually a tree cover because of the pixel-based image classification processing. Therefore, in order to create the AD, the Component considered matching the tree cover of the land cover / land use maps created from LANDSAT 4, 5, 7, and 8 satellites with the forest definition of Kenya. In the current study, it was also considered that there would be a total of 10 classifications by distinguishing between 3 types of forests, 3 stratification by canopy density, and plantation forests.

As a result of examination, the land cover / land use map is a pixel-based map based on the LANDSAT-8 satellite image (30m * 30m per pixel, unit area 0.09ha). In order to meet the minimum area 0.5ha in the forest definition, the Component devised a filtering process so that 6 pixels (0.54 ha) is the smallest unit of the forest area. The devised filtering process recognizes a cluster of forest pixels of 5 pixels or less as a cluster of connected forest pixels by 8 neighborhood searches as shown in Figure 1.3.2.4, and replaces the group of forest pixels of 5 pixels or less with the largest land cover / land use classification classes in the surrounding area. It is a replacement algorithm.

After filtering processing, forest area on the land cover / land use map was classified into four categories of "Montane Forest / Western Rain Forest", "Costal Forest / Mangroves", "Dryland Forest", and "Plantation" by zoning. The zoning data (Shape file) and plantation boundary (Shape file) shown in Figure 1.3.3.10 was provided by KFS.

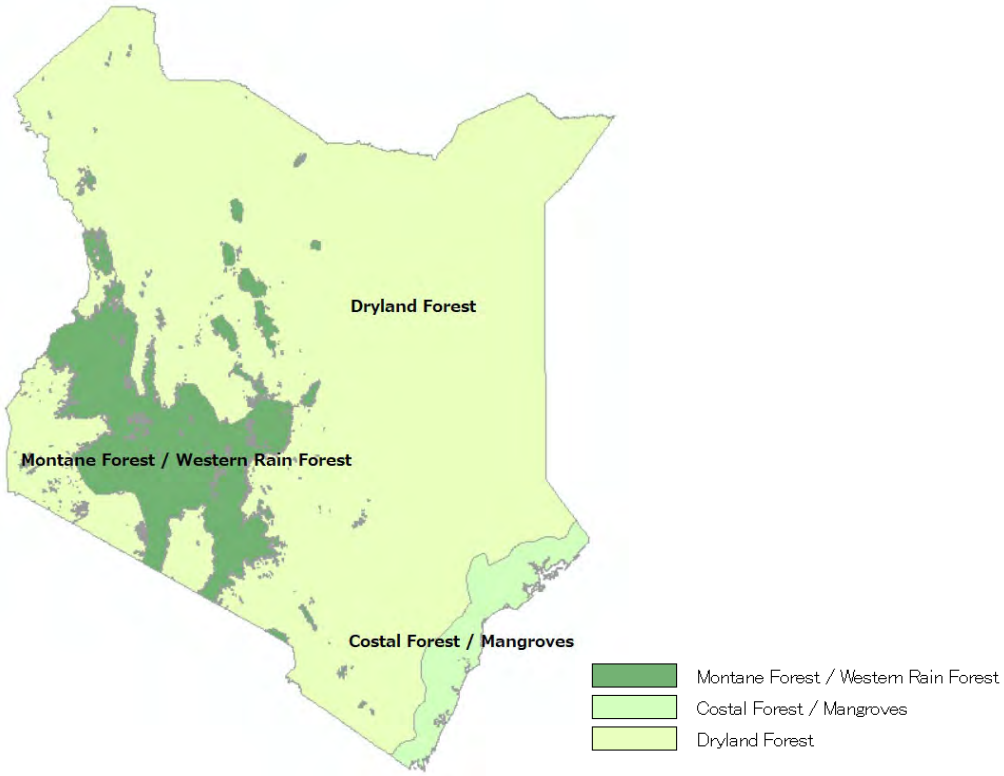


Figure 1.3.3.10 Forest Type Zoning Data

The land cover / land use map after zoning was encoded as shown in Table 1.3.3.6 below so that the area size for each forest type can be calculated.

Table 1.3.3.6 Land cover / land use map code and area size at each code

(ha)

		CODE	1990	2000	2010	2014
Montane Forest / Western Rain Forest (10)	Dense (1)	11	1,174,515	978,308	1,074,485	1,110,721
	Moderate (2)	12	242,631	249,411	226,519	203,081
	Open (3)	13	140,587	131,976	86,646	104,792
Costal Forest / Mangroves (20)	Dense (1)	21	283,968	177,556	303,810	421,452
	Moderate (2)	22	296,861	373,598	248,156	125,039
	Open (3)	23	11,848	22,957	14,156	6,241
Dryland Forest (30)	Dense (1)	31	844,301	971,645	966,123	970,632
	Moderate (2)	32	359,589	532,561	330,947	287,009
	Open (3)	33	320,973	333,874	314,750	305,132
Plantation (40)	Dense (1)	41	62,660	41,099	49,091	53,046
	Moderate (2)	42	2,519	2,216	3,369	1,073
	Open (3)	43	251	868	321	546
Crops (50)	Annual Crops (1)	51	3,139,213	4,227,298	5,786,329	5,900,262
	Perennial Crops (2)	52	303,801	222,932	260,347	299,515
Glass Land (60)	Open Grasses (1)	61	9,430,989	9,773,592	9,488,048	8,825,587
	Wooded Grass (2)	62	34,847,463	33,239,062	31,847,934	32,375,231
Wetland (70)	Water body (1)	71	1,206,488	1,215,703	1,215,930	1,224,234
	Vegetated Wetland (2)	72	26,636	20,412	45,245	38,845
Other (80)	~~Settlement (1)~~	~~81~~	–	–	–	–
	Other (2)	82	6,505,448	6,685,673	6,938,535	6,948,302
TOTAL			59,200,742	59,200,742	59,200,742	59,200,742

In the improvement of the land cover / land use creation guidance materials, the above mentioned filtering process and zoning process examined in the Component were added to the guidance material and used in the land cover / land use map creation training in the pilot area. This filtering process and zoning process are also added as improvements to the technical manual for land cover / land use creation.

Also, in the technical manual, the processing related to land cover / land use change is added as the AD creation.

(6) Guidance for Creation of Land Cover/Land Use Map at Pilot Area

In the land cover / land use map creation guidance at the pilot area, the creation guidance was conducted twice, from September 22nd to 29th, 2017 and October 7th to 15th, 2019.

Pilot area for guidance on creation of land cover / land use map was discussed with the C/P and it was conducted for one scene of LANDSAT-8 satellite imagery as pilot area. For the selection of one satellite imagery scene, it was considered that the area has landscape conditions of wide variety and it has natural forest type with forest canopy density as open from 15% to 40%, moderate from 40% to 65% and dense above 65%. Based on this, the pilot area was selected as the coverage of Kakamega Forest area in one satellite imagery scene.

The first guidance for map creation were provided to 6 trainees from the KFS headquarters and they were the C/P. The method used in SLEEK is an image classification method by semi-automatic processing and it is a sustainable and efficient method because time and cost can be drastically reduced compared with normal classification processing including manual work. For this reason, six staff members were selected as trainees. If six people are full-time assigned for the implementation, it will be possible to create the land cover / land use map for the entire country of Kenya in about three months. The list of lecturers, participants and assistants are as shown in Table 1.3.3.7.

Table 1.3.3.7 List of lecturers, trainees and assistants (First training)

Lecturers

Name	Organization	Profession
Kei Sato	CADEP-SFM	Remote Sensing / GIS
Faith K. Mutwiri	KFS (FIS)	Remote Sensing / GIS

Participants

Name	Organization	Profession
Eunice W. Maina	KFS (FIS)	Remote Sensing
Kevin Ngigi	KFS (FIS)	GIS
Edna Kimenju	KFS (FIS)	Remote Sensing
Divinah Nyasaka	KFS (Forest Inventory)	Inventory
Frank Juma	KFS (Survey)	Survey
Richard Mwangi	KFS (FIS)	Database

Assistants

Name	Organization	Profession
Sahori Fujimura	CADEP-SFM	Remote Sensing / GIS assistant
Florence Sialo Tuukuo	CADEP-SFM	Local Staff of CADEP-SFM compornent3

The following was explained during training; the role of AD, basic remote sensing, the purpose of creation of the land cover / land use map, what already conducted for preparation of AD, how to implement the field survey (Ground Truth), how to select satellite image, how to download, how to extract site training data and supervised classification. In the filed survey practice, participants went to Kakamega forest area in the southwest part of Kenya from 24th to 27th September 2017 and conducted practical training for data collection and entry for filling the field note. Table 1.3.3.8 shows the training schedule and contents.

Table 1.3.3.8 Training schedule (First training)

Date	Contents	Lecturers
Sep 22 (Fri), 2017	1. Position of activity data for REDD+ 2. Basic Remote Sensing and Image processing 3. Why field survey 4. How to extract field data (Sample points) 5. Field data collection sheet 6. Explanation for SLEEK Manual	Kei Sato Faith Mutwiri Sahori Fujimura
Sep 24 (Sun), 2017	Travelling to Kisumu	
Sep 25 (Mon), 2017	1. Travelling to Kakamega forest 2. Visiting Kakamega forest Ecosystem Conservator's office for explanation of visiting purpose 3. Practice for field survey − Canopy Dense of forest (Open from 15% to 40%, Moderate from 40% to 65%, Dense above 65%) 4. Travelling to Kisumu	Kei Sato Faith Mutwiri Sahori Fujimura
Sep 26 (Tue), 2017	1. Visit to the surroundings of Kakamega forest 2. Practice for field survey - Annual cropland - Perennial cropland - Wooded grassland, Grassland, Other 3. Arrangement of field note 4. Travelling to Kisumu	Kei Sato Faith Mutwiri Sahori Fujimura
Sep 27 (Wed), 2017	Travelling back to Nairobi	
Sep 28 (Thu), 2017	1. Introduction of SLEEK's technical manual 2. How to select and download the satellite image	Kei Sato Faith Mutwiri

Date	Contents	Lecturers
	3. Image pre-processing for classification 4. How to process mask for cloud and shadow	
Sep 29 (Fri), 2017	1. Eco-logical zone processing 2. Extraction of site training data 3. R-Script (Random Forest)	Kei Sato Faith Mutwiri

The second guidance for map creation were provided to 5 trainees from the KFS headquarters. The list of lecturers, participants and assistants are as shown in Table 1.3.3.9.

Table 1.3.3.9 List of lecturers, trainees and assistants (Second training)

Lecturers

Name	Organization	Profession
Kei Sato	CADEP-SFM	Remote Sensing / GIS
Faith K. Mutwiri	KFS (FIS)	Remote Sensing / GIS
Merceline Ojwala	DRSRS	Remote Sensing / GIS

Participants

Name	Organization	Profession
Kiyoko Nzioka	KFS (FIS)	Database
Edwin Kariuki	KFS (Inventory)	Inventory
Peter Sirayo	CADEP-SFM	Forester
Frank Juma	KFS (Survey)	Survey
Vancy Kangogo	KFS (Survey)	Survey

Assistants

Name	Organization	Profession
Yoshihiko Sato	CADEP-SFM	Remote Sensing / GIS assistant
Florence Sialo Tuukuo	CADEP-SFM	Local Staff of CADEP-SFM Component 3

Table 1.3.3.10 shows the training schedule and contents.

Table 1.3.3.10 Training schedule (Second training)

Date	Contents	Lecturers
Oct 7 (Mon), 2019	1. Orientation 2. Why we need the field survey 3. Field data collection note 4. How to use the tablet tool for field survey 5. Move to Kisumu	Kei Sato Faith Mutwiri Merceline Ojwala
Oct 8 (Tue), 2019	1. Move to Kakamega forest	Kei Sato

Date	Contents	Lecturers
	2. Visiting Kakamega forest jurisdiction office of explanation of visiting purpose 3. Confirming to the classification result on the field 4. Practice for field survey for three forest type − Canopy Open (15% to 40%) − Canopy Moderate (40% to 65%) − Canopy Dense (> 65%)	Faith Mutwiri Merceline Ojwala
Oct 9 (Wed), 2019	1. Visit to surrounding of Kakamega forest 2. Practice for filed survey for Non-Forest − Annual Cropland, Perennial Cropland − Wooded Grassland, Open Grassland − Otherland	Kei Sato Faith Mutwiri Merceline Ojwala
Oct 10 (Thu), 2019	Back to Nairobi	
Oct 11 (Fri), 2019	1. Back ground of the training position of Activity Data in REDD+ 2. What we have done for Activity Data for FRL (REDD+) 3. Basic Remote Sensing and image processing 4. How to select and download the satellite image 5. Image pre-processing for classification	Kei Sato Faith Mutwiri Merceline Ojwala Yoshihiko Sato
Oct 14 (Mon), 2019	1. How to process the mask for cloud and shadow *practice 2. Arrange the filed note *practice 3. Let look the sample points on Landsat image 4. Explanation for SLEEK method of classification 5. Echo-logical zone processing *practice 6. Extraction of site training data *practice	Kei Sato Faith Mutwiri Merceline Ojwala
Oct 15 (Tue), 2019	1. R-Script (Random Forest) *practice 2. Filtering processing *practice 3. Zoning processing *practice 4. Creating LCLU change map processing *practice	Kei Sato Faith Mutwiri Merceline Ojwala

Figure 1.3.3.11 shows the situation at the time of training on the photos.

Remote Sensing lecturing

Collection of forest data at field survey

Collection of non-forest data at field survey

Practice for map creation

Figure 1.3.3.11 Training situation for creation of land cover / land use map

(7) Reediting the classified category of Land Cover / Land Use Map 2014

Regarding reediting the classified category of the Land Cover / Land Use Map 2014, there was consideration as whether:

① To adjust to class type of land cover map (1990, 2000, 2010) which was created by "Forest Preservation Program"

② To use the class type of land cover / land use map 2014 which was created by SLEEK

Based on above 2 cases, as a result of the assessment of the process and results on the Land Cover / Land Use Map of 2014, class type of SLEEK's map was adopted as in ② and this class type can be used as one of AD for FRL and Forest cover monitoring. Therefore, change of classification class type was not implemented.

(8) Creation of Forest Cover/Land Use Change Map

The Land Cover / Land Use Change Map will be prepared according to the reference year of the FRL. Regarding the reference year, as a result of repeated discussions at the TWG meeting including KFS and stakeholders, change maps for various reference years were created. The reference year of the created Land Cover Map / Land Use Change Map is as follows.

- The Land Cover / Land Use Change Map according to the reference year of the first FRL
  - 1990 – 2000
  - 2000 – 2010
  - 2010 – 2014
- The Land Cover / Land Use Change Map according to the reference year of the second FRL
  - 2000 – 2014
- The Land Cover / Land Use Change Map according to the reference year of the final FRL
  - 2002 – 2006
  - 2006 – 2010
  - 2010 – 2014
  - 2014 – 2018

The filtering and zoning processing were applied to the land cover / land use maps at each year before creating the change map. In creating land cover / land use change maps, the team discussed about the changes that needed to be emphasized were coded and colored according to the each changed items as shown in Table 1.3.3.11. Figure 1.3.3.12 shows the change map for 1990 - 2000 as an example of the land cover / land use change map.

Table 1.3.3.11 Change class code number and coloring

			2000											
			Montane Forest / Western Rain Forest (10)			Costal Forest / Mangroves (20)			Dryland Forest (30)			Plantation (40)		
			Dense (1)	Moderate (2)	Open (3)	Dense (1)	Moderate (2)	Open (3)	Dense (1)	Moderate (2)	Open (3)	Dense (1)	Moderate (2)	Open (3)
1990	Montane Forest / Western Rain Forest (10)	Dense (1)	1	2	3									
		Moderate (2)	11	12	13									
		Open (3)	21	22	23									
	Costal Forest / Mangroves (20)	Dense (1)				31	32	33						
		Moderate (2)				41	42	43						
		Open (3)				51	52	53						
	Dryland Forest (30)	Dense (1)							61	62	63			
		Moderate (2)							71	72	73			
		Open (3)							81	82	83			
	Plantation (40)	Dense (1)										91	92	93
		Moderate (2)										101	102	103
		Open (3)										111	112	113
	Crops (50)	Annual Crops (1)	121	122	123	124	125	126	127	128	129	130	131	132
		Perennial Crops (2)	140	141	142	143	144	145	146	147	148	149	150	151
	Glass Land (60)	Open Grasses (1)	159	160	161	162	163	164	165	166	167	168	169	170
		Wooded Grass (2)	178	179	180	181	182	183	184	185	186	187	188	189
	Wetland (70)	Water body (1)	197	198	199	200	201	202	203	204	205	206	207	208
		Vegetated Wetland (2)	216	217	218	219	220	221	222	223	224	225	226	227
	Other (80)	Settlement (1)												
		Other (2)	235	236	237	238	239	240	241	242	243	244	245	246

			2000							
			Crops (50)		Glassland (60)		Wetland (70)		Other (80)	
			Annual Crops (1)	Perennial Crops (2)	Open Grasses (1)	Wooded grass (2)	Water Body (1)	Vegetated Wetland (2)	Settlement (1)	Other (2)
1990	Montane Forest / Western Rain Forest (10)	Dense (1)	1	2	6	7	15	9		10
		Moderate (2)	12	13	16	17	18	19		20
		Open (3)	24	25	26	27	28	29		30
	Costal Forest / Mangroves (20)	Dense (1)	34	35	36	37	38	39		40
		Moderate (2)	44	45	46	47	48	49		50
		Open (3)	54	55	56	57	58	59		60
	Dryland Forest (30)	Dense (1)	64	65	66	67	68	69		70
		Moderate (2)	74	75	76	77	78	79		80
		Open (3)	84	85	86	87	88	89		90
	Plantation (40)	Dense (1)	94	95	96	97	98	99		100
		Moderate (2)	104	105	106	107	108	109		110
		Open (3)	114	115	116	117	118	119		120
	Crops (50)	Annual Crops (1)	133	134	135	136	137	138		139
		Perennial Crops (2)	152	153	154	155	156	157		158
	Glass Land (60)	Open Grasses (1)	171	172	173	174	175	176		177
		Wooded Grass (2)	190	191	192	193	194	195		196
	Wetland (70)	Water body (1)	209	210	211	212	213	214		215
		Vegetated Wetland (2)	228	229	230	231	232	233		234
	Other (80)	Settlement (1)								
		Other (2)	247	248	249	250	251	252		253

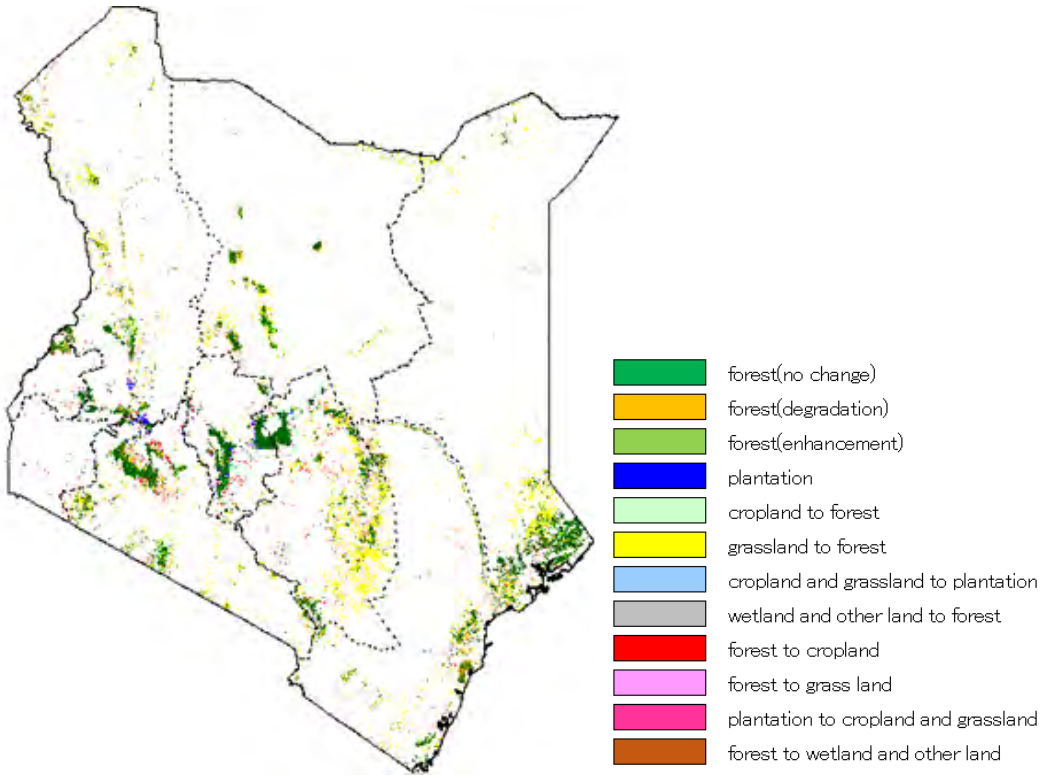


Figure 1.3.3.12 Land Cover / Land Use Change Map (1990 – 2000)

The reference period of AD used in FRL is 2002-2006, 2006-2010, 2010-2014 and 2014-2018. The Land Cover / Land Use Change Map used for FRL as the AD is stored in FIP as data as shown in Figure

1.3.3.13.

