REDD+ Training on Measurement, Reporting, and Verification (MRV)

Target Participants : KFS Staff who does not know REDD+ well. 30 Persons from HQs and each conservancy

Date : 4th and 5th July 2018

Place : Naivasha, Masada Hotel

Day 1

Time	Activity	Lecturer/Instructor
8：30 ～ 9：00	Registration	Ms. Florence
9：00 ～ 9：20	Orientation and Self-Introduction	Mr. Peter N
9：20 ～ 11：20	Outline of REDD+ (Background and Mechanism of REDD+)	Mr. KATO
11：20 ～ 11：50	Health Break / Tea Break	
11：50 ～ 13：00	Outline of National Forest Monitoring System (NFMS)	Mr. KATO
13：00 ～ 14：00	Lunch Break	
14：00 ～ 15：30	Progress of Kenya's REDD+	Mr. Peter N.
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. K. SATO

Day 2

Time	Activity	Lecturer/Instructor
9：00 ～ 10：00	Measurement of AD in Kenya（SLEEK map development and Land cover/land use conversion matrix)	Mr. K. SATO
10：00 ～ 10：30	Health Break / Tea Break	
10：30 ～ 11 ：30	Measurement of Emission Factor -EF- (National Forest Inventory (NFI))	Mr. Y. SATO
11：30 ～ 12：30	Measurement of EF (Conversion from volume to biomass amount and carbon stock)	Mr. Fredrick O.
12：30 ～ 13：30	Lunch Break	
13：30 ～ 15：00	Group Work • Introduction (10min) • Group Discussion (60min) • Presentation and Discussion of Group Work (10min * 2 Groups)	Mr. Peter N Mr. KATO

Time			Activity	Lecturer/Instructor
15：00	～	15：30	Quiz of Training	Mr. KATO
15：30	～	16：00	Health Break / Tea Break	
16：00	～	16：30	Review（Check the Quiz）	Mr. Peter N. Mr. KATO
16：30	～	17：00	End of Training	Mr. Peter N.

2018 MRV TRAINING PARTICIPANTS' LIST

S/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
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

Outline of REDD+

The REDD+ Readiness Component
in
the Capacity Development Project for the Sustainable Forest Management
in the Republic of Kenya

By Kazuhisa KATO - Compornent3 Team Leader
2018.7.4

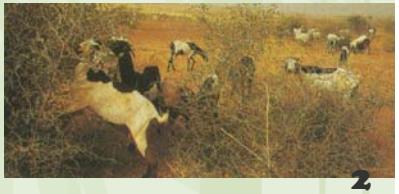
Background
(Global Environmental Crises and the Consideration of Solution)

1. Promotion of Sustainable Forest Management

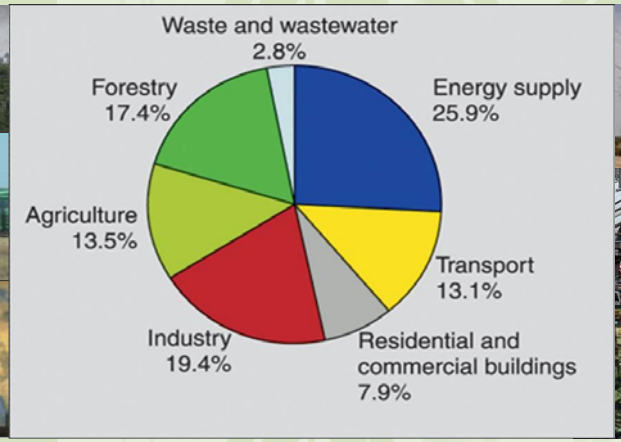
- **The Earth Summit ; UN Conference on Environment and Development (1992 Agenda 21)**
- **Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management**
- **Conservation and Sustainable Development of All Types of Forests**

2. Measures against Global Warming

- **The Intergovernmental Panel on Climate Change (IPCC) points out global warming**
- **THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)**

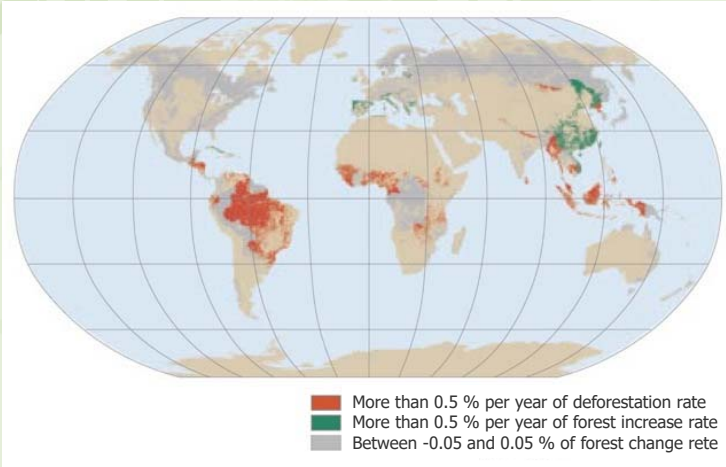


How much of the greenhouse gases (GHG) are emitted by the forestry sector



Source: IPCC Fourth Assessment Report, 2007

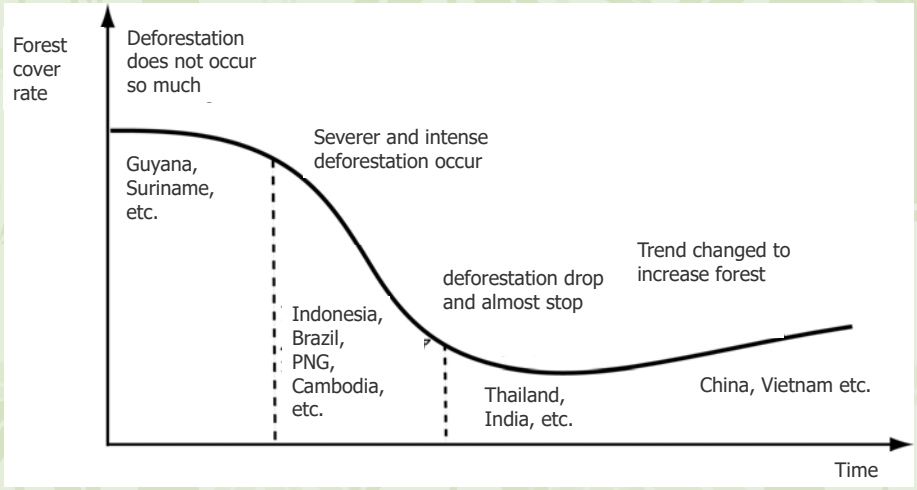
Change of forest area in the world



Rate of forest area change from 2000 to 20005
Information source: FRA 2005 by FAO

- Net deforestation area in the world was 7.3 million ha (2000–2005)
- Deforestation concentrating in the developing countries
- However, forest conditions in the developing countries were not same
- Biggest deforestation : 3.1 million ha in Brazil and 1.87 million ha in Indonesia which account for 60 % of the world deforestation area

Pattern of forest change



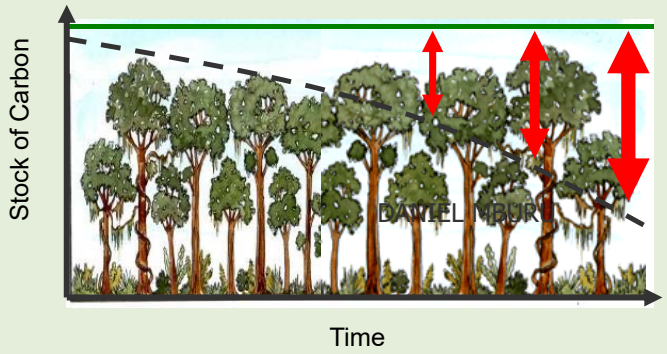
What is REDD Plus?

- REDD+（REDD-plus）Mechanism

  The basic concept of REDD+ is to provide economic incentives such as funding to developing countries for activities reducing GHG emissions from deforestation and forest degradation, and maintaining or enhancing carbon stocks through forest conservation.

- ✓ REDD is "Reducing Emissions from Deforestation and Forest Degradation"
- ✓ "+" is forest conservation, sustainable forest management and enhancement of forest carbon sinks

Concept of REDD+



With REDD+ activities

providing economic incentives for reducing GHG emissions

Forest Reference (Emission) Level

(without REDD activities)

Framework under the United Nation

Over a decade ago, most countries joined an international treaty -- the United Nations Framework Convention on Climate Change (UNFCCC) -- to begin to consider what can be done to mitigate global warming and to cope with whatever temperature increases are inevitable.

In addition to the treaty: the Kyoto Protocol, which has more powerful (and legally binding) measures, was adopted in 1997 and came into force in 2005. the Paris agreement, which has no legal binding, was adopted in 2015 and came into force in 2016 following Kyoto Protocol.

The UNFCCC secretariat supports all institutions involved in the climate change process, particularly the COP, the subsidiary bodies and their Bureau (SBSTA).

Proposing REDD+ mechanism

COP11 (Montreal, 2005)

"Acquisition of carbon credit through REDD: Reducing Emissions from Deforestation in the Developing Country" was proposed jointly by Papua New Guinea and Costa Rica on behalf of the Coalition for Rainforest Nations

"Pioneering this proposal, it was began to rapidly take up REDD in international negotiations on the climate change"

Launching REDD Mechanism

COP13 (Bali, Indonesia 2007)

"Policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation (REDD) in developing countries;
and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries".

"Bali Action Plan"

Progress of discussion on REDD Mechanism

COP15 (Copenhagen, 2009)

"Recognizing the crucial role of reducing emissions from deforestation and forest degradation and the need to enhance the sequestration of GHG, and immediately establishing a system of REDD+, providing positive incentives, and advancing the mechanism to enable the funding from the developed country "

"The Copenhagen Accord"

Progress of discussion on REDD Mechanism

COP16 (Cancun, 2010)

"the following REDD+ overall framework was determined"

・Decision made on the following five (5) REDD+ activities
(i) Reducing emissions from deforestation, (ii) reducing emissions from forest degradation, (iii) Conservation of forest carbon stocks, (iv) Sustainable management of forests, and (v) Enhancement of forest carbon stocks,

・Decision made on the following four (4) requirements to implement REDD+ in the developing countries
(1) REDD+ National Strategy, (2) Forest Reference (Emission) Level (FREL/FRL), (3) National Forest Monitoring System (NFMS), (4) Safeguards

"The Cancun Agreement"

Progress of discussion on REDD Mechanism

COP19 (Warsaw, 2013)

"Necessary technical items after The Cancun Agreement were agreed, showing more detail view of REDD+. Discussion of technical issues on REDD+ was completed. The following seven (7) decisions documents were agreed"

(1) modalities for national forest monitoring systems, (2) the timing and the frequency of presentations of the summary of information on the safeguards, (3) addressing the drivers of deforestation and forest degradation, (4) guidelines and procedures for the technical assessment of submissions on proposed REL/RL, (5) modalities for measuring, reporting and verifying (MRV), (6) coordination of support for the implementation of activities, including institutional arrangements (7) work programme on results-based finance

"Warsaw Framework for REDD+"

【Five activities decided as REDD+ activities】

① Reducing emissions from deforestation

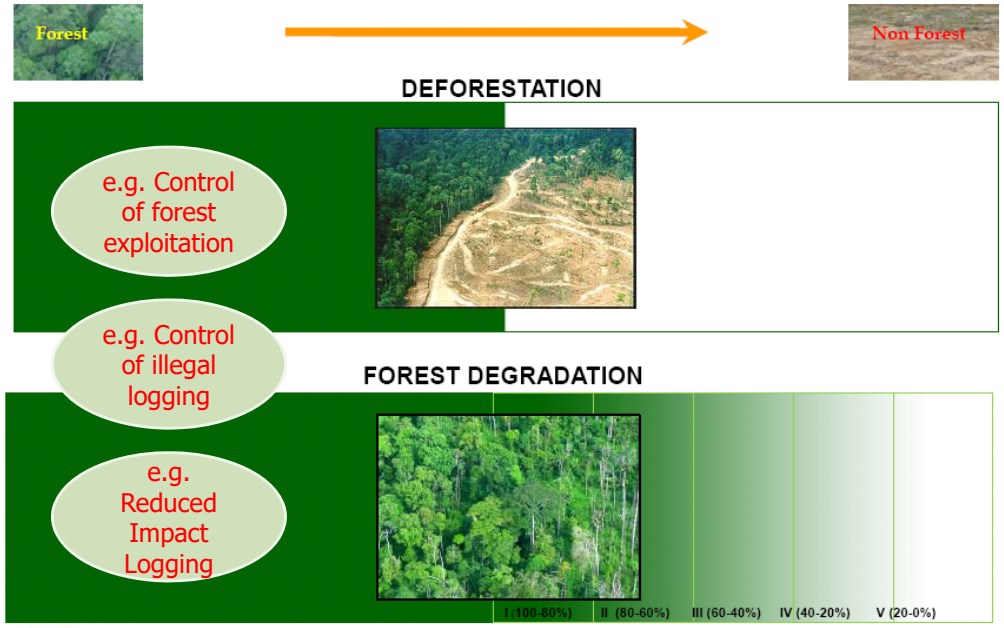
② Reducing emissions from forest degradation

③ Conservation of forest carbon stocks

④ Sustainable management of forests

⑤ Enhancement of forest carbon stocks

【Deforestation and Forest Degradation】



Source：Reference Emission Levels Indonesia - Ruandha Sugardiman、MRV Meeting Mexico.

【Conservation of forest carbon stocks】 【Sustainable management of forest】 【Enhancement of forest carbon stocks】

Forest Management

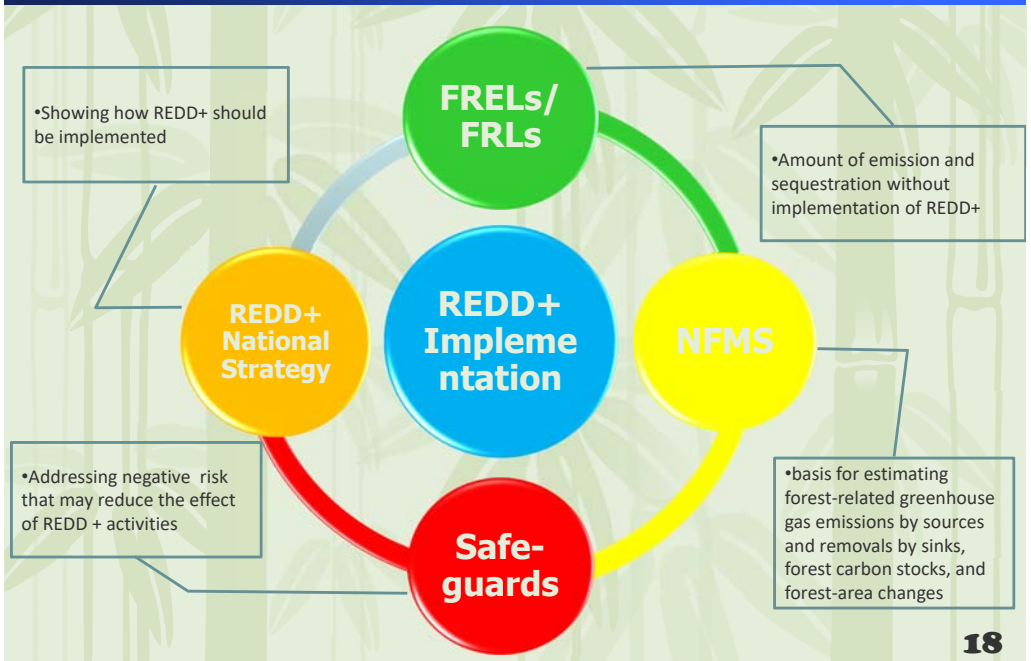
Plantation

【Scope of REDD+】

REDD+ is covered by three categories of land use change according to the IPCC Good Practice Guidance for LULUCF:

1. Forests converted to other lands
   - Deforestation
2. Forests remaining as forests
   - Forest degradation
   - Conservation of forest carbon stocks
   - Sustainable management of forests
   - Enhancement of forest carbon stocks in existing forests
3. Other lands converted to forests
   - Enhancement of forest carbon stocks in bare lands

【Requirement for implementation of REDD+ (The Cancun Agreement) 】



【The Requirement (1) REDD+ National Strategy】

Points to be Considered on REDD+ National Strategy

- Measures against drivers of deforestation and forest degradation
  - ✓ Since deforestation and forest degradation drivers are different by each country, measures that match the drivers of each country should be applied
  - ✓ In the implementation of REDD + at the national and sub-national levels, "policies and measures (PaMs)" are effective and necessary
- Cross-sectoral initiatives
  - ✓ Cross-sectoral approach with development policies and land-use policies closely related to REDD+ is necessary

Therefore, it is necessary to formulate the REDD + national strategy through the participation of various stakeholders

【The Requirement (2) Safeguards】

The following seven Safeguards should be supported and protected

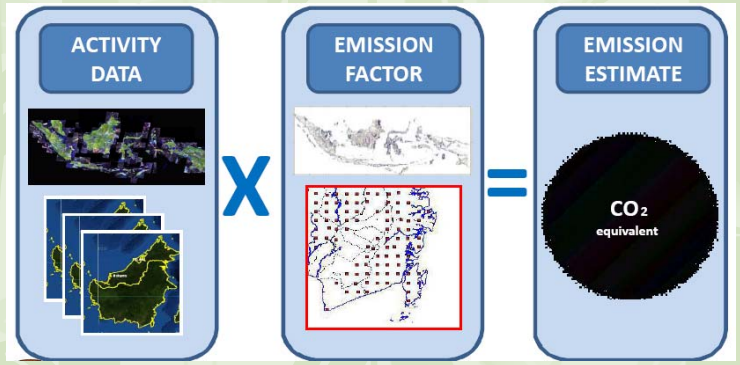
1. **Actions complement or are consistent with the objectives of national forest programmes and relevant international conventions and agreements;**
2. **Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;**
3. **Respect for the knowledge and rights of indigenous peoples and members of local communities;**
4. **The full and effective participation of relevant stakeholders, in particular, indigenous peoples and local communities;**
5. **Actions are consistent with the conservation of natural forests and biological diversity;**
6. **Actions to address the risks of reversals (related to non-permanence);**
7. **Actions to reduce displacement of emissions (related to leakage) .**

【Issues to be considered for Safeguards】

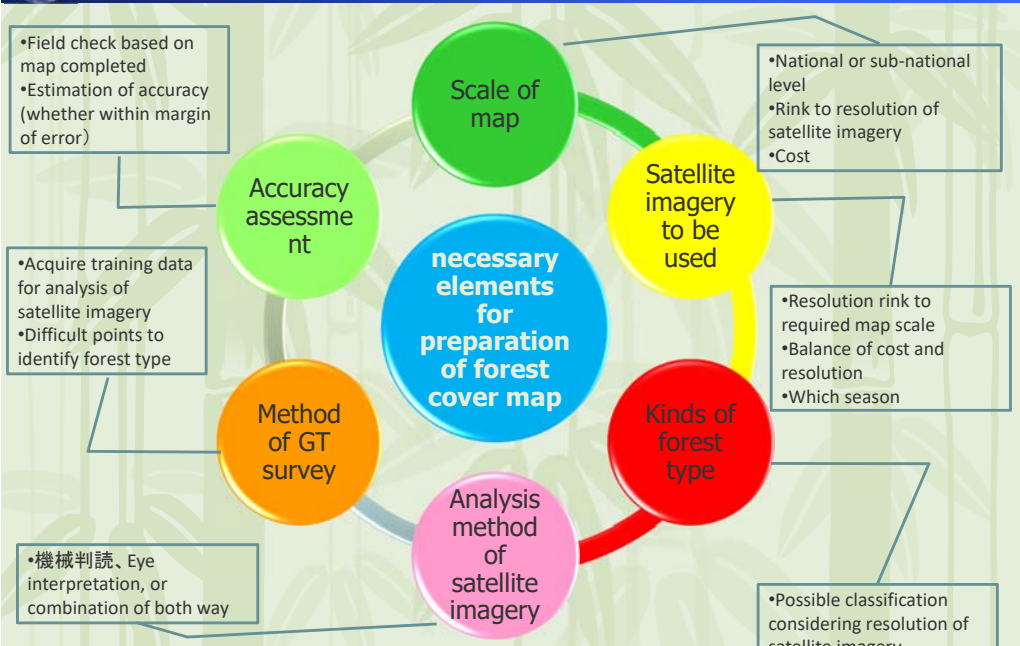
- How criteria and indicators for each item are set
- How to address safeguard issues
- Safeguard Information System(SIS) (Inter-communicational, Transparent, Accessibility, Easily evaluated by a third party（Check list and the evaluation of results））
- Monitoring system

【The Requirement (3) National Forest Monitoring System (NFMS) 】

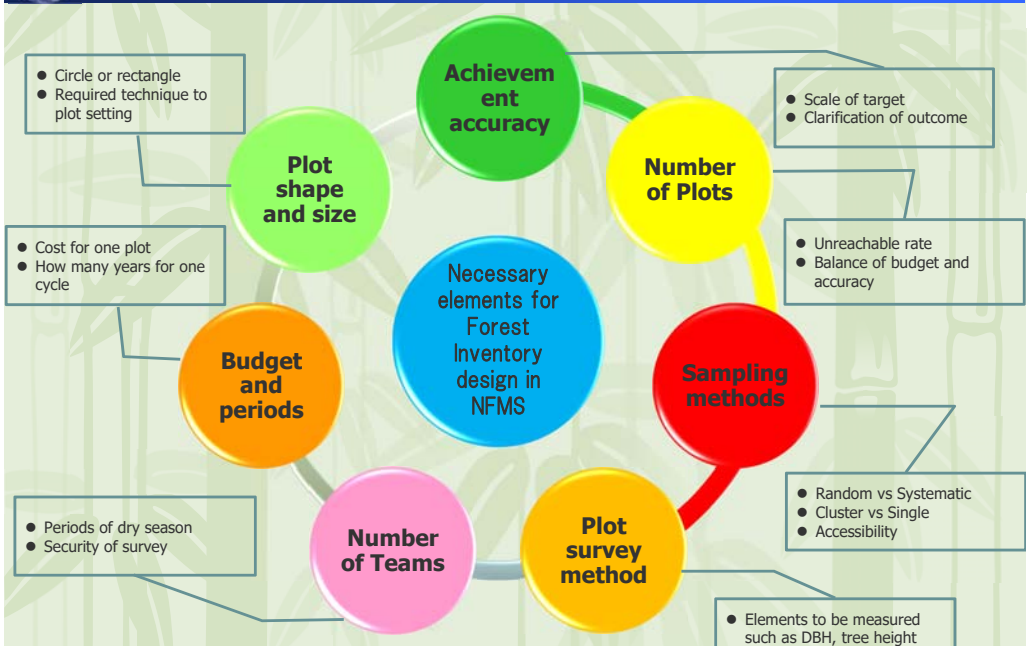
【Necessary monitoring based on the estimation method of emission amount】



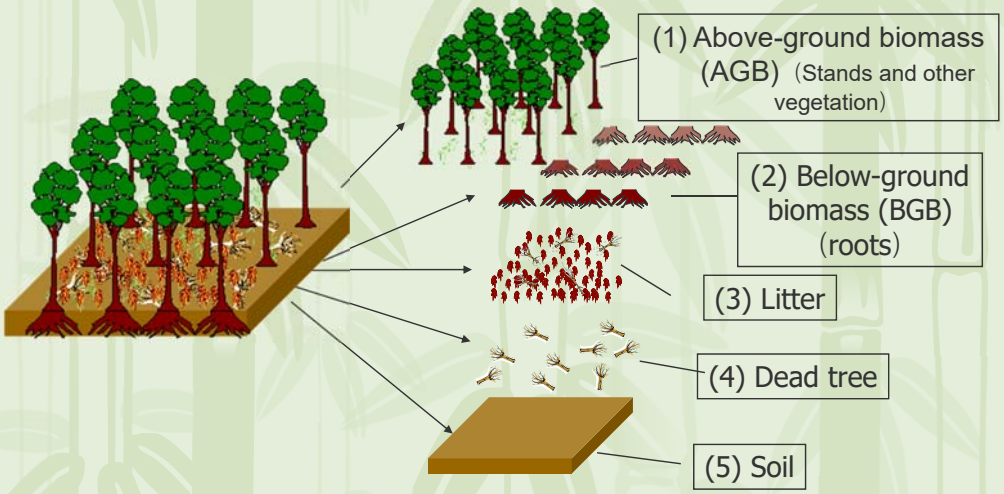
【Points to be considered for preparation of forest cover map】



【Points to be considered for design of forest inventory】



【Carbon Pools in a Forest】



【MRV】

M: Measurable
R: Reportable
V: Verifiable

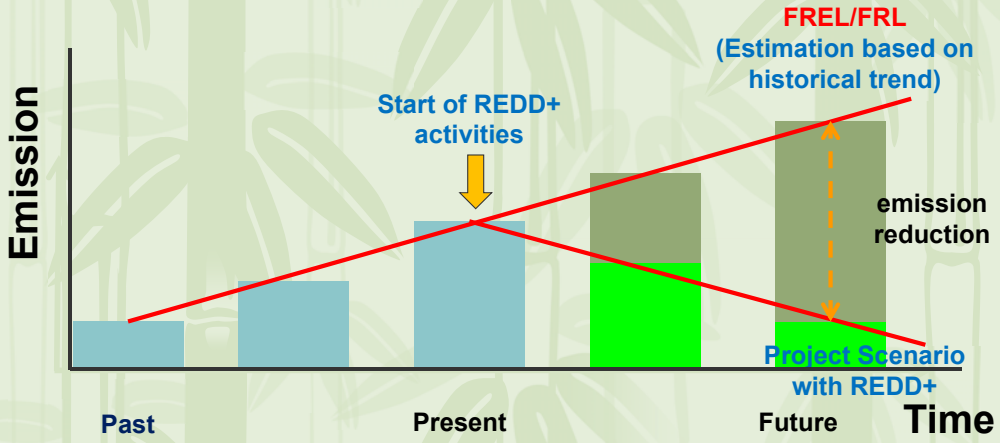
with respect to **M** among them, on which discussion and consideration has been progressing most

1) Implementing forest inventory to record the state of forests
2) Recording changes of the forest based on remote sensing and ground-truth survey
3) Converting the change in forest to changes in the amount of carbon

【Points on establishing MRV system】

- Each country needs to build a forest monitoring system at the national level with high transparency based on each situation and capabilities
- In accordance with IPCC guidance, the estimation of emissions and removals which eliminated the uncertainty as much as possible is necessary
- For monitoring and reporting, substantial participation of indigenous and local communities is recommended
- Although the need is recognized for the "report" and "verification" of the MRV system, the details still not yet completely agreed (it is recognized that "Report" is made by Biennial Update Report (BUR))
- The need to build the MRV system in anticipation of a benefit-sharing system

The Requirement (4) FREL/FRL



- FRELs/FRLs establish business-as-usual (BAU) baselines against which actual emissions are compared.
  ⇒Emission reductions are estimated as the difference between actual emissions and FRELs/FRLs within an established period.
- FRELs/FRLs are benchmarks for assessing each UNFCCC Party's performance and determine its eligibility for international, results-based payment for REDD+

Common Understanding of What FRELs and FRLs Refer to

- FRELs only count emissions of the greenhouse gases (GHGs) from deforestation and forest degradation.
- FRLs count both emissions of GHGs from deforestation and forest degradation and removals of GHGs from the "sink" activities such as enhancement of forest carbon stock.

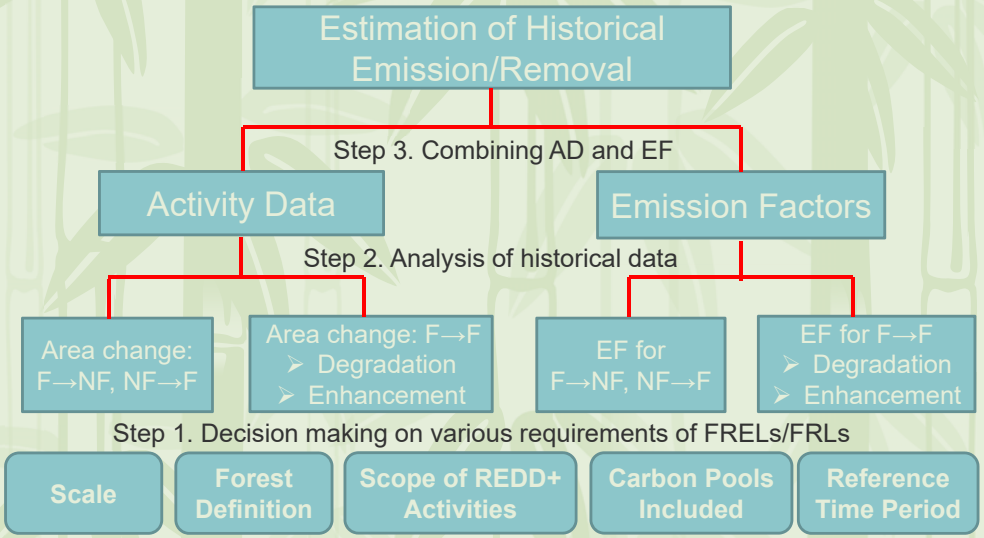
Outline of Development of FRELs/FRLs

Development of FRELs/FRLs can be simplified to the 2 components under the UNFCCC guidance:

1. Analysis of Historical Change of Forests
2. Estimation of Future Change of Forests with Adjustment by National Circumstances

Developing country Parties in establishing FRELs/FRLs should do so transparently taking into account **historic data**, and adjust for **national circumstances** (decision 4/CP.15, paragraph 7)

Process of Estimating Historical Change



F: forest
NF: non forest
EF: emission factor

Source: Meridian Institute, 2011 (modified)

FRELs/FRLs Requirements – Scale

Comparison between different approaches:

UNFCCC	FCPF-CF	JCM (draft)
➢ National ➢ Subnational (as an interim measure)	➢ National ➢ One or more jurisdiction ➢ Designated area (e.g. eco-regions)	Project level

Countries that firstly submitted FRELs/FRLs to the UNFCCC:

Brazil	Subnational: Amazonia biome (out of 6 biomes in the country)
Colombia	Subnational: Amazon biome (out of 5 biomes in the country)
Ecuador	National
Guyana	National
Malaysia	National (only the permanent reserved forests)
Mexico	National

FRELs/FRLs Requirements – Forest Definition

There is no guidance on how to define the forest for REDD+ under any REDD+ standards, but most countries actually use the same criteria used for CDM: minimum area between 0.05 and 1 ha; minimum average height between 2 and 5 m; minimum cover between 10 and 30 %.