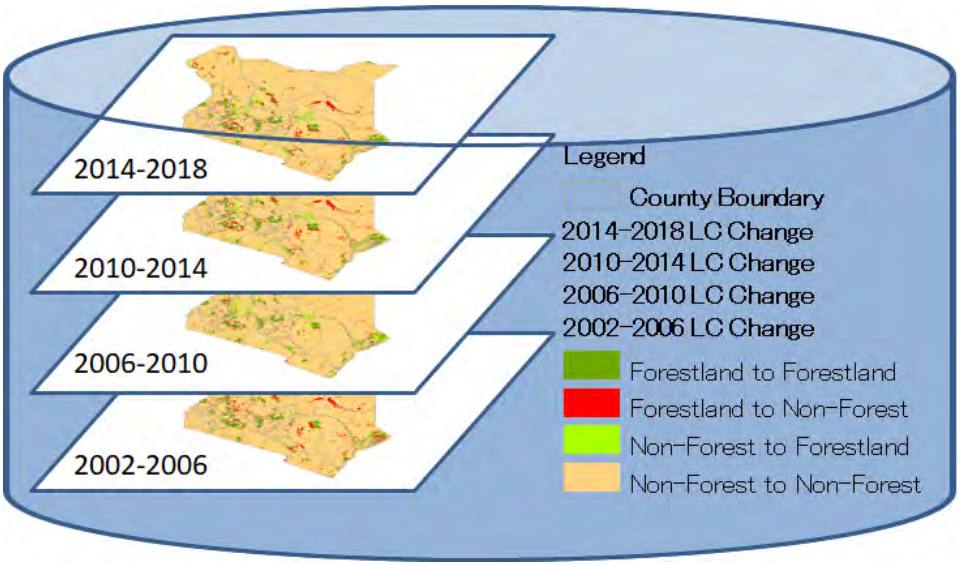


Figure 1.3.3.13 Land Cover / Land Use Change in FIP (Example)

(9) Guidance for Creation of 2020 Land Cover/Land Use Map

The guidance for the creation of 2020 Land Cover / Land Use Map was started in November 2020 due to the progress of observations by the LANDSAT-8 satellite. The instructed items are as follows.

- Satellite Image Data Archive Search, Selection and Download
- Satellite Image Quality Check
- Pre-processing
- Review of Subsequence Work Flow Items after Pre-processing
- Site Training Data

In the satellite image data archive search, the Component instructed to search the data observed in 2020 from the archive with a cloud coverage of 20%, and to consider cloud removal and to select multiple images as candidates for the image with higher cloud coverage. The satellite image data archive search was conducted in two parts, from January to October 2020 and from October 2020 to March 2021. For the downloaded satellite images, it was instructed to check the image quality in each of these periods. The quality check report is attached as Appendix 15. Figure 1.3.3.14 shows the downloaded LANDSAT-8 satellite image covering Kenya.

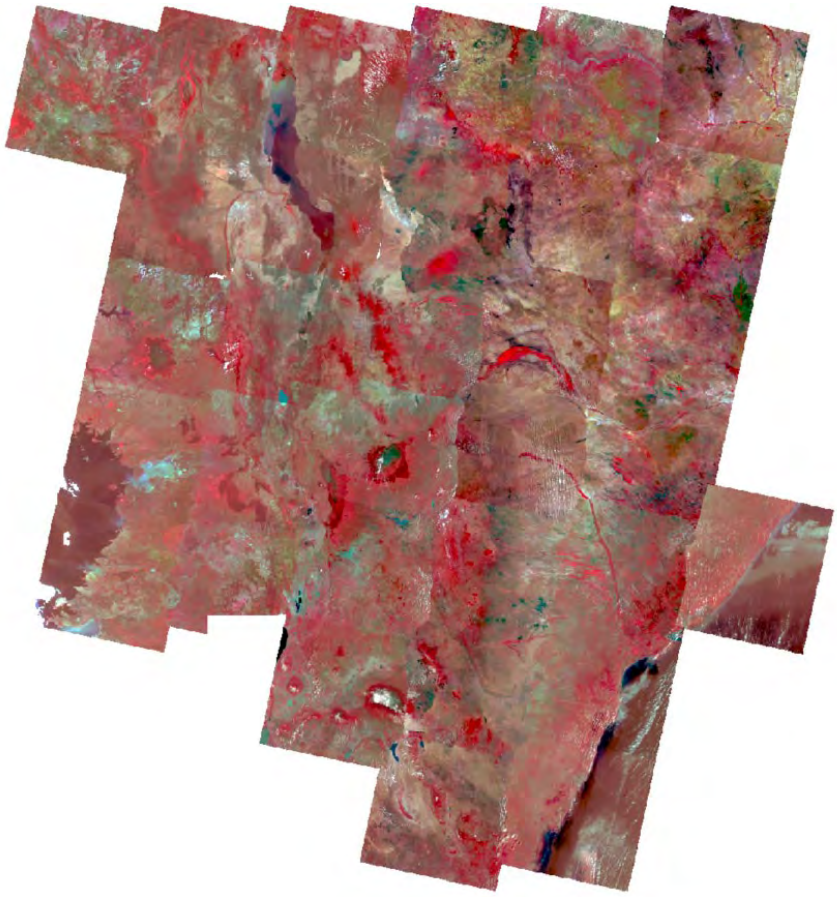


Figure 1.3.3.14 LANDSAT-8 satellite image covering the entire Kenya

Regarding the pre-processing of downloaded satellite images, the Component decided to perform the pre-processing by SOK for the following described reasons; what SOK had done so far when creating the time series land cover / land use map, and the satellite image download from USGS was carried out by SOK which has a good internet connection environment. And also KFS has limited office access due to COVID-19. Therefore, the SOK proceeded the pre-processing for the satellite image little by little for the Land Cover / Land Use Map 2020.

In addition, as for the subsequent processing items after the pre-processing, since the COVID-19 continues, in order to accelerate the land cover / land use map creation by effectively utilizing the limited resources, the Component reviewed the work procedure, and then decided not to conduct the ground truth survey for acquiring the site training data. Instead, the Component instructed to utilize the site training data used in the Land Cover / Land Use Map 2018 creation and the results of the field survey conducted in the accuracy verification. Through this review, the Component were able to start the image classification process for the map creation in July 2021.

As of October 2021, the image classification process for the Land Cover / Land Use Map 2020 is still in progress, and 90% of the image classification process is completed. Additionally, the progress in the entire process has reached 75%. In the future, if the image classification processing is completed, the remaining processes will be only for two items, mosaic processing that integrates the classification results by image as the classification results for the entire Kenya country, and accuracy verification (including field survey) of the classification results. It is expected that the Land Cover / Land Use Map

2020 will be completed.

1.3.4 Activity on FRL

(1) Preparation of Carbon Map in 2014

The Carbon Map for 2014 was created based on Land Cover / Land Use Map 2014. It was performed after filtering and zoning during classification class category change on the Land Cover / Land Use Map 2020 activity. For the creation of the Carbon Map, the area by forest type for each county was calculated based on the Land Cover / Land Use Map 2014 and the CO_2 amount was calculated by using of the CO_2 amount (t / ha) based on forest type as shown in Table 1.3.4.1.

Table 1.3.4.1 CO_2 amount (ton/ha) of each forest type class in the Country data

(t/ha)

Class	Canopy coverage	AGB CO2 amount	BGB CO2 amount	TOTAL CO2 amount
Montane Forest &Western Rain Forest	Dense	594.50	170.76	765.26
	Moderate	100.70	28.92	129.62
	Open	40.09	11.52	51.61
Coastal forest & Mangrove forest	Dense	163.07	50.89	213.96
	Moderate	104.17	25.01	129.18
	Open	61.14	13.80	74.93
Dryland Forest	Dense	138.42	58.13	196.56
	Moderate	59.49	23.83	83.32
	Open	24.58	7.06	31.64
Plantation	Dense	752.54	216.15	968.69
	Moderate	195.67	56.20	251.87
	Open	238.20	68.42	306.62

The Carbon Map 2014 by color-coded of each county of CO_2 is shown in Figure 1.3.4.1.

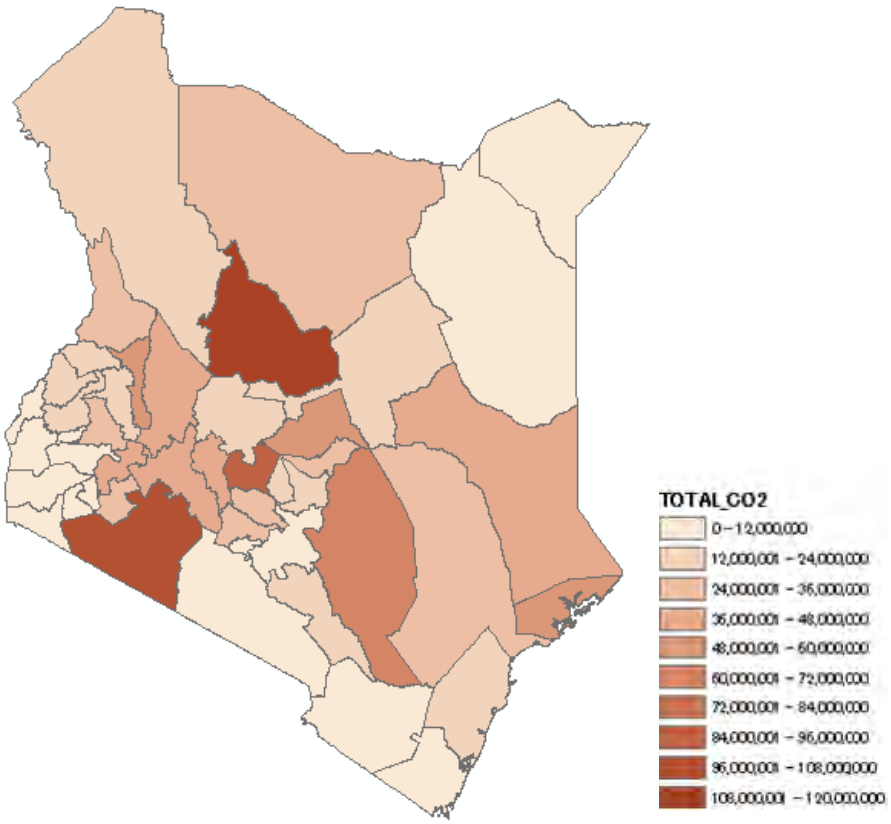


Figure 1.3.4.1 Carbon Map 2014

In addition, the Carbon Map 2014 shown in Figure 1.3.4.1 contains not only the total CO_2 amount of each county as attribute data but also the CO_2 amount of each forest type. Therefore, when displaying the carbon map on the Forest Information Platform (FIP), it is also possible to display the area for each forest type and the CO_2 amount for each forest type on a county basis.

(2) Analysis of Land Cover/Land Use Change Based on the Land Cover/Land Use Map

An analysis of land cover/land use change was conducted, and the cause of the change that occurred in Kenya was examined based on the analysis. Understanding the characteristics of forest change is expected to contribute to the various actions of REDD+ such as verification of validity of FRL calculation, information provision and reporting to external organizations such as UNFCCC, and implementation of effective deforestation and forest degradation measures in Kenya.

FRL of Kenya was initially scheduled to be submitted to the UNFCCC in January 2019 with three reference periods (1990-2000, 2000-2010 and 2010-2014). However, the FRL report was not submitted to the UNFCCC in January 2019 due to the delay of the modification based on the feedback from stakeholders and other relevant organizations. FRL in Kenya was ultimately submitted in January 2020 with the reference period changed to four periods: 2002-2006, 2006-2010, 2010-2014 and 2014-2018.

For this reason, this activity was conducted twice, first analysis was conducted in 2018 for the original FRL reference period (1990-2014), and second analysis was conducted in 2021 for the revised FRL reference period (2002-2018). The analyses was reported in the documents respectively (see Appendix 16 and Appendix 17 for details). The documents with the analysis data for reporting were shared with

C/P staff and others.

A summary of the analysis for the revised FRL reference period (2002-2018) is described below.

1) Methodology

In Kenya, the disturbance of clouds in the satellite data or noise effect of satellite imagery was examined carefully and the Land Cover / Land Use maps of 2002, 2006, 2010, 2014, 2018 in which these effects are relatively small were developed. Land Cover / Land Use Change maps of four periods of the year 2002 to 2006, 2006 to2010, 2010, to 2014 and 2014 to 2018 were created from these the Land Cover Land Use maps. In creating the Land Cover / Land Use Change maps, the classification of change is shown in Table 1.3.4.2.

The analysis was to attempt to grasp the geographical and temporal trend of Land Cover / Land Use Change based on the Land Cover / Land Use Change maps and change of the area of each Land Cover / Land Use Change classification.

Table 1.3.4.2 Land Cover / Land Use Change classification and REDD+ activities

No	Forest Cover Change	The Legend of Forest Cover Change Map	REDD+ activities
1	Forest remaining as Forest (No Change)	Forest (No Change)	-
2	Forest remaining as Forest (Degradation)	Forest (Degradation)	Reducing emissions from degradation
3	Forest remaining as Forest (Enhancement)	Forest (Enhancement)	Enhancement of forest carbon stocks
4	Cropland converted to Forest	Cropland to Forest	Enhancement of forest carbon stocks
5	Grassland converted to Forest	Grassland to Forest	Enhancement of forest carbon stocks
6	Other Land uses converted to Forest	Wetland and Other Lands to Forest	Enhancement of forest carbon stocks
7	Forest converted to Cropland	Forest to Cropland	Reducing emissions from deforestation
8	Forest converted to Grassland	Forest to Grassland	Reducing emissions from deforestation
9	Forest converted to Other Land uses	Forest to Wetland and Other Lands	Reducing emissions from deforestation

In addition, Forest stratum in Kenya was divided on four areas in FRL setting (Figure 1.3.4.2). It was also attempted to grasp the geographical and temporal characteristics of land cover/land use change in each forest type area.

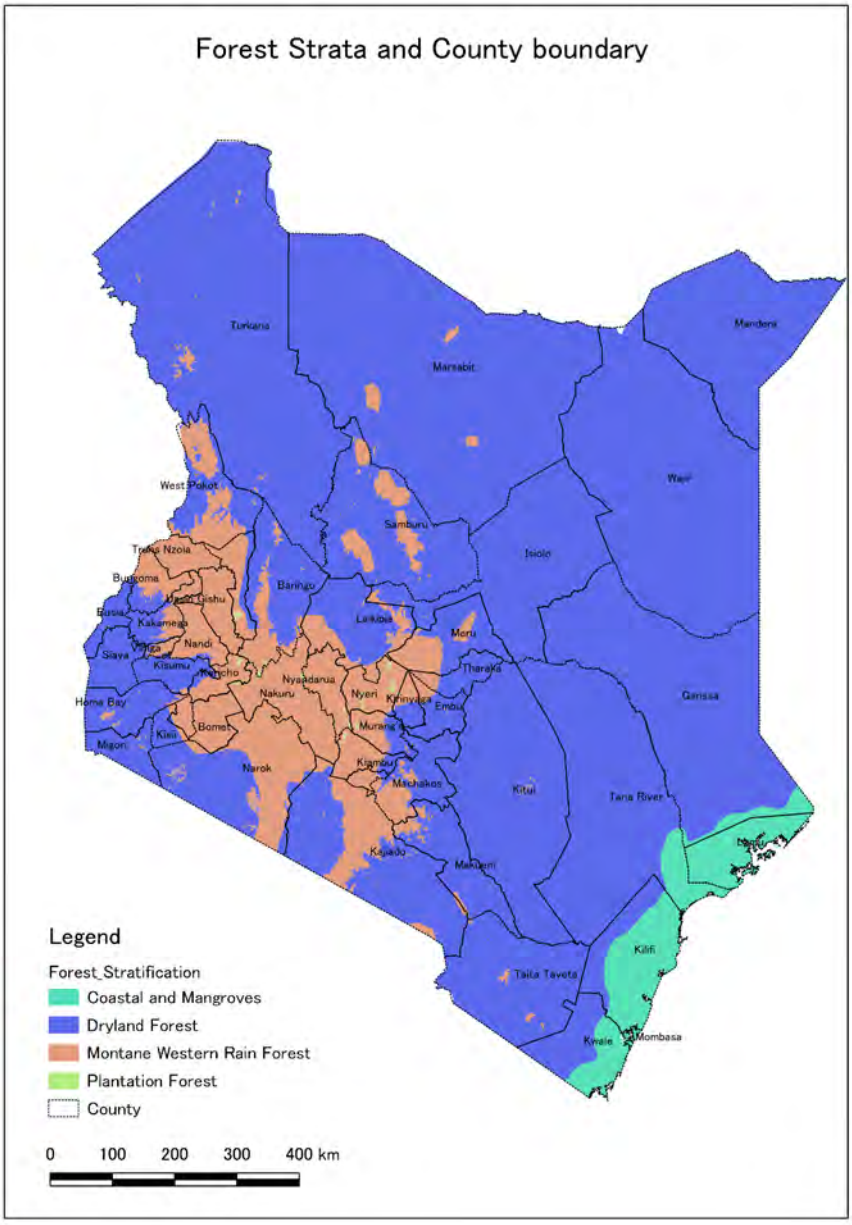


Figure 1.3.4.2 Forest strata and Counties in Kenya

2) Result

Throughout the period 2002-2018, the maps exhibited the following characteristics:

- The areas where Land Cover / Land Use Changes related to the forest were detected, are located especially in the southern part of Kenya,
- Many of the areas that are maintained as large forest are forest reserves,
- The area which was detected as enhancement and degradation was small compared to the area of no change in forest land.

By the each period,

- In 2002-2006, there are the conversion between Grassland and Forest Land in D Forest. In addition, the change from Cropland to Forest Land can be detected in M&W Forests (especially densely inhabited area)
- In 2006-2010, the change from Grassland to Forest in D Forest and the change from Cropland to Forest Land were confirmed.
- In 2010-2014, the change from Grassland to Forest Land and the change from Cropland to Forest Land were confirmed.
- In 2014-2018, the change from Forest Land to Grassland was confirmed. In addition, Forest (Degradation) appeared in M&C Forest.

In addition, Figure 1.3.4.3 shows area of the Land Cover / Land Use Change. In each period, Forest (No change) area showed the largest value, followed by Grassland to Forest or Forest to Grassland. In 2002 - 2014, Forest (Enhancement) exceeded the value of Forest (Degradation), while in 2014 - 2018, Forest (Degradation) exceeded the value of Forest (Enhancement). In the forest area of about 3,500 - 3,800 thousand ha of Land Cover/Land Use classification, about 1,000 thousand ha of Forest Land changed from Grassland to Forest Land, and about 1,000 thousand ha changed from Forest Land to Grassland in each period.

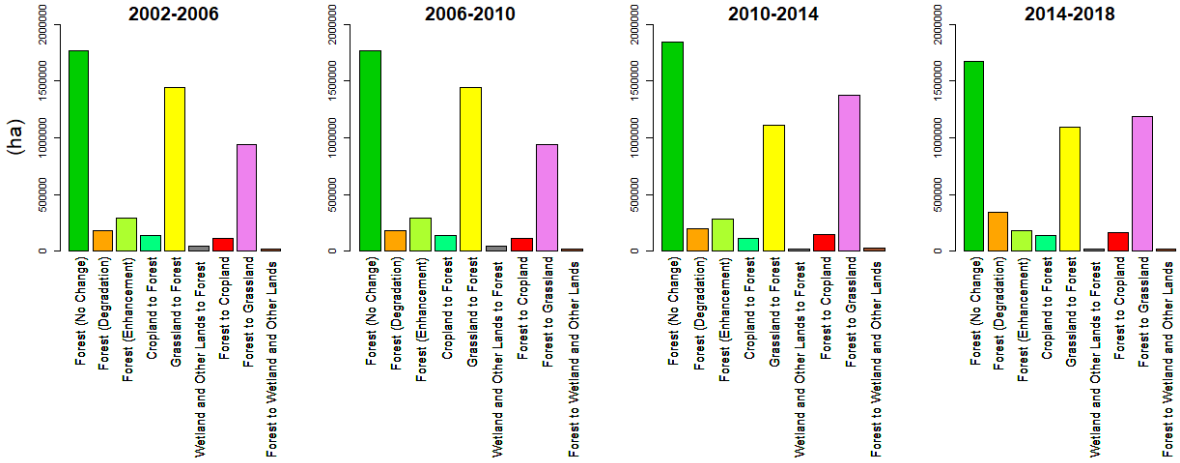


Figure 1.3.4.3 Area of Land Cover / Land Use Change classification

Figure 1.3.4.4 shows the area of Land Cover / Land Use Change classification by Forest strata. The Figures indicate the most conversion between Grassland and Forest Land occurred in D forest. The area of deforestation occurred in M&W Forest more than other Forest strata.

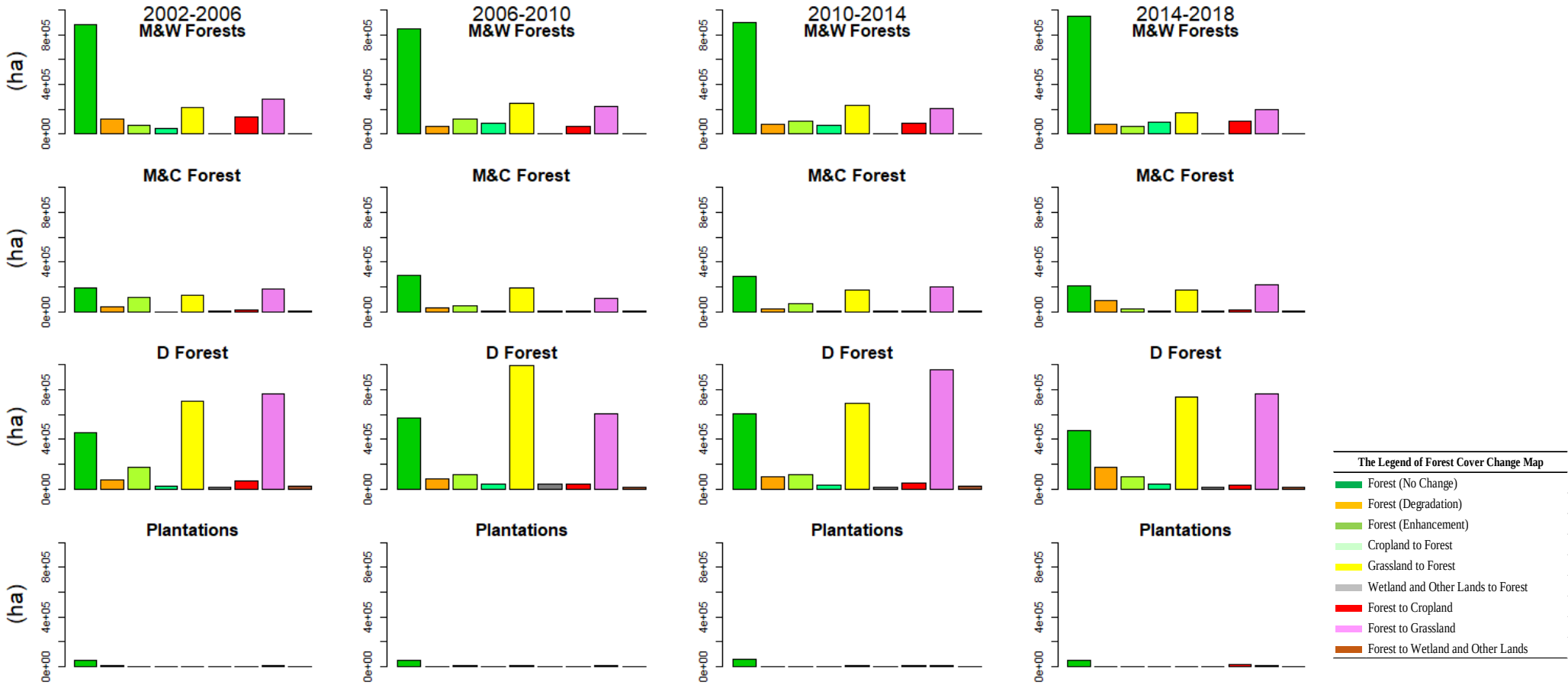


Figure 1.3.4.4 Area of Land Cover / Land Use Change classification by Forest strata

3) Discussion

This analysis was able to grasp the two trends of land cover change in Kenya. 1. Conversion of forest to agriculture land in the population concentrated area, 2. Large scale change occurs between forest and grassland. For the implementation of REDD+ activities in the future, it is important to consider countermeasures to tackle deforestation and forest degradation related to these trends. It was not possible to understand the details of drivers of all land cover/land use change in this analysis, especially large-scale change between forest and grassland. It is important to align actions for implementation of REDD+ in accordance with changes on fields, based on the progress to investigate drivers of change by monitoring and vegetation surveys and the improvement of the accuracy of analysis by enhancing the methods for creating the Land Cover/Land Use Change Map etc.

(3) Collection of Information for Emission Factor and Guidance on Forest Inventory Methods Which Is Necessary for Setting Emission Factor

1) Collection of information for Emission Factor

For the setting of the Emission Factor (EF), information on the forest inventory data was collected from a pilot forest inventory implemented by the Improving Capacity in Forest Resources Assessment in Kenya (IC-FRA) project.

The collected data were re-analyzed by stratifying them into forest types based on SLEEK and forest classes with zoning designations such as montane forest & western rainforest. IC-FRA's pilot forest inventory was conducted based on a stratification different from the SLEEK and forest classes, whereas the current FRL is set based on a forest classification that factors in forest classes in addition the SLEEK stratification, as described above. Based on this forest classification, Table 1.3.4.3 shows the number of IC-FRA data plots that can be used for the country data calculations for the development of the EF.

Table 1.3.4.3 Number of plots in each 12-forest type class from the IC-FRA pilot forest inventory data

Class	Dense	Moderate	Open	Total
Montane Forest & Western Rain Forest	4	4	0	8
Coastal Forest & Mangrove Forest	10	2	3	15
Dryland Forest	2	2	7	11
Plantation	23	6	0	29
Total				63

2) Guidance on forest inventory methods necessary for setting the emission factor

First, to conduct a pre-Inventory study for the implementation of the National Forest Inventory (NFI) of Kenya and collection of knowhow on setting the EF as country data, the Team analyzed a gap based on the results of studies of the existing IC-FRA data. The following explanation describes a way to think about this gap in the research (Figure 1.3.4.5).

The following steps were taken to set the expected number of plots to be surveyed in the additional pilot forest inventory (that is, the gap / the difference). First, as described in 1), the former IC-FRA forest inventory data were probed to find the level of existing available plot survey data by the forest inventory

(Table 1.3.4.3). The Team decided that only the data matching the forest classification of Activity Data (12 forest types) can be used as existing available data. Second, the level of the required number of surveyed plots was set. For pre-inventory, the required number of samples for each stratification is 5 to 10 plots[1]. Meanwhile, if the number of plots is less than the required number for NFI, the data are unreliable for NFI. Since the NFI could not be financially implemented in CADEP-SFM, it was clear that the sample numbers in the additional pilot forest inventory survey would not be sufficient to meet the NFI. Therefore, the goal for this gap study was to ensure that the data from the additional pilot forest inventory survey to be conducted would not only serve as country data at the Tier 2 level for setting the EF, but would also provide a reliable basis for finding a sufficient number of plots for the future NFI at the Tier 3 level.

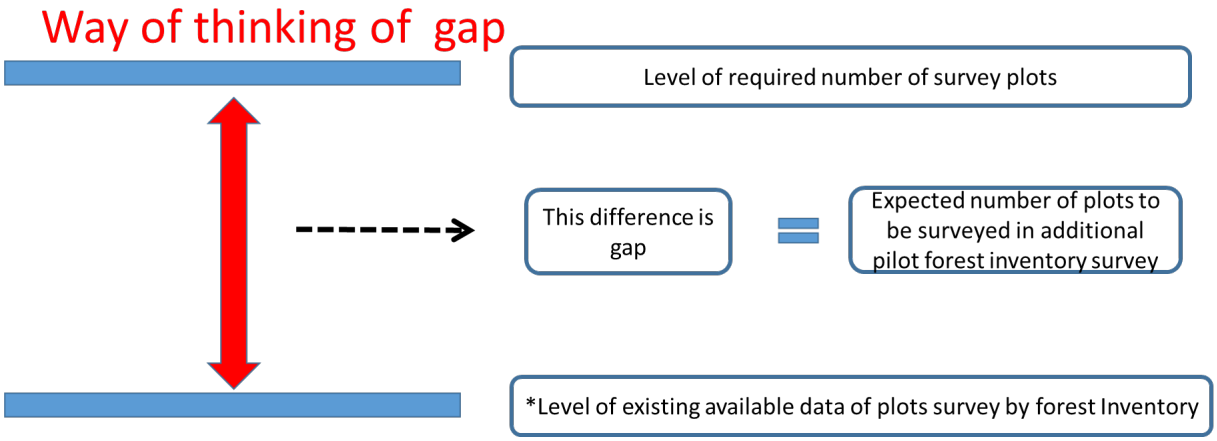


Figure 1.3.4.5 Way of thinking about the gap for the survey

Table 1.3.4.4 Number of plots for the survey results in each 12 forest type

Class	Dense	Moderate	Open	Total
Montane Forest & Western Rain Forest	5	3	6	14
Coastal Forest & Mangrove Forest	8	10	13	31
Dryland Forest	6	6	0	12
Plantation	0	0	7	7
Total				64

Table 1.3.4.5 Number of plots for the survey results in Agro-forestry

Class	Number
*(Agro-forestry)	10
Total	10

*The application of the Agro-forestry class has been considered for the setting of the FRL.

[1] Mr. Hideo Kataoka states that from 5 to 10 plots were required in the pre-inventory reported in his publication (in Japanese) in 1959.

Table 1.3.4.6 Total number of plots in each 12-forest type class

Class	Dense	Moderate	Open	Total
Montane Forest & Western Rain Forest	9	7	6	22
Coastal Forest & Mangrove Forest	18	12	16	46
Dryland Forest	8	8	7	23
Plantation	23	6	7	36
Total				127

Based on the above concept, a gap was found between the calculated number of survey plots required as pre-inventory for the NFI and the existing valid data from the IC-FRA forest inventory. This gap can be regarded as the expected number of plots to be surveyed in the additional pilot forest inventory survey.

According to the number analyzed in the gap survey, an additional pilot forest inventory survey was implemented in 76 plots in the field. A total of 74 plots, however, were selected as the total number of available plots, for data correction. The numbers of additional plots of the forest type and Agro-forestry classes in the pilot forest inventory are shown in Table 1.3.4.4 and Table 1.3.4.5, respectively. The total number of plots, encompassing both the examined IC-FRA data (Table 1.3.4.3) and available additional pilot forest inventory data (Table 1.3.4.4), is shown in Table 1.3.4.6. The number of plots in the additional pilot forest inventory survey for coastal forest and mangrove forest was increased as a contingency for a possible reclassification of each forest type in the future.

The additional survey was implemented from 15th February 2017 to 14th March, 2017. A summary of the survey is given in i) through iv) below.

i) Method: Non-random sampling survey
ii) Plot shape type: concentric circle plot (same as the IC-FRA pilot forest inventory)
iii) Measurements design: plan and implementation according to the IC-FRA field manual
iv) Items measured: tree height, DBH, plot gradient, tree direction, canopy coverage, and species identification. The results of tree, bamboo, climber, deadwood, and stump measurements were recorded at the plot level

After the completion of the survey, the field data from each survey team was combined into a single dataset to prepare for the EF calculation for setting the FRL, and the Above Ground Biomass (AGB) was thereupon computed. Using the plot results, the Below Ground Biomass (BGB) was calculated based on the Root/Shoot ratio, while the carbon stock was calculated using the carbon fraction (CF). Allometric equations were applied to the AGB calculation in this work. The volume, biomass, and carbon stock were calculated on a trial basis according to the method indicated above. The details of the calculations are shown in the attached Appendix 18.

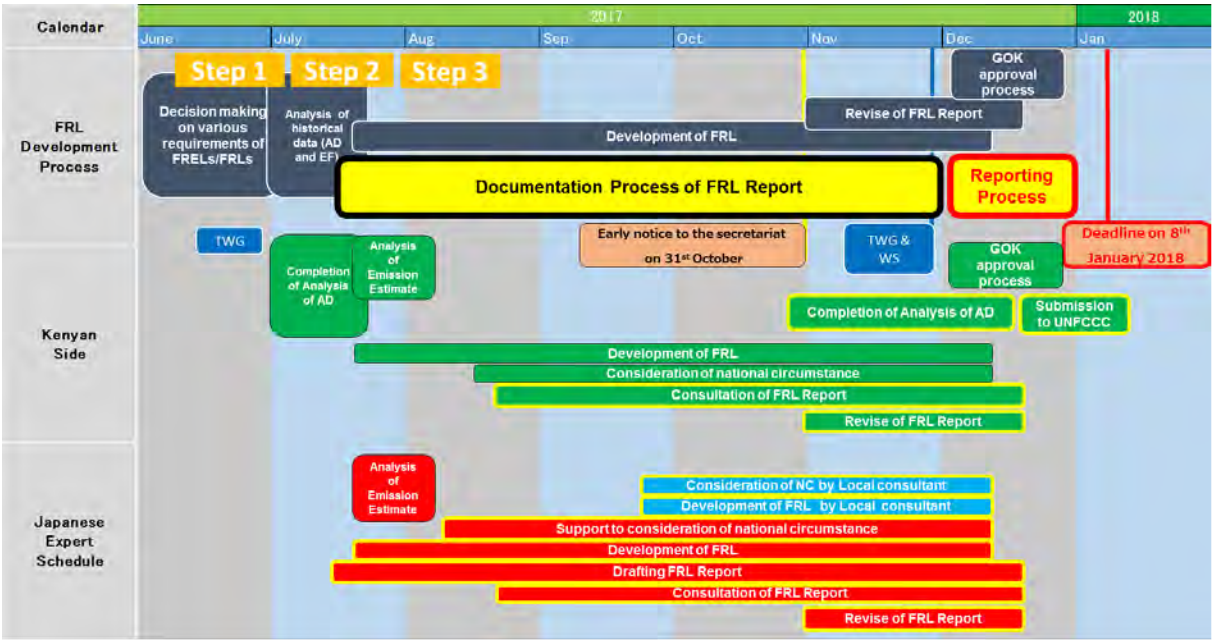
(4) Setting FRL

1) Preparation of the 1st draft of the FRL toward submission to UNFCCC in January 2018

The 1st draft of the FRL was developed jointly by the Team and the C/P through the following processes: (a) determination of the requirements for setting the FRL, (b) analysis of the AD and EF, (c) analysis of the carbon stock estimates, (d) setting of the FRL, (e) review and considerations on the national

circumstances, and (f) documentation from the FRL report. Table 1.3.4.7 shows the timeline for setting the FRL with the goal of submitting the FRL report in January 2018. The items in the FRL setting are described below.

Table 1.3.4.7 Timeline for FRL setting



(a) Decisions made on various requirements of the FRL

The FRL-setting process has requirements. Discussions and decisions on the process requirements are described below.

a) Scale:

National scale.

b) Forest Definition:

Forest is a minimum area of land 0.5 ha with tree crown cover (or equivalent stocking level) of more than 15 percent with trees with the potential to reach a minimum height of 2 meters at maturity in situ.

c) Forest stratification for Kenya:

Forest is classified as plantation or natural forest, sub-stratified into coastal forest and mangrove, montane forest / western rainforest / bamboo, dryland forest. Further forest type stratifications have been determined on the basis of the canopy covers of 15-40 %, 40-65 %, and above 65 %, based on the SLEEK Map. The definitions used for the SLEEK Map Stratification are shown below (Table 1.3.4.8).

Table 1.3.4.8 Definitions used for the SLEEK Map Stratification

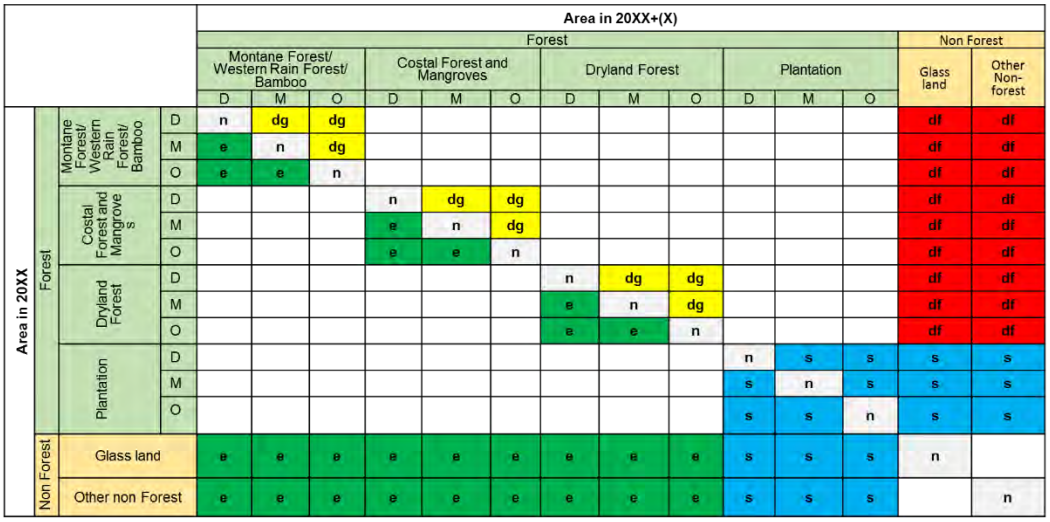
	Definition	Stratification	Sub-stratification	Definition
Forest	-Land spanning at least **0.5 ha** covered by trees, attaining a height of at least **2m** and a canopy cover of at least **15%**. -Forest is classified 3 levels that are open, moderate, dense. The open is the forest which crown cover is 15% to 40%, the Moderate is 40 to 65%, and the dense is more than 65%. → Classified by image analysis	Montane Forest/Western Rain Forest/Bamboo	-	The forest in the Montane Forest/Western Rain Forest/Bamboo area which is defined by Forest Stratification zoning*. →Classified by zoning
		Costal Forest and Mangroves	-	The forest in the Costal forest and Mangroves area which is defined by Forest Stratification zoning. →Classified by zoning
		Dryland Forest	-	The forest in the Dryland forest area which is defined by Forest Stratification zoning. →Classified by zoning
		Plantation	-	Plantation area occupied within all the KFS's plantation boundary. Plantation area which is defined by Forest Stratification zoning using the KFS's plantation boundary. Classified by zoning
Non Forest	Land which isn't forest → Classified by image analysis	Grassland	Wooded grassland	Grass land with trees and its canopy cover is less than 15% → Classified by image analysis
			Open grassland	Grass land →Classified by image analysis
		Cropland	Perennial Cropland	Perennial Crop which consists of Tea plantation, Coffee plantation, Sisal, Sugar cane and agroforestry which includes herbaceous crops, more than one year. → Classified by image analysis
			Annual Cropland	Annual Crop such as corn, wheat and etc. →Classified by image analysis
		Wetland	Vegetated Wetland	→Classified by image analysis
			Open Water	Lake, river →Classified by image analysis
		Settlement and Other land	Settlement	No data, Classification together with other land
			Other land	→Classified by image analysis

*Forest Stratification zoning: Fist Kenya is divided into 3 Forest area (Montane Forest/Western Rain Forest/Bamboo, Costal Forest and Mangroves and Dryland Forest) referring ecological zoning. Then Plantation area is set piling up KFS plantation zoning file.

d) Scope REDD+ Activities:

The REDD+ activities covered are (i) Reducing emissions, from deforestation, (ii) Reducing emissions from forest degradation, (iii) Sustainable management of forests, and (iv) Enhancement of forest carbon stocks. Matrix (Table 1.3.4.9) shown below illustrates the decision on how each REDD+ Activity is accounted for in the FRL setting.