Countries that firstly submitted FRELs/FRLs to the UNFCCC:

	Minimum Area	Minimum Height	Minimum Cover
Brazil	0.5 ha	5 m	10%
Colombia	1 ha	5 m	30%
Ecuador	1 ha	5 m	30%
Guyana	1 ha	5 m	30%
Malaysia	Based on the national legislation		
Mexico	50 ha	4 m	10%

FRELs/FRLs Requirements– Scope of REDD+ Activities

Comparison between different approaches:

UNFCCC	FCPF-CF	JCM (draft)
➢ One or more of the 5 defined REDD+ activities ➢ Significant activities should not be excluded ➢ Justification of why omitted activities are not significant	➢ Deforestation: required ➢ Degradation: required if emissions from degradation are greater than 10% of total emissions. ➢ Enhancement: optional	In accordance with the UNFCCC (no detailed information available)

Countries that firstly submitted FRELs/FRLs to the UNFCCC:

Brazil	Deforestation
Colombia	Deforestation
Ecuador	Deforestation
Guyana	Deforestation, Degradation
Malaysia	Sustainable Forest Management
Mexico	Deforestation

FRELs/FRLs Requirements – Carbon Pools

Comparison between different approaches:

UNFCCC	FCPF-CF	JCM (draft)
➢ Significant pools should not be excluded. ➢ Justification of why omitted pools are not significant.	➢ Carbon pools less than 10% of total emissions in the covered area may be excluded. ➢ Exclusion of the pool is also allowed if it is demonstrated to be conservative.	Carbon pools less than 5% of total emissions from the project may be excluded.

Countries that firstly submitted FRELs/FRLs to the UNFCCC:

Brazil	AGB, BGB, Litter
Colombia	AGB, BGB
Ecuador	AGB, BGB, Deadwood, Litter
Guyana	AGB, BGB, Deadwood, Litter, Soil
Malaysia	AGB, BGB, Litter
Mexico	AGB, BGB, Deadwood, Litter

FRELs/FRLs Requirements – Reference Period

Comparison between different approaches:

	UNFCCC	FCPF-CF	JCM (draft)
Reference Period	Not specified	➢ Up to 10 yrs. (up to 15 yrs. with justification) ➢ End year: two years before assessment of the draft ER Program	At least 10 yrs. back from the project start
Number of Data Points Required	Not specified	Not specified	At least 5 data points

Countries that firstly submitted FRELs/FRLs to the UNFCCC:

	Reference Period	Number of Data Points
Brazil	1996 – 2005	11: Every year
Colombia	2000 – 2012	7: Every two years
Ecuador	2000 – 2008	2: 2000, 2008
Guyana	2001 – 2012	6: 2001, 2005, 2009, 2010, 2011, 2012
Malaysia	1990 – 2011	22: Every year
Mexico	2000 – 2010	11: Every year

Extrapolation of the Historical Trend

Comparison between different approaches:

UNFCCC	FCPF-CF	JCM (draft)
"Adjustment for national circumstances" is allowed.	➢ FRELs/FRLs should not exceed average annual emissions over the reference period. ➢ Upward adjustment is only allowed for countries with high forest cover and historically low deforestation.	➢ Average emissions of the reference period ➢ Regression formula based on historical trends ➢ Projection models

Countries that firstly submitted FRELs/FRLs to the UNFCCC:

Brazil	Historical average
Colombia	Historical average with qualitative adjustment
Ecuador	Historical average
Guyana	Historical average with quantitative adjustment
Malaysia	Historical average
Mexico	Historical average

Findings from the six countries FREL/FRL

- Most countries follow a stepwise approach, initially including a limited number of REDD+ activities, carbon pools
  - These countries intend to expand its scope as more complete and better quality data become available.
- Some of FRELs/FRLs submitted cover subnational
  - These countries intend to develop National FRELs/FRLs, combining the subnational FRELs/FRLs.

FRELs/FRLs secondly Submitted

Country	Scale	Forest Definition	REDD+ Activities	Carbon Pools	Reference Period	Method of extrapolation
Chile	Subnational	Cover: 10% Area: 0.5ha	Deforestation Degradation Enhancement Conservation	AGB BGB Dead wood Soil	1997 – 2012	Historical average
Costa Rica	Subnational	Cover: 30% Height: 5m Area: 1ha	Deforestation Enhancement	AGB BGB Dead wood Litter	1st period (1997 – 2009): 1986 – 1996 2nd period (2010 – 2025): 1997 – 2009	Historical average
Ethiopia	National	Cover: 20% Height: 2m Area: 0.5ha	Deforestation Enhancement	AGB BGB Dead wood	2000 – 2013	Historical average
Indonesia	Subnational	Cover: 30% Height: 5m Area: 0.25ha	Deforestation	AGB Soil	1990 – 2012	Historical average
Peru	Subnational	Cover: 10% Height: 5m Area: 0.09ha	Deforestation	AGB BGB	2001 – 2014	Historical forest change trend
Vietnam	National	Cover: 10% Height: 5m Area: 0.5ha	Deforestation Degradation Enhancement	AGB BGB	1995 – 2010	Historical average
Zambia		Cover: 10% Height: 5m Area: 0.5ha	Deforestation	AGB BGB Dead wood	2000 – 2014	Historical average

【Warsaw Framework for REDD+】

(1) modalities for national forest monitoring systems,
(2) the timing and the frequency of presentations of the summary of information on the safeguards,
(3) addressing the drivers of deforestation and forest degradation,
(4) guidelines and procedures for the technical assessment of submissions on proposed REL/RL,
(5) modalities for measuring, reporting and verifying (MRV),
(6) coordination of support for the implementation of activities, including institutional arrangements
(7) work programme on results-based finance

http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf#page=34

①Modalities for national forest monitoring systems (NFMS)

Outline：The development of NFMS should take into account the most recent guidance provided in IPCC, and the NFMS should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying.

Function：NFMS should build upon existing systems as appropriate, and enable the assessment of different types of forest in the country, including natural forest, as defined by the Party.

②the timing and the frequency of presentations of the summary of information on the safeguards

Outline：Developing country Parties should start providing the summary of information on safeguards in their national communication or communication channel, including via the web platform of the UNFCCC, after the start of the implementation of activities of REDD+. The frequency of subsequent presentations of the summary of information should be consistent with the provisions for submissions of national communications

③addressing the drivers of deforestation and forest degradation

Outline：Encouraging all Parties, relevant organizations, and the private sector and other stakeholders, to continue their work to address drivers of deforestation and forest degradation and to share the results of their work on this matter; and developing country Parties to take note of the information from ongoing and existing work on addressing the drivers of deforestation and forest degradation.

④ Guidelines and procedures for the technical assessment of submissions on proposed REL/RL

Objectives of technical assessment：To assess the consistency with the guidelines for submissions of information on FREL/FRL, and to offer a facilitative and non-intrusive technical exchange of information keeping the construction and future improvements of FREL/FRL in mind.

Composition of assessment team：Each submission shall be assessed by two LULUCF experts selected from the UNFCCC roster of experts, one from a developed country and one from a developing country. The Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention may nominate one of its experts to participate in the technical assessment as an observer.

Timing and method of publication：Assessment sessions will be organized once a year. Assessment will be done for about a year. the Party may modify its submitted FREL/FRL in response to the technical inputs of the assessment team. Publication of final report on assessment results is made via the web platform on the UNFCCC website.

⑤ Modalities for measuring, reporting and verifying (MRV)

Outline：To be consistent with the methodological guidance provided in decision of COP15, and any guidance on the MRV of nationally appropriate mitigation actions (NAMA) . Data and information used in the estimation of forest-related emissions by sources and removals by sinks etc. should be transparent, and consistent over time and with the FREL/FRL

Report：The Data and information will be submitted through the biennial update reports (BUR) and technical annex by Parties. The technical team of experts shall make an analysis and prepare a technical report to be published via the web platform.

⑥ Coordination of support for the implementation of activities, including institutional arrangements

Requirement：To designate a national entities or focal points of developing country

Function of the entity：Identify needs and functions related to the coordination of support, strengthen the sharing of relevant information, knowledge, experiences and good practices, identify possible needs and gaps in coordination of support, provide opportunities to exchange information between the relevant bodies, provide information and any recommendations to improve the effectiveness of finance.

⑦ Work programme on results-based finance

Requirement to obtain finance：developing countries seeking to obtain and receive results-based finance of REDD+ activities should meet requirement of The Cancun Agreement, and those actions should be fully measured, reported and verified, the countries should provide the most recent summary of information on the safeguards before they can receive results-based payments;

Publication of information：To establish an information hub on the web platform on the UNFCCC website as a means to publish information on the results of the activities, and corresponding results-based payments;

Green Climate Fund：The Green Climate Fund (GCF) plays a role of result-based financing the REDD+ activities.

Financing methods discussed in REDD+ mechanism

- **Fund method:** Developing countries implement REDD+ activities on the basis of funds. As such funds, e.g. an international fund, fund between the two countries developed and developing countries, the multilateral fund can be considered. ➡ GCF can become the biggest funding source.
- **Market method:** making a deal for emission reduction amount of carbon as credits in carbon markets
- **Hybrid method:** Combination of fund method and market method

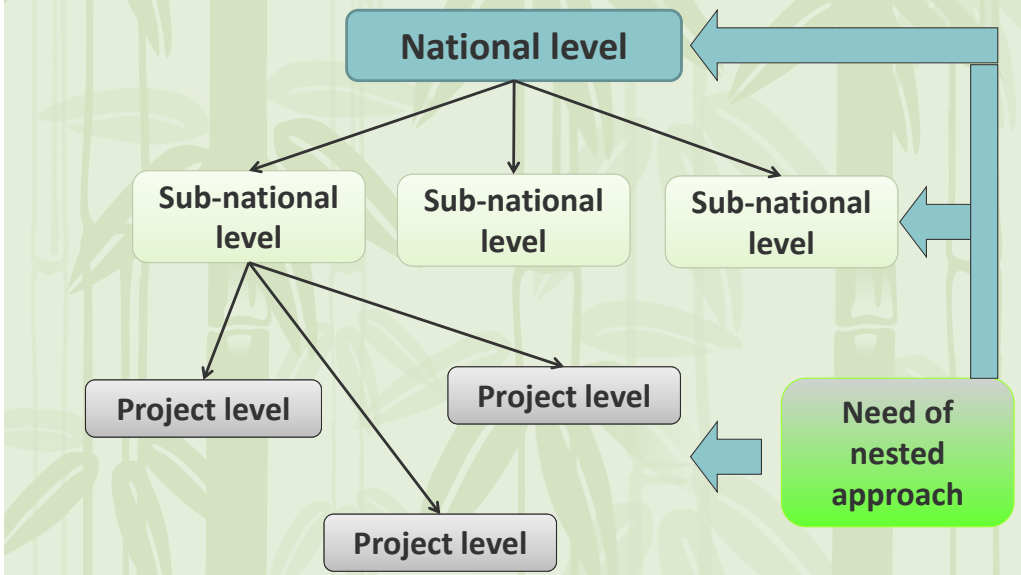
Advantages & issues of three Financing methods

- **Fund method**: The readiness fund can be provided, it is not necessarily to strictly take result-oriented basis
  - Possible to provide advance funding to business
  - Depending on the outcome of the emission reduction, it is possible to obtain additional funds too.
  - No deal in the market・If it is not result-based payment, long-term funding may be difficult
- **Market method**: method based on the payment by result-based
  - If carbon credits as amount for emissions reductions of developed countries can be offset, it is possible to collect large amount of money
  - Since reliability of the market is required, REDD + activities that the MRV system are established are required, also increase in the effectiveness of the business can be recognized
  - If getting involved in the market priority, interest in the forest focus on only carbon, diversity of forest function is neglected
- **Hybrid method**:
  - it is possible to obtain funds by the fund method in the preparation stage and early stage of implementation, it is possible to obtain the large amount of money in the market method after entering the full-scale implementation stage

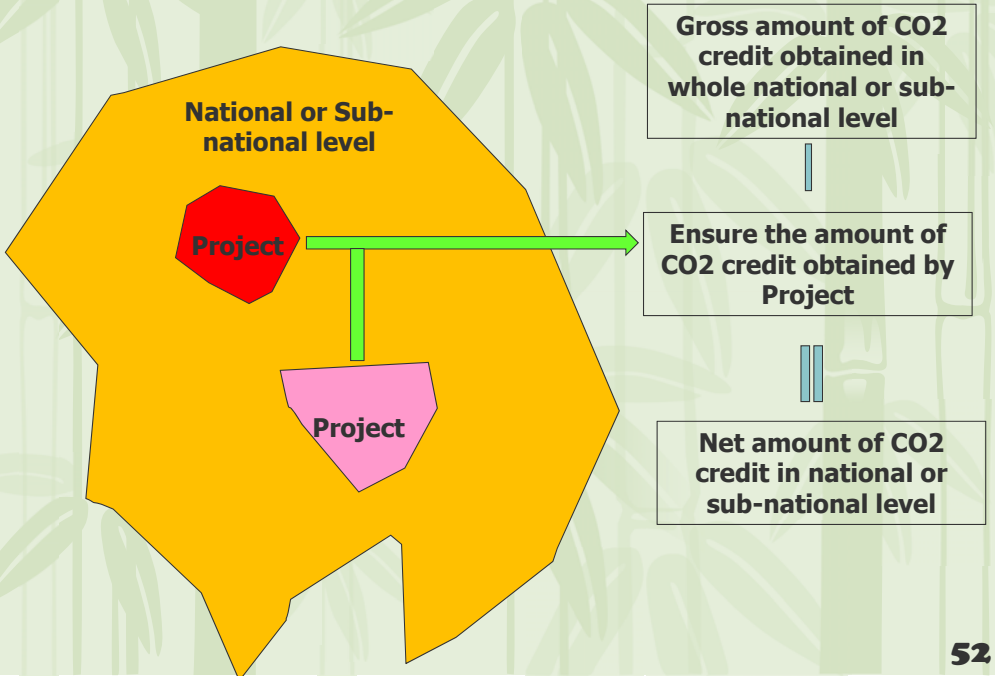
Phased approach of REDD+ implementation

Phase 1 readiness	Phase 2 Implemen-tation	Phase 3 Full Implemen-tation
Preparing National REDD+ strategy, improvement of the capabilities required to REDD + implementation	Trial of REDD + activities in accordance with the countries' ability (continuation of capacity building)	Aiming at making markets, the implementation of REDD + activities in the results-based by robust monitoring system

Level of REDD+ (Three Classes)



Example of Nested Approach

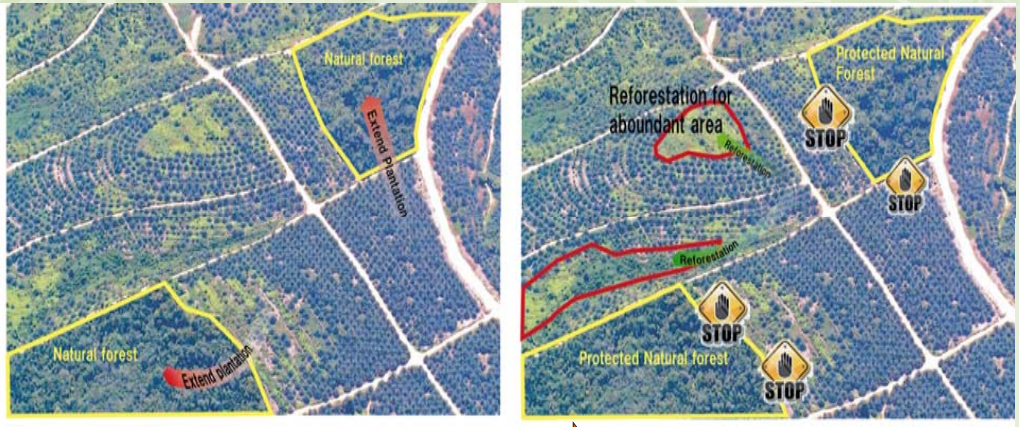


Process of practice of REDD+ activities

- **Step 1**: Identifying drivers to promote deforestation and forest degradation → Issue is to quantitatively grasp the drivers
- **Step 2**: Formulating strategy of REDD+ including action plan
- **Step 3**: Practicing REDD+ activities by PaMs based on the strategy

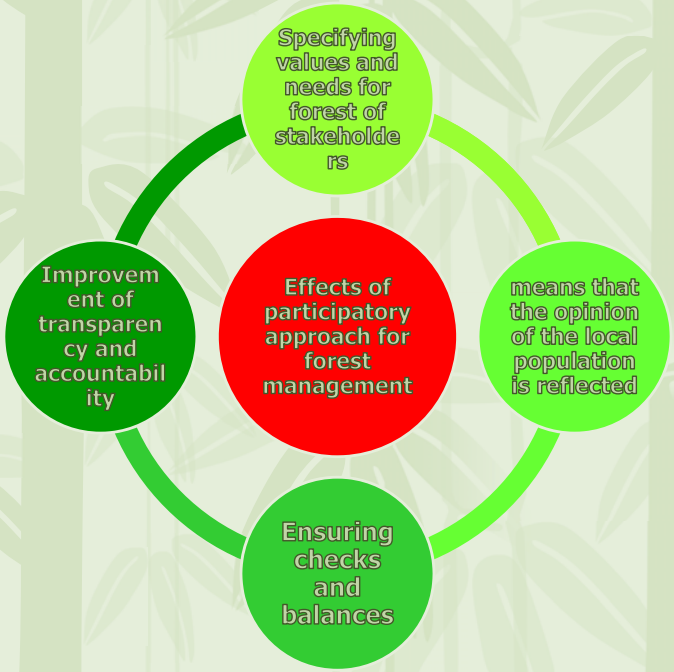
→ Issues are capacity, technology and governance

REDD Mechanism and Concept



Business as usual (Now) → **Protection activity** → **Protect forest and sequence carbon (Future)**

Participatory forest management for success of REDD+



Consistency with other fields for success of REDD+

- The development with a deforestation such as agriculture, timber exports, and mining are often given to priority on the policy, and it is not uncommon that site to be protected as forest and area of development planned competes.
- Therefore, If the developing countries commit to and implement REDD+, the consistency with the development policies and climate change measures in the field of non-forest is important.


Thank you very much
(Meru, Oct. 2017)

Outline of National Forest Monitoring System (NFMS) as a Part of MRV's M

The REDD+ Readiness Component
in
the Capacity Development Project for the Sustainable Forest Management
in the Republic of Kenya

By Kazuhisa KATO – Component 3 Team Leader
2018.7.4

UNFCCC Requirements

Mechanism of REDD+

Readiness
(To receive results-based finance, developing country party should have the following in place)

- ☐ A national strategy or action Plan
- ☐ An assessed forest reference emission level and/or Forest reference level
- ☑ A national forest monitoring system (NFMS)
- ☐ A system for providing information on how the safeguards are being addressed and respected

Implementation
(Developing country party undertake the following activities to receive results based finance)

- ☐ Reducing emissions from deforestation
- ☐ Reducing emissions from forest degradation
- ☐ Conservation of forest carbon stocks
- ☐ Sustainable management of forests
- ☐ Enhancement of forest carbon stocks

1/CP.16 The Cancun Agreements Paragraph 70,71

Modalities for national forest monitoring systems

Decision 11/CP.19

2. Decides that the development of Parties' national forest monitoring systems for the monitoring and reporting of the activities,1 as referred to in decision 1/CP.16, paragraph 70, with, if appropriate, subnational monitoring and reporting as an interim measure, should take into account the guidance provided in decision 4/CP.15 and be guided by the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources, and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes;

3. A lso decides that robust national forest monitoring systems should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes resulting from the implementation of the activities referred to in decision 1/CP.16, paragraph 70, taking into account paragraph 71(b) and (c) consistent with guidance on measuring,reporting and verifying nationally appropriate mitigation actions by developing country Parties agreed by the Conference of the Parties, taking into account methodological guidance in accordance with decision4/CP.15;

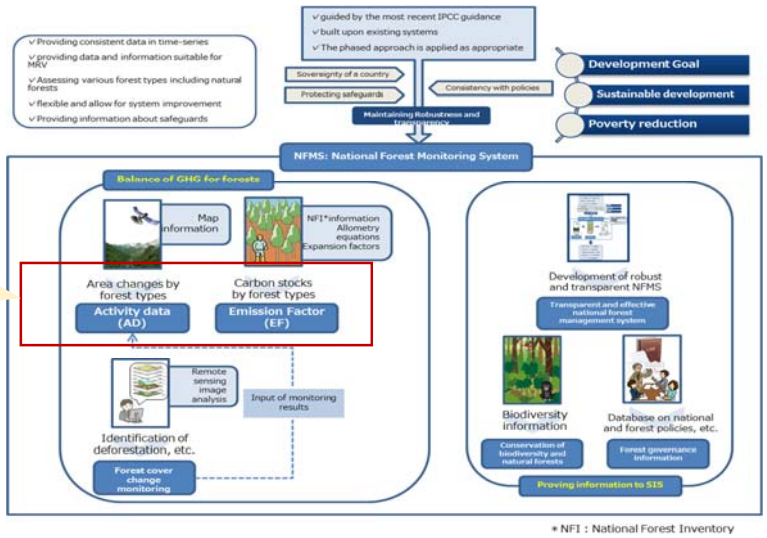
Definition of the NFMS in Kenya

Defining the NFMS as methodology and the NFMS as a database (forest information platform)

- **NFMS**
  Methodology of how forests are monitored
- **Forest Information Platform**
  A database to provide information that does not only include the information identified according to the NFMS but the information necessary for implementing REDD+ and sustainable forest management

Modalities for national forest monitoring systems

Need to Identify each methodologies as Kenya REDD+



＊NFI：National Forest Inventory

Development of the NFMS

Contents（What）	Purpose（Why: Why the information is needed）	Needed Information (Which: by which information the contents are developed)	Specific information (How: How the information is obtained)	Methodologies（How：How to grasp the information）	Place to get information（Where：where the information is prepared）	Frequency and time（When：When and how often the data is updated）	Persons in charge（Who：Who are the persons in charge）
Activity data							
Emission Factor							
Forest cover change monitoring							
Contribution to Safeguard							
Policy Implementation monitoring							
Others if any							

Have to be decided

Development of the NFMS (Example)

Contents（What）	Purpose（Why: Why the information is needed）	Needed Information (Which: by which information the contents are developed)	Specific information (How: How the information is obtained)	Methodologies（How：How to grasp the information）	Place to get information（Where：where the information is prepared）	Frequency and time（When：When and how often the data is updated）	Persons in charge（Who：Who are the persons in charge）
Activity data	Grasping the Balance of GHG from forests	Area changes by forest types	Land Use Land Cover MAP	Method used by SLEEK	SLEEK	Every years?	SLEEK
Emission Factor	Grasping the Balance of GHG from forests	Carbon stocks per hectare (ha) by forest types	EF is Calculated by multiplying the Result of National Forest Inventory and allometric equation that will be selected for Kenya REDD+.	Carbon esitimation【Forest】 NFI Methodology : ICFRA Allometric equation : Proposed by ICFRA and modified by JICA 【Non Forest】 Apply Tier 1 data of IPCC guideline	KFS, 〇〇Department	NFI : At any times or every〇years	KFS〇〇Department Mr.〇〇
Forest cover change monitoring	Grasping information about deforestation and forest degradation	Forest cover change monitoring developed by the Work	・Analysis of remote sensing data （it will be developed in the Work） ・Use of JJ-FAST		KFS（C/P of the Work）?	Once/year (frequency in the Work)?	KFS〇〇Department Mr.〇〇
Contribution to Safeguard	Providing safeguard information system (SIS) with information on forest governance	Diagram of forest governance system in Kenya, Forest-related laws and programmes	Summarize the organization chart of KFS, forest-related policies, programmes, laws and treaties.	Link to Safeguard information system	KFS, 〇〇Department KFS, △△Department	At any times or 〇 times/year	KFS〇〇Department Mr.〇〇
	Providing SIS with information for consideration of biodiversity	Wild animals and plants protection area map National Park map Other biodiversity information	Collaboration with the Kenya Wildlife Service (KWS), Incorporate biodiversity information item into forest inventory item	Link to Safeguard information system	KWS, In charge of NFI department	At any times or every〇years Modification after the implementation of forest inventory	KFS〇〇Department Mr.〇〇

Methodology to develop AD

- **Forest Definition:**

Minimum surface area	0.5ha
Minimum Height	2m
Minimum Cover	15%

- **MAP :**

Map	SLEEK MAP
Image	Land Sat image or any available and more aculeate image
Methodology	Wall to Wall Supervised Classification Developing 2014 map as base map
Time	Every two years??

Methodology to develop AD

- Stratification: SLEEK stratification will be used

forest classe
Montane Forest, Western Rain Forest and Bamboo Forest
Mangrove Forest and Coastal Forest
Dryland Forest
Plantation

X

Canopy coverage classe
Dense
Moderate
Open

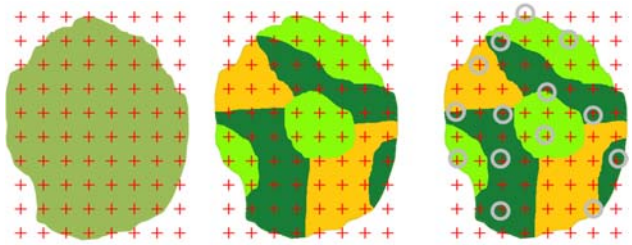
= 12 forest types

Methodology to develop EF

- NFI is utilized for developing EF

Sampling Design of NFI

1 Systematic grid spacing for clusters : Distance of 2km-by-2km: (4km^2 grids) over the whole country
2 Stratified sampling method: SLEEK stratification (12 forest types)
3 Random sampling method: The number of clusters to be calculated based on the SLEEK stratification.



Systematic sampling method Stratified sampling method Random sampling method

Methodology to develop EF

- Sampling Design of NFI

ICFRA proposal: Cluster sampling method

- Cluster design is as follows. However, since SLEEK stratification which is different with ICFRA stratification is used for the NFMS, it is needed to decide how the cluster design will be adjusted, e.g. left side figure is for forest except for mangrove, right side figure is for mangrove. In addition, cluster method itself should be re-considered whether it is applied or not because of possibility that more than two forest types are mixing in a cluster.

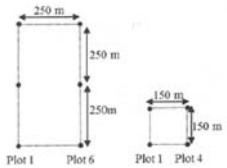


Figure . Cluster designs in Strata 1-3 (left) by ICFRA and in Stratum 4 (right).

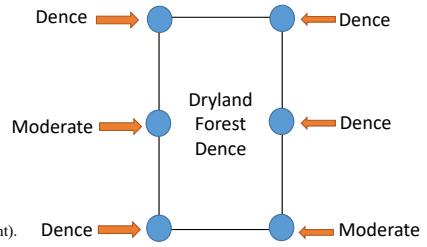


Figure . Example of cluster with more than two forest type mixed

In this case, how can the data be compiled? Moderate data is compiled as Dense forest or moderate forest? Otherwise no cluster method applied?

Methodology to develop EF

- Plots shape

ICFRA proposal: Cercle shape is used as mentioned in the following figure. However, since SLEEK stratification is used, it is needed to decide how each shape will be applied to the SLEEK stratification, e.g. left side is for non-forest, right side is for forest.

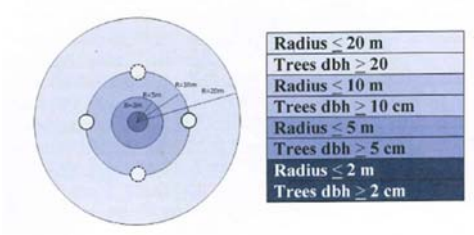


Figure . Sample plot design for Stratum 1 and 3

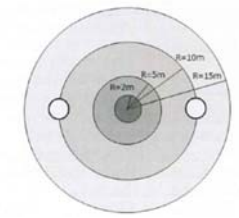


Figure . Sample plot design for Stratum 2 and 4

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya.

Methodology to develop EF

- **Measurement method in the plots:**
- ICFRA proposal: As mentioned in the table

Table .Measurement on the circular sample plots.