Table 1.3.4.9 Monitoring Land Cover / Land Use Changes of REDD+ Activities in Kenya



e) Scope of Carbon pools:

In the final decision on the carbon pools to be covered in the first submission of Kenya's FRL to UNFCCC, the carbon pools are to consist of Above-ground Biomass (AGB) and Below-ground Biomass (BGB). Therefore, deadwood, litter, and soil are not covered as carbon pools. There was some discussion, however, on whether or not the soil organic carbon should be included. The final decision regarding the soil carbon pool was to remove it, according to the TWG meeting held on 28th June 2017. The reasons for Kenya's decision to omit the soil carbon pool are shown in the attached Appendix 19.

f) GHG:

Pursuant to the final decision made at the TWG meeting on 28th June, Green House Gas (GHG) is calculated from CO_2 only. Thus, Kenya decided not to include Non-CO_2 Gases emitted such as Methane (CH_4). CH_4 gas makes up most of the gas emitted, particularly from wildfires and managed fires. Until now, however, Kenya has had no quantitative spatial area data on CH_4 from forest fires. The unavailability of these data prompted Kenya's decision to remove CH_4.

g) Reference Time Period and AD adjustment with the forest definition:

Regarding the reference period, 1990, 2000, 2010, and 2014 were initially selected as reference years with 10 years interval and year of latest available map information. The GCF scorecard[2] later showed that reference periods of 20 years or more were unacceptable, which prompted Kenya to reset the reference period to the 14-year period from 2000 to 2014. The reference years and reference period were decided based on screenings of the LANDSAT imagery data for image quality parameters such as cloud cover areas (i.e., NO-DATA area) and strip gap. The results of the data screening are presented in Table

[2] A decision on how to implement the result-based payment was reached at the GCF's eighteenth Executive Board meeting. The GCF scorecard shows details on the conditions/requirements for receiving the result-based payment. For detailed documentation, see GCF (2017) GCF/B.18/23.

1.3.4.10. The years shown in green utilized LANDSAT imagery of good quality evaluated by the stripping effect, with small NO-DATA cover ratios. The highlighted years shown in yellow utilized LANDSAT imagery of good quality with slightly higher NO-DATA cover ratios, of moderate quality with small NO-DATA cover ratios, or of moderate quality with slightly higher NO-DATA cover ratios.

Table 1.3.4.10 Results of the data screening

	1990	1995	2000	2002	2003	2004	2005	2006
No DATA (%)	10.59%	14.35%	6.50%	6.53%	8.56%	23.77%	20.86%	23.13%
LANDSAT4 (scene)	26	0	0	0	0	0	0	0
LANDSAT5 (scene)	8	34	0	0	0	0	0	0
LANDSAT7 (scene)	0	0	34	34	34	34	34	34
Missing scenes	0	0	0	0	0	0	0	0
LANDSAT8 (scene)	0	0	0	0	0	0	0	0
Stripping Effect (scene)	0	0	0	0	0	34	34	34
Ratio of Stripping Effect (%)	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**100.00%**	**100.00%**	**100.00%**

	2007	2008	2009	2010	2011	2012	2013	2014
No DATA (%)	26.14%	28.00%	15.85%	6.81%	12.51%	20.85%	16.98%	3.75%
LANDSAT4 (scene)	0	0	0	0	0	0	0	0
LANDSAT5 (scene)	0	0	11	24	15	0	0	0
LANDSAT7 (scene)	34	34	23	9	19	34	13	0
Missing scenes	0	0	0	1	0	0	0	0
LANDSAT8 (scene)	0	0	0	0	0	0	21	34
Stripping Effect (scene)	34	34	23	9	19	34	13	0
Ratio of Stripping Effect (%)	**100.00%**	**100.00%**	**64.60%**	**26.50%**	**55.90%**	**100.00%**	**38.20%**	**0.00%**

Regarding the AD adjustment with the forest definition, the pixel size in the LANDSAT imagery is 30 m x 30 m, or the equivalent of 0.09 ha, while the minimum forest area in the forest definition is at least 0.5 ha. Therefore, in order to fulfill the forest definition, continuously connected forest class pixels must consist of at least by 6 pixels, which equals 0.54 ha. The Component has therefore developed a filtering function for removing forest pixel groups consisting of less than 6 pixels. The details on both cases are shown in Appendix 20.

h) EF:

For the method for calculating the Emission Factor (EF) using Tier 2 country data based on the results of the pilot inventory implementation, allometric equations for conversion from timber volume (m^3) to the biomass amount (t) were used based on the literature review. The allometric equations and the biomass and carbon stocks calculated using them are shown in Appendix 18.

Meanwhile, two methods for setting the EF, one using country data and one using default data, were shown in the stakeholder workshop held in March 2017, as shown in the attached Appendix 21. In the TWG meeting held after the workshop, on 28th June 2017, the TWG decided that the FRL was to be set using country data. The country data was judged to be the better choice, as it was consistent with the forest stratification.

The EF is calculated using of the following formulas:

- EF (Conversion within Forestland remaining as Forestland) = CO2 amount (Forest type at the end

of the reference period) - CO2 amount (Forest type at the beginning of the reference period)

- EF (Conversion from Forestland to Non-forestland) = CO2 amount (Forestland) - CO2 amount (Non-forestland)

The CO2 amounts in the respective forest types, which form the basis for calculating the EF, are shown in the below Table 1.3.4.11.

Table 1.3.4.11 CO2 amount (ton/ha) of each forest type class in the Country data

Class	Canopy coverage	AGB CO2 amount	BGB CO2 amount	TOTAL CO2 amount
Montane Forest &Western Rain Forest	Dense	594.11	170.65	764.76
	Moderate	100.57	28.89	129.46
	Open	39.67	11.39	51.06
Coastal forest & Mangrove forest	Dense	159.95	50.22	210.17
	Moderate	104.17	25.01	129.18
	Open	60.74	13.71	74.45
Dryland Forest	Dense	136.62	57.36	193.98
	Moderate	58.31	23.32	81.63
	Open	24.58	7.06	31.64
Plantation	Dense	752.54	216.15	968.69
	Moderate	195.67	56.20	251.87
	Open	238.20	68.42	306.62

i) Method for Constructing the FRL:

The averaging method was selected for the construction, because the reference years are at two points in time.

j) National Circumstances:

The TWG decided that the national circumstances would not be projected in the first FRL in Kenya. The details on this are described in section (e).

(b) Analysis of AD and EF

The land use / land cover change area within one reference period from each of the two determined reference years (2000 and 2014) was calculated. Then, based on the calculated data, the data (i.e., the figures on the change area) were aggregated according to the categories in the matrix of REDD+ activities (Table 1.3.4.9) to establish the AD (Table 1.3.4.12).

Table 1.3.4.12 shows data on trends that contribute significantly to enhancing the forest carbon stocks, such as the change from grassland stratification to natural forest dense stratification. Among the trends shown in the table, the change from the dryland forest stratification to the grassland stratification contributes significantly to the reduction of emissions from deforestation.

Table 1.3.4.12 Area of Land Cover / Land Use change in the reference period (ha/14years)

* Public plantation forest areas cover 136,890 ha. The areas changed from non-forest to non-forest in KFS plantation sites

			2014															
			Montane Forest / Western Rain Forest / Bamboo			Costal Forest and Mangroves			Dryland Forest			Plantation			Cropland	Grassland	Wetland	Settlement and Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open				
2000	Montane Forest / Western Rain Forest / Bamboo	Dense	764,212	32,274	11,406										75,352	74,634	312	634
		Moderate	80,651	75,942	13,003										18,195	58,395	540	89
		Open	28,207	12,440	24,809										15,817	49,464	30	177
	Costal Forest and Mangroves	Dense				130,627	14,832	662							1,164	29,471	259	539
		Moderate				149,599	70,438	2,636							7,748	141,963	377	838
		Open				2,185	2,034	255							1,410	16,942	14	116
	Dryland Forest	Dense							332,473	35,597	21,645				68,784	509,509	1,881	1,523
		Moderate							117,224	64,691	25,926				28,461	291,851	1,618	2,734
		Open							33,921	31,761	50,164				11,168	200,725	1,432	4,669
	Plantation	Dense										46,713	1,029	525	6,578	5,959	8	6
		Moderate										3,392	302	47	381	737	5	2.25
		Open										1,403	53	7	202	268	0.09	0.36
	Cropsland		47,186	4,175	1,804	2,304	303	18	16,270	1,756	421	6,557	134	74				
	Grassland		164,906	76,748	53,075	134,762	36,753	2,624	462,145	148,928	194,297	20,137	853	293				
	Wetland		254	13	6	1,209	476	42	3,577	1,359	843	0	0	0				
	Settlement and Other land		450	236	289	775	196	4	4,597	2,877	11,836	109	0.90	0.27				

amount to 41,115 ha within the total non-forest to non-forest areas. These areas are defined as forest areas with no stocks and will placed under sustainable management of forest during REDD+ implementation.

Second, the EF was aggregated in line with the matrices of REDD+ activities and set using the country data for forests and default data for Non-forest (Table 1.3.4.13). The positive values in Table 1.3.4.13 indicate emission, while the negative values in the table indicate removal. Table 1.3.4.11 shows the amounts of carbon dioxide in the respective forest stratifications used for setting the EF values. Therefore, the magnitudes of the values in Table 1.3.4.11 for montane forest / western rainforest / bamboo dense stratification and plantation dense stratification also have a significant effect on the EF value for the Enhancement and Deforestation shown in Table 1.3.4.13.

In addition, due to the research method, the plots stratified as plantation open were selected in the old thinned forest stands. For this reason, the plantation open stratification is assigned a larger value than the plantation moderate stratification in the sustainable management of forest.

Table 1.3.4.13 Matrix for EF-setting for the Country data (Forest) with Default data (Non-forest) CO_2 (ton/ha) Emission

			The end year of the period															
			Montane Forest/Western Rain Forest/Bamboo			Coastal Forest and Mangroves			Dryland Forest			Plantation			Cropland	Grassland	Wetland	Settlement and Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open				
The beginning year of the period	Mountane Forest /Western Rain Forest/Bamboo	Dense	0	635.64	713.66										765.26	749.31	765.26	765.26
		Moderate	-635.64	0	78.02										129.62	113.67	129.62	129.62
		Open	-713.66	-78.02	0										51.61	35.66	51.61	51.61
	Coastal Forest and Mangroves	Dense				0	84.78	139.03							213.96	198.01	213.96	213.96
		Moderate				-84.78	0	54.25							129.18	113.23	129.18	129.18
		Open				-139.03	-54.25	0							74.93	58.98	74.93	74.93
	Dryland Forest	Dense							0	113.24	164.91				196.56	180.61	196.56	196.56
		Moderate							-113.24	0	51.68				83.32	67.37	83.32	83.32
		Open							-164.91	-51.68	0				31.64	15.69	31.64	31.64
	Plantation	Dense										0	716.82	662.07	968.69	952.74	968.69	968.69
		Moderate										-716.82	0	-54.75	251.87	235.92	251.87	251.87
		Open										-662.07	54.75	0	306.62	290.67	306.62	306.62
	Cropland		-765.26	-129.62	-51.61	-213.96	-129.18	-74.93	-196.56	-83.32	-31.64	-968.69	-251.87	-306.62	0			
	Grassland		-749.31	-113.67	-35.66	-198.01	-113.23	-58.98	-180.61	-67.37	-15.69	-952.74	-235.92	-290.67		0		
	Wetland		-765.26	-129.62	-51.61	-213.96	-129.18	-74.93	-196.56	-83.32	-31.64	-968.69	-251.87	-306.62			0	
	Settlement and Other land		-765.26	-129.62	-51.61	-213.96	-129.18	-74.93	-196.56	-83.32	-31.64	-968.69	-251.87	-306.62				0

(c) Analysis of the emission estimates

Table 1.3.4.14 shows the results of the analysis of emission estimates, according to the AD and EF values shown above in section (b). As the table shows, significantly large enhancements of the forest carbon stocks from grassland stratification to natural forest dense stratification can be found. These changes were driven mainly by two factors. First, the increasing area of enhancement of forest carbon stocks shifted from the grassland stratification to the natural forest dense stratification in the AD, which affected the emission estimates. Second, the EF values in montane forest / western rainforest / bamboo

dense stratifications also affected the emission estimates. Another trend affecting the emission estimates is the increasing removal to plantation dense forest. This value was caused by the large EF value of the plantation dense stratification.

Table 1.3.4.14 Matrix for the Emission Estimate Calculation* (tCO_2/14 years)

			2014														
			Montane Forest / Western Rain Forest / Bamboo			Costal Forest and Mangroves			Dryland Forest			Plantation			Cropland	Grassland	Wetland	Settlement and Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open				
2000	Montane Forest / Western Rain Forest / Bamboo	Dense	0	20,514,964	8,140,090	–	–	–	–	–	–	–	–	–	57,664,330	55,924,102	238,647	485,009
		Moderate	−51,265,071	0	1,014,428	–	–	–	–	–	–	–	–	–	2,358,513	6,637,946	70,020	11,549
		Open	−20,130,464	−970,908	0	–	–	–	–	–	–	–	–	–	816,247	1,763,688	1,565	9,136
	Costal Forest and Mangroves	Dense	–	–	–	0	1,257,445	92,079	–	–	–	–	–	–	249,042	5,835,443	55,400	115,493
		Moderate	–	–	–	−12,882,670	0	142,987	–	–	–	–	–	–	1,000,922	16,074,723	48,703	108,229
		Open	–	–	–	−303,777	−110,368	0	–	–	–	–	–	–	105,670	999,272	1,066	8,659
	Dryland Forest	Dense	–	–	–	–	–	–	0	4,030,849	3,569,564	–	–	–	13,519,989	92,020,778	369,741	299,423
		Moderate	–	–	–	–	–	–	−13,273,936	0	1,339,788	–	–	–	2,371,370	19,662,222	134,800	227,823
		Open	–	–	–	–	–	–	−5,594,010	−1,641,319	0	–	–	–	353,401	3,150,080	45,327	147,733
	Plantation	Dense	–	–	–	–	–	–	–	–	–	0	737,266	347,626	6,372,412	5,676,949	7,323	6,190
		Moderate	–	–	–	–	–	–	–	–	–	−2,431,790	0	−2,548	95,841	173,939	1,292	567
		Open	–	–	–	–	–	–	–	–	–	−928,710	2,902	0	62,008	77,802	28	110
	Cropland		−38,109,674	−541,130	−93,072	−493,039	−39,146	−1,389	−3,197,948	−146,288	−13,311	−6,351,575	−33,798	−22,794				
	Grassland		−123,566,003	−8,724,210	−1,892,434	−26,683,996	−4,161,597	−154,777	−83,466,477	−10,033,410	−3,049,198	−19,185,148	−201,159	−85,153				
	Wetland		−194,293	−1,727	−316	−258,612	−61,457	−3,143	−703,129	−113,241	−26,685	0	0	0				
	Settlement and Other land		−344,644	−30,600	−14,918	−165,739	−25,287	−290	−903,505	−239,702	−374,538	−105,752	−227	−83				

* The value obtained by multiplying the AD and EF in the reference period.

(d) Setting the FRL

The emission estimates for the historical trend were calculated in the 14-year reference period between 2000 and 2014, as shown in (c) above. The emission estimates shown are divided by 14 years (aggregated). The gross emission and removal values per year are shown in Table 1.3.4.15, the emission and removal values per year categorized as REDD+ activities are shown in Table 1.3.4.16, and the FRL values are shown in Table 1.3.4.17. Due to the historical average method used for the FRL calculation, the FRL value is composed of the Net emission value in Table 1.3.4.15 and the Total (Emission estimates (Net)) in Table 1.3.4.16. According to the FRL value calculated, the FRL shows the negative values as removal, as the gross removal value surpasses the gross emission value in Table 1.3.4.15. In the same context, the value for enhancement of forest carbon stock is larger than the value for emission reduction from deforestation in Table 1.3.4.16.

Table 1.3.4.15 Emission estimates (tCO_2/year)

Period	2000–2014
Net Emisssion	−7,471,382
Gross Emission	24,039,316
Gross Removal	−31,510,697

Table 1.3.4.16 Total emission/removal for each REDD+ activity (tCO_2/year)

Period	2000–2014
Deforestation	20,206,141
Degradation	2,864,442
Sustainable management of forest	−1,127,606
Enhancement	−29,414,359
Total (Emission estimates (Net))	−7,471,382

Table 1.3.4.17 Forest Reference Level (tCO_2/year)

FRL	−7,471,382

(e) Consideration of the national circumstances

Considerations on the national circumstances were not included in the beginning of the work by the Team in TOR. In its communications with the team, the Kenyan side eagerly requested that the work be done. The Team thereupon hurriedly commenced discussion on the national circumstances with the C/P. This section consists of four parts: a) Collection of information for suggestions, b) Suggestions on the Team's methodology for considering national circumstances, c) Consideration of national circumstances by the local expert, d) The work process and the final decision with the C/P.

a) Collection of information for suggestion

The Team considered the national circumstances described in the FRL reports previously submitted by other countries, and also the projection methods used for reporting on the international trends in national circumstances in the reports published by UN-REDD+, Global Forest Observation Initiative (GFOI), and FCPF-CF. Using the available past data, Kenya's FRL has been set based on calculations by the historical average method. To incorporate the projected national circumstances into this FRL value, any changes between the reference year and the FRL covered period, such as any acceleration of deforestation or forest degradation after the reference year, had to be shown. Thus, the Team collected information about Kenya's policies on the agricultural and energy and social infrastructure sectors, that is, the sectors driving forest deforestation and forest degradation, and also Kenya's forest policies on possible ways to contribute the value of the enhancements of forest carbon stock. The references considered by the Team are listed in Table 1.3.4.18.

Table 1.3.4.18 Reference information collecting for setting the FRL

Title	Institution	Key point
COP Decision (4/CP.15, 1/CP16, 12/CP.17 and 13/CP.19)	UNFCCC	The FRL should be projected according to national circumstances for data transparency. (4/CP/15)
Emerging approaches to Forest Reference Emission Levels and/or Forest Reference levels for REDD+(2014)	UN-REDD,	The FRL-setting process was analyzed in previously submitted FRL reports from Brazil, Chile, Costa Rica, Democratic Republic of the Congo, Ghana, Guyana, Mexico, Nepal and Viet Nam.
Technical considerations for Forest Reference Emission Level and/or Forest Reference Level construction for REDD+ under the UNFCCC (2015)	UN-REDD	Construction methods are mainly described in previously submitted FRL reports.
Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gasses in forests Edition 2.0 (2016)	GFOI	A decision tree is helpful for setting the national circumstances in the FRL.
Methods and Guideline document module 3: Forest Reference Emission Levels and Forest Reference Levels: Extended Methodological Advice (2015)	GFOI	A decision tree is helpful for setting the national circumstances in the FRL (the previous version of "Integrating remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gasses in forests").