	DBH/ diameter (cm)	Height/ length (m)	Plot radius (m)	Plot area (m^2)
Tree	≥ 2	≥ 1.3	2	12.6
Tree	≥ 5	≥ 1.3	5	78.5
Tree	≥ 10	≥ 1.3	10	314.2
Tree (Strata 2 and 4)	≥ 20	≥ 1.3	15	706.9
Tree (Strata 1 and 3)	≥ 20	≥ 1.3	20	1256.6
Climber	≥ 2	≥ 1.3	2	12.6
Climber	≥ 5	≥ 1.3	15	706.9
Bamboo		≥ 1.3	10 or 2 × 2.0	314.2 or 25.13
Lying dead wood	≥ 10	≥ 1.0	15	706.9
Shrub		≥ 1.3	15 or 2 × 2.0	706.9 or 25.13
Stump			15	706.9
Regeneration	< 2	≥ 0.10	2 × 1.5	14.13

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya.

Methodology for contribution to SIS

- **How NFMS can contribute to SIS**

1. **Actions complement or are consistent with the objectives of national forest programmes and relevant international conventions and agreements**
2. **Transparent and effective national forest governance structures, taking into account national legislation and sovereignty**
3. **Respect for the knowledge and rights of indigenous peoples and members of local communities**
4. **The full and effective participation of relevant stakeholders, in particular, indigenous peoples and local communities**
5. **Actions are consistent with the conservation of natural forests and biological diversity**
6. **Actions to address the risks of reversals (related to non-permanence)**
7. **Actions to reduce displacement of emissions (related to leakage)**

→ Policies and laws related REDD+
Conventions related climate change already ratified
National REDD+ strategy

→ Institutional Arrangement for REDD+ with role of each institution
Information on forest governance

→ Rule & regulation and other detailed information (area, data on endangered and of precious species etc.) of protected area including national parks

Draft contents of NFMS document

Chapter 1	Background and Purpose	
Chapter 2	UNFCCC Requirements	
Chapter 3	Basic conditions for NFMS in Kney	3.1 Scale
		3.2 Forest Definition
		3.3 Forest Stratification and Classification
		3.4 Land use categorization Carbon Pool
		3.5 Carbon Pool
		3.6 Scope of GHG
		3.7 Selected REDD+ activity
		3.8 Definition of national REDD+ activities
Chapter 4	Conceptual design of the NFMS in Kenya	4.1 Purpose of Kenya's NFMS
		4.2 Composition of NFMS
		4.2.1 Monitoring Function
		4.2.2 Data Management Function
		4.3 Phased Approach
Chapter 5	Monitoring Function	5.1 Forest cover area and forest cover change for AD
		5.2 Forest Carbon stock for Emission Factors
		5.3 PaMs
		5.4 Biodiversity
		5.5 REDD+ and AR-CDM project for the register
		5.6 Data Management System in the Forest Information System
Chapter 6	Data Management function by FIP	6.1 Component and contents of the FIP
		6.2 Access right of each content
		6,3 Linkage with FMIS
		6.2 Update and operation
Chapter 7	Institutional Arrangement for NFMS	7.1 Institutional Arrangement for Monitoring Function
		7.2 Institutional Arrangement for Data Management Function
Chapter 8	Calendar of NFMS	

Chapter 1 : Background and Purpose

Write the Background and Purpose for developing NFMS in Kenya

- Example -

The Followings should be described in the chapter

- ✓ Forest conditions in Kenya
- ✓ Importance of REDD+
- ✓ Necessity and requirement of NFMS based on COP decision
- ✓ Contents and purpose of NFMS document

Chapter 2 : UNFCCC Requirements

Write the principal COP decisions that have defined the requirements of an NFMS developed to implement REDD+

- Example -

The principal COP decisions that have defined the requirements of an NFMS developed to implement REDD+ activities include:

Decision 4 of COP 15 in 2009 in Copenhagen, Denmark
The Conference of the Parties requests developing country Parties to establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems that:

(1) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

(2) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;

(3) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties

Decision 1 of COP 16 in 2010 in Cancun, Mexico, Decision 11 of COP 19 in 2013 in Warsaw, Poland … etc.

Chapter 3 : Basic conditions for NFMS

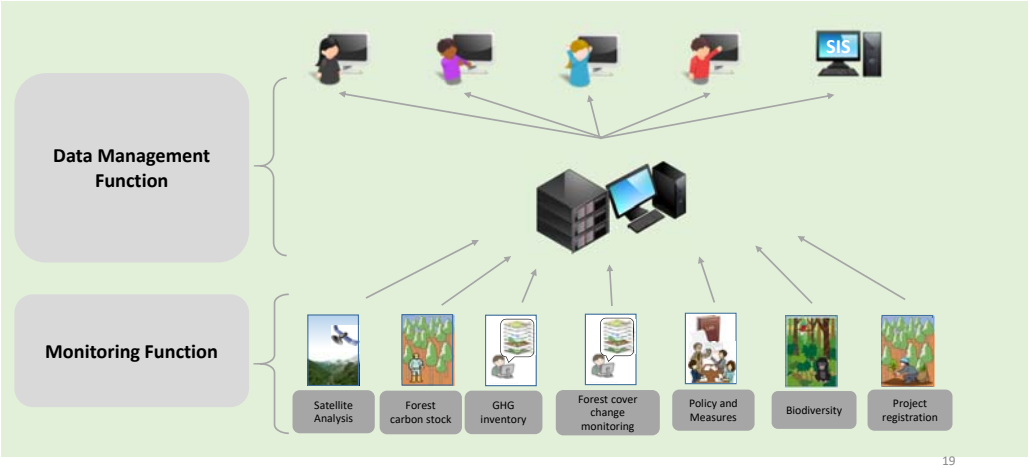
Write current Forest Monitoring situation in Kenya (If there are no activity about them, write it as there are no activity.)

- Example -

- Scale
  National or sub-national scale which Kenya selected
- REDD+ Activity
  REDD+ activities to be selected from among five REDD+ activities shown in COP decision and definition of each REDD+ activity
- Forest Definition
  Threshold between forest and non-forest from the viewpoints of minimum tree crown cover value, minimum land area, and minimum tree height
- Carbon Pool
  Selected carbon pool from among five forest carbon pools
- Scope of GHG
  Selected GHG

Chapter 4 : Conceptual design of the NFMS in Kenya

Write conceptual design of the NFMS in Kenya



Chapter 4 : Conceptual design of the NFMS in Kenya

Write conceptual design of the NFMS in Kenya

- Example -

Phased Approach

The NFMS will be developed in a phased approach that is synchronized with the implementation of the three phases of the REDD+ program, which is depicted in Figure. The criteria that will be used to guide the development through each of these phases include UNFCCC requirements, national policies, the availability of data, operational costs, and the capacities of users of the NFMS to operate the system and use the information provided in a meaningful manner.

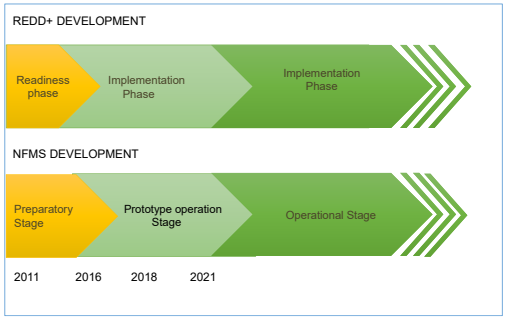


Figure Phased approaches of the development of the REDD+ program and the NFMS in Kenya

Chapter 5 : Monitoring function

Write how to develop NFMS components

- Example -

Forest cover area and forest cover change for Activity Data (AD)

Kenya has monitored the distribution of forest areas using satellite-based Land use / Land cover maps since 1990. Therefore, activity data should be developed based on the LULC map.
Purpose, Scope (land classification, measurement interval), Methodology, and Accuracy assessment should be described.

Map	Land use/ Land cover Map
Responsible agency	SLEEK
Image	Land Sat image or any available and more aculeate image
Methodology	Wall to Wall Supervised Classification Developing 2014 map as base map
Interval year	Every two year?

Chapter 5 : Monitoring function

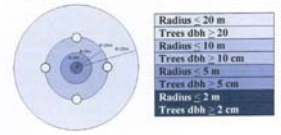
Write how to develop NFMS components

- Example -

Forest Carbon stock for Emission Factors (EF)

Kenya will estimate emission factor using data of National Forest Inventory (NFI). The methodology of the NFI will be implemented using the methodology to be approved as Kenya's NFI methodology.
Purpose, Scope (Target carbon pool, Tire level, implementation cycle), and Methodology should be described

- Sampling method
  - ✓ Systematic sampling method: distance of 2km-by-2km (4km^2 grids) over the whole country
  - ✓ Stratified sampling method: 4 forest classes (Montane Forest, Western Rain Forest and Bamboo Forest, Mangrove Forest and Coastal Forest, Dryland Forest, and Plantation) and 3 class of canopy coverage, total 12 forest types
  - ✓ Random sampling method: Necessary number of clusters of each forest type are selected from grids
  - ✓ Cluster sampling method:
- Shape of plots: Cercle plots
- Measurement items and method in the plot: DBH, tree height, etc.
- Conversion method to carbon stock data: allometric equation

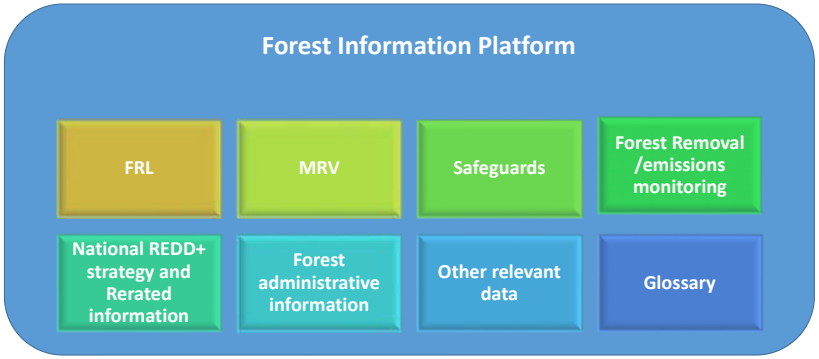


Chapter 6 : Data management function by FIP

Write how to manage data in the forest information platform

- Example –

Components of FIP should be mentioned.



Concrete objectives of FIP, function of the FIP, Information to be operated in FIP, access right of each content, and system for update and operation of FIP should be mentioned in this section as well.

Chapter 7 : Institutional Arrangement for NFMS

Write Institutional Arrangement for the NFMS in Kenya

- Example -

Institutional arrangement for monitoring function and data management function

Institutions to be involved in the decision making and implementation of the following monitoring should be illustrated

In addition, if there are institutions to be involved in coordination and/or consultation of the monitoring should be also illustrated.

- ✓ Activity Data
- ✓ Emission Factors
- ✓ Some other necessary information and data such information and data related with Safeguard

Furthermore, institutions to be involve for operation of the FIP, the update of data and information in the FIP, and improvement of the FIP functions should be illustrated.

Chapter 8 : Calendar of NFMS

Write Calendar of NFMS

Example

Year	Activity Data By Mapping	Emission Factor by NFI	FREL/FRL	Submission of BUR	remarks
2017	Year 2000, 2014 map				
2018					
2019	○ (for 2018 map, the followings are same)		○ (Reference Period 2000-2014)		
2020		○			Paris Agreement come into force
2021	○			○	
2022					
2023	○			○	
2024					
2025	○			○	
2026					
2027	○			○	
2028					
2029	○			○	
2030		○			

REDD+ PROCESS IN KENYA

REDD+ MRV TRAINING AT MASADA HOTEL, NAIVASHA

CONTENTS

Policy Context

Kenya is a **signatory to UNFCCC and commits to conserving** carbon storehouses; ratified the **Paris Agreement;**

- **Paris Agreement recognizes REDD+ process for CC response;**
- Climate Change Act, NCCRS, Green economy strategy, LCDS and Forest policy and law for orienting national CC efforts;
- NDC development underway with forest as a key sector for its actualization ;
- Forestry sector is a **source of emission of GHGs –unsustainable** utilization, land use changes, fires, Charcoal burning, logging etc,
- Forests are **carbon storehouses , carbon sinks and therefore a** CC solution.
- Policy framework concluded at UNFCCC

REDD+ Goals

Kenya is participating in REDD+ Readiness to support :

- Realization of Constitutional ,vision 2030 and Green Economy Strategy objectives
- Design of policies and measures to protect and improve forest resources;
- Realization of the NCCRS goals.
- Contribution to global climate change goals.
- Access to International carbon finance to support forestry development;

Scope of REDD+ Activities

- Reducing Deforestation ;
- ・Reducing forest Degradation;
- ・Sustainable management of forests;
- ・Enhancement of forest carbon stocks
- Important that FLR, NFMS and SIS recognize these
- activities during construction

Priority Areas of Focus

1. Reducing pressure to clear forests for agriculture,
settlements, infrastructure and other land uses;
2. Promoting sustainable utilization of forests by promoting efficiency, energy conservation;
3. Improving governance in the forest sector by strengthening land and forest tenure, capacity for FLEG , advocacy and awareness ;
4. Enhancement of carbon stocks through forestry extension, fire control and FLR

REDD+ Readiness Activities

Readiness activities include;

- A **national strategy for implementation and the** institutional and legal implementation framework,
- A **Reference Emission Level and/or Forest Reference Level for greenhouse gases (GHG) emissions;**
- A **Measuring, Reporting and Verification (MRV) and Monitoring system to assess the effect of the REDD+** strategy on GHG emissions, livelihoods and other benefits.
- **Safeguard Information system for ensuring REDD+** safeguards are respected and addressed
- These activities collectively referred to as **Warsaw Framework of activities**

REDD+ Readiness Process

1. National Strategy and implementation framework will require:

・Clear understanding of drivers of forest cover change
・Transparent, equitable and accountable benefit sharing/benefit distribution mechanisms,
・Inclusive participation of stakeholders;
・safeguards and grievance mechanisms to protect the interests of stakeholders;
・Clarification of national land, forest and carbon tenure rights.

・Clear institutional roles and responsibility

Readiness Process

2. REL/FRL and NFMS should be established to serve

multiple functions including:

- Assessing performance of REDD+ activities
- National GHG inventory and reporting
- Support forest sector planning and decision making
- Access to result-based finance for REDD+
- Compliance with Constitutional and legal requirements
- Reporting to FAO &other International bodies

Readiness Achievements

Towards **strategy and implementation framework :**

The following analytical studies have been completed;

- Detailed drivers of deforestation and forest degradation
- Demand and supply of forest products in the country
- Charcoal value chain analysis & barriers to investment
- Legal Preparedness studies ongoing
- Carbon rights, Benefit sharing and corruption risks ;
- Assessment of financing options and benefit distribution mechanism
- Stakeholder and FPIC guidelines

Readiness efforts

- **Towards the Safeguards**
- Carbon rights, Benefit sharing and corruption risks studies completed
- SESA road map prepared including a FGRM
- Taskforce on strengthening governance established
- Stakeholders engagement and FPIC guidelines

Readiness efforts

Towards MRV and FREL

- Roadmap completed
- Forest cover mapping
- Strengthened Institutions for implementation of activities
- FRL and NFMS establishment commenced

THANK YOU FOR LISTENING

1

Progress of Kenya's REDD+

Interaction Workshop for CADEP-SFM

Component 3
(REDD+ Readiness)

2018. 7. 4
Peter Nduati

2

Roles and objectives of the REDD+ Readiness Component in the Project

Strengthening national capacity at the national and county level for sustainable forest management

1. Enhancing implementing and monitoring capacities of forest policies/strategies at the national level
2. Pilot forest management activities
3. Implementing REDD+ readiness activities
   - Developing a system for periodical forest monitoring
     - Developing NFMS (system development using outputs produced in the past)
     - Capacity development of C/P organizations through development of NFMS
4. Breeding drought tolerant trees
5. Strengthening regional cooperation

3

Overall Framework of Component 3

Developing a system for forest cover change monitoring

Creating various types of map

Setting FRL

Supporting capacity development through the Measurement Reporting &Verification(MRV) training

Developing National Forest Monitoring System(NFMS) including the Forest Information Platform(FIP)

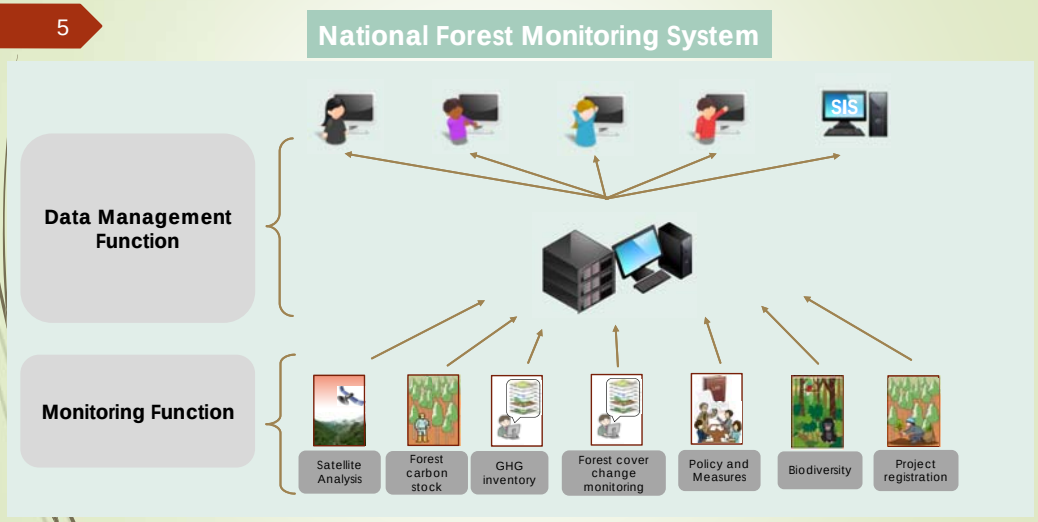
REDD+ Readiness activities

4

1 Development of National Forest Monitoring System(NFMS)

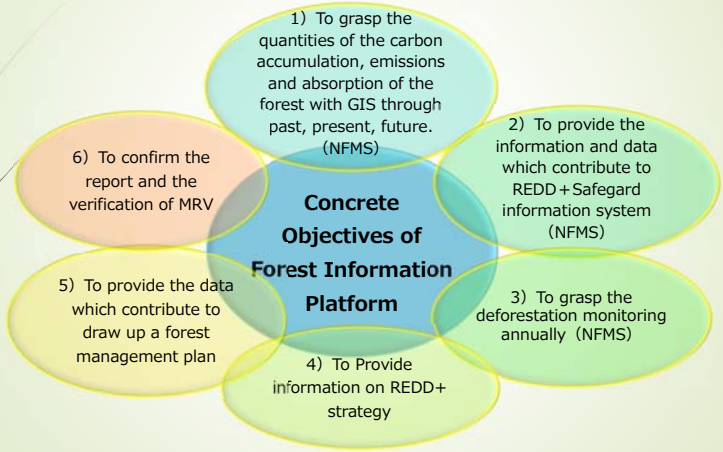
Conceptual Design of NFMS consisting of two functions

5



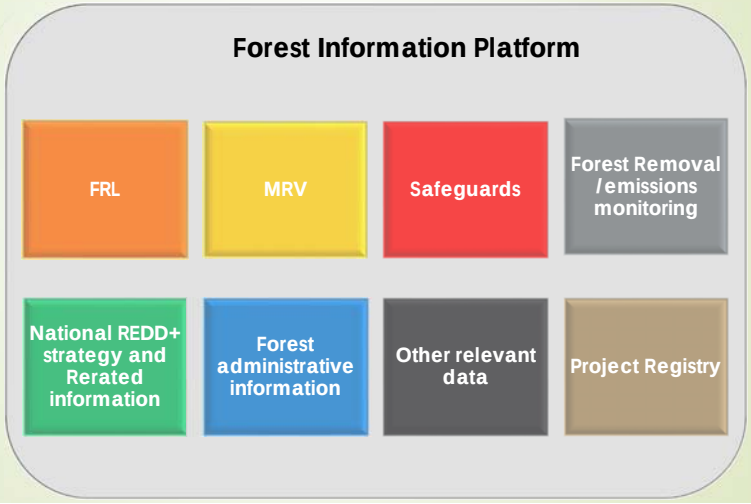
Objectives of Forest Information Platform (FIP) as Data Management Function in the NFMS

6



Main 8 Components of FIP

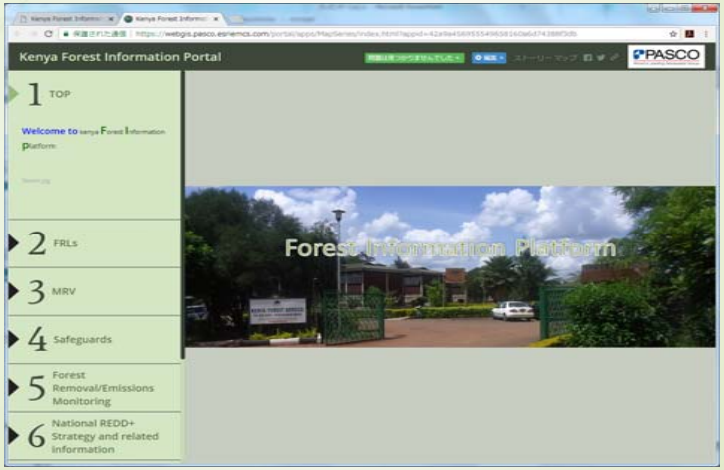
7



Development of FIP

The FIP sample layout as sitemap have been developed

8



Development of FIP

9

The FIP contents are classified in detail by tab function or linked to other web page

Management of Inventory Data

Forest Inventory Collection Tool: Survey 123

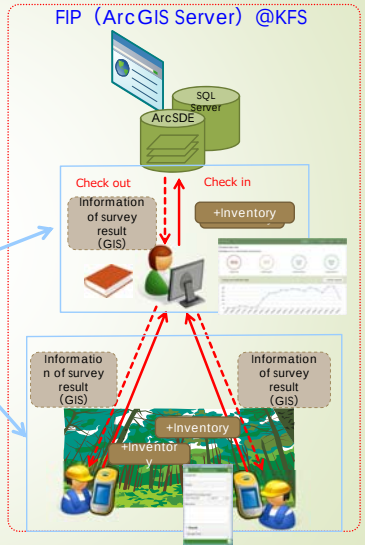
Survey 123

Survey 123 is the software based on ArcGIS Online Solution. Because FIP takes ArcGIS Online as a web service core software for open data survey 123 will be adapted for the data collection at field survey.

[The merit of Survey 123]

- Centralized management of inventory collect data using administrator's function
- Registration of location information referring Map and Satellite imagery.

*Interface and function will be developed based on the function of ArcGIS Server

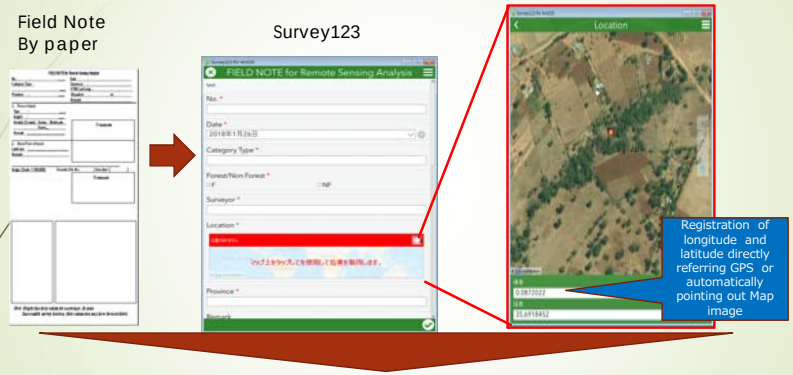


Development of Forest Inventory Collection Tool Based on Remote Sensing Analysis for this year

11

Field Note By paper

Survey123



Survey123 for National inventory survey is to be designed after decision of survey items

Draft contents of NFMS document

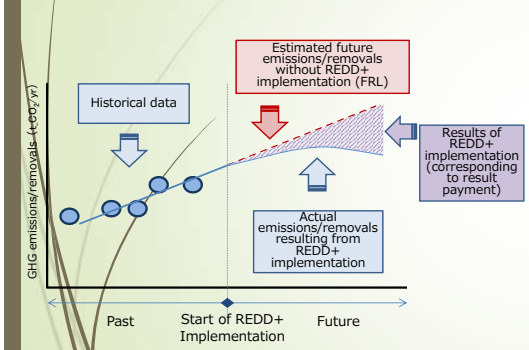
12

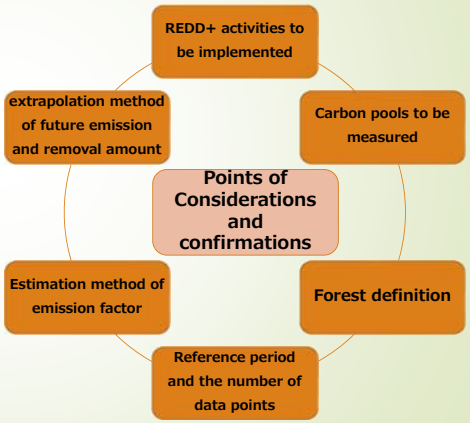
Chapter 1	Background and Purpose	
Chapter 2	UNFCCC Requirements	
Chapter 3	Basic conditions for NFMS in Kney	3.1 Scale
		3.2 Forest Definition
		3.3 Forest Stratification and Classification
		3.4 Land use categorization Carbon Pool
		3.5 Carbon Pool
		3.6 Scope of GHG
		3.7 Selected REDD+ activity
		3.8 Definition of national REDD+ activities
Chapter 4	Conceptual design of the NFMS in Kenya	4.1 Purpose of Kenya's NFMS
		4.2 Composition of NFMS
		4.2.1 Monitoring Function
		4.2.2 Data Management Function
		4.3 Phased Approach
Chapter 5	Monitoring Function	5.1 Forest cover area and forest cover change for AD
		5.2 Forest Carbon stock for Emission Factors
		5.3 PaMs
		5.4 Biodiversity
		5.5 REDD+ and AR-CDM project for the register
		5.6 Data Management System in the Forest Information System
Chapter 6	Data Management function by FIP	6.1 Component and contents of the FIP
		6.2 Access right of each content
		6,3 Linkage with FMIS
		6.2 Update and operation
Chapter 7	Institutional Arrangement for NFMS	7.1 Institutional Arrangement for Monitoring Function
		7.2 Institutional Arrangement for Data Management Function
Chapter 8	Calendar of NFMS	

13

2 FRL setting

Development of a highly applicable FRL that can meet requirements of UNFCCC





15

Decision made for requirements of FRL

- **Scale:** National
- **Forest Definition:** 15% canopy cover, 0.5 ha, 2m
- **Forest stratification:** Divide 12 forest types
- **Scope REDD+ Activities:**
  - Reducing emissions from deforestation
  - Reducing emissions from forest degradation
  - Sustainable management of forest
  - Enhancement of forest carbon stocks
- **Scope Carbon pools:** AGB, BGB
- **Reference Time Period:** 2000-2014
- **GHG:** CO_2
- **Construction Method:** Average method
- **National circumstance:** Rejected

16

Activity data (AD) and Emission Factor (EF)

- Requisite items: AD and EF for FRL setting
- AD: to be made by the Land cover/Land use change map data calculated by the Land cover/Land use maps in the different two point of times in2000 and 2014 for the period between 2000 and 2014
- EF: to be acquired by the default data from 2006 IPCC Guidelines or the country data which was from the forest inventory data
- The unit of AD: ha/years, as area data
- The unit of EF: tCO_2/ha

17

REDD+ activities in the Matrix

Area in 20XX			Area in 20XX+(X)														
			Forest												Non Forest		
			Montane Forest/ Western Rain Forest/ Bamboo			Costal Forest and Mangroves			Dryland Forest			Plantation Forest			Glass land	Other Non-forest
			D	M	O	D	M	O	D	M	O	D	M	O		
Forest	Montane Forest/ Western Rain Forest/ Bamboo	D	n	dg	dg										df	df
		M	e	n	dg										df	df
		O	e	e	n										df	df
	Costal Forest and Mangroves	D				n	dg	dg							df	df
		M				e	n	dg							df	df
		O				e	e	n							df	df
	Dryland Forest	D							n	dg	dg				df	df
		M							e	n	dg				df	df
		O							e	e	n				df	df
	Plantation Forest	D										n	s	s	s	s
		M										s	n	s	s	s
		O										s	s	n	s	s
Non Forest	Glass land		e	e	e	e	e	e	e	e	e	s	s	s		
	Other non Forest		e	e	e	e	e	e	e	e	e	s	s	s		

df Deforestation (F→NF)
n No Change (F→F)
dg Forest Degradation (F→F(Degraded))
s Sustainable Management of Forest (F→F, F→NF, NF→F)
e Enhancement (F→F(Improved) ,NF→F)

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The method of calculation of Emission estimates

- Method of calculation: multiplication between AD and EF

Activity Data × Emission Factor = Emission Estimate

- Emission estimate: indicated by the emission/removal in the amount of CO_2 as weight per year (ton/year)
- The unit of Emission estimate: tCO_2/year.

19

The result of emission estimate as historical tred and FRL by the Average method

Emission estimates (tCO_2/year)

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

Total emissions/removals 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

- According to the basis of the average annual historical emission, FRL value is shown as below.