Title	Institution	Key point
Sourcebook COP22 version 01 (2016)	GOFCI-GOLD	The sourcebook clearly describes how national circumstances are considered in the projection.
Methodological Framework (2016)	FCPF Carbon Fund	The method for considering emission amounts is described. The ER-P provides an original definition for setting the FRL according to the forest cover.
Previous FRL reports submitted to UNFCCC and TA (Mexico, Viet Nam, Costa Rica, Guyana, Columbia, Democratic Republic of the Congo, Peru)	-	The Guyana and Columbia reports were used as references for considering the national circumstances. The Viet Nam report was also a helpful reference in setting the national circumstances.
Vision 2030	GoK	Vision 2030 provides descriptions of the achievement of the goal of 10% forest cover, the utilization of plantation, and the carbon offset scheme.
Second National Communication to UNFCCC	GoK	The predictions on future emission reduction are described with reference to the contribution of REDD+, plantation and forest recovery programme in the forest sector.
Draft National Forest Policy,2015	MEWNR	The targeted forest coverage rate in 2030 is described as 10%.
Technical Report on the national assessment of Forest and Landscape restoration opportunities in Kenya 2016	MENR	The report describes an analysis of the drivers of deforestation and forest degradation, and the potential to scale up landscape restoration in Kenya.
National Forest Programme 2016-2030	KFS	The plantation programme and forest recovery programme are described.
AGRICULTURAL SECTOR DEVELOPMENT strategy (ASDS) (2009-2020)	GoK	No quantifiable information on the conversion from forest to farmland in projects to expand farmland.
Analysis of drivers and underlying cause of forest cover change in the various forest types of Kenya	Ministry of Forestry and Wildlife	The paper describes the main drivers of deforestation in Kenya, such as the changes of land use and deforestation by timber and fuel extraction.
Agriculture and Food Authority (AFA) Strategic Plan 2016 – 2021	Ministry of Agriculture livestock and Fisheries	No quantifiable information on the conversion from forest to farmland in projects to expand farmland.
ENERGY SECTOR OPPORTUNITIES IN KENYA (2016)	Business Sweden	The current power supply is dependent on the 50% of water power. In 2030, geothermal power supply will replace water power supply.

b) Suggestions from the Team on the methodology for considering the national circumstances

The Team discussed the methodology for considering the national circumstances at the time, a matter that had been requested by the C/P for the FRL projection. The Team considered the projection for the national circumstances by investigating the FRL reports previously submitted by other countries and the reports published by UN-REDD+, GFOI. Based on its reviews of the reports, the Team suggested, for the projection of the national circumstances, that the trends driving deforestation would have to be quantified and projected in cases where the trends were found to change between the past reference period and FRL period. The Team also suggested that the data should be studied for the projection of the national circumstances if Kenya has quantitative evidence on future changes in the trends of the drivers of deforestation. In the alternate case, with no evidence in the data, the Team suggested that the

report only include descriptions of the current national circumstances, and that the FRL be projected with scientifically available data for national circumstances in the future using a phased approach.

c) Consideration of the national circumstances by the local expert

The C/P highlighted the need to incorporate projections on national circumstances such as future policies into the FRL by developing a modelling method because of making the prediction of future emission in forest sector by using modelling towards 2030 including future economic growth and policies in the previous GHG inventory published in 2010. For this reason, the FRL was considered to project national circumstances using models to be developed by the local expert based on past trends modelled by averaging methods. The details are described below.

First, the local experts developing the GHG inventory researched whether the national circumstances could be quantified or not by studying information/data on the sectors of forest governance, climate, economics, energy, infrastructure and industrial development, development of agriculture and forest, and rural development.

The C/P's point of view was focused on whether or not the respective sectors were related to the forest sector. Then, specific sections that were quantifiable were selected for the modelling for the projection. The climate sector was considered unfit for modelling projection in the result, given its broad coverage encompassing parameters such as the temperature distributions, annual temperature changes, rainfall distributions, climate change characteristics, and extreme climate events. Also, in terms of the FRL calculation methods and models reflecting the content of the abovementioned field, the Team suggested to set variable as the policies can be reflected to the value of EF and AD, as the local expert showed a formula for analysis applying only EF as a variable.

In addition, according to the CO2 reduction goal of the forest sector in Nationally Determined Contribution (NDC), the local expert attempted to make the projection with the national circumstances based on the FRL value without the national circumstances proposed by the Team. The accuracy of the land cover / land use map in reference years, revision of reference years, and reference period were examined during the work of the local expert. Further, the Team and C/P spent time searching for an antidote to solve the changes between grassland and forest stratifications. The work on the national circumstances was conducted in these contexts.

d) The work process and the final decision with the C/P

The final decision on whether or not to project the national circumstances was reached in the middle of December 2017. For the first submission in January 2018, the C/P decided not to project the national circumstances due to the lack of sufficient evidence for the FRL. According to that decision, the projection of the FRL was based only on past data calculated by the historical average method towards 2030.

(f) Documentation of the FRL report

In the TWG meeting on June 2017, the TWG decided that the C/P and the Team would work together and draft the FRL report to be submitted to the UNFCCC, after setting the FRL value. Based on that

decision, the Team began drafting the FRL report with the C/P. The documentation process proceeded in the following steps.

First, the first draft was submitted to the C/P in early August 2017. Then the draft was shared with the stakeholder by the Team and the C/P. In October 2017, KFS through sent an early notice to UNFCCC through MENR. The final draft was submitted to the C/P by the middle of December 2017. After the submission to the C/P, the C/P held internal meetings for draft consultation and revision for the completion of the documentation process.

Second, the KFS circulated the final draft to the stakeholders for a peer review that was to be conducted by the beginning of January 2018 based on a TWG decision in the beginning of December 2017. A UNFCCC reviewer also commented on the final draft before the deadline of the review. In the beginning of January 2018, the C/P and the Team considered how the final draft would be modified in accordance with the comments from the reviewers, for submission to the UNFCCC by the deadline. Also, the Team submitted a revised final draft to the C/P on the 4th January 2018. The Kenyan side continued the works up to the 8th January 2018, the deadline for the submission. Corrections based on the comments, however, had not been completed by the deadline. Eventually, the C/P decided to cancel the submission to the UNFCCC in 2018, judging that several matters would require further consultation and revision before the submission. One matter was the negative FRL value as removal, which would not be profitable for Kenya in relation to a results-based payment. Correction of the AD was therefore called for, as the current AD caused a negative FRL value.

See Appendix 22 for the version of the draft FRL report before it was sent for peer review by stakeholders.

2) Development of the FRL toward submission to UNFCCC in January 2020

A series of discussions/consultations was held on the improvement of the draft FRL based on deliberations on matters such as the change of the conditions for setting the FRL towards submission of the FRL report to UNFCCC. Following is a summary of the points to be improved/modified, mainly based on the comments from the peer review in December 2017.

(a) Methodology for estimating the uncertainty of the FRL

(b) Conditions for setting the FRL

a) Estimation of carbon emission from forest degradation
b) To include deadwood and litter into carbon pools
c) Reconsideration of the EF for conversion from non-forest to dense forest
d) Additional reference year point in the reference period
e) Reconsideration of the EF for conversion from a lower class of forest cover density to a higher class, such as conversion from open forest to moderate and dense forest
f) Aggregation of the forest cover density for plantation forest

The above points are outlined below.

(a) Methodology for estimating the uncertainty of the FRL

The estimated uncertainty of the FRL needs to be calculated from the uncertainty of the EF and AD.

a) Estimation of the uncertainty of the EF

The uncertainty of the EF was calculated using the inventory survey data of 127 plots, which was the basis for setting the EF. As 127 plots made up a population too small to calculate uncertainty, the bootstrap method was used to calculate the approximate distribution of the population. By a bootstrap of 10,000 times, the lower and upper limits from the means within the 95% confidence interval for the estimation of the uncertainty of the EF were -22.8% and 24.7%, respectively.

b) Estimation of the uncertainty of the AD

The Component considered how to calculate the uncertainty of AD, and how to design a sampling method for an AD assessment. In the current study, the Component collected the scientific papers which were published through related remote sensing society, and reviewed them. The main papers that served as a reference are as follows:

- "Good practices for estimating area and assessing accuracy of land change"
- "Making better use of accuracy data in land change studies: Estimating accuracy and area and quantifying uncertainty using stratified estimation"

The above mentioned two papers, mainly written by Professor Olofsson, have been referenced by many countries in the AD assessment of FRL reports and the calculation of AD uncertainty. In the Component, sampling design such as calculation of the required number of sampling points and allocation of sampling points were performed with reference to the sampling survey method for accuracy verification described in the paper. In addition, to enable the remote sensing staff of KFS to design sampling in a continuous manner, a calculation sheet was created that can automatically calculate the required number of sampling points by inputting the area size of the land cover / land use change items.

Regarding the calculation of uncertainty, the Component created an uncertainty calculation sheet with reference to the paper, and it was a simple calculation sheet so that the uncertainty can be calculated simply by inputting the results of the AD assessment. The calculation sheet for the number of sampling points and the calculation sheet for uncertainty that were created, and explained to the remote sensing staff and the technology was transferred to them so that KFS can continue to implement them in the future.

The design contents of sampling for AD assessment implemented in the Component are as follows:

- To calculate the necessary number of sampling points based on each change pattern area size
  * Note: Number of sampling points should meet the 95% confidence interval
- Minimum necessary sampling points will be 50 points, and power allocation to the rare case of change pattern
  * Note: Minimum points are 50 to 100 points according to professor Olofsson.
- Sampling points are randomly generated and placed according to the number of points

assigned to each land cover / land use change pattern

Based on the above described sampling design, the Component verified the accuracy of AD at the reference year and time interval in FRL. Table 1.3.4.19 shows the number of sampling points were required to meet the statistical confidence interval of 95% for each reference year time interval and accuracy verification on land cover / land use change pattern.

Table 1.3.4.19 Reference year and time interval, number of sampling points

Reference Year and Time Interval	Number of points for confidence interval 95%
2002 – 2006	2,925
2006 – 2010	2,923
2010 – 2014	2,918
2014 – 2018	2,927

In this component, when verifying each sampling point, a sampling point check sheet was created in consideration of reducing human error when inputting the verification result as much as possible.

(b) Conditions for the setting of the FRL

a) Estimation of carbon emission from forest degradation

In the first FRL setting, the carbon emissions from forest degradation were calculated using the land cover / land use change matrix. Forest degradation in the change matrix was defined as the transition from dense to moderate and open, and the transition from moderate to open, in natural forest. Forest degradation was estimated to account for 2.8 million tons of CO_2 emissions. It was pointed out in the peer review that the estimation value by the change matrix may be too small, given the present status of firewood and charcoal production in Kenya. The methods for estimating firewood, charcoal production, and forest fires, that is, the causes of forest degradation, were therefore examined from this point of view using the statistical values.

i) Carbon emission from forest degradation by firewood and charcoal consumption (checking the consistency of the statistical data and the status of firewood and charcoal production in Kenya)

The Component carried out a comparison between FAOSTAT, the statistical data on firewood and charcoal production in Kenya produced by FAO, and WISDOM (Wood fuel Integrated Supply/Demand Overview Mapping) implemented by Yale University and other organizations. The Component also examined the method for estimating carbon emissions caused by forest degradation using WISDOM data. Through an analysis of the comparison, the use of FAOSTAT data was determined to be unsuitable due to the small number of measurement values in the firewood data and a gap between the data for 2005 and 2006 and beyond. As the WISDOM data are estimated based on personal consumption and population trends, they may be used to reflect the actual circumstances in Kenya using the latest data on personal consumption. Thus, the WISDOM data were judged to be more effective than the FAOSTAT data.

According to WISDOM, the amount of firewood and charcoal produced exceeding the annual increment of the forest makes up 35% to 41% of the total production amount. As such, a portion of the carbon emission from forest degradation can be estimated based on the production amount exceeding the annual increment.

Lastly, however, it was noted that though this method may provide better information on what is actually happening to the forests, the estimation is guided by population changes, data on the adoption of improved cook stoves, and data on the adoption of non-biomass energy sources for the future monitoring. These type of data, which change over time, are unavailable and cannot be estimated by any accurate method.

In consideration of the above, the estimation of emissions from forest degradation using firewood and charcoal consumption was postponed in the present FRL setting, and the previous method for estimating emissions from forest degradation, a method based on the change of the forest cover density from dense to moderate or open, and from moderate to open, was restored.

ii) Carbon emissions from forest degradation by forest fires

Forest fire data derived from the statistical data from Medium Resolution Imaging Spectrometer (MODIS), FAOSTAT, and KFS were compared and examined. MODIS, a radiometer developed by NASA, can detect forest fires by radiation observation. MODIS fire data were temporarily found to be the most effective. The MODIS fire data clipped in the forest area and the FAOSTAT data showed the same trend, while the MODIS fire data were found to be more accurate and more compatible for Kenya.

However, as mentioned above, the previous method for estimating emissions from forest degradation, a method not reliant on firewood consumption, charcoal consumption, and forest fires, was restored.

b) Including deadwood and litter in the carbon pools

Based on the past forest inventory reports conducted in Kenya, the amounts of carbon from deadwood and litter were small. Therefore, deadwood and litter are not judged to be significant as carbon pools. In addition, deadwood is assumed to be used as firewood and charcoal. When estimating carbon emissions from forest degradation based on firewood and charcoal production, a risk of double counting the carbon emissions emerges. Kenya therefore decided not to include deadwood and litter in the carbon pool to be measured.

c) Reconsideration of EF for conversion from Non-forest to dense forest

The EF of the change from non-forest to dense forest was determined to be excessive compared to the amount calculated based on the standard value of annual increment indicated by the IPCC guidelines over the 14-year reference period between the reference years 2000 and 2014. On the assumption that dense forest is mature forest, the period required for growth to a matured forest must be considered when setting the EF value of the change from non-forest to dense forest. If, for example, it takes 60 years to grow into a matured forest, the method of multiplying 14 (years) by the value obtained by dividing the current EF by 60 (years) can be used for the calculation of the revised EF. The periods that forests in Kenya require to reach maturity were studied. According to the analysis, the growth model developed

by SLEEK (System for Land Based Emission Estimation in Kenya) is available. However, no SLEEK manuals or accompanying data on growth models have been published. Under this condition, capacity building for growth curve development purposes will be required in the future.

Instead of using the growth model mentioned above, however, it was proposed that the conversion of non-forest into forests be performed by calculating the EFs using a growth rate for each forest strata for trees < 20 yr based on the IPCC 2006 guidelines, as the reference period is 16 years and such forests have been growing for less than 20 years. This alternate method is deemed appropriate, as a forest does not immediately achieve the carbon stock of the forest it is mapped into but rather a carbon stock value described by its growth rate and the number of years it has been growing. Moreover, in cases where the growth calculation results in a stock that exceeds the stock factor of the specific canopy class, a capping was done to retain the stock of the specific canopy class.

d) Additional reference year point in the FRL reference period

The addition of reference year points in the reference period in the first draft FRL report was recommended. While an increase of points in 2000-2014, the reference period, was considered, realizing the increase was difficult. The quality of the satellite images was good only for the years close to 2000, and those years is too near to 2000 to increase the points using data of those years. Meanwhile, the 2018 Land Cover / Land Use map (SLEEK) was prepared by mainly the Directorate of Resource Survey and Remote Sensing (DRSRS).

Therefore, it was decided to consider adding 2018, the year on which the latest land cover / land use data are based, as a reference year point. Based on this consideration, the reference years of first proposal were 2000, 2014, and 2018. Ultimately, however, 2 reference year points, 2002 and 2018, were proposed, for the following reasons.

First, the year 2002 was selected instead of 2000 for the following reason.

In the year 2001, part of the proposal to excise 167,000 hectares of forestland was partially implemented in the Mau forest, leading to the conversion of at least 67,000 ha of forest into agricultural land. The year 2002 came just after major excisions of the montane forests were performed in 2001, and no further excisions have been performed since.

In addition, the incoming new government in 2002 brought in planning of large-scale development under the Vision 2030 targets. Moreover, many environment-friendly policies that may have favored forest conservation were enacted in the years after 2002. The aforesaid policies related to climate change include The National Climate Change Strategy of 2010, the Kenya Climate Change Act 2016, the National Climate Change Framework Policy 2016, and the Climate Change Action Plan 2018, among others.

Therefore, 2002 was proposed as the starting point reference year instead of 2000.

Second, two reference years were selected instead of a single year for the following reason.

As a result of calculating the past emissions based on the reference year at three points, in 2002, 2014, and 2018, the annual emissions in 2014-2018 were compared with the same values in 2002-2014. The

annual emissions in 2014-2018 became a big value more than 4 times of the other. As described above, this increase can be partly explained by the method used to calculate the EF of the enhancement. This EF was calculated by multiplying the reference period based on the 12 years from 2002 to 2014 and the 4 years from 2014 to 2018. As the latter EF value was smaller than the former, the amount of removal for the latter was smaller, in spite of the same change from non-forest to forest. This was one of the reasons.

In addition, if the place changed from non-forest to forest from 2002 to 2014 was changed to non-forest from 2014 to 2018, as mentioned above, the EF from 2002 to 2014 was set based on the annual growth rate. Therefore, in spite of having the same CO_2 stock as the EF value in 2014, the CO_2 tons based on plot data, which are bigger than CO_2 stock in 2014, are emitted from 2014 to 2018. If the calculations can capture how the same place changed at three points using the concept of Time Series Analysis (TSA) (an image that follows one pixel instead of thinking about dividing two periods), it would be possible to estimate more accurate emissions adopting different EF values in the same change in one period. It was difficult for Kenya to carry out this TSA, however, given the considerable amount of work entailed due to the classification of the forests into the dense, moderate, and open levels. Considering the condition at hand, it was proposed that the FRL in the reference period be set at two time points, 2002 and 2018.

The reference year should be selected based on the technical conditions such as the quality of the satellite images used for the creation of the time series of the land cover / land use maps. The following Table 1.3.4.20 shows the quality of the satellite images. The highlighted years shown in green, determined using LANDSAT images, were judged to be of good quality, with a stripping effect with small NO-DATA cover ratios, and were qualified for the mapping. Meanwhile, the years shown in yellow, determined using LANDSAT imagery, were judged to be second best, offering a lower stripping effect ratio compared with other remaining images without color highlighting. According to the table, the years 2002 and 2018 are good quality years.

Table 1.3.4.20 The results of data screening

	2000	2002	2003	2004	2005	2006	2007	2008
No DATA (%)	6.50%	6.53%	8.56%	23.77%	20.86%	23.13%	26.14%	28.00%
LANDSAT4 (scene)	0	0	0	0	0	0	0	0
LANDSAT5 (scene)	0	0	0	0	0	0	0	0
LANDSAT7 (scene)	34	34	34	34	34	34	34	34
Missing scenes	0	0	0	0	0	0	0	0
LANDSAT8 (scene)	0	0	0	0	0	0	0	0
Stripping Effect (scene)	0	0	0	34	34	34	34	34
Ratio of Stripping Effect (%)	**0.00%**	**0.00%**	**0.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

	2009	2010	2011	2012	2013	2014	2015	2018
No DATA (%)	15.85%	6.81%	12.51%	20.85%	16.98%	3.75%	4.00%	4.30%
LANDSAT4 (scene)	0	0	0	0	0	0	0	0
LANDSAT5 (scene)	11	24	15	0	0	0	0	0
LANDSAT7 (scene)	23	9	19	34	13	0	0	0
Missing scenes	0	1	0	0	0	0	0	0
LANDSAT8 (scene)	0	0	0	0	21	34	34	34
Stripping Effect (scene)	23	9	19	34	13	0	0	0
Ratio of Stripping Effect (%)	**64.60%**	**26.50%**	**55.90%**	**100.00%**	**38.20%**	**0.00%**	0.00%	0.00%

Although the REDD + TWG in July 2019 concluded that the reference years and the reference period

were determined as mentioned above, some suggestions were made: 1) efforts to improve the reference period by adding more reference years were to be considered, if judged feasible, and 2) emissions were estimated by the five-year interval from 1995 to 2015 in a training for National Inventory Report (NIR) and GHG inventory held in August 2019. The addition of reference years for the FRL was also discussed in the training, and proposals were made to add reference years at four-year intervals, utilizing five data points in 2002, 2006, 2010, 2014, and 2018.

According to the proposal mentioned above, the method of estimating AD at three or more data points was considered anew, and trial calculations of emissions at three and five data points were conducted for confirming the actual figures of emissions. As a result, it was decided to set up AD based on the reference years of five data points in 2002, 2006, 2010, 2014 and 2018, and on four periods in 2002-2006, 2006-2010, 2010-2014 and 2014-2018.

e) Reconsideration of the EF for conversions from a lower class of forest cover density to a higher class, such as conversion from open forest to moderate and dense forest

Regarding improvement of forest stock due to canopy enhancement in forest remaining as forest, Kenya decided that the EFs for conversion from a lower class of forest cover density to higher class were to be calculated using a growth rate associated with each of the forest strata for trees >=20 yr, based on the IPCC 2006 guidelines. The >=20 yr rate was selected because the forests were already grown forests that had previously been degraded and were undergoing stock enhancement. The reason for this choice in setting the EF was based the following: a forest undergoes a process of growth after conservation measures are initiated, and any canopy improvement (as in the case of the conversion of open forest to dense forest) attains not a carbon stock value of the forest it is mapped into, but rather a value described by its growth rate and the number of years of growth typical to such a forest strata.

f) Aggregation of forest cover density for plantation forest

Any variations in canopy cover among plantation forest may not necessarily be associated with degradation or enhancement. Therefore, Kenya adopted a single canopy cover for plantation forest.