Forest Reference Level (tCO_2/year): -7,471,382

20

3 Creation of various types of map

21

The 1st year

Assessment of land cover map 2014 by SLEEK

- **Process assessment** Confirmation of methodology and contents implemented by interview
- **Result assessment** Checking fields by ground-truth survey

Preparing land cover map creation guidance

→ **Preparing land cover/land use change map**

From 2nd to 4th year

Guiding creation of Land Cover Map at pilot area – Improvement by PDCA -

- **Satellite imagery analysis** Base on land cover map creation guidance
- **Ground-truth survey** Pre-survey and verification survey

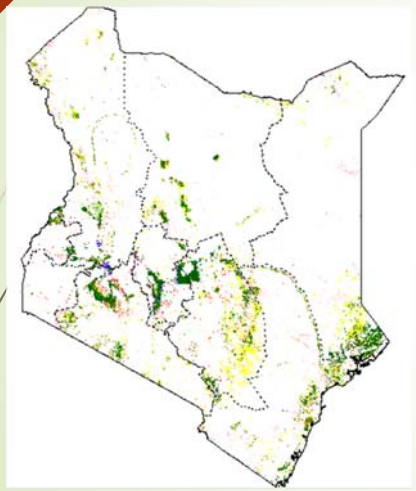
The Fifth year

Guidance and creation of Land Cover/Land Use Map in 2020

- **Satellite imagery analysis** Base on revised land use map creation guidance
- **Ground-truth survey** Implementing survey in the place for mainly difficult categories for classification

Preparation of land cover/land use change map

22



land cover/land use change maps between 1990-2000, 2000-2010, and 2010-2014 were prepared by use of legend shown in below legend

- forest(no change)
- forest(degradation)
- forest(enhancement)
- plantation
- cropland to forest
- grassland to forest
- cropland and grassland to plantation
- wetland and other land to forest
- forest to cropland
- forest to grass land
- plantation to cropland and grassland
- forest to wetland and other land

Example of land cover/land use change maps between 1990-2000

Preparation of carbon map in 2014

23

Estimating carbon amount in each county

Displaying carbon amount by color-coding
The large amount is dark red, the smaller is pink, gray

Total Forest area

△△forest ××ha ▲▲CO_2t
■■forest ◇◇ha ◆◆CO_2t
Total ○○ha ●●CO_2t

4 MRV Training

24

Number of Participant of 1st MRV training in 2017: 24 from from KFS Headquarter and conservancies

Contents on Day 1 (5th July)
・Introductions and Training Objectives. ・Quick overview of CADEP-SFM project
・Outline of REDD+ ・Background and Mechanism of REDD+
・Progress of Kenya's REDD+
・Outline of NFMS as part of MRV's M

Contents on Day 2 (6th July)
・Measurement for Activity Data AD ・Introduction to remote sensing and utilization of remote sensing in forest monitoring
・Measurement for Activity Data AD ・SLEEK map development ・Land cover/land use conversion matrix
・Measurement for Emission Factor EF ・National Forest Inventory NFI
・Measurement for Emission Factor EF ・Conversion from Biomass to Carbon Stock

REPUBLIC OF KENYA
Ministry of Environment and Natural Resources
Kenya Forest Service
REDD+ Readiness Component

Lecture for Basic Remote Sensing

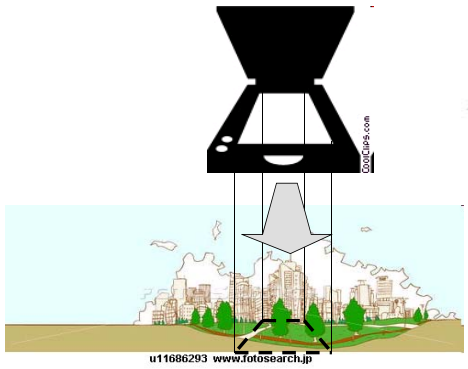
Date: 4th July 2018

By Faith MUTWIRI and Kei SATO

What is Remote Sensing?

Concept of Typical Remote Sensing

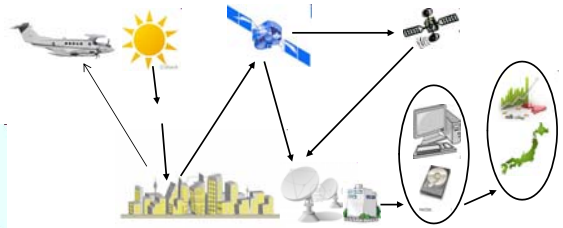
Scanning to the Earth
Earth Observation from Space



like Flatbed Scanner

Earth Surface Information Gathering

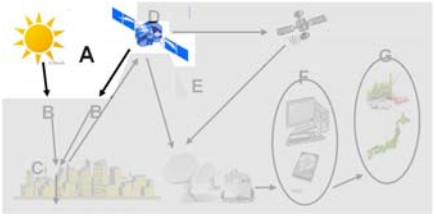
Processes of Remote Sensing
for Gathering Earth Surface Information

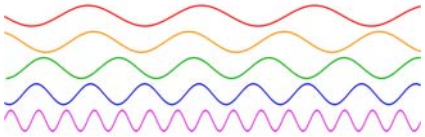


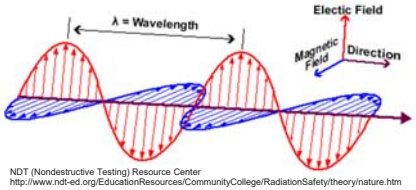
Indirect Measurement
using Electromagnetic Wave

Basic Knowledge of Remote Sensing

Electromagnetic Radiation



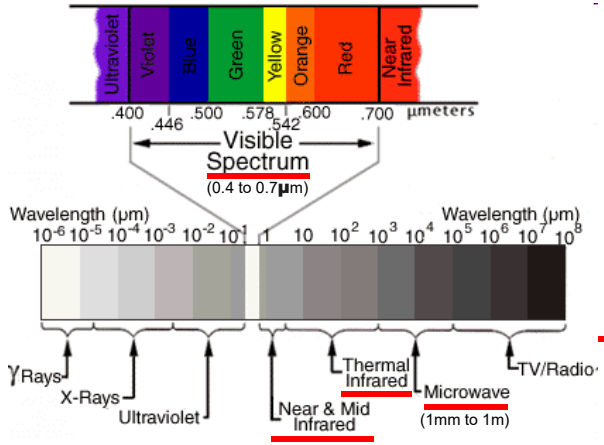




NDT (Nondestructive Testing) Resource Center
http://www.ndt-ed.org/EducationResources/CommunityCollege/RadiationSafety/theory/nature.htm

$C = \lambda v$
λ: wavelength (m)
v: frequency (cycle per second, Hz)
c: speed of light (3×10^8 m/s)

Electromagnetic Spectrum



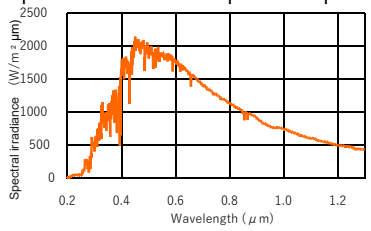
Band	Wavelength (mm)
Ka	7.5-11
K	11-16.7
Ku	16.7-24
X	24-37.5
C	37.5-75
S	75-150
L	150-300
P	300-1000

Remote Sensing Used Wavelength

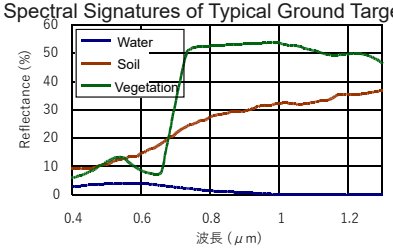
1 cm = 10^{-2} m
1μm = 10^{-6} m
1 nm = 10^{-9} m

Wavelength of Visible-Infrared Remote Sensing

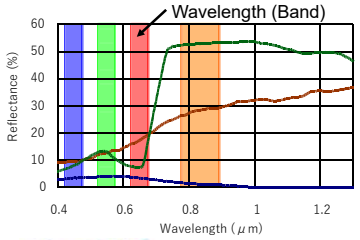
Spectral Irradiance at Top of Atmosphere

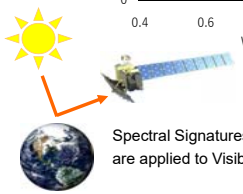


Spectral Signatures of Typical Ground Targets



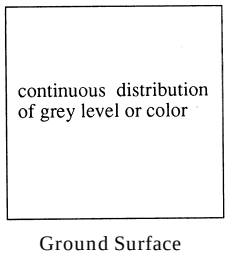
Remote Sensing Sensors' Wavelengths' and Spectral Signature

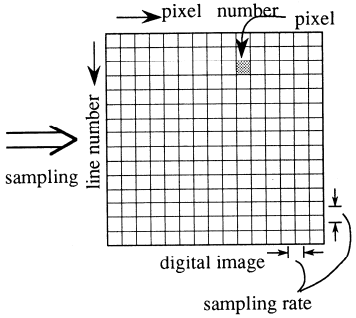


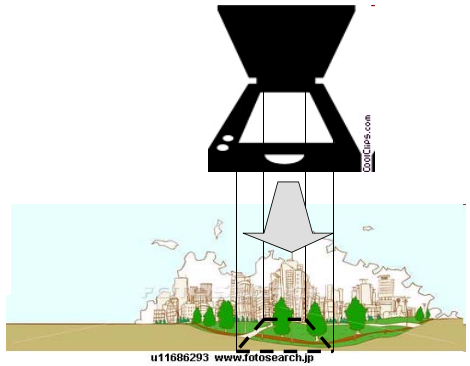


Spectral Signatures that reflected on Earth Surface are applied to Visible-Infrared Remote Sensing

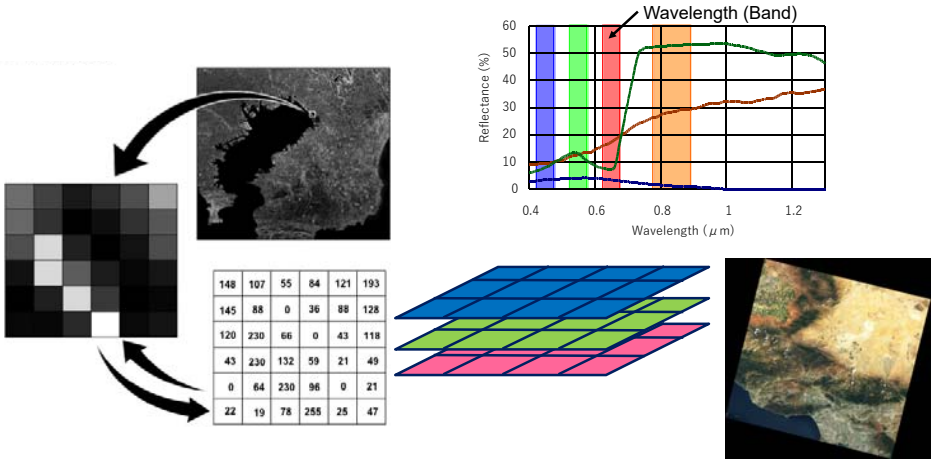
What is scanning to the Earth?







What is scanning to the Earth?



Source:https://landsat.gsfc.nasa.gov/landsat-8/landsat-8-bands/

Limitation of Remote Sensing

Sampling Size and Quantization Bit Rate on Imagery

The digital imagery is defined by sampling size and quantization bit rate.

The quantization bit rate is determined by how many levels it is necessary to express the information.

The sampling size is determined by the utilization purpose.
For examples, what you want to know what's that or what gender, age….

Limitation of Remote Sensing

Different Quantization Bit Rate and its Effect on Imagery

Effects depend on the different quantization bit rate

Sampling Size
256X256

8 bit	4 bit
2 bit	1 bit

Limitation of Remote Sensing

Different Sampling Size and its Effect on Imagery

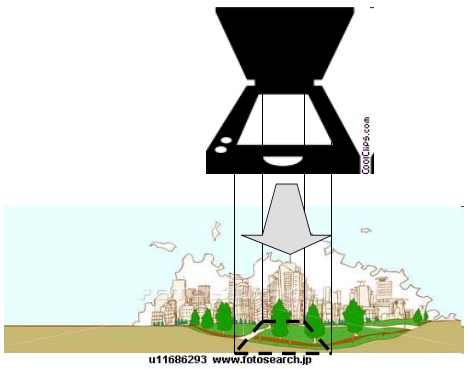
Effects depend on the different sampling size

8bit Quantization

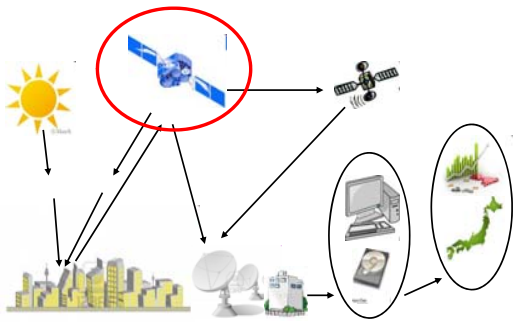
256X256	128X128
64X64	32X32

What is Satellite Imagery Remote Sensing?

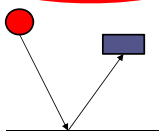
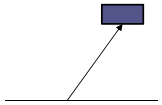
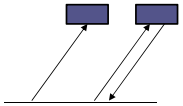
What is Satellite Imagery Remote Sensing?



e.g. LANDSAT Satellite series

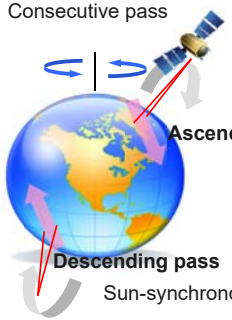


Type of LANDSAT Satellite as typical EO satellite

	Visible･Infrared Remote Sensing	Thermal Remote Sensing	Microwave Remote Sensing
			
Radiation Source	Sun	Target	Target Radar
Measurement Target	Reflectance	Thermal Radiation (Temperature/emissivity)	Microwave backscattering Radiation coefficient
Spectral Radiance	Solar Radiation	Earth Radiation	
	0.5μm 3－4μm	10μm	

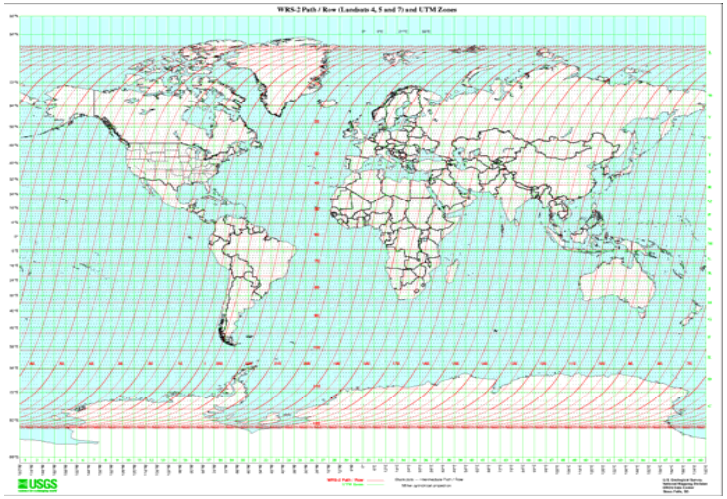
LANDSAT Orbit and Swaths

New Area with each Consecutive pass

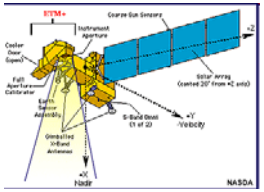


Sun-synchronous

Local Sun Time



Specification of LANDSAT 7



Sun-synchronous Sub-Recurrent Orbit
Recurrent Period 16 days
Circles the Earth every 98.9 minutes
altitude of 705 km (438 mi)
Launched: April1999

Sensor	Wavelength Range/ Frequency	Spatial Resolution	Observation Width
Enhanced Thematic Mapper Plus (ETM+)	Band 1 Visible (0.45 – 0.52 µm) Band 2 Visible (0.52 – 0.60 µm) Band 3 Visible (0.63 – 0.69 µm) Band 4 Near-Infrared (0.77 – 0.90 µm) Band 5 Near-Infrared (1.55 – 1.75 µm) Band 6 Thermal (10.40 – 12.50 µm) Band 7 Mid-Infrared (2.08 – 2.35 µm) Band 8 Panchromatic (PAN) (0.52 - 0.90 µm)	Band 1 30 m Band 2 30 m Band 3 30 m Band 4 30 m Band 5 30 m Band 6 60 m Low Gain / High Gain Band 7 30 m Band 8 15 m	Swath width, 185 km (115 mi)

Source:http://landsat.usgs.gov/about_landsat7.php
http://www.satimagingcorp.com/satellite-sensors/alos.html

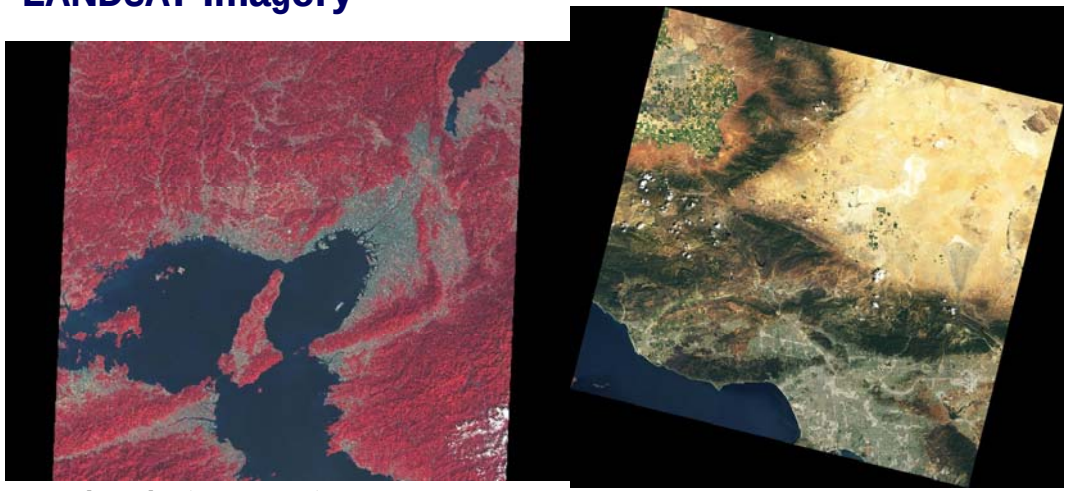
Specification of LANDSAT 8

Sun-synchronous Sub-Recurrent Orbit
Recurrent Period 16 days
Circles the Earth every 98.9 minutes
altitude of 705 km (438 mi)
Launched: February 2013

Sensor	Wavelength Range/ Frequency	Spatial Resolution	Observation Width
Operational Land Imager (OLI)	Band 1 New Deep Blue (0.43 – 0.45µm) Band 2 Visible (0.45 – 0.52 µm) Band 3 Visible (0.53 – 0.60 µm) Band 4Visible (0.63 – 0.68 µm) Band 5 Near-Infrared (0.85 – 0.89 µm) Band 6 SWIR 2 (1.56 – 1.66 µm) Band 7 SWIR 3 (2.10 – 2.30 µm) Band 8 PAN (0.50 – 0.68 µm) Band 9 SWIR (1.36 - 1.39 µm)	Band 1 30 m Band 2 30 m Band 3 30 m Band 4 30 m Band 5 30 m Band 6 30 m Band 7 30 m Band 8 15 m Band 9 30m	Swath width, 185 km (115 mi)
Thermal Infrared Sensor (TIRS)	Band 10 TIRS 1 (10.60 - 11.19 µm) Band 10 TIRS 2 (11.50 - 12.51 µm)	Band10 100m Band11 100m	

Source:https://landsat.gsfc.nasa.gov/landsat-8/landsat-8-bands/

LANDSAT Imagery

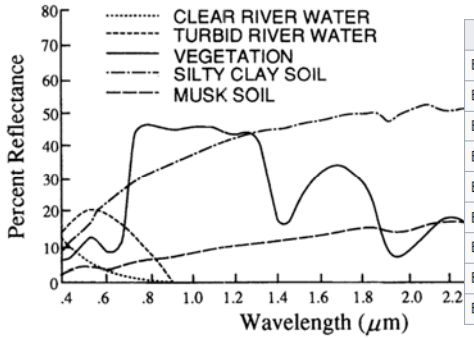


False Color (LANDSAT 7)

True Color (LANDSAT 8)

Source:https://landsat.gsfc.nasa.gov/landsat-8/landsat-8-bands/

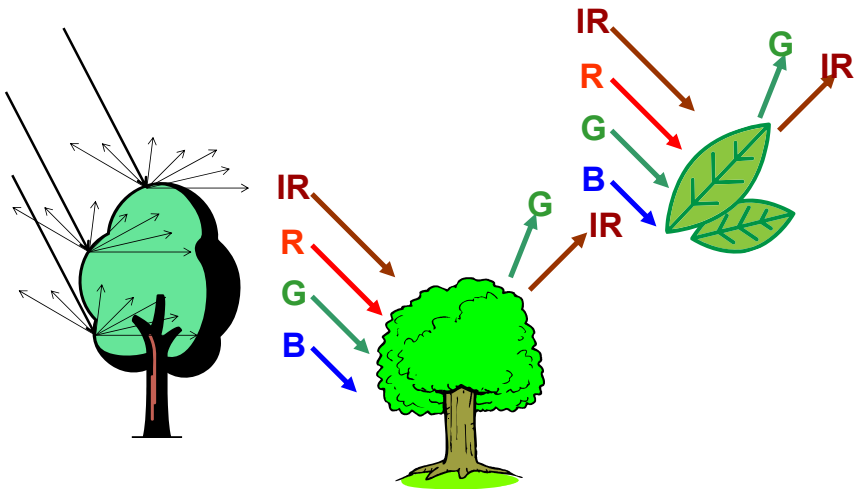
Characteristic of Electromagnetic Wavelength



Spectral Band	Wavelength	Resolution	Solar Irradiance
Band 1 - Coastal / Aerosol	0.433 – 0.453 µm	30 m	2031 W/(m²µm)
Band 2 - Blue	0.450 – 0.515 µm	30 m	1925 W/(m²µm)
Band 3 - Green	0.525 – 0.600 µm	30 m	1826 W/(m²µm)
Band 4 - Red	0.630 – 0.680 µm	30 m	1574 W/(m²µm)
Band 5 - Near Infrared	0.845 – 0.885 µm	30 m	955 W/(m²µm)
Band 6 - Short Wavelength Infrared	1.560 – 1.660 µm	30 m	242 W/(m²µm)
Band 7 - Short Wavelength Infrared	2.100 – 2.300 µm	30 m	82.5 W/(m²µm)
Band 8 - Panchromatic	0.500 – 0.680 µm	15 m	1739 W/(m²µm)
Band 9 - Cirrus	1.360 – 1.390 µm	30 m	361 W/(m²µm)

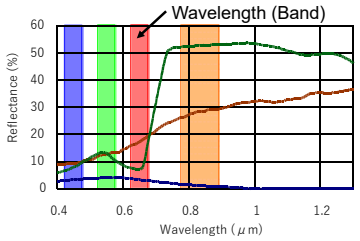
Figure shows **three curves of spectral reflectance** for typical land covers; vegetation, soil and water.

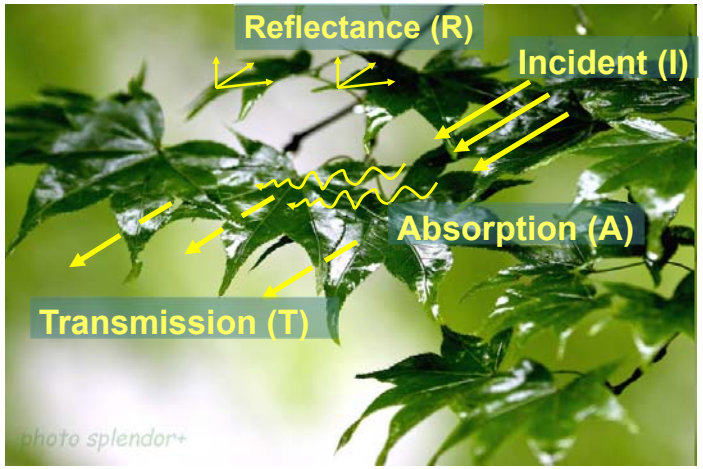
Spectral Characteristics



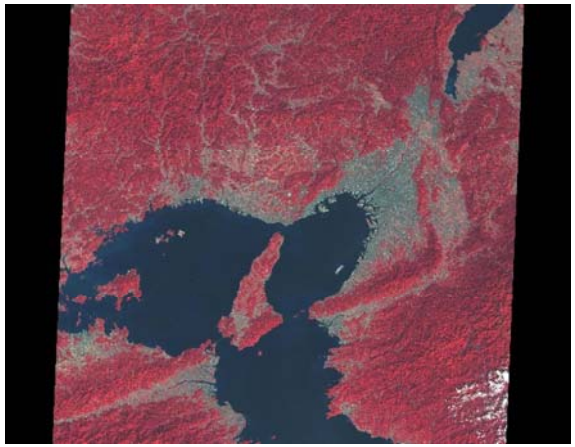
Visible-Infrared Remote Sensing

Model of Radiation and Target Interaction





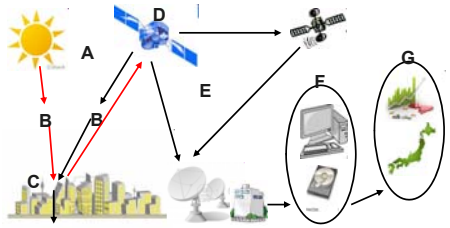
Gathering the reflection from the Earth Surface



False Color

Earth Surface Information Gathering

Processes of Remote Sensing
for Gathering Earth Surface Information



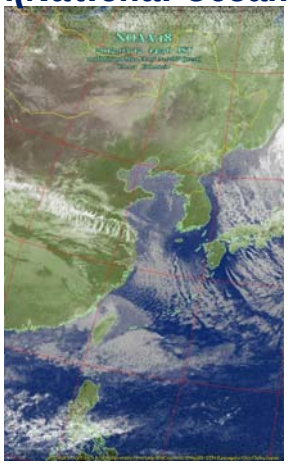
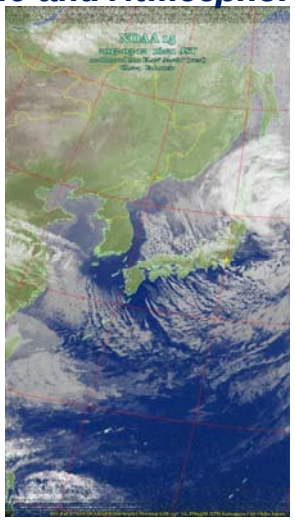
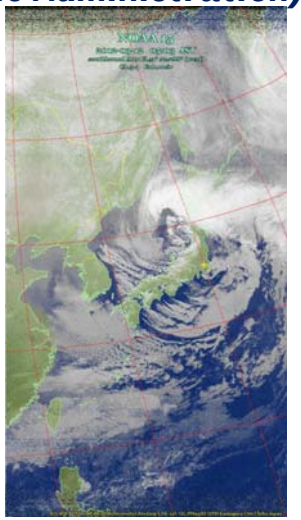
NOAA(National Oceanic and Atmospheric Administration)

Now Operating:
NOAA 15 : AM Secondary **NOAA 18 : PM Secondary**
NOAA 16 : PM Secondary **NOAA 19 : PM Primary**
NOAA 17 : AM backup
Geostationary Orbit
Altitude: Approximately 870 km
Launched: 02/06/2009 **NOAA 19**

Sensor	Wavelength Range/ Frequency	Spatial Resolution	Observation Width
AVHRR/3	Channel 1: 0.58 - 0.68(μm)(Visible) Channel 2: 0.725 - 1.00(μm) (NIR) Channel3A: 1.58 - 1.64(μm) (NIR) Channel3B: 3.55 - 3.93(μm) (MIR) Channel 4: 10.30 - 11.30(μm) (TIR) Channel 5: 11.50 - 12.50(μm) (TIR)	0.5 km 1.0 km 1.0 km 1.0 km 1.0 km 1.0 km	Swath Width : 2800km

Source:http://ja.allmetsat.com/satellite-noaa.php

NOAA(National Oceanic and Atmospheric Administration)

ALOS

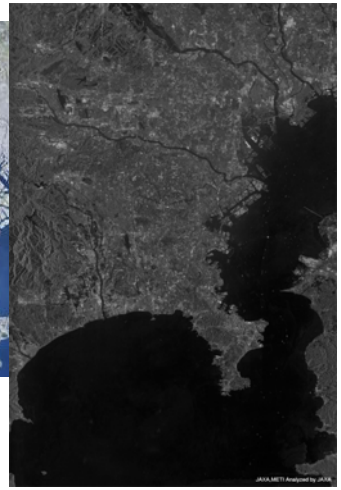
Sun Synchronous Sub-Recurrent Orbit
Recurrent Period: 46 days
Sub cycle: 2 days
Altitude: Approximately 692km (above the equator)
Launched: January 2006

Sensor	Wavelength Range/ Frequency	Spatial Resolution	Observation Width
PRISM	0.52-0.77(μm)	2.5m	Swath Width : 35km(Triplet mode) 70km(Nadir Only)
AVNIR-2	Band1:0.42-0.50 (μm)(blue) Band2:0.52-0.60 (μm)(green) Band3:0.61-0.69 (μm)(red) Band4:0.76-0.89 (μm)(near-IR)	10m	Swath Width : 70km
PALSAR	Frequency L-Band 1.3 (GHz)	10m(fine resolution mode) 100m(Scan Sar mode)	Observation Swath : 70km(fine mode) 250-350km(Scan SAR)

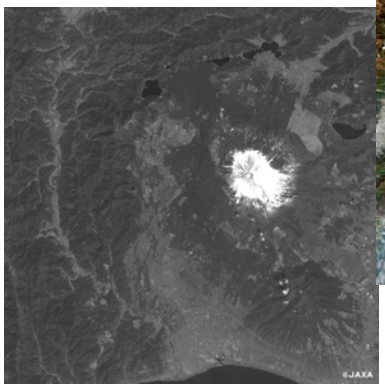
Source:http://www.alos-restec.jp/en/staticpages/index.php/aboutalos
http://www.satimagingcorp.com/satellite-sensors/alos.html

ALOS

PALSAR

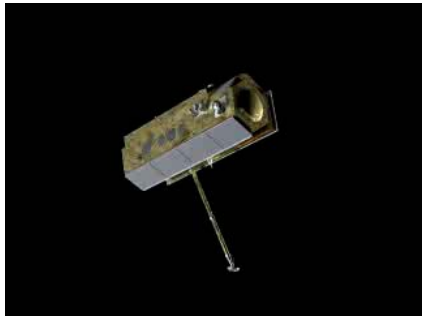



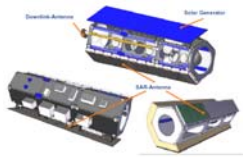
AVNIR-2



PRISM

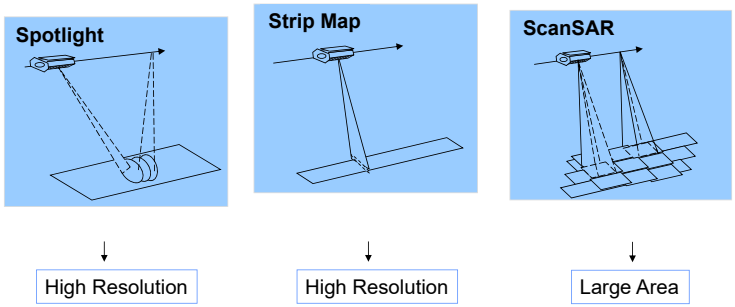
TerraSAR-X (Commercial Satellite)



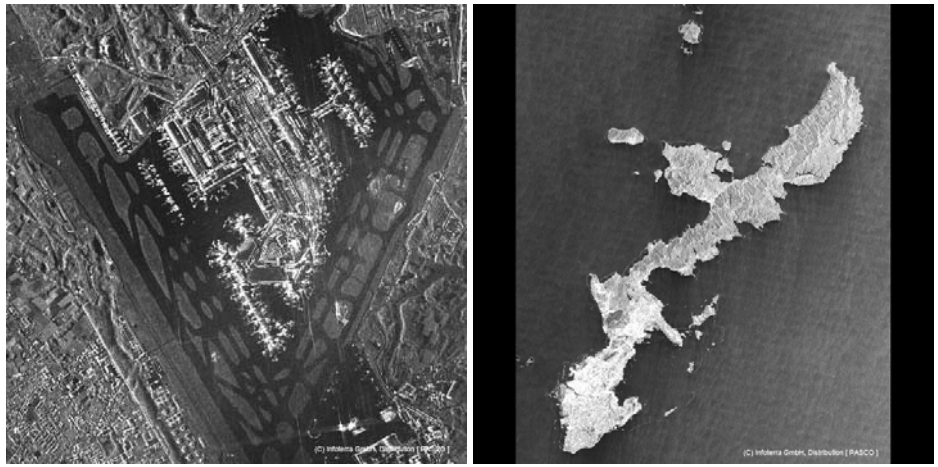


Sensor	Active Phased Array X Band SAR
Satellite Mass	1,230kg
Antenna Size	4.8m × 0.7m × 0.15m
Orbit	Sun Synchronous Sub-Recurrent
Recurrent Period	11 days
Orbit Altitude	514km
Angle of inclination with respect to the equator	97.44°
Equatorial Crossing Time (Local Time)	06:00±0.25h (Descending) 18:00±0.25h (Ascending)

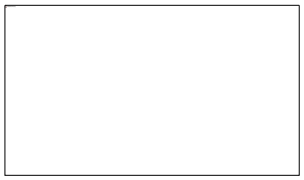
Three Acquisition mode of TerraSAR-X



TerraSAR-X (Commercial Satellite)

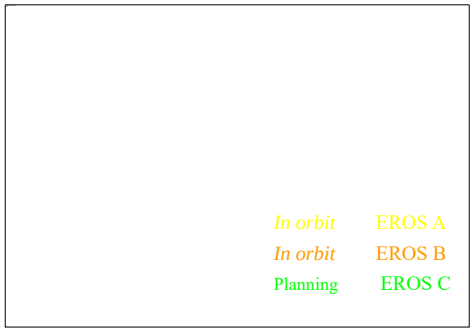


Sub-Meter Commercial Satellite EROS-A&B



EROS-A

2000～
ImageSat International
Designed Life Time 10years
Overflight AM9:45 (EROS-A)
AM13:45 (EROS-B)
over Japan
Altitude:500km
Recurrent Period : less than 7days

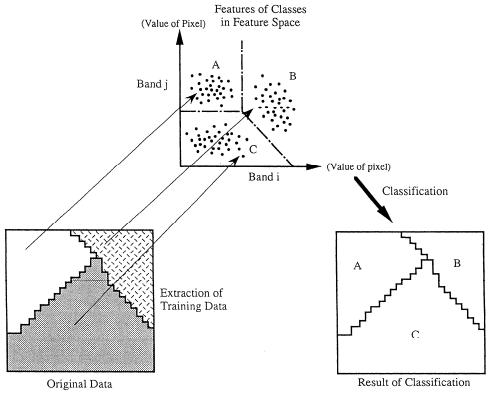


	EROS-A	EROS-B	EROS-C
Launch	Dec.,2000	Apr.,2006	(Designed)
Wavelength	0.50 -0.90 mm	0.50-0.90 mm	0.50-0.90 mm
Ground Resolution	1.9 m	0.7 m	0.7 m 2.8 m (Multi-mode)
Swath	14 km	7 km	--

Sub-Meter Commercial Satellite EROS-A&B

Image processing for classification

What is image classification?



In many cases, classification will be undertaken using a computer, with the use of mathematical classification techniques.

This Figure shows the concept of classification of remotely sensed data.

Methodology of classification processing

Pixel based classification **Object based classification**

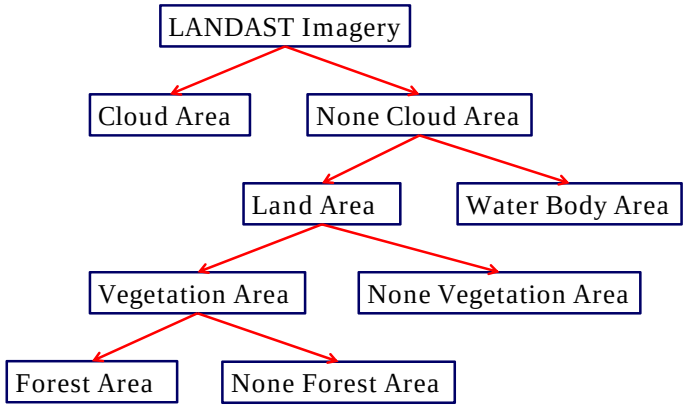
Typical methodology of classification processing

- Multi level slice classifier
- Decision tree classifier
- Minimum distance classifier
- Maximum likelihood classifier
  - Supervised, unsupervised, clustering

Other methodology of classification processing

- Fuzzy theory
- Expert system
- Neural Network i.e. AI

Decision Tree classifier

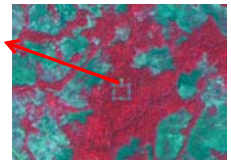


Supervised classification

Extraction of site training data

- Ground Truth Survey
- Refer to the Google Earth

Site Training Data



LANDAST Imagery

Input

Supervised classification process

To classify into similar characteristic cluster of pixel value based on site training data

Land Cover / Land Use Map

Example as application of Satellite Remote Sensing

Extraction of logging area by image processing

Satellite Imagery

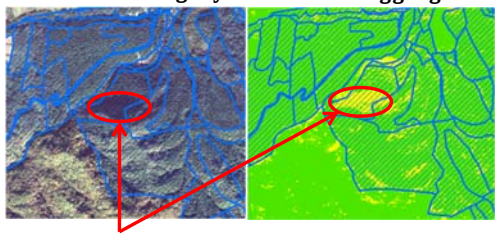
NDVI calculation

Setting threshold of NDVI

Extraction of logging area

$$\text{NDVI} = \frac{NIR - R}{NIR + R}$$

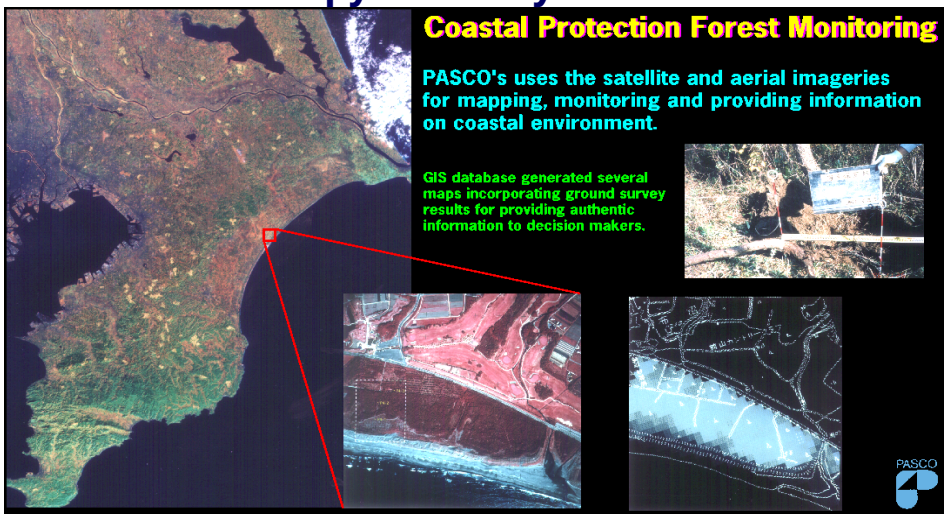
Extraction of logging area by image processing



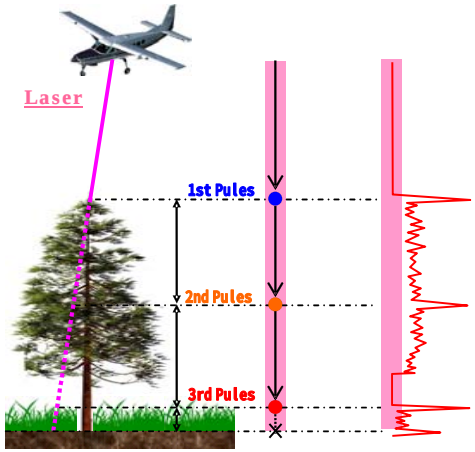
Affected by shadow

Affected by grass after logging

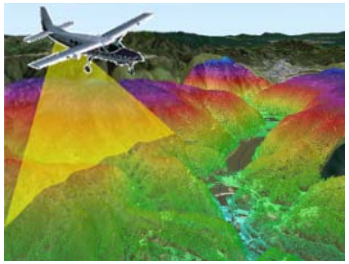
Extraction of Canopy Dense by NDVI and BI



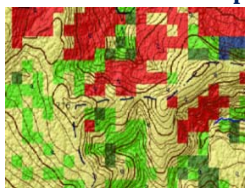
Analysis of Airborne Lidar survey for canopy density

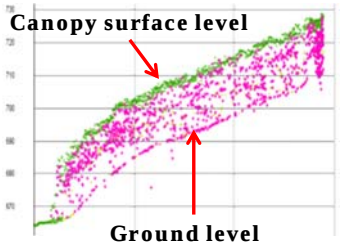


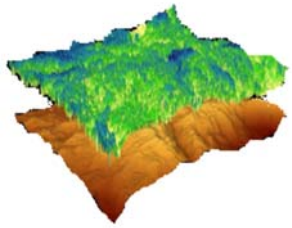
Analysis of Airborne Lidar survey for canopy density



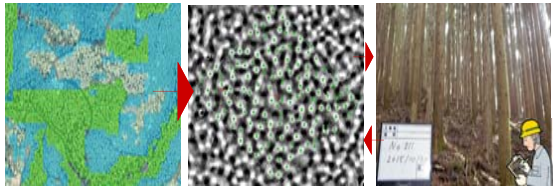
Forest Resource Map



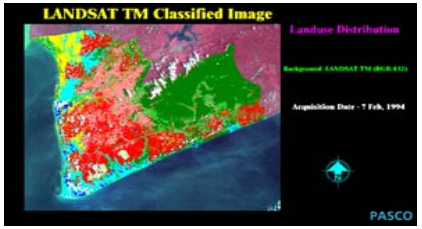


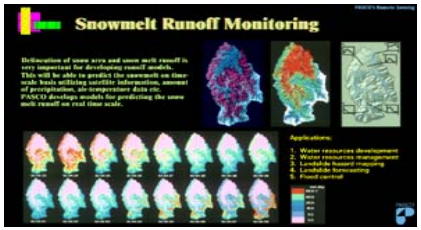


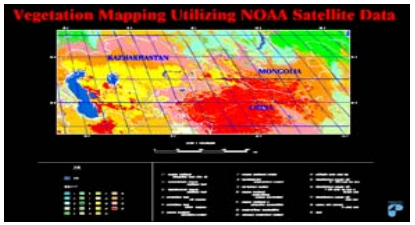
Forest Type Map | Individual Canopy Map | Site Survey



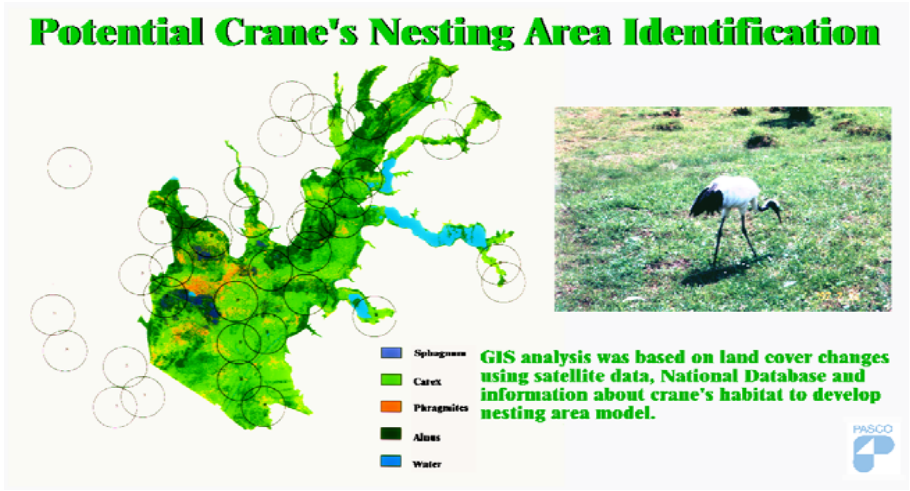
Example of other application



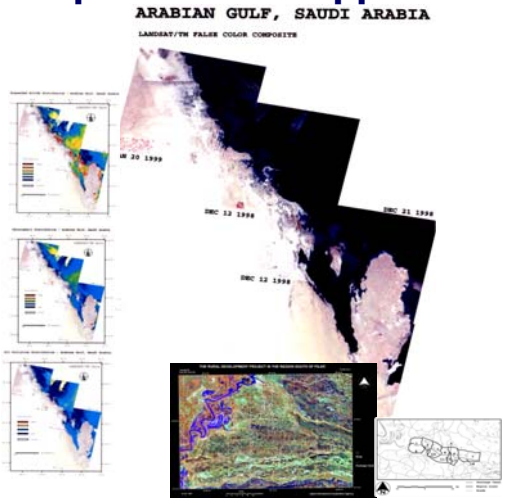


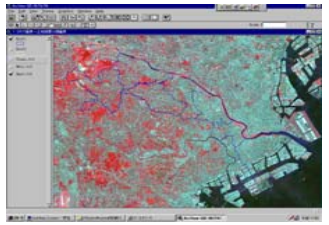


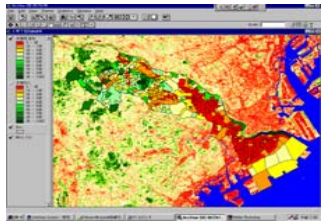
Example of other application



Example of other application







Thank you very much!

Contact address: f.mukabi@gmail.com
koetia2696@pasco.co.jp

REPUBLIC OF KENYA
Ministry of Environment and Natural Resources
Kenya Forest Service

MRV TRAINING – ACTIVITY DATA

Date: 5th July 2018

By Faith MUTWIRI and Kei SATO

SLEEK Time Series Land Cover / Land Use Map preparation

Activity Data

Introduction

- Mapping done in support of the SLEEK to establish robust MRV (Measurement, Reporting and Verification) system to track land-based emissions.
- SLEEK designed to track all emissions and removals in the land-sector;
- The mapping team provides land cover and change information required for national land based greenhouse gas estimation
- A multi-institutional Technical Working Group established to do the mapping,
- Work strongly guided by a Technical and process manual.

Capacity building

- Several trainings have been undertaken by FAO and CSIRO

1.CSIRO (Commonwealth Scientific and Industrial Research)

- ➢Random Forest classification and scripts used in the classification
- ➢Terrain illumination correction
- ➢Change detection and time series

2.FAO (Food Agricultural Organization

- ➢Accuracy Assessment
- ➢Change detection using Google Earth Engine
- ➢Land Cover Classification System (LCCS)
- ➢Data collection using collect earth

Methodology

1. Testing of methods

A. Methods as used by various institutions were tested.

- **Maximum likelihood,**
- **Progressive extraction and disaggregation of land covers,**
- **Random forest classification and**
- **Decision tree classifier.**

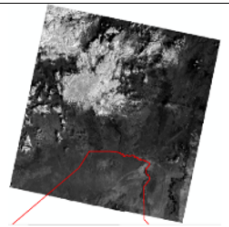
B. Classification using Random Forest – pixel based method was selected

- **✓Open source**
- **✓Store probability's**
- **✓Accurate**
- **✓Ease of implementation**

2. Data acquisition - *Data selection*

- **Cloud cover** – desired 0% cloud cover, low cloud cover (20%) is acceptable
- **Season** – dry season - January to February and July to August.
- **Sensor** - Landsat 5, Landsat 7 SLC-on, Landsat 8 are preferred over Landsat 7 SLC-Off
- **Date** - If more than one cloud-free choice is available, then dates of neighbouring scenes are considered (same-date with neighbours in the path or close date to neighbouring row will be preferred)

Sample of Data acquisition - *Data selection report*

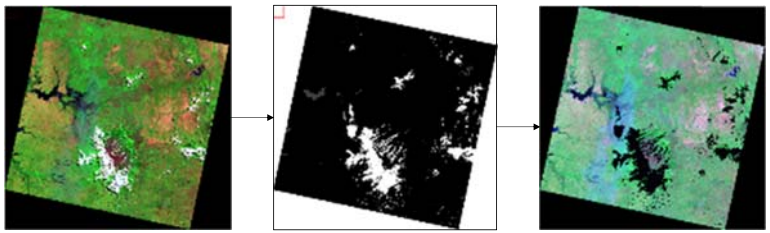
Image ID/Path-Row	Sensor	Season	Description	Screen Shot	Availability on Archive
P170_R056_2014_016	L8	Dry	Out 22 images this was the best. Good Image. No cloud within the Kenya boundary region		Y

Note: These archives were accessed at (*http://glovis.usgs.gov/* or *http://earthexplorer.usgs.gov/*).

3. Data preparation

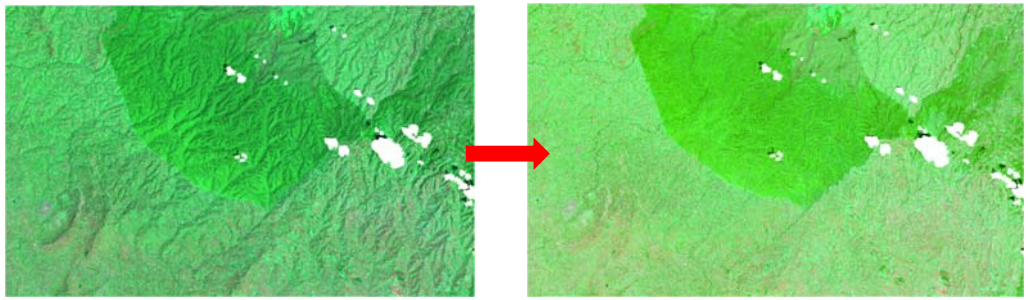
1.Cloud and shadow masking

- **masking all cloud and shadow**
- **Used "cfmask" band from USGS**



2. Terrain illumination Correction

- variations in slope and aspect
- to correct terrain illumination effects so that the same land cover will have a consistent digital signal



3. Projection to the Kenyan Coordinate System

- Projection from **UTM WGS 84** to **UTM Arc1960 37 South**

4. Land Cover / Land Use Classification

1. Land cover classes for LCC Mapping

I. Forest

1. Dense Forest > 65% canopy cover
2. Moderate Forest 40 – 65% canopy cover
3. Open Forest 15 – 40% canopy cover

II. Cropland

1. Annual Cropland
2. Perennial cropland

III. Grassland

1. Open Grassland
2. Wooded grassland

IV. Wetland

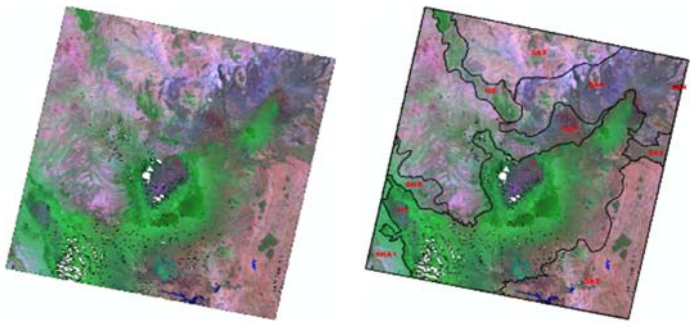
1. Open Water
2. Vegetated wetland

V. Settlement

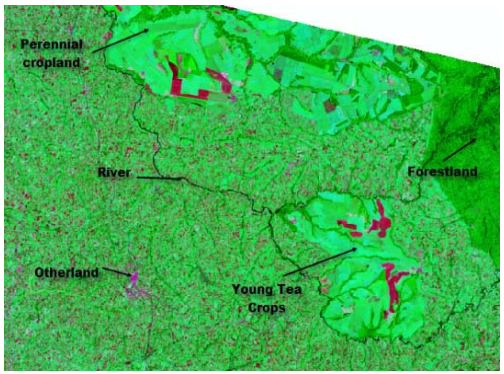
VI. Otherland

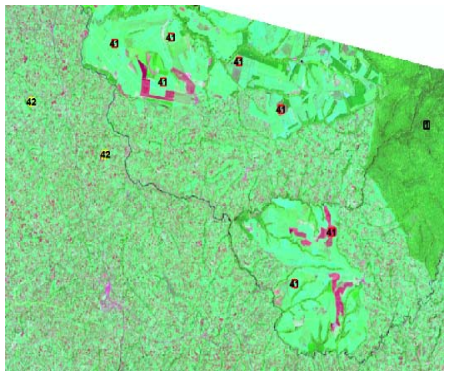
2. Stratification – spectral stratification zones

- Land cover / land use variations in Kenya
- spectral stratification zones were initially based on Kenya's Agro-Ecological Zones later modified



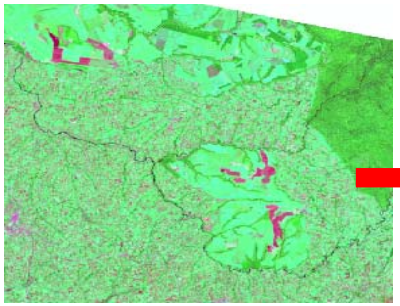
3. Selection of Training Sites



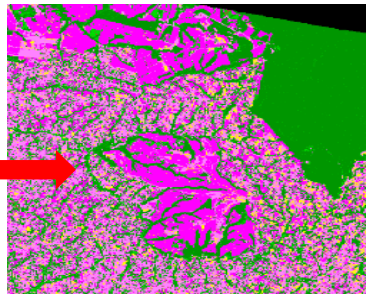


4. Classification using Random Forests

- Running R-Scripts



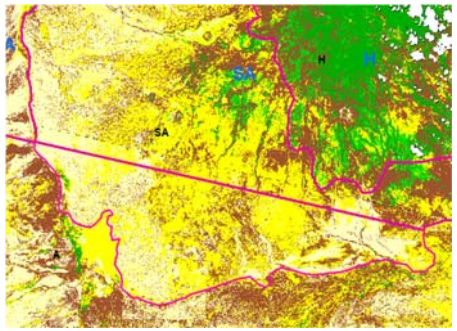
Landsat Image



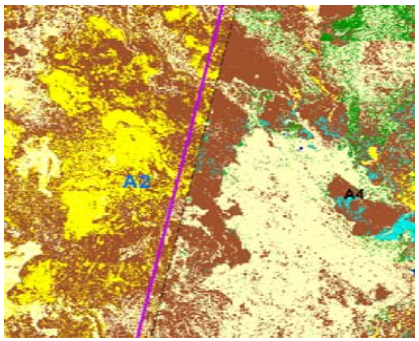
Output: Classified Image

5. QA/QC of the classification

- Checking for consistent classification results across scene and zone boundaries (pink lines)

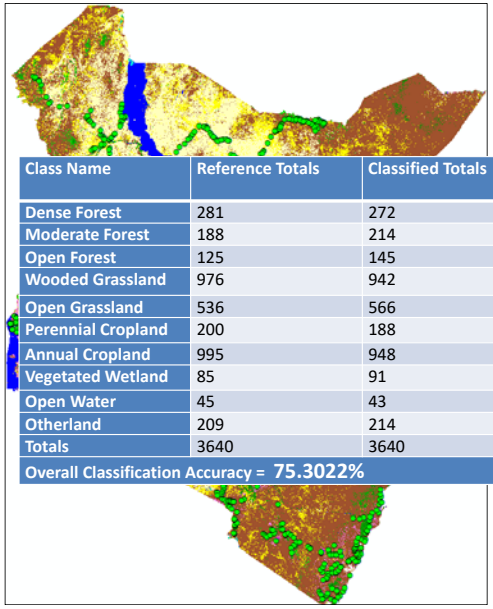


- Classification inconsistencies between neighbouring scenes



5. Accuracy Assessment

- Checking the correctness of the map
- Sampling Procedure - *Proportionate stratified random*
  - ➢ To consider accessibility
  - ➢ To consider number of points per day
  - ➢ To consider balance of class type
  - ➢ To consider interested class type
  - ➢ To consider accommodation possibility

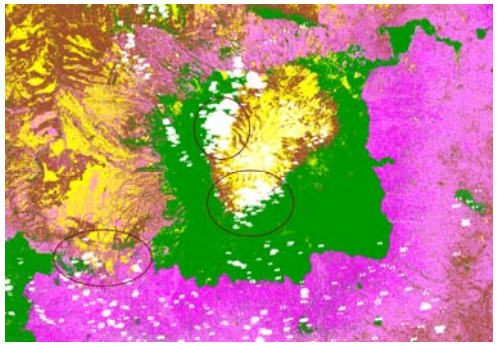


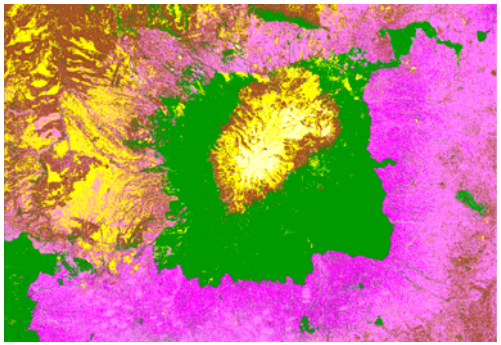
Results - SLEEK Team

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Dense Forest	281	272	216	76.87%	79.41%
Moderate Forest	188	214	148	78.72%	69.16%
Open Forest	125	145	94	75.2%	64.83%
Wooded Grassland	976	942	737	75.51%	78.24%
Open Grassland	536	566	395	73.69%	69.79%
Perennial Cropland	200	188	150	75%	79.79%
Annual Cropland	995	948	726	72.96%	76.58%
Vegetated Wetland	85	91	66	77.65%	72.53%
Open Water	45	43	36	80%	83.72%
Otherland	209	214	173	82.78%	80.84%
Totals	3640	3640	3640		
Overall Classification Accuracy = 75.3022%					