(c) Preparation of FRL reports for submission to the UNFCCC

The FRL report was revised based on the results mentioned above. The tables below show the revised historical emissions.

Table 1.3.4.21 Historical Annual CO2 Net Emissions classified by forest strata (tCO2/year)

Forest Strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	Average
Montane &Western Rain Forest	44,644,932	26,587,270	29,212,476	31,226,464	32,917,786
Costal & Mangrove Forest	4,824,805	2,015,603	5,196,054	9,712,528	5,437,247
Dryland Forest	10,631,166	7,666,989	14,132,878	12,239,340	11,167,593
Public Plantations	2,732,682	1,829,312	1,887,435	4,276,302	2,681,433
Total	62,833,585	38,099,174	50,428,843	57,454,634	52,204,059

Table 1.3.4.22 Historical Annual CO2 Net Emissions classified by REDD+ Activity (tCO2/year)

REDD+ Activity	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	Average
Deforestation	54,755,246	39,143,087	48,736,134	50,033,292	48,166,940
Degradation	13,836,587	8,350,601	9,563,829	11,792,785	10,885,950
Sustainable management of forest	2,732,682	1,829,312	1,887,435	4,276,302	2,681,433
Enhancement	-8,490,930	-11,223,826	-9,758,555	-8,647,746	-9,530,264
Total (Emission estimates (Net)	62,833,585	38,099,174	50,428,843	57,454,634	52,204,059

The method for constructing the FRL is the historical averaging of emissions and removals between 2002 and 2018, with 4-year intervals. Therefore, according to the average annual historical emission used as the basis in the tables above, the FRL value was as shown below.

Forest Reference Level (tCO2/year): 52,204,059

The final stakeholder workshop was held on December 9th and 10th 2019, based on the revised FRL report. A total of 30 experts from government agencies such as KFS, DRSRS, MoEF, KEFRI, JICA, universities, private companies, and NGOs (such as Wildlife Works) attended. Each of the elements of the FRL (such as AD, EF, and EE) was explained in detail at the workshop, and each topic was discussed. Finally, all of the participants basically agreed on the revised FRL report.

A final draft of the FRL report was prepared based on the discussions at the stakeholder workshop and submitted to the CCF of KFS on December 16th 2019. The draft was sent to the MoEF for final clearance for submission of the report to UNFCCC.

With the approval of the MoEF, the FRL report was submitted to UNFCCC on 6th January 2020 (please see Appendix 23 for the FRL report submitted to UNFCCC).

(5) Support for FRL improvement based on Technical Assessment by UNFCCC

While UNFCCC's assessment session during the Technical Assessment (TA) was scheduled to take place in Bonn, Germany in the week of March 16, it was postponed due to the COVID-19 pandemic (please see Appendix 24 for the initial TA plan). Through coordination by UNFCCC, a remote assessment session was held from June 8 to 12 for Kenya's FRL (please see Appendix 25 for the revised TA plan).

Before the remote session, the TA team at UNFCCC in charge of Kenya's FRL requested Kenya to respond to inquiries/clarifications regarding the FRL report submitted to UNFCCC. The responses were then prepared and provided to the TA team.

The remote assessment was managed based on the inquiries/clarifications and responses. The TA team then asked for additional inquiries/clarifications in the assessment, and Kenya responded to each inquiry/clarification. The main issues raised by the TA team and discussed in the TA session were the

following: 1) the rationale for setting the forest type thresholds (15%, 40% and 65%) and forest definitions, 2) confirmation of the method for estimating emission based on the Excel spreadsheet (in the calculation of FRL values, there was a discrepancy of values due to rounding in Excel), 3) confirmation of the satellite image analysis method, 4) confirmation of the rationale and AD & EF for the sustainable management of forests as a REDD+ activity targeting public plantation forest, 5) consistency between GHG inventory and FRL, 6) confirmation of the EF of mainly activities related to enhancement of carbon (please see Appendix 26 for details on the inquiries/clarifications and responses).

The revision work of the FRL report was conducted based on the results of the TA. The modified FRL report was submitted to UNFCCC in August 2020. See Appendix 27 for the modified report.

The main points modified in the FRL report were as follows: 1) the addition of a rationale for the forest definition; 2) clarification of KFS-managed plantations targeted in the sustainable management of forests, one of the five REDD+ activities; 3) the addition of a rationale for not including conservation of forest carbon stocks, one of the five REDD+ activities, in the target REDD+ activities in Kenya; 4) modification of the description of the consistency with GHG inventory; 5) explanation of the differences in the figures due to rounding; 6) the addition of descriptions for Tables 20-23 in the report; and 7) measurement of BGB and carbon stocks in non-forest areas, especially in permanent agricultural land, for future improvements.

The historical emissions in the modified FRL report submitted to UNFCCC were unchanged from those in the initial FRL report submitted in January 2020 (see Table 1.3.4.21 and Table 1.3.4.22). Therefore, the FRL value (shown below) was also unchanged.

Forest Reference Level (tCO2/year): 52,204,059

The TA team prepared the draft TA report in the context of the modified FRL submission. The Kenyan side then made comments on the draft report. The TA report was finalized based on the comments and published online at the following URL:

https://unfccc.int/documents/267566

1.3.5 Activity for forest cover change monitoring in the whole of Kenya

Regarding the forest cover change monitoring activity throughout Kenya, since the canopies are classified as forest type into three categories: open, moderate, and dense on the image classification in Kenya, the Component utilized the methodology to study and to consider the development of monitoring function to monitor the canopy density. However, due to a mid-term review from February 14-21, 2019, this activity was discontinued. Because it was requested to adjust component activities efficiently and flexibly to utilize limited assignment of JICA experts in the activity of REDD+ process including FRL development. Another reason is the possibility of updating the time series land cover/land use maps on an annual basis in Kenya, and forest cover change monitoring by utilizing JJ-FAST is also possible. The following describes (1) Consideration to Sustainable Method for Forest Cover Change Monitoring and (2) Development for Function of Forest Cover Change Monitoring carried out by this component up to the mid-term review.

(1) Consideration to Sustainable Method for Forest Cover Change Monitoring

Forest cover change monitoring was supposed to be carried out once a year. On the other hand, due to the fact that "deforestation", "forest degradation" and "forest recovery" are the subjects of monitoring and considering it once a year, "deforestation" and "forest recovery" are based on creating land cover / land use map every year by utilizing of SLEEK method, it is possible to perform single sustainable forest cover change monitoring. (At the time of discussions from 2017 to 2018, the creation of an annual basis land cover / land use map was under considered. The NFMS calendar, as indicated in the NFMS document, plans to create the map once every two years.) For this reason, regarding change monitoring method for “forest degradation” was discussed with the C/P several times. As a result, it was decided to study the analysis method of forest canopy density using optical satellite images for extraction of “forest degradation” and the improvement of classification accuracy of forest type (by canopy density of open from 15% to 40%, moderate from 40% to 65% and dense above 65%) on land cover / land use map. The degree of density change can be grasped by comparing this forest canopy density as a unified index to time series.

Regarding forest crown canopy density analysis, there are various methods such as a method of dividing the forest crown canopy density from 2 grades or 3 grades from the land cover classification and a method of dividing the forest crown canopy density stepwise by the level of the vegetation index (NDVI: Normalized Difference Vegetation Index). However, there are problems such as the difficulty of classification and the occurrence of classification error in the case of land cover classification and the fact that the vegetation index level does not depend merely on the forest crown canopy density. For that reason, it was considered to obtain a numerical value that depends on shade of forest crown canopy density as much as possible.

As a result of the consideration, for one of the methods of extracting the forest crown canopy density, it was decided to use forest crown canopy density analysis of combining vegetation index and bare land index (BI). The advantage of this method is that by combining not only the vegetation index but also the bare land index, it is possible to suppress factors other than the forest crown canopy density contained in the vegetation index and to add the degree of appearance of the ground which is one of the important indicators in the forest crown canopy density.

In particular, each index will be extracted separately by image processing, and then suitable regression equation of forest crown canopy density index is derived by plotting the proportion at each point for each index as a graph as shown in Figure 1.3.5.1.

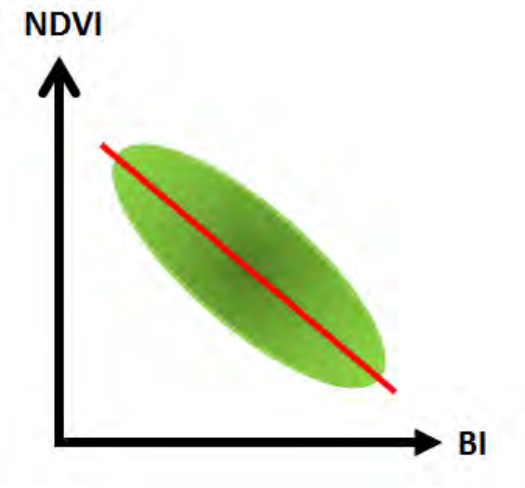


Figure 1.3.5.1 Graph of the canopy density

In order to utilize forest crown canopy density analysis as forest cover change monitoring, equalization of satellite images at every year is also necessary. By equalization, it becomes possible to monitor the forest crown density index at the same level as basis on the satellite image for each year. In the equalization of the satellite image as mentioned here, it means arranging the satellite images with variations in brightness value as homogeneous images because the brightness value in a satellite image at different observation year has different variations even in the same place, and atmospheric correction to eliminate the influence of the contained atmosphere is also carried out at the same time.

After the equalization of the satellite image, it is necessary to calculate the forest crown canopy density index, but before that, it is necessary to obtain the optimum of vegetation and bare land indices which is suitable for region characteristics. Therefore, for obtaining of optimum indices, investigation to the luminance values of each band (for example, blue, green, red, near infrared, mid infrared etc.) in the satellite image will be conducted to the forest area and it will be decided on as whether to consider the effectiveness of each band. This is a necessary step to study the optimum band for forest crown canopy density analysis.

(2) Development for Function of Forest Cover Change Monitoring

For the development of forest cover change monitoring function, based on the above-mentioned study results of sustainable forest cover change monitoring method, the extraction of forest crown canopy density index by optimum band combination of the satellite image will be specifically conducted. Land cover situation in Kenya has various aspects and forest types are also different such as "Montane Forest / Western Rain Forest", "Costal Forest / Mangroves", "Dryland Forest" in each region. Therefore, it is necessary to investigate the optimum band for each forest type. This is also because it corresponds to the difference in color tones of satellite images due to different regional characteristics. Therefore, it is necessary to use satellite images with different forest types and regional characteristics and three scenes of satellite images were set as test areas for constructing the function.

The actual scenes are under consideration by the C/P, but one scene was selected that is containing the Kakamega forest area same as the pilot area for guidance of land cover / land use map 2020 creation. Since it is a construction of change monitoring function, time series LANDSAT-8 satellite image for 5 years was decided to be utilized for this purpose which are in 2013, 2014, 2015, 2016 and 2017.Regarding the satellite images of the three scenes that have been set for each year, equalization will be applied in order to compare each band (for example, blue, green, red, near infrared, mid infrared, etc.) in each region.

Regarding the equalization of the satellite image, the permanent bright and dark spots with no change will be extracted and that can be used commonly from the satellite image at each year and will be calculated for the equalization equation based on pixel value on each spot. For that reason, it was decided to keep the observation times of satellite images at each year to be uniform as possible.

After the mid-term review, the construction of the forest cover monitoring function was canceled after the planning stage as mentioned above, but the canopy density analysis method examined in the Component can provide forest cover change monitoring for "forest deterioration". And also it leads to improved classification accuracy of forest types (open, moderate, and dense). In the future, it is expected that the Kenyan side will build a forest cover monitoring function to utilize the current analysis methodology.

1.3.6 Activity on the MRV training

Throughout the MRV training, the Project aimed at training participants to acquire REDD+ outline and the methodology of M of MRV in particular and developing human resources for appropriately conducting MRV on REDD+ implementation in Kenya. The Component conducted the MRV training four times and the total number of participants were 94. The 1st and 2nd MRV trainings targeted beginners of REDD+ to get the basic knowledge of REDD+. The 3rd and 4th MRV trainings were planned for the KFS staff selected from among participants of the previous 1st and 2nd MRV training in order for them to strengthen their knowledge on REDD + and the progress of REDD+ readiness activities in Kenya. Table 1.3.6.1 shows the summary of each MRV training (Details on Appendix 28 - Appendix 31).

The MRV Training used to be held in July every year, but the 3rd MRV training was changed to January 2020 because the content of the training includes the Kenya's FRL setting submitted to the UNFCCC in January 2020. Due to the COVID-19 pandemic, dispatch of Japanese experts to Kenya was suspended since March. Therefore, the 4th MRV training which was initially scheduled to be held in July 2020 was held in July 2021.

Table 1.3.6.1 Summary of MRV training

No.	Date	Venue	Participants	Contents	Note
1st	5th–6th Jul. 2017	Naivasha	24	Outline of REDD+, Progress of Kenya’s REDD+, Outline of NFMS as part of MRV's M, Measurement for Activity	Appendix 28
2nd	4th–5th Jul. 2018	Naivasha	30		Appendix 29

No.	Date	Venue	Participants	Contents	Note
				Data, Measurement for Emission Factor, etc.	
3rd	21st–23rd Jan. 2020	Nakuru	20	Review of Outline of REDD+ and NFMS, FIP (including practice of use of FIP), FRL setting, Field practice for forest inventory, Introduction of Community Based Forest Biomass Monitoring, etc.	Appendix 30
4th	7th–9th Jul. 2021	Nakuru	20		Appendix 31

The following is a description of each MRV training activity, divided into Basic course; 1st and 2nd MRV training, and Advanced course; 3rd and 4th MRV training.

(1) Preparing the plan of MRV training

1) Basic course: 1st and 2nd MRV training

In consultation with the C/P, 1st MRV training was aimed at training personnel who will be responsible for REDD+ in Kenya in the future. 1st and 2nd MRV training were planned for KFS staff who are not familiar with REDD+, in order for them to understand REDD+ in general and the situation in Kenya, as well as understanding the M of MRV, especially AD and EF.

1st MRV training contents incorporated an overview of REDD+ and NFMS as the M of MRV on the first day, and AD and EF (forest inventory and biomass survey) on the second day (Table 1.3.6.2). In 2nd MRV training, in order to collect more opinions from the trainees as an improvement of 1st MRV training, the content was set for discussion and presentation by the trainees at the work shop (Table 1.3.6.3).

Table 1.3.6.2 Schedule of MRV training 2017

Day 1	
Time	**Activity**
8.30am - 9.00am	Registration
9.00am - 9.20am	Introductions and Training Objectives. Quick overview of CADEP-SFM project • Mr. Peter Nduati
9.20am - 10.50am	Outline of REDD+ Background and Mechanism of REDD+ • Mr. Kazuhisha KATO
11.00am - 11.30am	**HEALTH BREAK/TEA BREAK**
11.30am - 1.00pm	Outline of REDD+ Background and Mechanism of REDD+ • Mr. Kazuhisha KATO
1.00pm - 2.00pm	**LUNCH BREAK**
2.00pm - 3.30pm	Progress of Kenya's REDD+ • Peter Nduati
3.30pm - 4.00pm	**HEALTH BREAK / TEA BREAK**
4.00pm - 5.30pm	Outline of NFMS as part of MRV's M

	• Kazuhisha KATO

Day 2	
Time	**Activity**
8.30am - 10.00am	Measurement for Activity Data AD Introduction to remote sensing and utilization of remote sensing in forest monitoring • Mr. Kei SATO
10.00am - 10.30 am	**HEALTH BREAK/TEA BREAK**
10.30am - 12.00pm	Measurement for Activity Data AD SLEEK map development Land cover/land use conversion matrix • Ms. Faith MUTWIRI
12.00pm - 1.30pm	Measurement for Emission Factor EF National Forest Inventory NFI • Mr. Kazuhiro YAMASHITA
1.30 pm - 2.30 pm	**LUNCH BREAK**
2.30 pm - 4.00pm	Measurement for Emission Factor EF Conversion from Biomass to Carbon Stock • Ms. Sahori FUJIMURA
4.00pm - 4.30pm	END OF TRAINING
4.30pm - 17.00pm	**HEALTH BREAK/TEA BREAK**

Table 1.3.6.3 Programme of MRV training 2018

Day 1		
Time	**Activity**	**Lecturer/Instructor**
8:30 – 9:00	Registration	Ms. Florence Tuukuo
9:00 – 9:20	Orientation and Self-Introduction	Mr. Peter Nduati
9:20 – 11:20	Outline of REDD+ (Background and Mechanism of REDD+)	Mr. Kazuhisa KATO
11:20 – 11:50	Health Break / Tea Break	
11:50 – 13:00	Outline of National Forest Monitoring System (NFMS)	Mr. Kazuhisa KATO
13:00 – 14: 00	Lunch Break	
14:00 - 15:30	Progress of Kenya's REDD+	Mr. Peter Nduati
15:30 - 16:00	Health Break / Tea Break	
16:00 - 17:30	Measurement of Activity Data -AD- Introduction of remote sensing and utilization of remote sensing in forest monitoring	Mr. Kei SATO and Ms. Faith Mutwiri

Day 2		
Time	**Activity**	**Lecturer/Instructor**
9:00 - 10:00	Measurement of AD in Kenya SLEEK map development and Land cover/land	Mr. Kei SATO and Ms. Faith Mutwiri

Day 2		
Time	**Activity**	**Lecturer/Instructor**
	use conversion matrix	
10:00 - 10:30	Health Break / Tea Break	
10:30 - 11:30	Measurement of Emission Factor EF National Forest Inventory	Mr. Yoshihiko SATO
11:30 - 12:30	Measurement of EF Conversion from volume to biomass amount and carbon stock	Mr. Fredrick Ojuang
12:30 - 13:30	Lunch Break	
13:30 - 15:10	Group Work • Introduction (10min) • Group Discussion (60min) • Presentation and Discussion of Group Work (10min * 3 Groups)	Mr. Peter Nduati and Mr. Kazuhisa KATO
15:10 - 15:30	Short Test of Training	Mr. Kazuhisa KATO
15:30 - 16:00	Health Break / Tea Break	
16:00 - 16:30	Review（Check the Short Test）	Mr. Peter Nduati and Mr. Kazuhisa KATO
16:30 - 17:00	End of Training	Mr. Peter Nduati

2) Advanced course: 3rd and 4th MRV training

Based on the consultation with the C/P, the 3rd and 4th MRV training were planned for the KFS staff selected mainly from among participants of 1st and 2nd MRV training in order for them to strengthen their knowledge on REDD + and the progress of REDD+ readiness activities in Kenya. In particular, the training aimed to develop individuals who can promote the REDD+ activities in Kenya by learning the methodology of FRL setting, which is the baseline of carbon emissions from forests. In addition, assuming the future implementation of NFI, which is indispensable in further monitoring activities, field practice on the methods of plot setting and tree measurement in the forest inventory survey was incorporated in the training programme (Table 1.3.6.4).