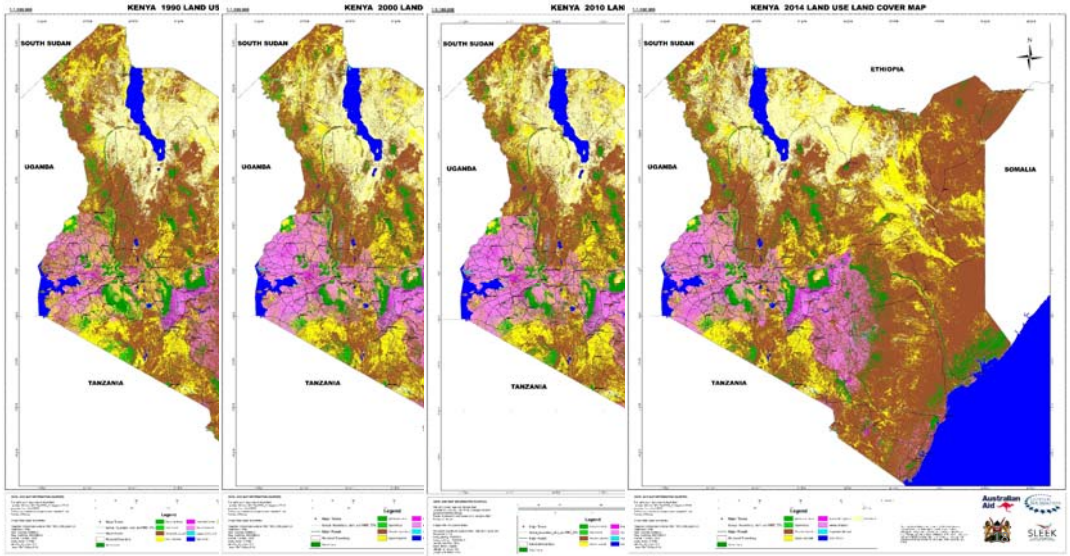
5. CPN (Conditional Probability Network)

- Due to data gaps a mathematical model known as a conditional probability network (CPN) is used to fill.
- It uses the time series maps and the probability bands developed during classification



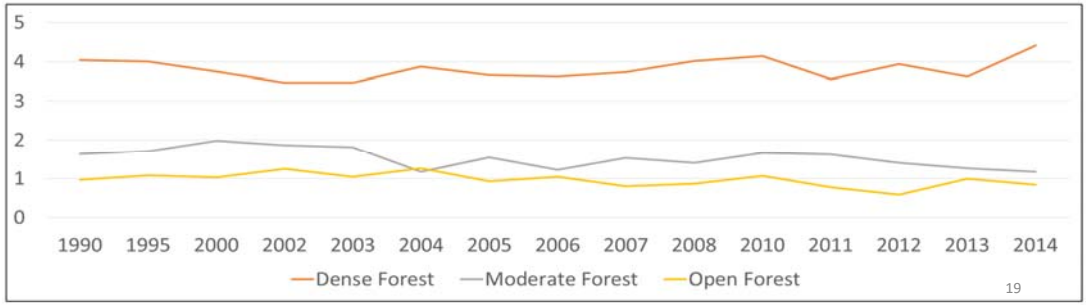


Time Series Maps

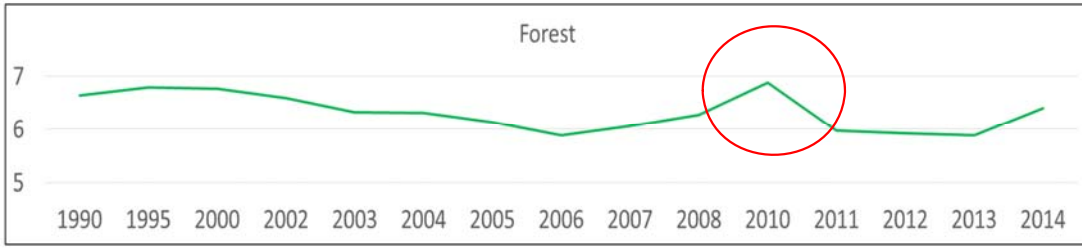


Statistics

	1990	1995	2000	2002	2004	2006	2008	2010	2012	2014
Dense Forest	4.06	4.21	3.77	3.60	4.14	3.89	4.30	4.29	4.09	4.53
Moderate Forest	1.32	1.56	2.02	1.74	0.94	0.94	1.07	1.49	1.18	1.00
Open Forest	1.28	1.10	1.02	1.24	1.21	1.00	0.81	1.06	0.53	0.82
Wooded Grassland	57.65	57.65	55.19	55.60	54.64	54.02	52.66	53.07	54.41	54.13
Open Grassland	16.76	16.84	17.42	16.09	16.49	16.39	17.79	16.60	16.62	15.72
Perennial Cropland	0.55	0.48	0.42	0.54	0.62	0.61	0.48	0.53	0.52	0.59
Annual Cropland	5.37	5.79	6.83	8.03	8.06	9.32	9.02	9.22	8.72	9.38
Vegetated Wetland	0.05	0.06	0.04	0.07	0.04	0.08	0.07	0.10	0.08	0.07
Open Water	2.04	2.04	2.05	2.05	2.02	1.99	2.01	2.06	2.11	2.07
Otherland	10.91	10.27	11.23	11.05	11.83	11.76	11.80	11.58	11.73	11.69

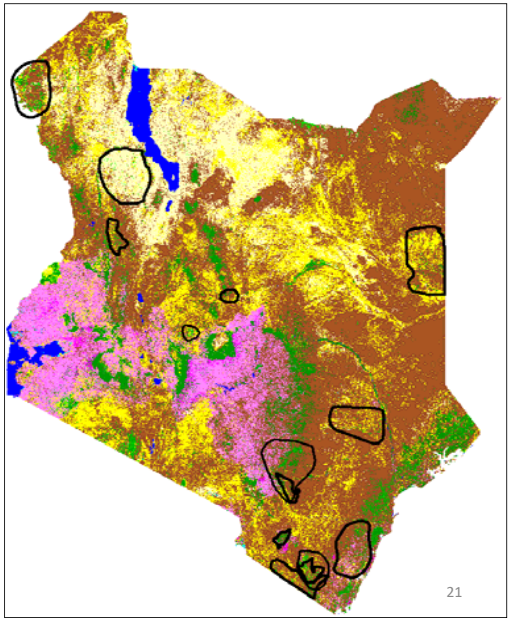


Statistics Cont...

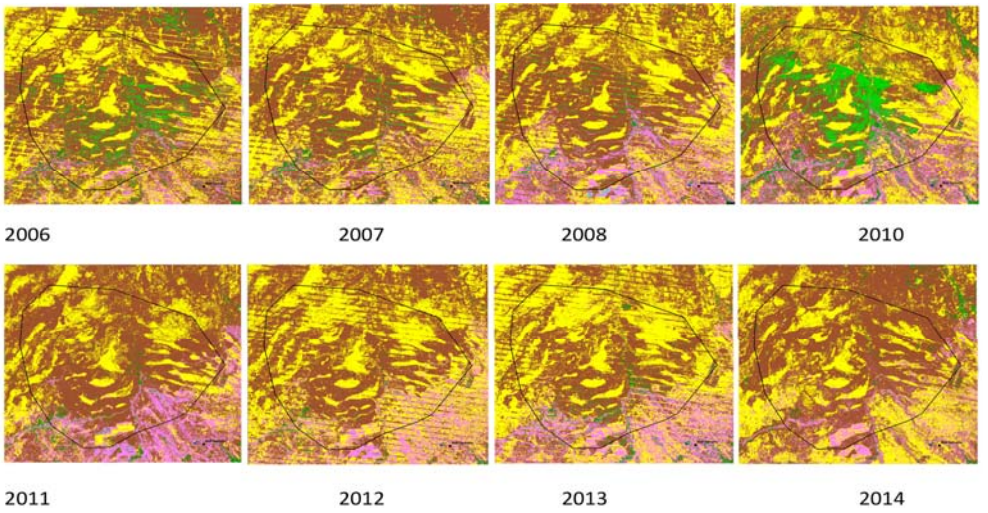


Post Classification

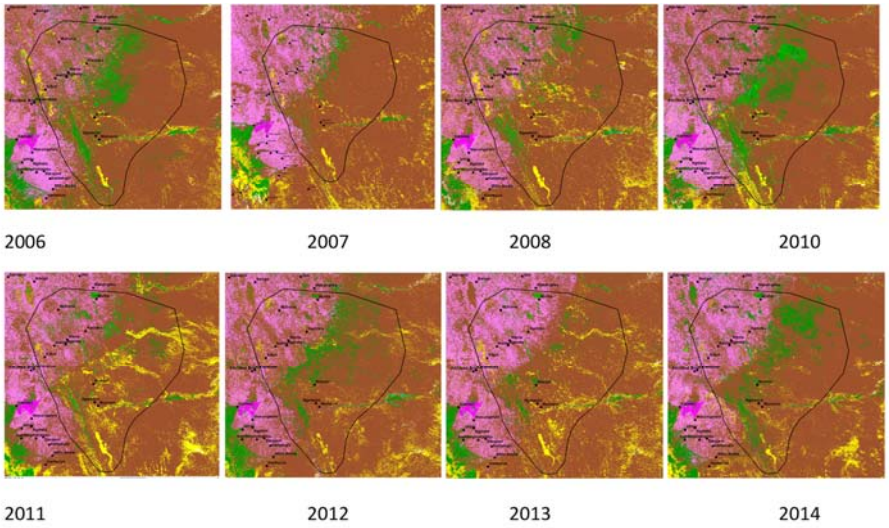
- In 2010 inconsistency in forest cover
- Post analysis of the land use land cover map
- Identifying areas with issues in Forest coverage year 2010



Post Classification - *Laikipia*

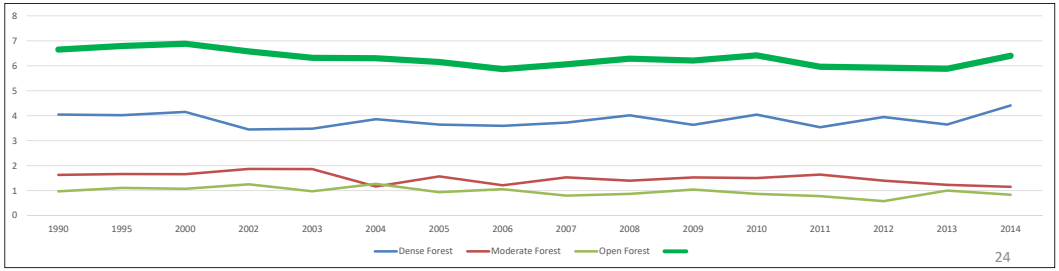


Post Classification - *Kitui*



Statistics after post classification

	1990	1995	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Dense Forest	4.05	4.02	4.15	3.45	3.48	3.86	3.64	3.60	3.72	4.02	3.64	4.04	3.54	3.95	3.65	4.41
Moderate Forest	1.63	1.66	1.66	1.87	1.86	1.17	1.57	1.22	1.53	1.40	1.53	1.50	1.64	1.40	1.23	1.15
Open Forest	0.97	1.11	1.07	1.25	0.98	1.27	0.94	1.06	0.80	0.87	1.04	0.87	0.78	0.58	1.00	0.84
Wooded Grassland	57.90	58.03	52.97	55.66	56.95	54.70	56.37	53.96	51.35	52.30	55.14	53.21	49.91	54.00	51.21	54.01
Open Grassland	16.65	16.64	16.59	16.07	16.04	16.50	15.78	16.34	18.33	17.83	15.91	16.83	20.50	16.67	17.62	15.73
Perennial Cropland	0.54	0.48	0.53	0.54	0.44	0.61	0.53	0.60	0.48	0.47	0.58	0.53	0.56	0.53	0.52	0.60
Annual Cropland	5.30	5.72	9.28	8.00	6.90	8.04	7.59	9.38	10.14	9.17	9.05	9.25	10.15	8.88	10.15	9.42
Vegetated Wetland	0.05	0.06	0.10	0.07	0.05	0.04	0.07	0.08	0.10	0.08	0.08	0.10	0.07	0.09	0.09	0.07
Open Water	2.04	2.04	2.05	2.05	2.03	2.02	2.03	1.99	2.06	2.00	2.04	2.05	2.02	2.11	2.06	2.07
Otherland	10.87	10.23	11.60	11.05	11.28	11.79	11.47	11.78	11.47	11.85	11.00	11.61	10.83	11.79	12.48	11.70



REDD + Decision on Activity Data

1. Accuracy Assessment

- **Checking the correctness of the map**
- **Sampling Procedure - *Proportionate stratified random***

FIELD NOTE for Remote Sensing Analysis

No.	: 012	Date	: 27/09/2016
		Surveyor	: Shrayo Peter
Category Type	:	UTM(X)/Lat	: S 00°22'57.4"
		UTM(Y)/Long	: E 35°56'36.3"
County	: Nakuru	Elevation	: 2238
		Remark	:

1. Forest land — Comments

Type	: Plantation(wood lot)
Height	: 15M
Density(Crown	: Dense
Remark	: Small (0.5ha) Eucalyptus wood lot plantation

2. Non-Forest Land — Comments

Land use	:
Remark	:

Foto

North : Dense wood lot plantation

South: Dense wood lot plantation

Result

Correctness Table by Verification Survey (SLEEK and JICA Consultant team)

Class Name	Land Cover / Land Use	Number of correct	Accuracy Ratio
Dense Forest	312	239	76.6%
Moderate Forest	221	152	68.8%
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**	**2852**	**75.1%**

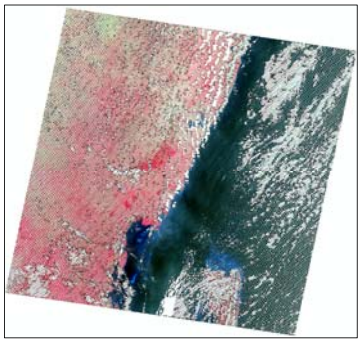
Class Name	Land Cover / Land Use	Number of correct	Accuracy Ratio
Forest	683	488	71.4%
Wooded Grassland	984	761	77.3%
Open Grassland	581	406	69.9%
Perennial Cropland	205	165	80.5%
Annual Cropland	989	748	75.6%
Vegetated Wetland	95	70	73.7%
Open Water	47	40	85.1%
Other Land	215	174	80.9%
TOTAL	**3799**	**2852**	**75.1%**

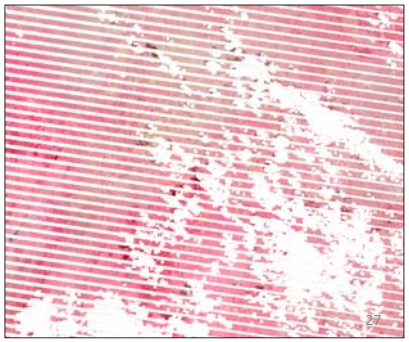
REDD + Decision on Activity Data

2. Reference year and interval

Data screening

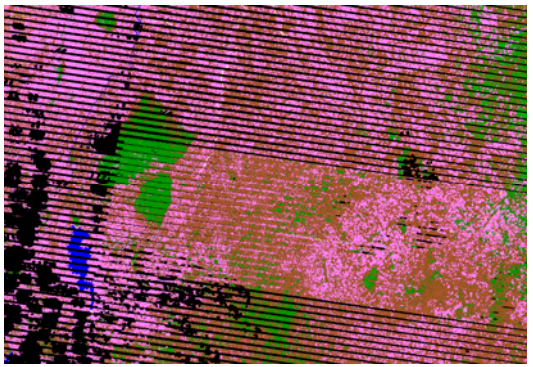
- The quality of Land Cover/ Land Use Map by image classification is affected by the quality of source data which is satellite imagery.
- So the good quality satellite imagery shall be utilized
- Stripping is from end of May 2003



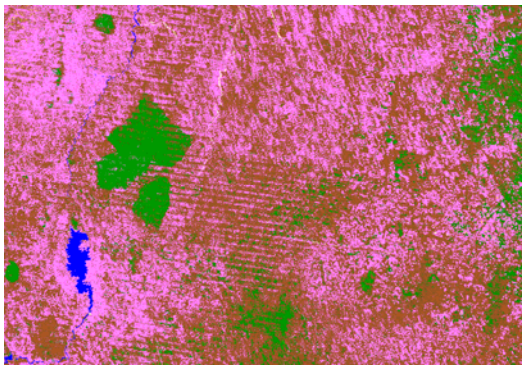


Stripping effect on classification

2006 Land cover Land use map



Before CPN



After CPN

Result of data screening and Recommendable Year

	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%**

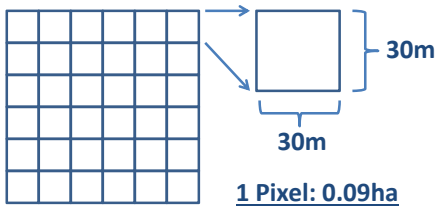
	2007	2008	2009	2010	2011	2012	2013	2014
No DATA (%)	26.14%	28.00%	15.85%	6.81%	12.51%	20.85%	16.98%	3.75%
LANDSAT4 (scene)	0	0	0	0	0	0	0	0
LANDSAT5 (scene)	0	0	11	24	15	0	0	0
LANDSAT7 (scene)	34	34	23	9	19	34	13	0
Missing scenes	0	0	0	1	0	0	0	0
LANDSAT8 (scene)	0	0	0	0	0	0	21	34
Stripping Effect (scene)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

10 Year's epoch shall be utilized and 2014 as recent Activity Data

2. Image Filtering to meet Forest Definition

Image vs. Forest Definition

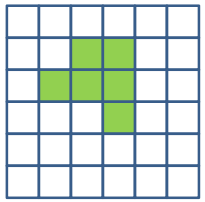
0.5ha as minimum mapping unit was considered as concept of SLEEK Map



LANDSAT Imagery

1 Pixel: 0.09ha

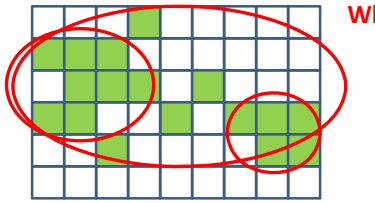
Forest Definition
- Canopy Cover Ratio: ≥ 15%
- Area size: 0.5ha



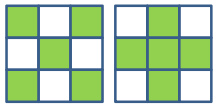
Forest area size: 0.54ha

Definition of Pixel Cluster

How to gather the forest class of pixels as one cluster for the filtering of unsatisfied forest definition?
What is forest cluster?



Which area do you think as one forest class of pixel cluster?



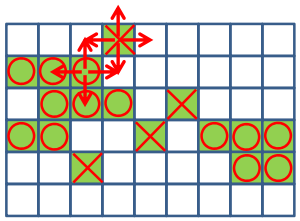
Recognized it as connected

Recognized it as connected

Cluster Searching Method 1

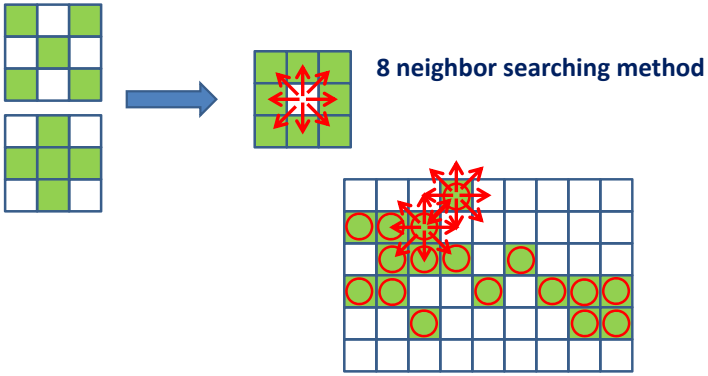
How to searching the forest cluster as same group?

4 neighbor searching method



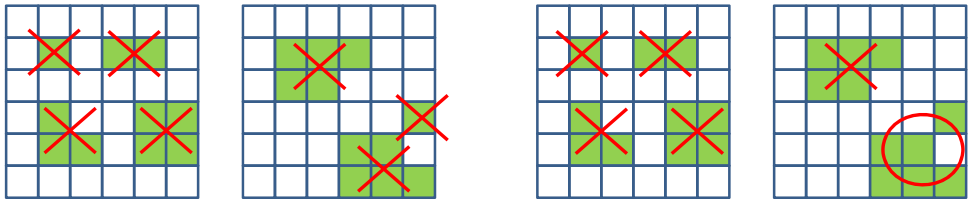
Cluster Searching Method 2

How to searching the forest cluster as same group?



Elimination of Cluster

Eliminate the pixels which are less than 6 pixels

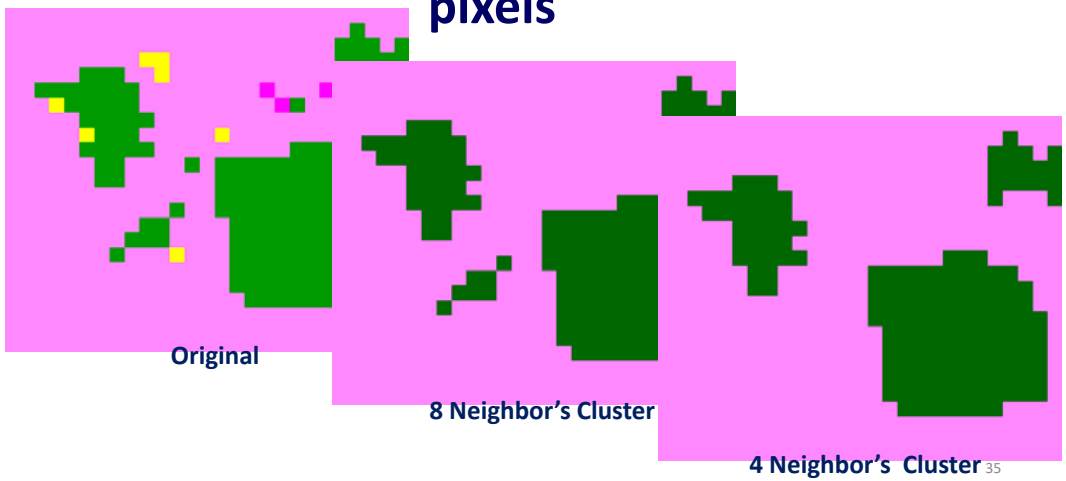


4 neighbor searching method

8 neighbor searching method

Eliminated less than 6 pixels will be replace neighbor bigger cluster of class Type

Example of Elimination which is less than 6 pixels



Thank you very much!

Contact address: f.mukabi@gmail.com
koetia2696@pasco.co.jp

Capacity Development Project for Sustainable Forest Management in the Republic of Kenya
(REDD+ Readiness Component)

MRV training
National Forest Inventory (NFI)

Yoshihiko SATO
Japan Overseas Forestry Consultants Association
5th July, 2018

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What is national forest inventory?

In order to evaluate forest resource of the entire country (e.g. areas volume and increment of growing stock, etc.), a forest resources survey is periodically carried out by the unified technique in most European and North American countries. This is called the national forest inventory. Today, sample-based national forest inventory data can be used for accurate carbon absorption by the forest.

REDD plus COOKBOOK(FFPRI, 2012)

Why is national forest inventory necessary ?

- to grasp quantity of national forest resources

  What is NFI to use for ?

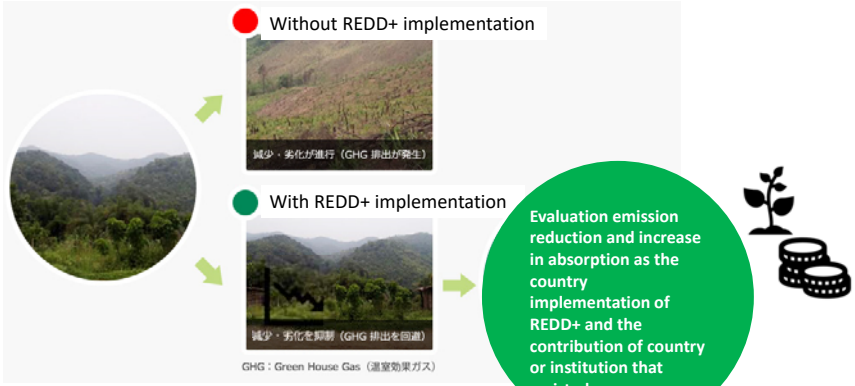
  - For forest policies
  - For REDD＋ activity

    NFI → EF → Estimation of Historical trend → Trade of carbon credits

For policies, such as implementation of sustainable forest management

https://srge.info/about-ge

For REDD+ activity



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Definition of forest inventory

- **Inventory :** a detailed list of items (tabulated information) classified according to their properties, as well as the action or process of creating the said list
- **Forest inventory:** a quantitative and qualitative inventory of the forest and the process for measuring and analyzing information

  Content, concepts, definitions of used inventories are permanently adapted to users' needs.

Types of forest inventory

Forest inventory: There are two main types of forest inventory:

- **Forest inventory:** by counting and comprehensive survey, is generally used in the management unit.
- **National Forest Inventory** by statistical sampling method at the country level.

Types of forest inventory

- **Forest inventory** by counting and comprehensive survey

Example - Forest management inventory
- Forest exploitation inventory

Method - Development of forest types maps using aerial photos
- Calculation of forest volumes by sampling temporary or permanent plots
- Identification of the volumes of each tree group using GIS and register

Objective - Planification by forest management units
- Analysis of wood supply and yield

Types of forest inventory

- **National Forest Inventory (NFI)**

Method - Statistical sampling design
- Actual measure of fixed plots: offers the advantage of a chronological track
- Inventory interval : about 5 to 10 years

Objective - Collect forest data over the country using uniform definitions
- Accountability for global environmental issues
- International report for the Convention on climate change and Kyoto Protocole, Process for forest sustainable management and REDD, etc.

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History of NFI

- The collection of some forest data goes back to the 19th century in Europe and North America.
- Mathematical basis of sampling methods used in NFI were developed in the early 19th century.
- NFI based on statistical sampling methods, were initiated by:
  - Nordic countries in the late 1910 and early 1920 ;
  - France, in 1958 ;
  - Democratic Republic of Germany, in the 60's (Federal Republic of Germany, in 1987) ;
  - Austria and Spain, in the 60's;
  - Switzerland in the 80's.

History of NFI

- Nowadays, NFI based on statistical methods, targetting a representative sampling, are carried out in most of European and North- american countries.
- Globally, there are still many countries that never carry out a NFI although new NFI are initiated every day:
  - Japan started in 1999 ;
  - Cameroon, in 2003.

  * NFI was made in 8 countries, including Cameroon and Zambia until 2009, and continued in 14 countries, including Kenya, DRC, Gambia, Angola and Tanzania, with the support of FAO (NFMA).
- Due to some international agreements, such as the Kyoto Protocol, the need for forest information significantly increased.

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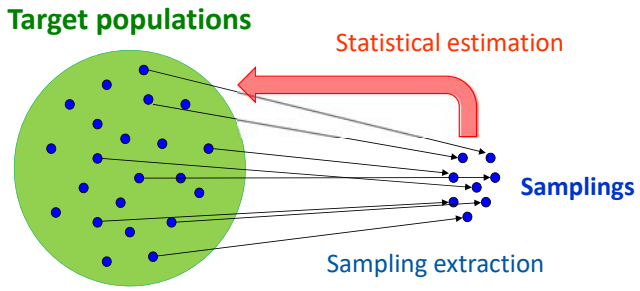
➢ Statistical sampling design & mehodology

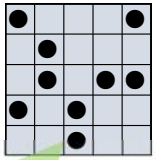
- It is not possible to examine all elements of the target populations.
- Statistical estimation : conduct sampling to determine the trend of target population.



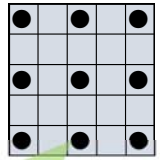
➢ Statistical sampling design & methodology

• Sampling extraction methods

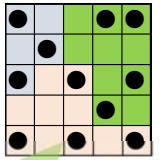
As simplified method, we have random sampling, systematic sampling, stratified sampling etc.



Random sampling : random sampling extraction using random numbers etc. (basic method)



Systematic sampling: sampling extraction at regular intervals



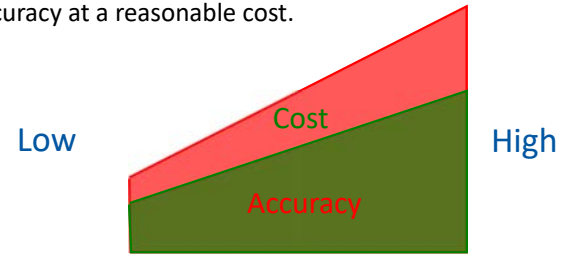
Stratified sampling: Sampling extraction by prior division of the population into several stratas.

➢ Statistical sampling design & methodology

• Planning a survey

The cost for NFI implementation is proportional to the level of data accuracy. The more data is accurate and true , higher is the cost.

However, thanks to ingenious ideas (e.g.: combination of methods), we can obtain an higher accuracy at a reasonable cost.



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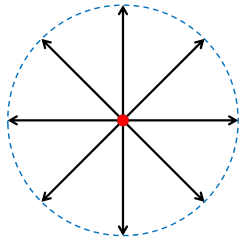
➢ Sampling Plot shape

- There are circular, square, rectangular etc.. plots.