Menengai forest was chosen for field practice incorporated into the programme of 3rd and 4th MRV training considering its forest conditions (i.e. forest type and understory vegetation, and safety) suitable for training purposes and its access from the MRV training venue in Nakuru. On account of this, the KFS forests in Nakuru County (Menengai, Bahati and Dundori forests) were surveyed

Table 1.3.6.4 Schedule of MRV training 2020 and 2021

Day 1: At a classroom in the Alps hotel

Time	Activity	Lecturer/Instructor
8:30 - 9:00	Registration	Ms. Florence Tuukuo /

Time	Activity	Lecturer/Instructor
		Ms. Veronica Syombua
9:00 - 9:20	Orientation and Self-Introduction	Mr. Peter Nduati
9:20 - 10:20	Review of Outline of REDD+ (Background and mechanism of REDD+)	Mr. Kazuhisa KATO
10:20 - 11:10	Review of Outline of National Forest Monitoring System (NFMS) of Kenya	Mr. Kazuhisa KATO
11:10 - 11:30	Health Break / Tea Break	
11:30 - 12:30	Forest Information Platform (FIP) in Kenya including practice of use of FIP	Mr. Richard Ngugi and Mr. Akinobu SEMBO
12:30 - 13:30	Lunch Break	
13:30 - 15:30	FRL setting in Kenya (1)	Dr. Mwangi Kinyanjui and Ms. Faith Mutwiri
15:30 - 16:00	Health Break / Tea Break	
16:00 - 17:30	FRL setting in Kenya (2)	Dr. Mwangi Kinyanjui and Ms. Faith Mutwiri

Day 2: At the classroom in Alps hotel and KFS forest

Time	Activity	Lecturer/Instructor
8:30 - 9:30	Explanation of the field practice for National Forest Inventory 1. How to use the devices 2. How to set a plot 3. How to measure trees	Mr. Fredrick Ojuang, Mr. Akinobu SEMBO, and Mr. Yoshihiko SATO
9:30 - 10:30 @Alps hotel	Field practice for forest inventory (1) 1. How to use the devices	Mr. Fredrick Ojuang, Mr. Akinobu SEMBO, and Mr. Yoshihiko SATO
10:30 - 11:30	Tea Break / Transportation to field	
11:30 – 13:00 @KFS forest	Field practice for forest inventory (2) How to set a plot	Mr. Fredrick Ojuang, Ms. Diana Kishiki, and Mr. Peter Sirayo
13:00 - 14:00	Lunch Break	
14:00 - 16:00 @KFS forest	Field practice for forest inventory (3) How to measure trees	Mr. Fredrick Ojuang, Ms. Diana Kishiki, and Mr. Peter Sirayo
16:00 – 17:00	Tea Break / Transportation to hotel	

Day3: At the classroom in Alps hotel

Time	Activity	Lecturer/Instructor
8:30 – 9:30	Conversion from volume to biomass	Mr. Fredrick Ojuang

Time	Activity	Lecturer/Instructor
	amount and carbon stock	
9:30 – 10:00	Introduction of Community Based Forest Biomass Monitoring	Mr. Yoshihiko Sato
10:00 - 10:30	Health Break / Tea Break	
10:30 - 12:30	Group Work Theme: Analysis of deforestation and forest degradation in Kenya • Introduction (10min) • Group discussion (60min) Presentation and discussion of Group Work (10min * 4 groups)	Mr. Peter Nduati and Mr. Kazuhisa Kato
12:30 - 13:30	Lunch Break	
13:30 - 14:00	Review	Mr. Peter Nduati Mr. Kazuhisa KATO
14:00 - 14:30	End of training	Mr. Peter Nduati

(2) Implementation of MRV Training

1) Basic course: 1st and 2nd MRV training

1st MRV training was held on July 5 and 6, 2017 at Masada Hotel, Nivasha. The summary of the training is as follows.

Objective : To understand REDD+ in general and the situation in Kenya, as well as an understanding of the M of MRV, especially AD and EF

Participants : Total 24 KFS staff

Date : 5th - 6th July 2017

Venue : Masada Hotel, Naivasha

A total of 30 participants (10 from the KFS main office and 2 from each conservancy (1 young and 1 mid-career)) were planned to participate the training, from KFS staff who is not familiar with REDD+. Since there were 6 absentees on the day of the training, the total number of participants was 24 (Table 1.3.6.5). Figure 1.3.6.1 shows the situation of the MRV training.

Table 1.3.6.5 Participant list of MRV training 2017

No	NAME	COUNTY	CONSERVANCY
1	ERICK ABUNGU	NANDI	North Rift
2	TOBIAS ACHUNGU	UASINGISHU	North Rift
3	PATRICIA KITHEKA	NAIROBI	Nairobi
4	PHILIP KOSGEY	NAIROBI	Nairobi
5	ROBERT KIPLAGAT TARUS	NYERI	Central Highlands
6	CAROLINE JULIA NJUA	KIAMBU	Central Highlands

No	NAME	COUNTY	CONSERVANCY
7	BENJAMIN PARENO	KAJIADO	Nairobi
8	BENJAMIN MUINDI	KAJIADO	Nairobi
9	CHARLES MURIUKI	KAJIADO	Nairobi
10	DANIEL MBURU	KAJIADO	Nairobi
11	ELIZABETH MUTHONI KARIUKI	EMBU	Eastern
12	MARGARET WANJIRU (NYANDARUA)	NYANDARUA	Central Highlands
13	EUNICE NJOROGE	NYANDARUA	Central Highlands
14	DOMINIC MUSANGO	KFS HEADQUARTERS	(Nairobi)
15	ALEX KATHUKU	KFS HEADQUARTERS	(Nairobi)
16	CAROLINE BUSURU	KFS HEADQUARTERS	(Nairobi)
17	EDWARD K. MUNENE	BARINGO	Mau
18	BONIFACE MULWA	KERICHO	Mau
19	AMBROSE GENGA	NAKURU	Mau
20	PETER KARIUKI KOORO	KIRINYAGA	Central Highlands
21	PETER NGANGA	KIRINYAGA	Central Highlands
22	SIMON GUCHU	THIKA	Central Highlands
23	FREDRICK OJUANG	KFS HEADQUARTERS	(Nairobi)
24	MARGARET WANJIRU(NAIROBI)	NAIROBI	Nairobi

Image1:Facilitation by C/P

Image2:The lecture of Japanese expert

Image3:The lecture of C/P

Image4:Group photograph after MRV training

Figure 1.3.6.1 the situation of MRV training in 2018

The summary of 2nd MRV training is as follows.

Objective : To understand REDD+ in general and the situation in Kenya, as well as an understanding of the M of MRV, especially AD and EF

Participants : Total 30 KFS staff (Table 1.3.6.6)

Date :4th - 5th July 2018

Venue : Masada Hotel, Naivasha

Figure 1.3.6.2 shows the situation of the training.

Table 1.3.6.6 List of participants 2018

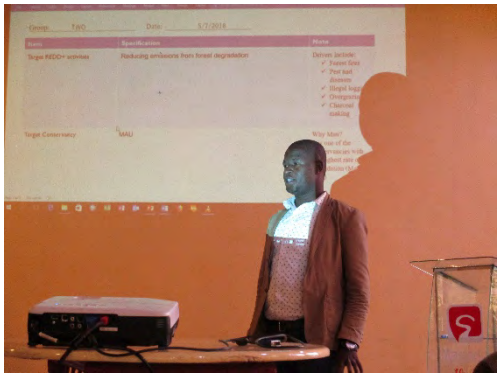
No	Name	Designation	County	Conservancy
1	Jane Chepkonga	ACF	Kiambu	Central Highlands
2	Charles Muriuki	ACF	Nakuru	Mau
3	Amina Osman	ACF	Muranga	Central Highlands
4	Margaret Wanjiru	ACF	Nakuru	Mau
5	Beth Welemba	ACF	Narok	Mau
6	Erick Migaya	ACF	Uasin Gishu	North Rift
7	Edwin Kipkut	ACF	Nyandarua	Central Highlands
8	Joseph Macharia	ACF	Kajiado	Nairobi

No	Name	Designation	County	Conservancy
9	Isaac Omoding	ACF	Migori	Nyanza
10	Ambrose Genga	ACF	Kilifi	Coast
11	Brian Watiri	ACF	Kilifi	Coast
12	Hance Juma	Forester	Isiolo	Ewaso North
13	Salome Biwott	Forester	Tharaka Nithi	Eastern
14	Antony Tompoi	Forester	Meru	Eastern
15	Allan Awita	Forester	Laikipia	Central Highlands
16	David Keiza	Forester	Kiambu	Central Highlands
17	Dominic Mose	Forester	Muranga	Central Highlands
18	Pius Mugendi	Forester	Meru	Eastern
19	Eliud Thuo	Forester	Kericho	Mau
20	Everline Kiptoo	Forester	Muranga	Central Highlands
21	Geofrey Olemeibuko	Forester	Meru	Eastern
22	Irine Kiprono	Forester	Makueni	Eastern
23	Jacob Kongo	Forester	Kitui	Eastern
24	Sarah Keah	Forester	Nyandarua	Central Highlands
25	Peter Kirui	Forester	Homabay	Nyanza
26	Nancy Gacheri	Forester	Embu	Eastern
27	Newton Ngero	Forester	Nyeri	Central Highlands
28	Rose Wawira	Forester	Kericho	Mau
29	William Shikuku	Forester	Baringo	Mau
30	Winnie Jemosop	Forester	Vihiga	Western

*ACF：Assistant Conservator Forests

The situation of MRV training at MASADA hotel

The situation of group discussion



The presentation by the participant

The implementation of the short test

Figure 1.3.6.2 the situation of MRV training in 2018

2) Advanced course: 3rd and 4th MRV training

The 3rd training was conducted from 21st to 23rd January 2020 for 3 days. The MRV trainings in previous years were conducted in July, but as the Kenya's FRL report was submitted to the UNFCCC in January 2020, the training was re-scheduled in January this year to fully align with the contents of the submitted FRL.

The outline of the 3rd training is shown below.

Training Objectives : Improve knowledge on REDD + and understand the progress of REDD+ readiness activities in Kenya

Participants : 20 KFS staffs selected from among the participants in the 1st and 2nd MRV training. Eventually, 20 KFS staffs from 9 Conservancies and HQs of KFS participated in the training (Table 1.3.6.7).

Date : 21st to 23rd January 2020 (for 3 days)

Venue : Alps hotel and KFS forest in Nakuru county

Table 1.3.6.7 Participant list of MRV training 2020

No	Name	Designation	County	Conservancy
1	Jane Chepkonga	ACF*	Kiambu	Central Highlands

No	Name	Designation	County	Conservancy
2	Edwin Kipkut	ACF	Nyandarua	Central Highlands
3	Allan Awita	Forester	Laikipia	Central Highlands
4	Robert Tarus	Forester	Nyeri	Central Highlands
5	Ambrose Genga	ACF	Kilifi	Coast
6	Antony Tompoi	Forester	Meru	Eastern
7	Irene Kiprono	Forester	Makueni	Eastern
8	Hance Juma	Forester	Isiolo	Ewaso North
9	Margaret Mugure	ACF	Nakuru	Mau
10	Brian Watiri	ACF	Baringo	Mau
11	Boniface Mulwa	ACF	Kericho	Mau
12	Charles Muriuki	ACF	Nakuru	Mau
13	Joseph Macharia	ACF	Kajiado	Nairobi
14	Margaret Wanjiru	ACF	Nairobi	Nairobi
15	Erick Migaya	ACF	Uasin Gishu	North Rift
16	Carolyne Busuru	ACF	Nandi	North Rift
17	Peter Kirui	Forester	Homabay	Nyanza
18	Winnie Jemosop	Forester	Vihiga	Western
19	Amina Osman	ACF	Nairobi	KFS HQs
20	Isaac Omoding	ACF	Nairobi	KFS HQs

*ACF：Assistant Conservator of Forests

In the field training conducted on the 2nd day, a training on how to use Survey123 using a tablet as an inventory survey device and Vertex for measuring tree height was carried out. In the field training, the participants were divided into 4 groups. Each group was trained respectively by instructors from KFS and/or Japanese experts. In the group work on the 3rd day, the groups conducted an analysis of deforestation and forest degradation in Kenya. (Figure 1.3.6.3)


Lecture in classroom on 1st day


Instruction of Vertex on 2nd day


Plot setting on-site on2nd day


Group work on 3rd day
(Analysis of deforestation and forest degradation)

Figure 1.3.6.3 The situation of MRV training in 2020

The 4th MRV Training was rescheduled from July 2020 to July 2021 due to the restriction of Japanese experts to travel to Kenya for the prevention of COVID-19 infection. The outline of the 4th MRV training is shown below.

Training Objectives : Improve knowledge on REDD + and understand the progress of REDD+ readiness activities in Kenya

Participants : 20 KFS staffs selected mainly from among the participants in the 1st and 2nd MRV training. Eventually, 20 KFS staffs from 9 Conservancies and HQs of KFS participated in the training (Table 1.3.6.8).

Date : 7th to 9th January 2021 (for 3 days)

Venue : Alps hotel and KFS forest in Nakuru county

Since the 4th MRV training was planned in the affection of the COVID-19 disaster, the Team consulted with the JICA Kenya office in advance to obtain approval, and the following measures were to come into

(1) To get a big enough conference room with adequate social distancing,

(2) To check the temperature at the registration, and wearing of appropriate facemasks, frequent washing hands with soap and sanitizing. Prepare and bring the spare facemasks and sanitizer.

(3) Remind participants to maintain social distance during lunch and break time, and to disinfect their hands when eating and drinking,

(4) Inform the participants to avoid the risk of infection during the travel to participate in the 4th MRV training in advance.

In the 4th MRV training, the 20 KFS staff from each Conservancy and KFS HQs were invited, and all members participated (Table 1.3.6.8). The implementation of the training is shown in Figure 1.3.6.4.

Table 1.3.6.8 Participant list of MRV training 2021

No	Name	Designation	County	Conservancy
1	Beth Welemba	ACF*	Narok	EC's office
2	Salome Biwott	Forester	Tharaka Nithi	Eastern
3	David Keiza	Forester	Kajiado	Nairobi
4	Dominic Mose	Forester	Muranga	Central Highlands
5	Pius Mugendi	Forester	Meru	Eastern
6	Everline Kiptoo	Forester	Nyeri	Central Highlands
7	Geofrey Olemeibuko	Forester	Baringo	Mau
8	Jacob Kongo	Forester	Kitui	Eastern
9	Sarah Keah	Forester	Nyandarua	Central Highlands
10	Nancy Gacheri	Forester	Embu	Eastern
11	Rose Wawira	Forester	Meru	Eastern
12	Patricia Kitheka	ACF	Nairobi	Nairobi
13	Eunice Njoroge	ACF	Nyandarua	Central Highlands
14	Betina Odhiambo	ACF	Nairobi	Karura
15	Vashit Kivondo	ACF	Nairobi	Karura
16	Philip Kosgey	ACF	Kajiado	Loitoktok
17	Benjamin Muindi	ACF	Narok	Mau
18	Erick Abungu	ACF	Marsabit	Ewaso North/lorenge
19	Tobias Achungu	ACF	Uasin Gishu	North Rift
20	Newton Ngero	Forester	Meru	Eastern

*ACF：Assistant Conservator of Forests

Figure 1.3.6.4 The situation of MRV training in 2021

(3) Review and Improvement of the MRV Training

1) Basic course: 1st and 2nd MRV training

The understanding of participants was confirmed by the short test after finishing the all lectures in the training. The short test consisted of a total 20 true-false questions: 8 questions in Outline of REDD+, 4 questions in AD, 4 questions in NFI and 4 questions in Carbon Stock (Figure 1.3.6.5 and Figure 1.3.6.6). As a result of the short test on 1st MRV training the average point was 13.0 points, and the percentage of correct answers was 65.2% as Figure 1.3.6.7 shows. As a result of the short test on 2nd MRV training the average point was 13.3 points, and the percentage of correct answers was 66.7% as Figure 1.3.6.8 shows. According to the result of short test, the percentage of correct answer was low in questions for REDD+ outline and NFMS. REDD+ outline and NFMS contain a lot of abstract contents such as REDD+ structure framework, methodology theory and trend of international discussion, so it seemed difficult for the participants of REDD+ beginner to understand all the contents in a short time.

There were many comments that the contents of lectures help to understand REDD+. There were also requests to allow more time to understand REDD+ and share all presentations, etc. The Team shared these results with the C/P and agreed to review the number of days of training, the contents and the method for the next MRV training.

The Short Test of REDD+ Training on Measurement, Reporting, and Verification (MRV)

The REDD+ component in the Capacity Development Project for the Sustainable Forest Management in the Republic of Kenya.

At Naivasha, 5th July 2018

first name	family name

Question	Answer	
1. According to the Fourth Assessment Report of the IPCC, which was published in 2007, about 30% of GHG emissions comes from deforestation and forest degradation. Also, FAO shows that deforestation is in progress in particular Brazil, Indonesia, and tropical Africa.	True	False
2. In the Cancun agreement, the Parties are required to set (a) action plan and/or national strategy of REDD+, (b) Forest reference levels and / or forest reference emission levels, (c) National forest monitoring system, and (d) Safeguard information system.	True	False
3. In a phased approach, it is divided into three phases, which are first phase; readiness, the second phase; implementation, and the third phase; full implementation.	True	False
4. The five activities of REDD + are, (i) Reducing emissions from the deforestation, (ii)reducing emissions from the forest degradation, (iii) conservation of forest carbon stocks, (iv) Enhancement of forest carbon stocks, and (v)monitoring of the forest carbon stocks.	True	False
5. It is necessary to clarify the driving forces of the deforestation and forest degradation, which are the basis for implementation of the REDD + activities.	True	False
6. For the calculation of the emission/removal, "Emission factor" that can be grasped by remote sensing image analysis and "Activity data" that can be grasped by National forest inventory and Biomass survey are required.	True	False
7. There are 5 items in the Safeguard for REDD+, (e.g. forest governance, respect for the knowledge and right of indigenes people, conservation of natural forest and biodiversity).	True	False
8. GCF is the biggest fund among international funds.	True	False
9. The resolution of LANDSAT satellite image which is used in SLEEK is 10m.	True	False
10. High reflection from vegetation occurs in the near infrared.	True	False
11. The classification method used in SLEEK is a supervised classification	True	False

1 / 2

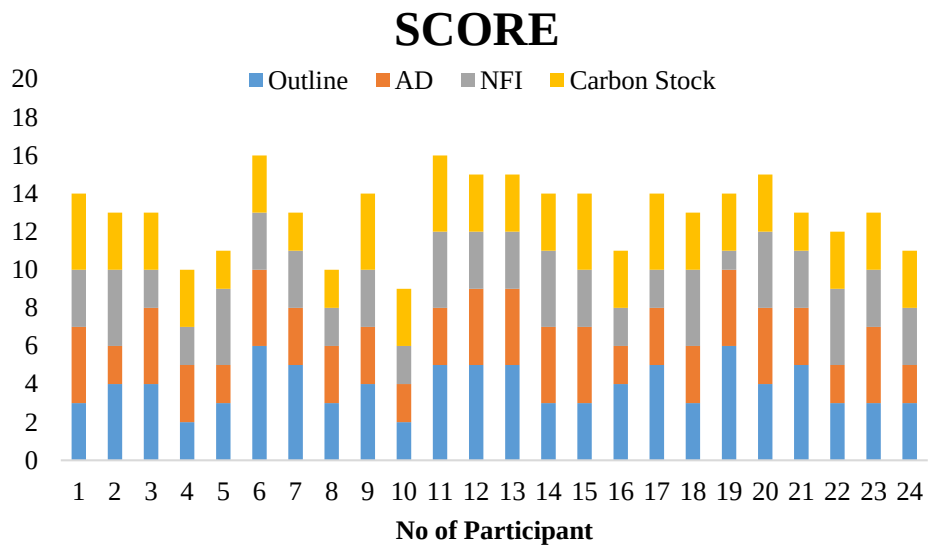
Figure 1.3.6.5 Short test sheet for 1st and 2nd MRV training (1)

12. The classification accuracy of the land cover / land use map created by SLEEK is less than 70%	True	False
13. Sampling for NFI implementation requires statistical processing.	True	False
14. The internationally approved shape of sampling plot is only square.	True	False
15. The plot shape of Kenya is that circle is proposed.	True	False
16. In the plot of the ICFRA proposal, regeneration have to be measured.	True	False
17. The amount of biomass is half (1/2) of the dry weight	True	False
18. Kenya has developed original allometric equation to calculate EF.	True	False
19. When designing a biomass survey, tree of the maximum diameter class must be included in the sample	True	False
20. By using BCEF, the amount of biomass can be calculated from volume.	True	False
If you have any comments or request that you can share with us, please describe in below		

Thank you .