✓ Circular plot

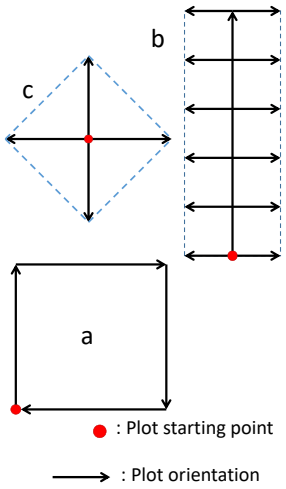
- Strengths :
  - Theoretically, this is the shape that minimizes more the edge effects.
  - It is not necessary to measure the perimeter
  - By changing the plot radius according to the slope, we can maintain the central projection area.
- Weaknesses :
  - The perimeter is a curved line (arc), it is possible to allow (without noticing) trees on the edge if you do not check the location of the tree inside/ outside this area.

  But, one can easily determine whether a tree is inside or outside the plot using a pole etc.. once the center position of the plot is determined (using Vertex, one can effectively know if the tree is inside / outside).



✓ Rectangular plot

- Strengths :
  - The perimeter is a straight line, it is easy to see if the trees are inside / outside the edge
  - Type c on the left, determines more effectively the plot contrarily to a circular shape (however, it is not possible to provide a plot with significant area)
- Weaknesses:
  - Topographic survey of the perimeter being necessary, the efficiency of determining the type a plot is reduced
  - Theoretically speaking, the edge effect is more important than in the circular plot



A single-plot system and Plot clustre

Plot cluster
Advantage :
possible to collect many data from several plots within a short time period.
(The plots are close together.)

Disadvantage :
the statistical analysis is more complicated.
(Plots in the same cluster may not be statistically independent.)

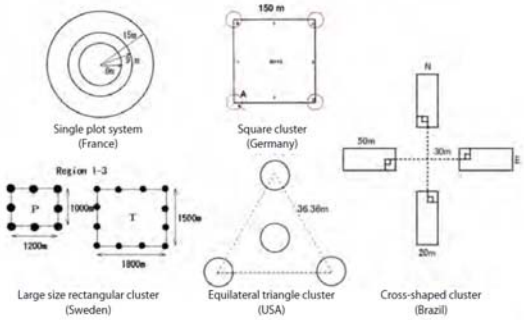


Figure T01-2 Type classification of the national forest inventory plot

REDD plus COOKBOOK (FFPRI, 2012)

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➢ Example of NFI in different countries

- NFI varies according to countries.

Table 2.3 Features of probability-based sampling designs used by NFIs

Country	Systematic grid spacing for plots or clusters of plots (km × km)	Strata criteria for stratified sampling	Random component in plot location	Number of field plots per cluster	Permanent plots (proportion of all plots)	Last NFI cycle	Current/ future NFI cycle
Austria	3.889 × 3.889	–	–	4	1.00	2000–2002	2007–2009
Belgium (Walloon Region)	1 × 0.5	–	–	1	1.00	1994–2008	2008–2018
Brazil	20 × 20	–	–	4	–	–	2009–
Canada	20 × 20	Terrestrial ecozone	–	1	1.00	2000–2006	2007–
China	–	–	–	1	1.00	2004–2008	–
Cyprus	–	–	–	1	1.00	2001–2005	–
Czech Republic	2 × 2	–	Within 300 m of grid point	1	1.00	2001–2004	–
Denmark	2 × 2	–	–	4	Approximately 0.33	2002–2006	2007–2011
Estonia	5 × 5	–	–	16	0.25–0.50	2004–2008	2009–2013
Finland	3 × 3 to 10 × 10	In North Lapland[a]	No	9–14	Approximately 0.25	2004–2008	2009–2013
France	1.41 × 1.41	–	Within 900 × 900-m cell	2	0.00	2004–2009	–
Germany	2 × 2 to 4 × 4	–	–	4	1.00	2000–2002	2011–2012
Great Britain	–	Forest type	Within polygons	1	–	1995–1999	2009–2013
Iceland	0.5 × 1 to 1.5 × 3	Plantation and birch	–	1	1.00	–	2005–2009
Ireland	2 × 2	–	Within 100 m of grid point	1	1.00	2004–2006	–
Italy	1 × 1	Administrative region and land cover	–	1	0.00[b]	2003–2007	–
Japan	4 × 4	–	–	1	1.00	2004–2008	–
Korea	4 × 4	–	–	4	1.00	1996–2005	2006–2010
Latvia	2 × 2 to 4 × 4	–	–	1	1.00	2004–2008	2009–2013

(continued)

➢ Example of NFI in different countries

Table 2.3 (continued)

Country	Systematic grid spacing for plots or clusters of plots (km × km)	Strata criteria for stratified sampling	Random component in plot location	Number of field plots per cluster	Permanent plots (proportion of all plots)	Last NFI cycle	Current/ future NFI cycle
Lithuania	4 × 4	–	–	1	0.75	2003–2007	2008–2012
Luxembourg	1 × 0.5	–	–	1	1.00	1999–2001	2008–2010
Netherlands	1 × 1	–	Within 1 × 1-km grid cell	1	0.5	2001–2005	2010–
New Zealand	4 × 4 and 8 × 8	Forest category	–	1 or 4	1.00	1945–1955	2002–2010
Norway	3 × 3			4	Some	2000–2004	2005–2009
Poland	4 × 4			1	1.00	–2001	–2009
Portugal	2 × 2			1	0.00	2005–2006	
Romania	2 × 2 to 4 × 4			4		2007–2008	
Slovak Republic	4 × 4			1	0.00	2005–2006	
Slovenia	4 × 4			5	1.00	2007	
Spain	1 × 1			1	1.00	1997–2007	2008–2018
Sweden	varying			4–12	Approximately 0.60	1993–2002	2003–2012
Switzerland	1.41 × 1.41			1	1.00	2004–2006	
USA	2,400 ha systematic hexagonal tessellation		Within 2,400 ha hexagon	4	1.00	2004–2008	2009–2013

[a]Percent non-productive forest land, volume, cumulative day-time temperature.
[b]All plots marked for possibility of future measurement.

Comparisons of National Forest Inventories (Mark, R., et al, 2009)

NFI in France

INVENTAIRE FORESTIER NATIONAL

- Beginning of the survey : 1958,
  since 1981 (Improved system)
  since 2004 (Current system)
- Most recent survey: NFI5 (from 2004 to 2009)
- NFI cycle: 10 to 12 years
- Survey unit : Division
- Body, staff and budget
  - National institute of forest resource research
  - About. 130 experts (2003)
  - Approx. 6,000 billion CFAF (2003)

fig. 4 - L'occupation du sol photo-interprétée en 2009

NFI in France

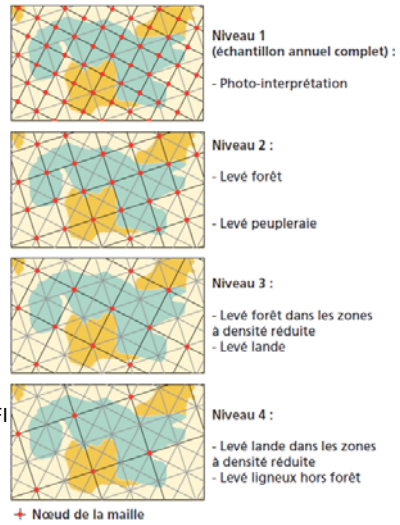
- Sampling method
  Sample is systematic in space and time.
  Level 1 : 1 node / 1000 ha
  Level 2 : 1 node / 2000 ha
  Level 3 : 1 node / 4000 ha
  Level 4 : 1 node / 8000 ha
- Develop forest

maps using aerial photos

- Verification of information

on the field

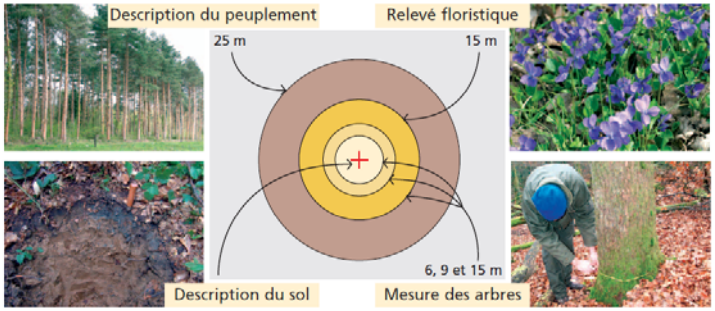
About 9000 points of the inventory grid are checked each year by the NFI field teams (2 or 3 agents).



NFI in France

- Points in production forest are the subject of many comments on forest population, vegetation and stationary conditions (slope, aspect, soil, etc.).. This also goes with measures taken on trees (height, diameter, etc.)..

Quadruple circular plot



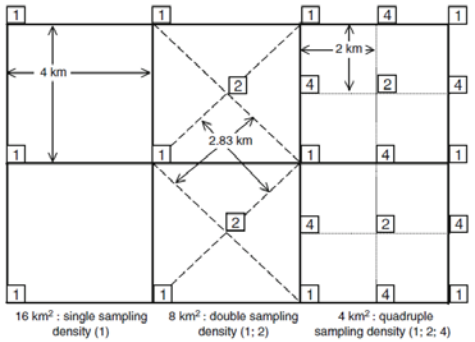
NFI in Germany

- Beginning of the survey : 1st inventory : from 1986 to 1990,
  2nd inventory : from 2000 to 2002
- Most recent survey : 3rd inventory : from 2011 to 2012
- NFI cycle: 10 to 12 years
- Survey unit: Region
- Body, Staff and Budget
  - Ministry of Agriclture and food
  - Carried out by forest agents or consultant under the supervision of the Region

NFI in Germany

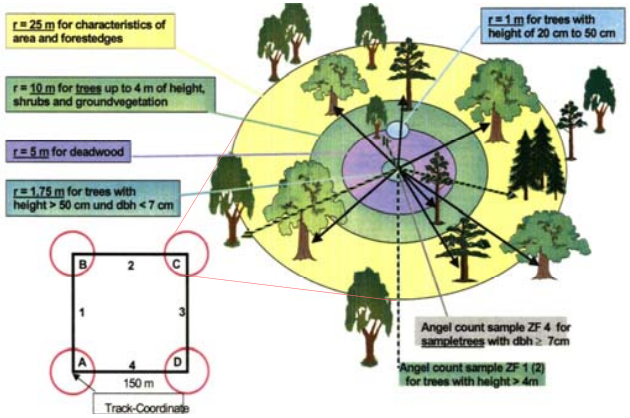
- Sampling method

The density of systematic sampling differs from one region to another:
3 types of sampling density
- 4 km x 4 km (x1)
- 2.83 km x 2.83 km (x2) and
- 2 km x 2 km (x4)



NFI in Germany

- Node structure : 150 m x 150 m
- Circular plots (Radius r=25 m) at the 4 corners

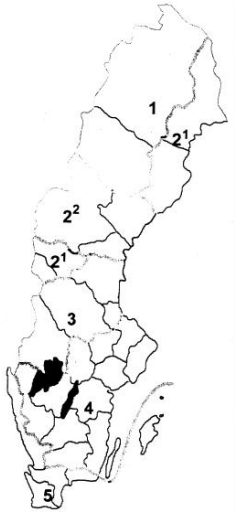


NFI in Germany

- « Invisible plot » :
  The metallic rod is pushed into the soil. It will be found using metal detector during the next inventory.

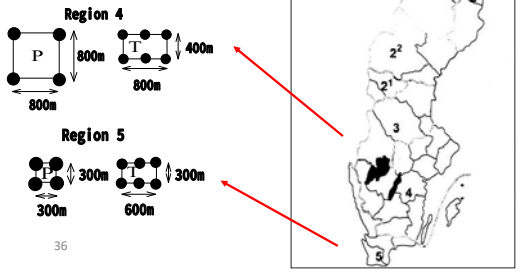
NFI in Sweden

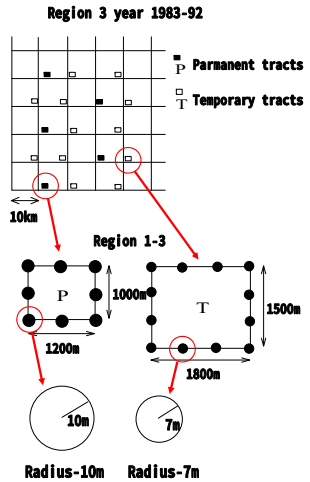
- Beginning of the survey : since 1923
- Carried out more than 6 times
- Body, staff and budget
  - National University of Agriculture Faculty of forests
  - About 2 billion CFAF per year (2003)



NFI in Sweden

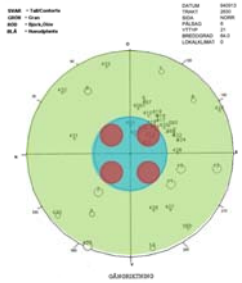
- Systematic sampling method
- Large sampling units
- Combination of permanent and temporary units





NFI in Sweden

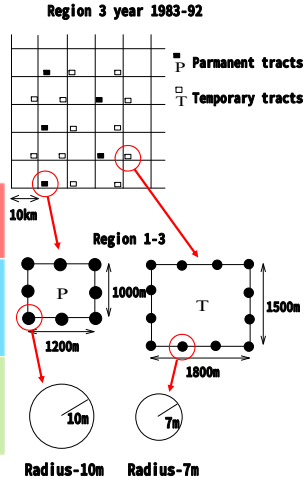
- Systematic sampling method
- Large sampling units
- Combination of permanent and temporary units



Count of small trees (height < 1.3m)

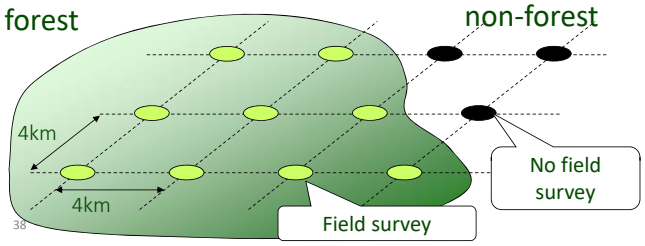
Measure and observations of trees (DBH ≧ 4.0cm)

Measure and observations of trees (DBH ≧ 10.0cm)



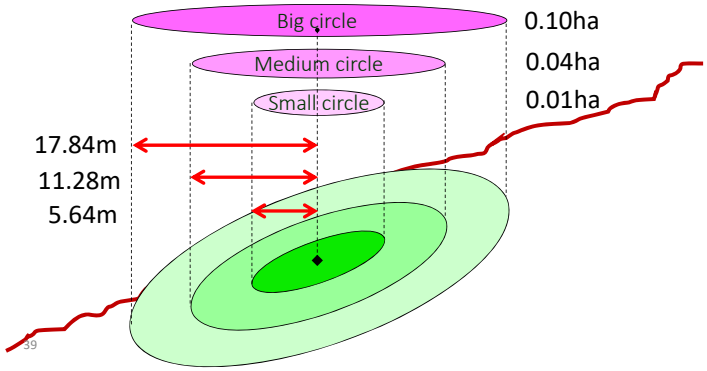
NFI in Japan

- **Beginning of the survey**: 1st inventory : from 1999 to 2004,
  2nd inventory: from 2004 to 2009
- **Sampling design** :
  Grid sampling : A grid (of 4 km x 4 km) covering the whole country was developed. Field plots extracted among 23,500 coordinates are approximately 15,000 coordinates (covering forest part).

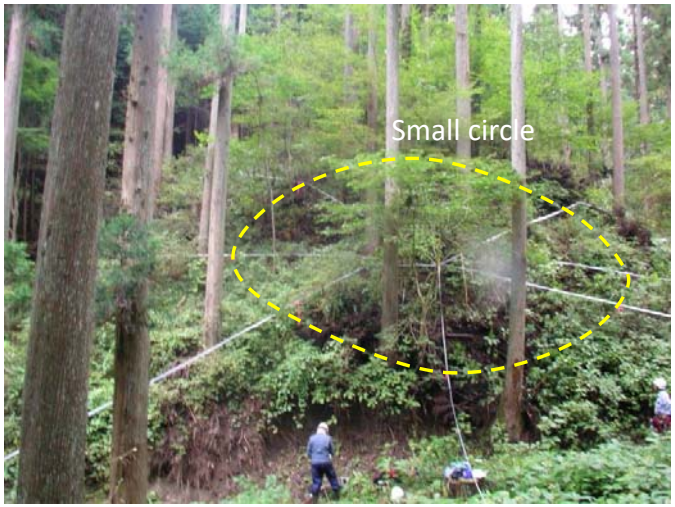


NFI in Japan

- Plot : 0.1 ha / Nested structure (triple circles)
- Determining a plot so that the horizontal projected surface is equal to 0.1 ha



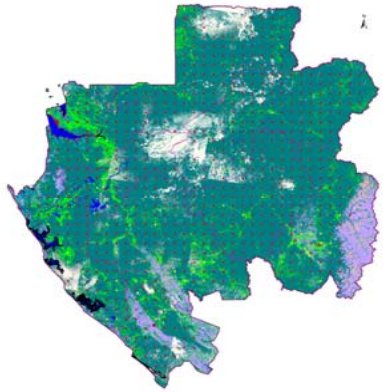
NFI in Japan



NFI in Gabon

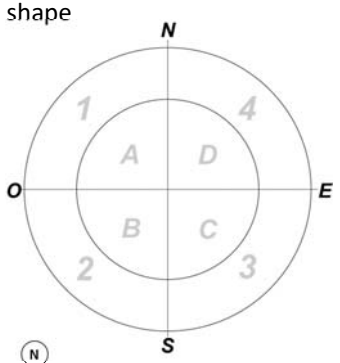
Number of plots per province

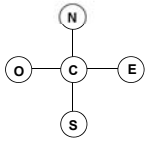
Province	Number of plots
Estuaire	62
Haut-Ogooué	73
Moyen-Ogooué	41
Ngounié	107
Nyanga	40
Ogooué-Ivindo	119
Ogooué-Lolo	91
Ogooué-Maritime	60
Woleu-Ntem	95
Total	**688**



NFI in Gabon

Plot shape





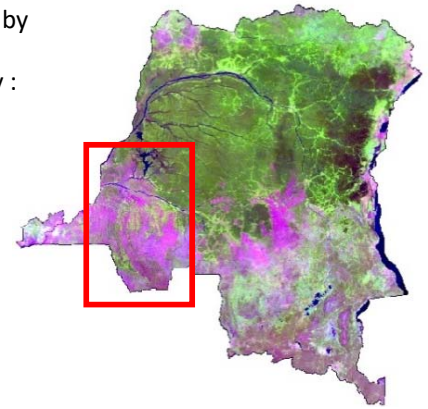
Draw the location of trees with a diameter (DBH≥ 60 cm) relatively larger than the other trees of the plot.
(this makes checking and sketching of the processed plot easier to the verification team.)

Large Circular Plot
- radius=17.84m
- surface area=0.1ha

Little Circular Plot
- radius=11.28m
- surface area=0.01ha

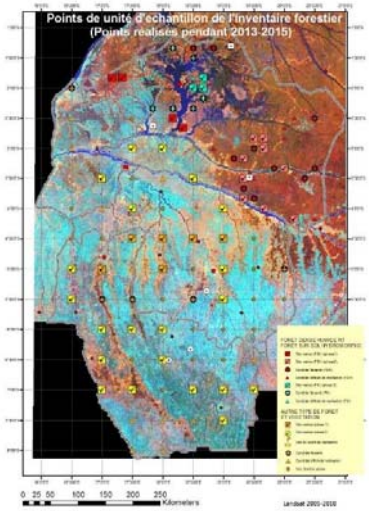
NFI in DRC

- 65 randomly distributed sites over the country by the FAO:
- 6 Sites in the Bandundu Province processed by : la DIAF/JICA;
- The remainder to be processed by FAO;
- Inventory work already started by DIAF/JICA in Bandundu province,
  more than 90 sites are foreseen, 10 already achieved.
  The methodoly has been developed and validated.



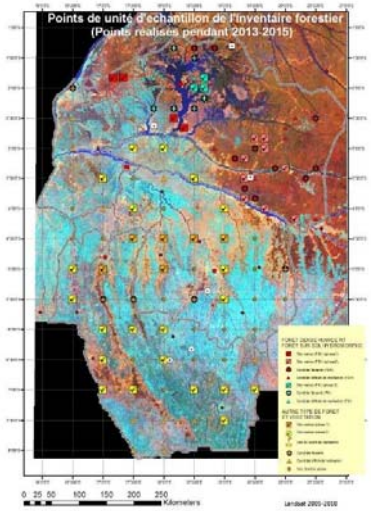
The project inventory methodology

- The sampling method is systematical and stratified
- Sampling spots are located each 10' in evergreen rainforest and rainforests with hydromorphous soils , and each 30' in other types of forests.
- The spots are selected within a radius of 10km from roads, rivers/lakes based on safety and effectiveness.

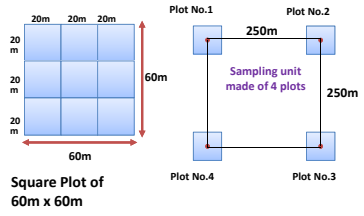


Project inventory methodology

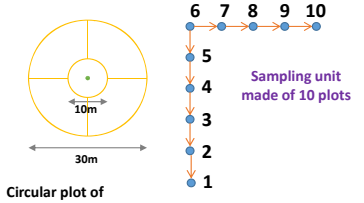
- Plots are arranged in groups (a group of plots makes a sampling unit).
- In majority type forests, (evergreen rainforests and rainforest with hydromorphous soils), we have square plots of 60m x 60m area.
- In other types of forests such as dry forests and savanah, there are circular plots of 30m diameter.



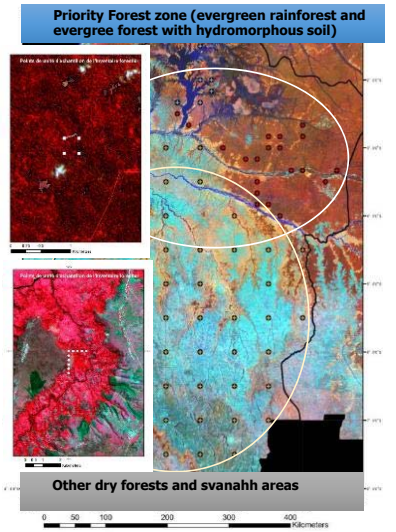
Project inventory methodology



Square Plot of 60m x 60m



Circular plot of 30m diameter



Inventory plots of the project

Number of plots per province and foprest type (by the end of 2014)

Plt type and forest type	Kwango	Kwilu	Mai-Ndombe	Total
Square plot				
Mature rainforest			20	20
Mature forest on hydromorphous soil			19	19
Secondary forest			1	1
Total Square Plots	**0**	**0**	**40**	**40**
Circular Plots				
Crops	18	17	2	37
Mature rainforest		1	8	9
Mature forest on hydromorphous soil	1	4	2	7
Dry forest / Light Forest	11			11
Secondary Forest	20	28	11	59
Mosaic of cropped lands / natural vegetation (shrubs and wooded)	2	3	1	6
Aquatic graaslands	1			1
Wooded savanah	69	3		72
Shrub savanah	7	7	9	23
Grassland	3	10		13
Total Circular Plot s	**132**	**73**	**33**	**238**

Data to be collected

DBH

TREE HEIGHT

Diameter of fallen tree

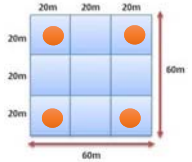
Sample and borderline

Data on wildlife and local communities

Tree species

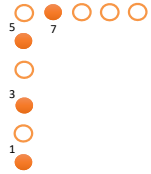
Item	Description
DBH	All trees (of 10cm diameter or above)
Tree species	All trees (of 10cm diameter or above)
Tree height	Some trees with regard to the diameter class
Fallen tree diameter	All fallen trees with 60 m length (10cm diameter or above)
Other data	Forest type, topography, erosion, soil texture, human activity, etc.

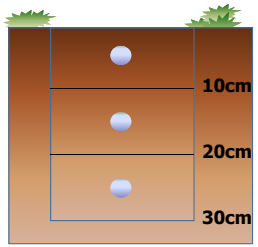
Data to be collected



B3, B5, B7 and B9 square plots and circular plots in 1, 3, 5, and 7. Three soil samples are taken at various depths.

4-spot soil sampling



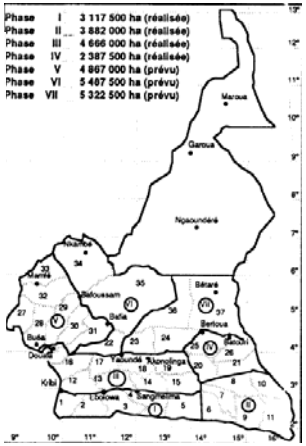


Soil sampling cylinder

NFI in Cameroon

- Twice : 1991-1995 supported by Canada
  2003-2005 supported by FAO

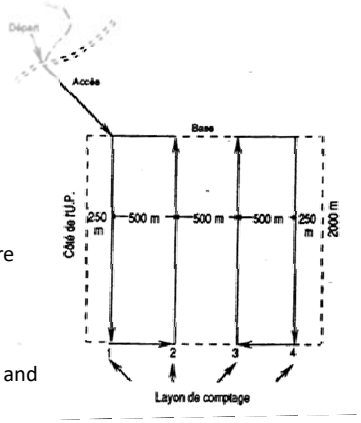
- First NFI
  - Compilation Unit (UC)
    NFI's target territory is divided into many UC.
    (approx. 500.000 to 600.000 ha)
  - Primary Unit (UP)
    The central point of each UP is systematically localized
    (UTM grid).
    Their number is set to 25 at least per UC.
    They are squares of 2 km x 2 km



NFI in Cameroon

- Twice : 1991-1995 supported by Canada
  2003-2005 supported by FAO

- First NFI
  - Primary Unit (UP)
  - 4 parallel strips per UP :
    2000 m x 25 m width
  - 10 sampling-tracts for each parallel strip :
    200 m x 25 m width (0.5 ha)
    All living trees (DBH ≧ 20 cm) are identified
  - 4 first meters of PE :
    4 m x 25 m width (0.01 ha)
    All living trees (DBH between 10 and 20 cm) are identified.



FAO method (2008)

- Basic method for programs supporting the implementation of survey plans on national forest resources in developing countries
- Minimum unit of a square grid in which one side is a latitude and longitude degree
- Square cluster of 1km in a point in which there are 4 plots of 20 x 250m

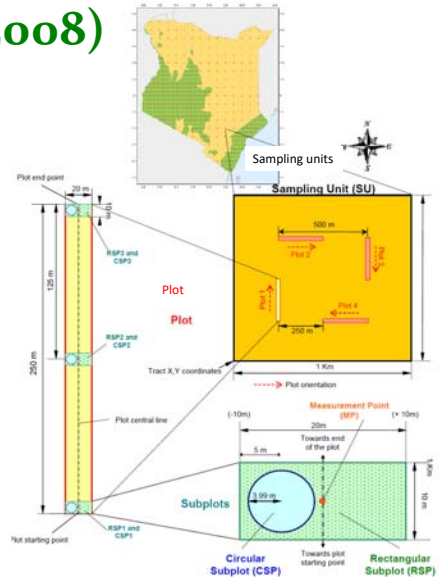


Table of Contents

Kenya's NFI

- **Stratification: SLEEK stratification will be used**

forest class
Montane Forest, Western Rain Forest and Bamboo Forest
Mangrove Forest and Coastal Forest
Dryland Forest
Plantation

X

Canopy coverage class
Dense
Moderate
Open

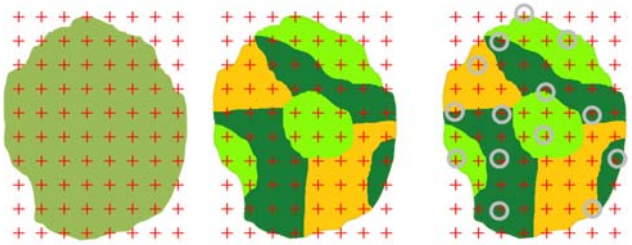
= 12 forest types

Kenya's NFI

- **NFI is utilized for developing EF**

Sampling Design of NFI : Random sampling method

1 Systematic grid spacing : Distance of 2km-by-2km: (4km^2 grids) over the whole country
2 Stratified of forests : SLEEK stratification (12 forest types)
3 Random sampling : The number of clusters to be calculated based on the SLEEK stratification.



Systematic sampling method Stratified sampling method Random sampling method

Kenya's NFI

- **Sampling Design of NFI**

ICFRA proposal: Cluster sampling method

- Cluster design is as follows. However, since SLEEK stratification is used that means, it is needed to decide how the cluster design will be adjusted, e.g. left side figure is for forest except for mangrove, right side figure is for mangrove. In addition, cluster method itself should be re-considered whether it is applied or not because of possibility that more than two forest types are mixing in a cluster.

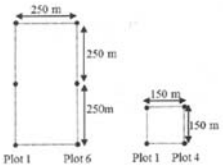


Figure . Cluster designs in Strata 1-3 (left) by ICFRA and in Stratum 4 (right).