Figure 1.3.6.6 Short test sheet for 1st and 2nd MRV training (2)

Figure 1.3.6.7 Result of MRV training short test 2017



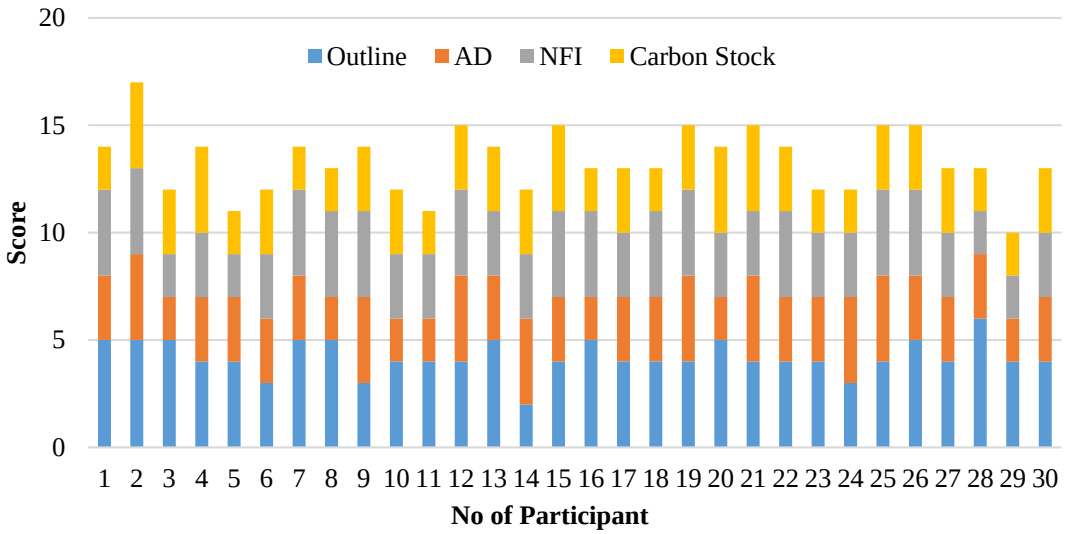


Figure 1.3.6.8 Result of short test of MRV training 2018

2) Advanced course: 3rd and 4th MRV training

An evaluation was conducted by a questionnaire on the final day of the training, and each participant was asked to answer for each subject in 5 levels of understanding among: 1. Very difficult to understand, 2. Difficult to understand, 3. Fair to understand, 4. Easy to understand, and 5. Very easy to understand (Figure 1.3.6.9 and Figure 1.3.6.10). The total average of understanding level of each participants was 4.5 in 3rd MRV training (Table 1.3.6.9), and 3.9 in 4th MRV training (Table 1.3.6.10). In general, the result of the self-evaluation shows that the participants' understanding of each subject was high.

There were many comments that the training contents were useful to understand REDD+. In addition, there were some requests such as "organizing regular training courses" and "securing more time for field practice" in order to master the techniques and understand more of the training contents.

4th REDD+ Training on Measurement, Reporting, and Verification (MRV) in 2021

Date → → : From 7th to 9th July 2021

Place → → : Alps hotel and KFS forest in Nakuru

Name → → :.....

Conservancy → :.....

Please answer the following questions so that we can improve our training in the future. Your cooperation to this questionnaire will be appreciated.

Q1: About the contents of the training, How well did you understand each class? Please select an applicable number as below for each class.

1. Very difficult to understand
2. Difficult to understand
3. Fair to understand
4. Easy to understand
5. Very easy to understand

Day1

1.0 Outline of CADEP-SFM, Forest Management in Japan, Introducing Drone

(Select an applicable number):

1, → 2, → 3, → 4, → 5

1.1 Review of Outline of REDD+.

1, → 2, → 3, → 4, → 5

1.2 Review of Outline of National Forest Monitoring System (NFMS) of Kenya.

1, → 2, → 3, → 4, → 5

1.3 Forest Information Platform (FIP) in Kenya including practice of use of FIP.

1, → 2, → 3, → 4, → 5

1.4 FRL setting in Kenya (1).

1, → 2, → 3, → 4, → 5

Day2

2.1 Explanation of the field practice for National Forest Inventory

1, → 2, → 3, → 4, → 5

2.2 Field practice for forest inventory.

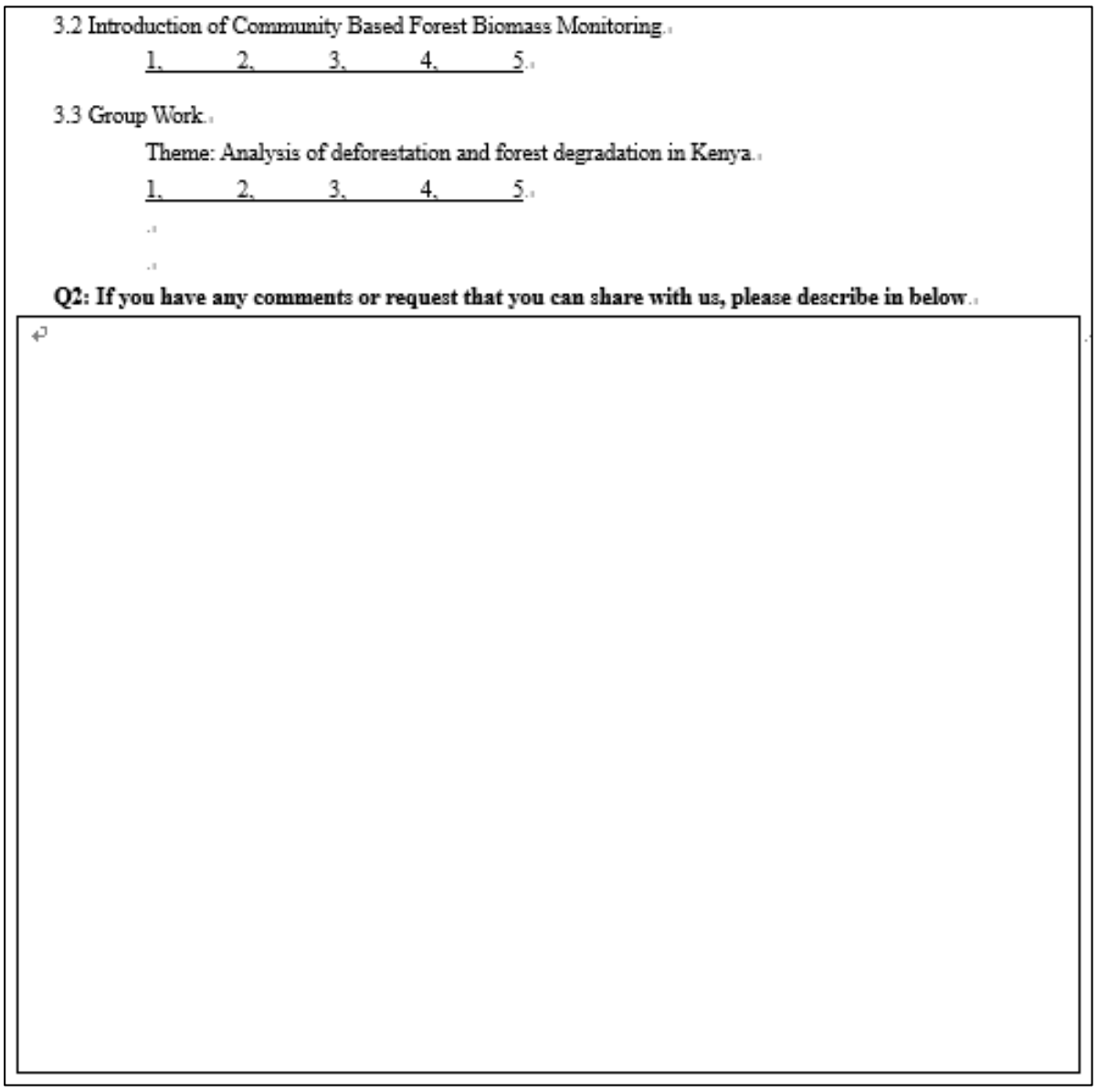
1, → 2, → 3, → 4, → 5

Day3

3.1 Conversion from volume to biomass amount and carbon stock.

1, → 2, → 3, → 4, → 5

Figure 1.3.6.9 Questionnaire sheet for evaluation of understanding in 3rd and 4th MRV training (1)


3.2 Introduction of Community Based Forest Biomass Monitoring.

1, 2, 3, 4, 5.

3.3 Group Work.

Theme: Analysis of deforestation and forest degradation in Kenya.

1, 2, 3, 4, 5.

Q2: If you have any comments or request that you can share with us, please describe in below.

Figure 1.3.6.10 Questionnaire sheet for evaluation of understanding in 3rd and 4th MRV training (2)

Table 1.3.6.9 Result of understanding level* for each class in MRV training 2020

Class /No	Day1				Day2		Day3			Ave.
	1.1 REDD+	1.2 NFMS	1.3 FIP	1.4 FRL setting	2.1 Explanation of Field practice	2.2 Field Practice	3.1 Calculation of Carbon Stock	3.2 Introduction of Participatory Forest Monitoring	3.3 WG	
1	3	4	4	3	5	5	4	3	5	4.0
2	5	5	5	5	5	5	5	5	5	5.0
3	4	4	5	3	3	3	4	5	5	4.0
4	4	4	5	4	5	5	4	4	5	4.4
5	4	4	4	3	4	5	3	3	4	3.8
6	5	5	4	4	4	4	4	5	4	4.3
7	4	5	5	5	5	5	4	5	5	4.8
8	4	5	4	3	5	4	3	4	4	4.0
9	4	4	4	4	4	4	4	4	4	4.0
10	5	5	5	5	5	5	5	5	5	5.0
11	5	5	5	4	5	5	5	5	5	4.9
12	4	4	4	4	4	4	3	3	3	3.7
13	5	5	5	5	5	5	5	5	5	5.0
14	4	5	3	5	5	5	5	4	5	4.6
15	4	4	5	4	4	4	4	4	5	4.2
16	5	5	5	4	5	5	4	5	4	4.7
17	5	5	5	5	4	5	4	5	5	4.8
18	5	5	5	5	5	5	4	5	5	4.9
19	5	4	5	5	5	5	4	5	5	4.8
20	5	5	5	5	5	5	5	4	5	4.9
Ave.	4.4	4.6	4.6	4.2	4.6	4.6	4.1	4.4	4.6	4.5

*Understanding level:

1. Very difficult to understand
2. difficult to understand
3. Fair to understand
4. Easy to understand
5. Very easy to understand

Table 1.3.6.10 Result of understanding level* for each class in MRV training 2021

Class /No	Day1					Day2		Day3			Ave.
	1.0 CADEP	1.1 REDD+	1.2 NFMS	1.3 FIP	1.4 FRL setting	2.1 Explanation of Field practice	2.2 Field Practice	3.1 Calculation of Carbon Stock	3.2 Introduction of Participatory Forest Monitoring	3.3 WG	
1	4	5	5	4	4	5	5	3	4	5	4.4
2	4	4	4	4	4	4	4	3	4	5	4.0
3	3	4	3	3	2	4	5	4	3	5	3.6
4	3	4	4	4	5	5	5	3	3	4	4.0
5	5	4	5	4	4	5	5	3	3	5	4.3
6	4	5	4	5	4	3	5	4	4	5	4.3
7	4	4	3	3	4	4	3	3	4	5	3.7
8	4	5	3	4	4	5	5	3	4	5	4.2
9	4	5	4	4	4	4	4	4	4	4	4.1
10	4	5	4	4	5	5	4	4	3	5	4.3
11	4	4	4	4	4	4	4	4	4	5	4.1
12	4	3	3	3	1	1	1	2	3	1	2.2
13	4	4	4	4	4	4	5	3	4	5	4.1
14	4	4	4	4	4	5	5	4	4	5	4.3
15	4	5	5	4	4	5	5	4	5	5	4.6
16	3	4		3	3	4	4	3	4	5	3.7
17	4	5	4	4	4	4	4	4	5	4	4.2
18	5	4	4	4	4	4	4	3	4	4	4.0
19	1	1	2	1	2	1	1	2	1	1	1.3
20	4	4	4	4	4	4	5		3	4	4.0
Ave.	3.8	4.2	3.8	3.7	3.7	4.0	4.2	3.3	3.7	4.4	3.9

*Understanding level:

1. Very difficult to understand
2. difficult to understand
3. Fair to understand
4. Easy to understand
5. Very easy to understand

(4) Reflecting the MRV Training to NFMS

1) Basic course: 1st and 2nd MRV training

In 1st MRV training, feedback that can be reflected to NFMS was small, because they were the lectures targeting the beginners and the contents of training were mainly classroom lectures. For this reason, from the 2nd MRV training, the Team conducted discussions and presentations by the trainees as work

shop, in addition to lectures, in order to obtain a wide range of feedback from the trainees. In response to requests from MRV training participants, the training materials used in the MRV training and participants list were posted on the FIP for sharing.

2) Advanced course: 3rd and 4th MRV training

In 3rd and 4th MRV training, the participants took the training on forest survey methods using Survey123 and Bertex, in preparation for NFI practice. In addition, FIP site on developing was introduced to the participants and the various functions to be implemented in the FIP were explained by the C/P development staff. These activities on MRV training led to the improvement of the survey form in Survey123 and the development of the FIP from the user's perspective.

2. Achievements of the Component

2 Output and Indicators

2.1 Outputs and indicators

2.1.1 Indicator 3-1 (The methodology of forest monitoring under the NFMS is established and documented.)

<Achieved>

The methodologies for monitoring forest features, such as the forest cover and forest cover change for the Activity Data and the forest carbon stock for the Emission Factor, have been developed, and the NFMS document ver.1 (draft) was elaborated to encompass details on the structure of the data management function, institutional arrangements, the calendar for NFMS operations, etc., as well as the aforementioned methodologies for the monitoring function.

2.1.2 Indicator 3-2 (Forest Information Platform as data management function of the NFMS is developed.)

The Forest Information Platform (FIP) has been installed on a newly procured server. The base software had been installed and updated. In addition, the process of designing and uploading content such as map data has been improved. The knowledge and capacity for the operation of FIP, GIS and field survey tool have been enhanced. The development of institutional arrangement for operation and maintenance of FIP has been achieved. FIP management team has been established inside the KFS. The upper level commission formation by all stakeholders will be established in the future when the FIP start to handle the agency wide contents.

2.1.3 Indicator 3-3 (FRL is established in consultation with other stakeholders for submission to the UNFCCC by the Kenyan Government.)

<Achieved>

The FRL report was submitted to UNFCCC in January 2020. The modified FRL report based on the results of the Technical Assessment (TA) by UNFCCC was then submitted to UNFCCC in August 2020. The TA report was finalized and published on the UNFCCC website.

2.1.4 Indicator 3-4 (Creation of Land Cover/Land Use Map of 2020 is undertaken.)

< Archived >

This indicator was achieved as the Land Cover / Land Use Map 2020 creation was planned and started. For the creation itself, the LANDSAT-8 satellite image data to be used was downloaded and pre-processed. Image classification was also carried out, and a draft version of the Land Cover / Land Use Map was created. Currently, final check is being made regarding quality such as classification errors. As of October 2021, the progress of map creation is 75%.

2.2 Project Purpose and indicators

REDD+ readiness process is advanced by the establishment of NFMS and FRL (Indicators for the Component)

<Achieved>

The process to establish the FRL has been completed and the process to establish the NFMS is almost completed. The REDD+ readiness process in Kenya was advanced through the aforementioned processes.

3 History of PDM Modification

A good many PDM modification ideas were recommended through the Consultation mission (July 2018) and Mid-term review (Feb. 2019), and the Project followed the recommendations. One of the major changes, according to the Mid-term review, was the name of Output 3 for the Component.

Output	Name of the Output in PDM ver.2	Name of the Output in PDM ver.3	Reason for the change
3	Technical capacities for REDD+ readiness activities in KFS are strengthened.	Technical capacities for REDD+ readiness activities and forest monitoring for sustainable forest management in KFS are strengthened.	The technical capacities to be strengthened include not only the REDD+ readiness capacity, but also the monitoring capacity for sustainable forest management.

While the Project, including the Component, was initially supposed to come to an end in June 2021, it was extended by four months (until Oct. 2021) on Apr. 2021 to adjust for delays in activities by the COVID-19 pandemic. The other PDM changes regarding indicators and activities are described in Appendix 32.

4 Others

4.1 Results of Environmental and Social Considerations (if applicable)

Nothing in particular

4.2 Results of Considerations on Gender/Peace Building/Poverty Reduction (if applicable)

Nothing in particular

III Results of Joint Review

1 Results of Review based on DAC Evaluation Criteria

Since “Results of the Review based on the Development Assistance Committee (DAC) Evaluation Criteria” are assessed in the project completion report of the Project, please refer the report.

2 Key Factors Affecting Implementation and Outcomes

1) Maintenance contracts for ESRI product

It is KFS's responsibility to secure a budget and renew the maintenance contract for ESRI products, but there was a delay in securing budget during the project. If the maintenance contract is not renewed, the operation of the field survey system using FIP and Survey123 would be disrupted disturbed, or even worse, the system itself may become inoperable.

2) Establishment of management and operation team and upper level commission for FIP

The Project has been discussing the necessity and the structure and the role of an upper level commission to manage and operate the FIP. The management team of KFS has been established. However, due to the wide range of agencies involved in the FIP, the establishment of the upper level commission has been delayed. If the upper level commission is not up and running soon after the project completion, there could be problems with collecting/updating information and its reliability in FIP operation. This team will totally manage the FIP temporally until the upper level commission is established.

<Lessons Learnt>

1) Maintenance contracts for ESRI product

Securing a maintenance budget is essential for the continuous operation of the FIP as it is constructed with commercial products. The importance of budgeting to maintain and operate a system should be well understood by an implementing agency and necessary actions to secure a budget should be made for the sustainable use of the system.

2) Establishment of management and operation team and upper level commission for FIP

Establishing a new structure within a government agency requires a certain time and close coordination among relevant stakeholders. Therefore, enough time should be secured and necessary coordination is to be made in accordance with the circumstances of a country before its establishment.

IV For the Achievement of Overall Goals after the Project Completion

1 Prospects to achieve Overall Goal

Of the indicators for Overall Goals set for the Project, the following section describes the prospects for achieving the indicator for the Component.

"Monitoring by methodologies set in the NFMS (National Forest Monitoring System) and the Forest Information Platform as data management function of the NFMS is sustainably implemented and utilized respectively." (Indicators for the Component)

Regarding implementation of monitoring by methodologies set in the NFMS, Kenya and the KFS have the ability to achieve the main components of the monitoring in the NFMS, namely, to create a land cover / land use map and implement a National Forest Inventory (NFI). In addition, the data input format by Survey 123 for the NFI was prepared, and exercises to master the usage of the format were conducted. Moreover, in order to ensure the sustainable utilization of the FIP operation, discussions are being held to secure the abilities needed to update the data on the FIP, etc. In December 2020, moreover, the KFS renewed the maintenance contract with ESRI Inc. for the FIP, which was developed based on the ESRI ArcGIS server. Therefore, a sustainable FIP has been guaranteed. The monitoring of the PaMs is an exercise Kenya has yet to undertake, however, and will require the further development of specific methods for each monitoring item.

Meanwhile, the data and information to be stored in the FIP can be utilized for REDD+ implementation and sustainable forest management in Kenya if the FIP is operationalized. For the operation, however, the maintenance contracts for the ESRI product should be continuously secured, and a management and operation organization for the FIP should be established and operationalized, as mentioned above in Section III.

In addition, the achievement of this indicator will provide a quantitative confirmation of the achievement of the targets of NDC and 10% forest cover in the Vision 2030. In this sense, the achievement of this indicator is indispensable.

2 Plan of Operation and Implementation Structure of the Kenyan side to achieve Overall Goal

SLEEK can function to coordinate the creation of a land cover / land use map in collaboration with KFS and other related organizations that have the technical ability to create it. The KFS also has the ability to coordinate and implement the NFI. As such, the monitoring can be implemented both technically and institutionally. A budget plan to implement the monitoring, however, has yet to be prepared.

3 Recommendations for the Kenyan side

The Government of Kenya should ensure that budget is allocated to the ongoing implementation of the monitoring as described in the NFMS document, as well as to the cost of properly managing and operating the FIP.

The current FRL report and NFMS document ver.1 mention future improvements. Kenya should

therefore seek the improvements when it obtains the technology to do so.