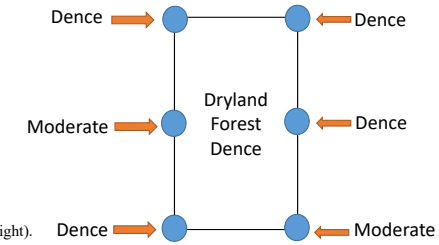
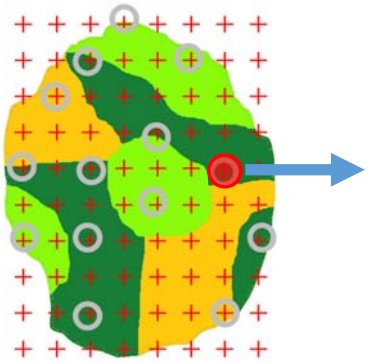
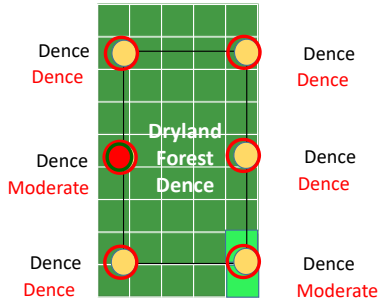


Figure . Example of cluster with more than two forest type mixed

In this case, how can the data be compiled? Moderate data is compiled as Dense forest or moderate forest? Otherwise no cluster method applied?

Consider about example of cluster with more than two forest type mixed

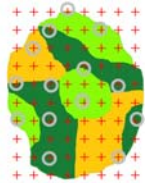


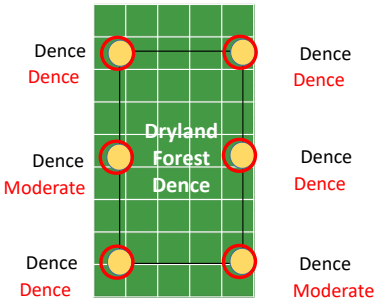


Error 1: forest inventory
The Plot is Dense

Error 2: remote sensing
The Pixels are Moderate

Consider about example of cluster with more than two forest type mixed





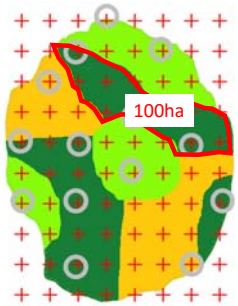
In this case, how can the data be compiled?

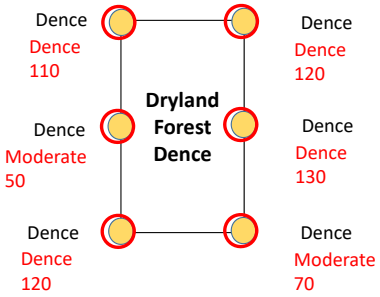
Moderate data is compiled as Dense forest or moderate forest?

Otherwise no cluster method applied?

Consider about example of cluster with more than two forest type mixed

In this case, how can the data be compiled? Moderate data is compiled as Dense forest or moderate forest?





As Dense
→ Dense forest resource is undervalued
Average: 100m3 / ha
Forest: 10,000m3

As Moderate
→ Dense forest resource is overvalue
Average: 120 m3 / ha
Forest: 12,000m3

Kenya's NFI

- **Plots shape**

ICFRA proposal: Cercle shape is used as mentioned in the following figure. However, since SLEEK stratification is used, it is needed to decide how each shape will be applied to the SLEEK stratification, e.g. left side is for non-forest, right side is for forest.

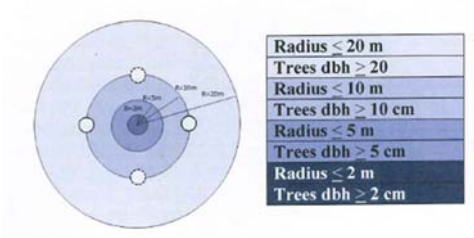


Figure . Sample plot design for Stratum 1 and 3

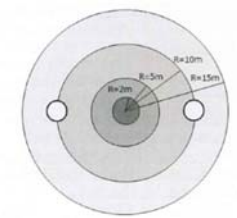


Figure . Sample plot design for Stratum 2 and 4

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya

Kenya's NFI

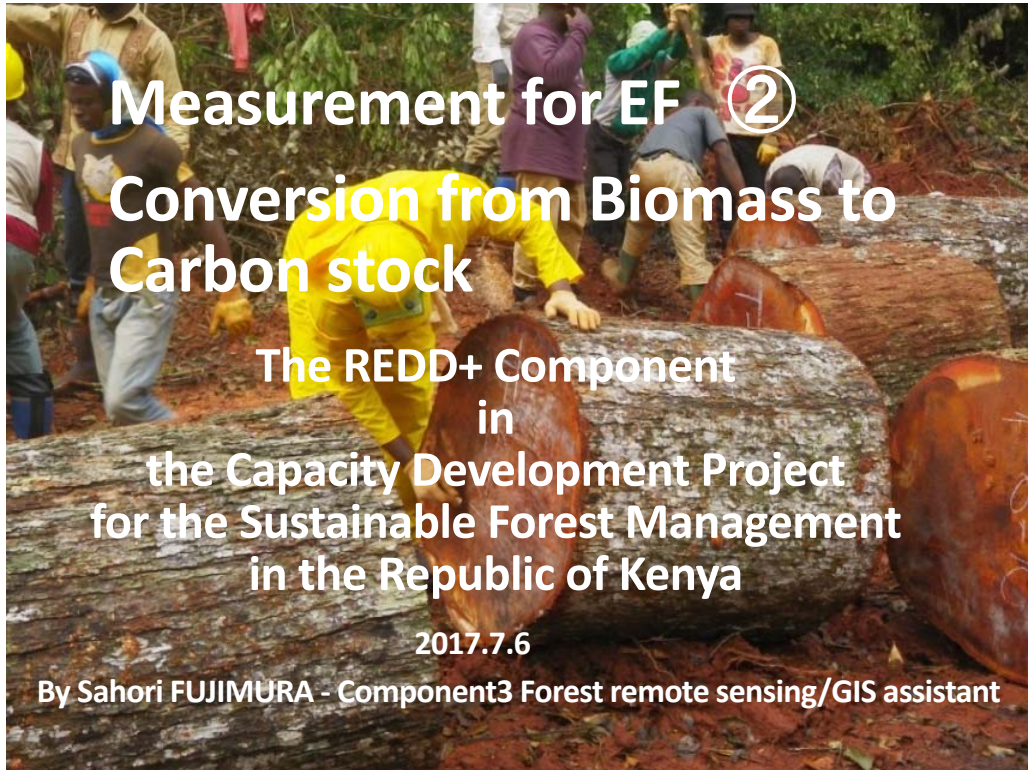
- **Measurement method in the plots:**
- ICFRA proposal: As mentioned in the table

Table .Measurement on the circular sample plots.

	DBH/ diameter (cm)	Height/ length (m)	Plot radius (m)	Plot area (m^2)
Tree	≥ 2	≥ 1.3	2	12.6
Tree	≥ 5	≥ 1.3	5	78.5
Tree	≥ 10	≥ 1.3	10	314.2
Tree (Strata 2 and 4)	≥ 20	≥ 1.3	15	706.9
Tree (Strata 1 and 3)	≥ 20	≥ 1.3	20	1256.6
Climber	≥ 2	≥ 1.3	2	12.6
Climber	≥ 5	≥ 1.3	15	706.9
Bamboo		≥ 1.3	10 or 2 × 2.0	314.2 or 25.13
Lying dead wood	≥ 10	≥ 1.0	15	706.9
Shrub		≥ 1.3	15 or 2 × 2.0	706.9 or 25.13
Stump			15	706.9
Regeneration	< 2	≥ 0.10	2 × 1.5	14.13

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya.

Thank you for your attention.



Measurement for EF ②
Conversion from Biomass to Carbon stock

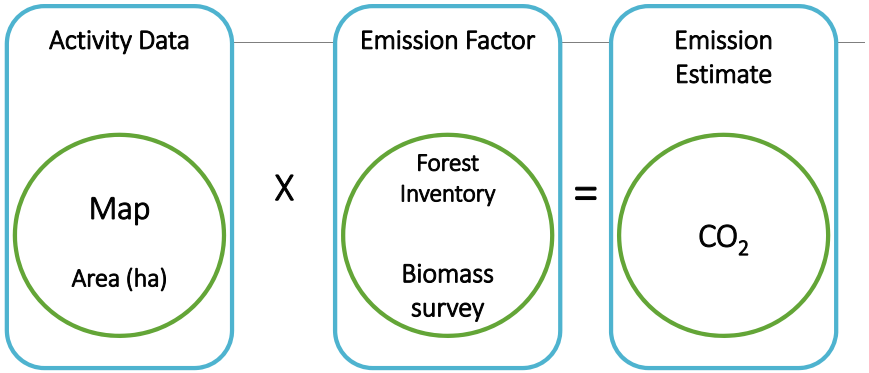
The REDD+ Component in the Capacity Development Project for the Sustainable Forest Management in the Republic of Kenya

2017.7.6

By Sahori FUJIMURA - Component3 Forest remote sensing/GIS assistant

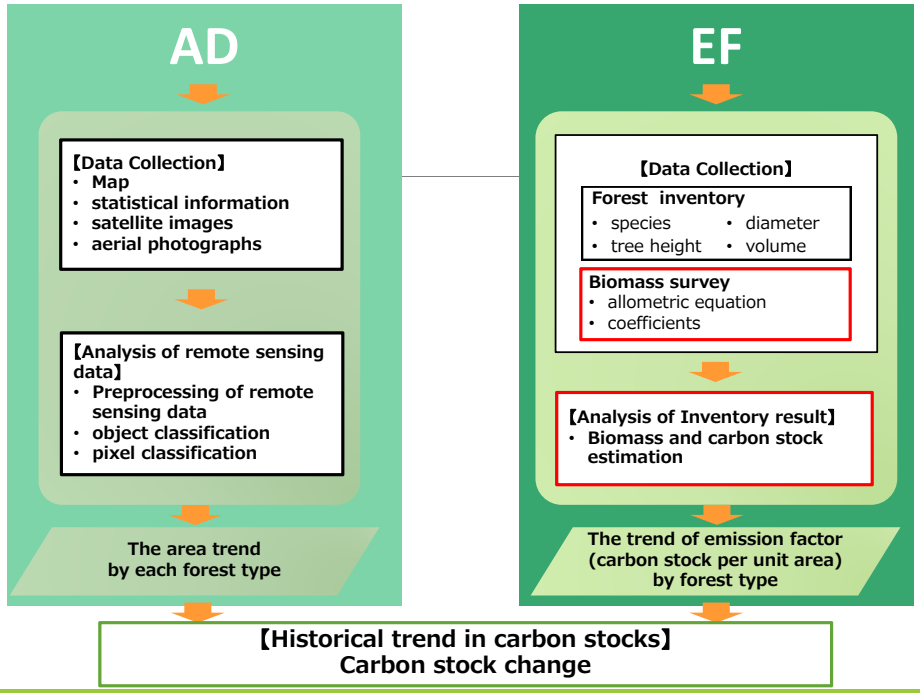
Estimating Carbon Emissions with IPCC Guidelines

Basic equation to estimate carbon emission from land use related activities is:



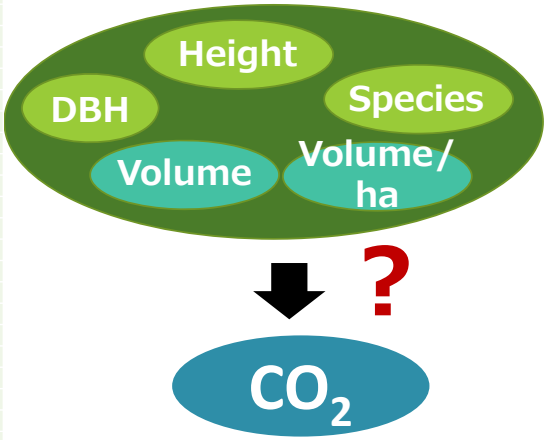
Carbon Estimation

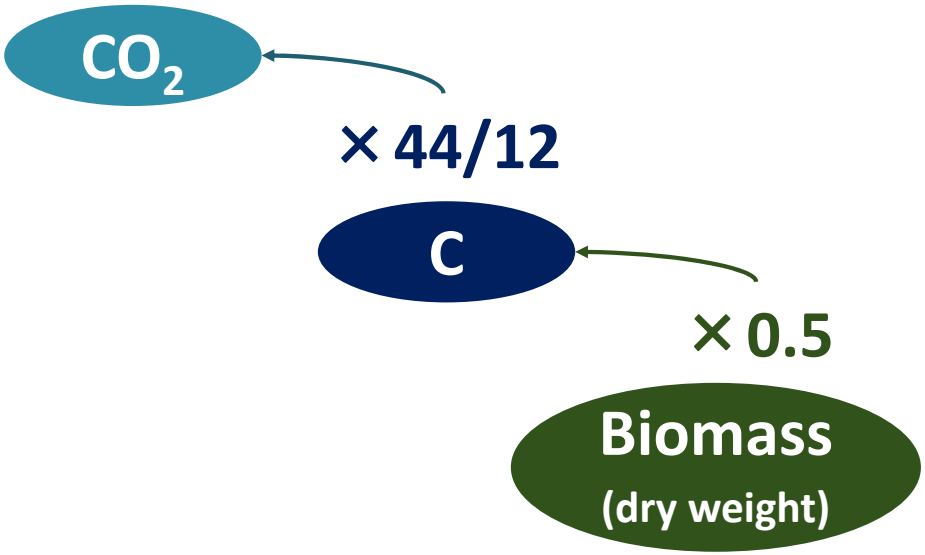
A monitoring system under UNFCCC will have to provide data on carbon stock and carbon stock changes as well as forest area and forest area changes



Species	DBH(cm)	Height(m)
Treculia obovoidea	10	3.4
Drypetes sp.	13	3.8
Irvingia gabonensis	15	6.0
Plagiostyles africana	18	8.3
Strombosia grandifolia	20	10.5
Allanblackia floribunda	21	9.2
Desbordesia glaucescens	24	12.0
Beilschmiedia obscura	26	14.3
Desbordesia glaucescens	33	16.8
Guarea thompsonii	35	15.5
Treculia obovoidea	40	19.2
Strombosia grandifolia	46	18.1
Allanblackia floribunda	52	14.4
Drypetes sp.	52	15.9
Irvingia gabonensis	55	22.5
Blighia welwitschii	64	18.4
Strombosiopsis tetrandra	67	24.2
Irvingia gabonensis	68	20.3
Strombosiopsis tetrandra	69	21.1
Diospyros suaveolens	70	28.9
Treculia obovoidea	73	24.4
Strombosia grandifolia	74	19.5
Anthonotha ferruginea	79	25.5
Coelocaryon preussii	81	20.7
Strombosia grandifolia	81	22.4
Scyphocephalium mannii	82	19.8
Angylocalyx zenkeri	85	28.3
Strombosia pustulata	90	22.0
Treculia obovoidea	98	25.9
Cyrtogonone argentea	101	26.8

After the National Forest Inventory, How we can calculate carbon stock form the result of the Inventory??





Carbon fraction

- The ratio of the carbon in the dry weight of the plant is around 50%
- This ratio is termed as carbon fraction and the value is around 0.5 (depending on the location and tree species)
- So the forest carbon stock is about half of the forest biomass.

What is the biomass?

What is biomass in forestry science ?

-Timber volume?

-Wet weight?

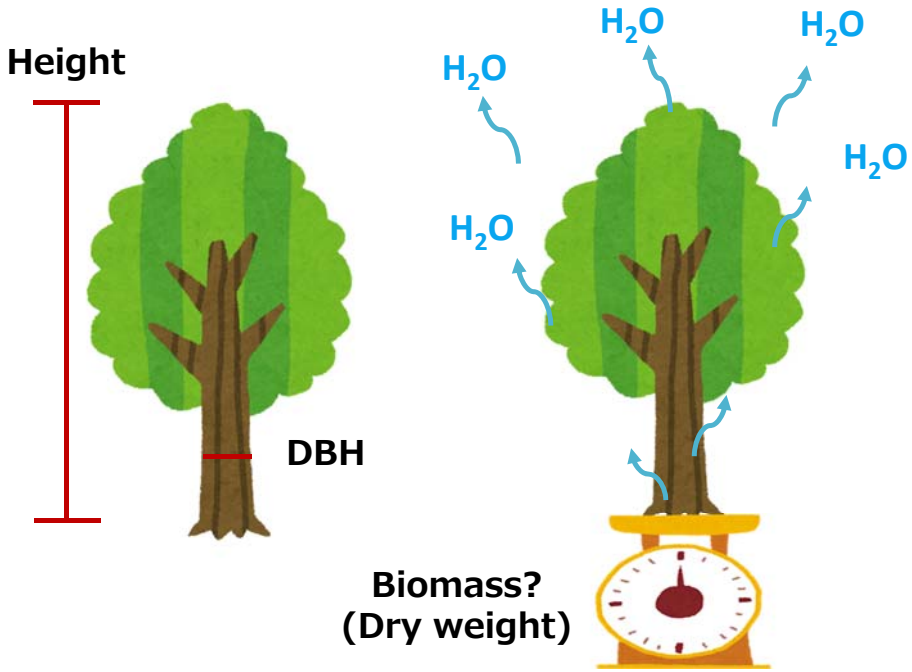
-Dry weight?

Biomass : The total amount , weight or volume of plants and animals in an area.

In forest science, biomass is the **dry weight** of trees and other plants in the forest

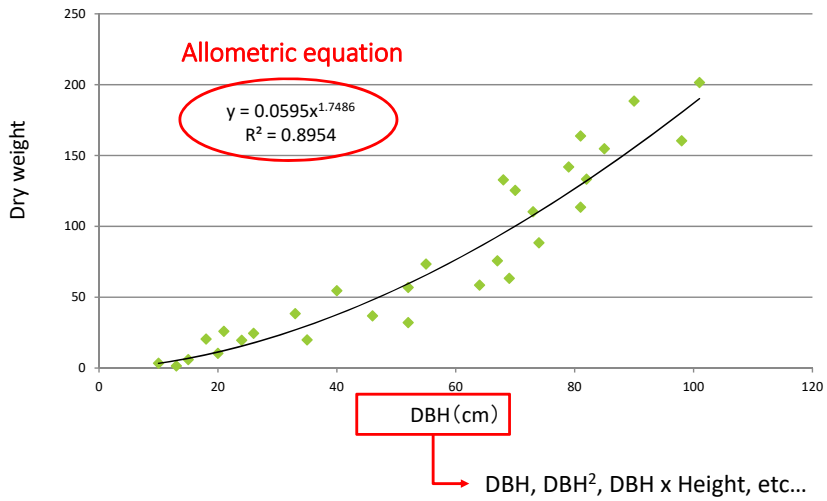
If we know the dry weight of each tree, we can calculate the amount of CO_2 which is stored in the forest.

But from the result of National Forest Inventory, we can not have the data of dry weight of each tree



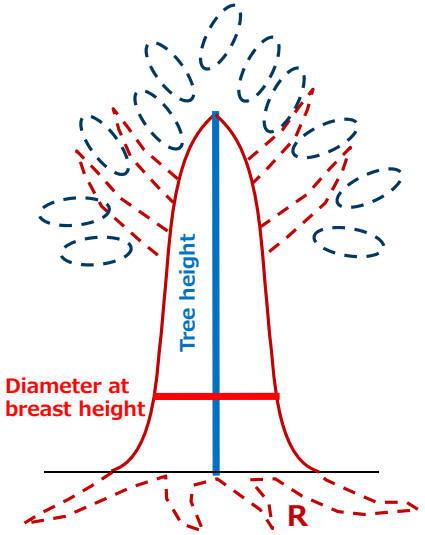
To know dry weight of each tree, Biomass survey is carried out in form of Destructive sampling

Allometric equation



DBH, DBH^2, DBH x Height, etc…

BEF and BCEF



Biomass Expansion Factors (BEF) :
expand merchantable volume to total volume to account for non-merchantable components of the tree, stand and forest

Biomass Conversion Expansion Factors (BCEF) :
convert directly merchantable volume to total biomass(Dry weight) to account for non-merchantable components of the tree, stand and forest

Biomass survey

1. Analysis of the result of NFI and design the sampling
2. Select sample trees in the field
3. Measure total fresh weight of sample trees
4. Collect sub-sample from sample tree
5. Dry the sub-sample
6. Measure the dry weight of sub-sample
7. Calculate total dry weight of sample tree
8. Develop allometric equation, BEF and BCEF

1. Analysis of the result of NFI and design the sampling

Species	DBH(cm)	Height(m)
Treculia obovoidea	10	3.4
Drypetes sp.	13	3.8
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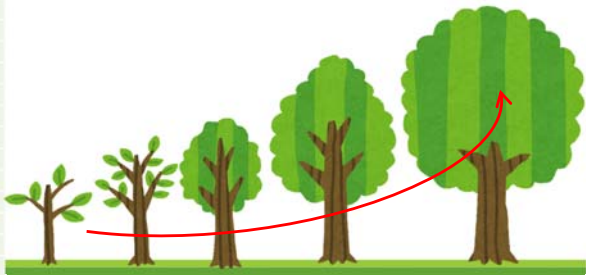
Angylocalyx zenkeri	85	28.3
Strombosia pustulata	90	22.0
Treculia obovoidea	98	25.9
Cyrtogonone argentea	101	26.8

- ✓ The biggest DBH
- ✓ Representative species
- ✓ Sample size interval
- ✓ Scope of the survey



2. Select sample trees in the field

Go to the field and select the sample trees measuring the DBH.

3. Measure total fresh weight of sample trees

Dig up root


Dig up around the sample tree to expose the roots and mark the boundaries of the position of the ground level.

3. Measure all fresh weight of sample trees

Fell tree





Fell the sample tree .

3. Measure total fresh weight of sample trees

Select stem and separate branches



Select the thickest and straight stem, then separate the other branches from the stem. Measure the length of stem and mark at the point of 1.3m above the ground level , then mark every 2m up to the top of the stem.

2. Measure total fresh weight of sample trees

Cut the Stem and measure the Diameter



Cut the stem Numbering Measure the diameter

3. Measure total fresh weight of sample trees

Separating branch and leaves

3. Measure total fresh weight of sample trees

Measure fresh weight of each component

Measure total fresh weight of each component(stem, branch, leaf).

3. Measure total fresh weight of sample trees

Dig up and clean all root, then measure the weight

Measure total fresh weight of each component(stem, branch, leaf).

Collect small roots which have remained in the soil

4. Get composite sample

Get sub-samples from each component and measure fresh weight of the sub-sample

Sub-sample of branch

Sub-sample of root

Sub-sample of leaves

5. Dry the Sub-sample

Put sub-sample in the dry machine

Sub-sample in the dry machine

6. Measure the weight of Sub-sample

Measuring dry weight of sub-sample

7. Calculate total dry weight (biomass) of sample tree

$$TDW = TFW \times \frac{SDW}{SFW}$$

TDW: Total dry weight of each component

TFW: Total fresh weight of each component

SDW: Sub-Sample dry weight of each component

SFW: Sub-Sample fresh weight of each component

Dry weight = Biomass

7. Calculate total dry weight (biomass) of sample tree.

Example of calculation

	Stem	Branches large+small	Leaves	Roots large+small	Total
Total fresh weight of sample trees by tree organs (kg)	7,650.5	3,241.9	140.7	692.0	11725.0
Fresh weight of Sub-Sample (g)	1,989.8	1,343.5	483.0	1,677.3	
Dry weight of Sub-Sample (g)	1,301.2	862.3	246.5	1,118.4	
Dry weight/Fresh weight of sub-samples	0.654	0.642	0.510	0.667	
Total dry weight by tree organs (kg/tree)	5,002.9	2,080.7	71.8	461.4	7616.9

Total dry weight of sample tree
= Biomass of sample tree

8. Develop allometric equation, BEF and BCEF

Allometric equation $y = a X^b$

y : Biomass

X : Parameter

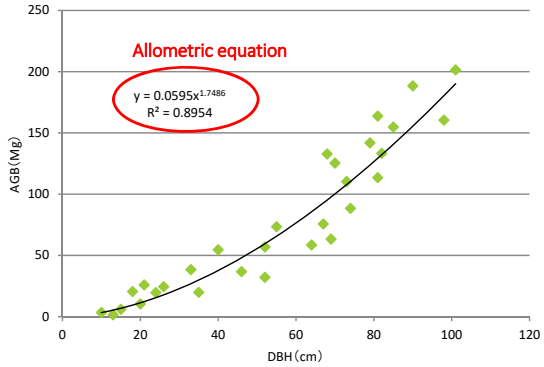
（e.g. DBH, DBH^2, D^2H etc.）

◦ a, b : Coefficient

8. Develop allometric equation, BEF and BCEF

sample tree No.	DBH (cm)	AGB (Mg)
1	10	3.4
2	13	1.5
3	15	6
4	18	20.5
5	20	10.4
6	21	25.9
7	24	19.6
8	26	24.5
9	33	38.4
10	35	19.9
11	40	54.6
12	46	36.8
13	52	56.9
14	52	32.1
15	55	73.4
16	64	58.5
17	67	75.7
18	68	132.8
19	69	63.3
20	70	125.4
21	73	110.3
22	74	88.4
23	79	141.9
24	81	113.5
25	81	163.8
26	82	133.3
27	85	154.8
28	90	188.4
29	98	160.4
30	101	201.5

Sample trees data

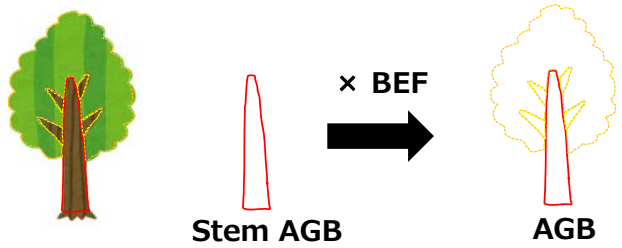


for example…

- Making equations from data of diameter and biomass.
  - DBH; Diameter at Breast height
  - AGB; Above Ground Biomass

8. Develop allometric equation, BEF and BCEF

- BEF is Biomass expansion factor
- BEF is the coefficient for estimation of AGB from stem biomass.



- BEF is the ratio of AGB to stem biomass.

BEF: Total AGB (stem + branches + leaves) / stem AGB

8. Develop allometric equation, BEF and BCEF

Biomass Expansion factor:

A factor that coverts the stem biomass into the biomass of the whole tree, including branches, leaves etc.

$$BEF = \frac{TDWa}{TDWs}$$

BEF : Biomass Expansion Factor

TDWa : Total dry weight of AGB

TDWs : Total dry weight of Stem

8. Develop allometric equation, BEF and BCEF

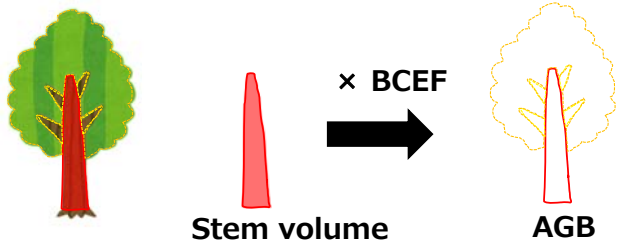
Calculation of Carbon stock with BEF

$$C = (V \times WD \times BEF) \times CF$$

C : Carbon stock (Mg-C)
V : Volume (m3)
WD : wood density (Mg/m3)
BEF : Biomass Expansion Factor
CF : Carbon factor

8. Develop allometric equation, BEF and BCEF

- BCEF is Biomass conversion expansion factor
- BCEF is the coefficient for estimation of AGB from stem volume.



- BCEF is the ratio of AGB to stem volume.

BCEF: Stem volume / AGB

8. Develop allometric equation, BEF and BCEF

Biomass Conversion and Expansion factor:

A factor that coverts directly the trunk volume into the biomass of the whole tree etc.

$$BECF = \frac{AGB}{V} = \frac{V \times WD \times BEF}{V} = WD \times BEF$$

BECF : Biomass Conversion and Expansion Factor

AGB : Above Ground Biomass V : volume

WD : wood density BEF Biomass Expansion Factor

8. Develop allometric equation, BEF and BCEF

Calculation of Carbon stock with BCEF

$$C = (V \times BCEF) \times CF$$

C : Carbon stock (Mg-C)
V : Volume (m3)
BCEF : Biomass Conversion and Expansion Factor
CF : Carbon factor

8. Develop allometric equation, BEF and BCEF

Default value of carbon fraction of AGB

TABLE 4.3
CARBON FRACTION OF ABOVEGROUND FOREST BIOMASS

Domain	Part of tree	Carbon fraction, (CF) [tonne C (tonne d.m.)$^{-1}$]	References
Default value	All	0.47	McGroddy *et al.*, 2004
Tropical and Subtropical	All	0.47 (0.44 - 0.49)	Andreae and Merlet, 2001; Chambers *et al.*, 2001; McGroddy *et al.*, 2004; Lasco and Pulhin, 2003
	wood	0.49	Feldpausch *et al.*, 2004
	wood, tree d < 10 cm	0.46	Hughes *et al.*, 2000
	wood, tree d ≥ 10 cm	0.49	Hughes *et al.*, 2000
	foliage	0.47	Feldpausch *et al.*, 2004
	foliage, tree d < 10 cm	0.43	Hughes *et al.*, 2000
	foliage, tree d ≥ 10 cm	0.46	Hughes *et al.*, 2000
Temperate and Boreal	All	0.47 (0.47 - 0.49)	Andreae and Merlet, 2001; Gayoso *et al.*, 2002; Matthews, 1993; McGroddy *et al.*, 2004
	broad-leaved	0.48 (0.46 - 0.50)	Lamlom and Savidge, 2003
	conifers	0.51 (0.47 - 0.55)	Lamlom and Savidge, 2003

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, 4.48, Table 4.3.

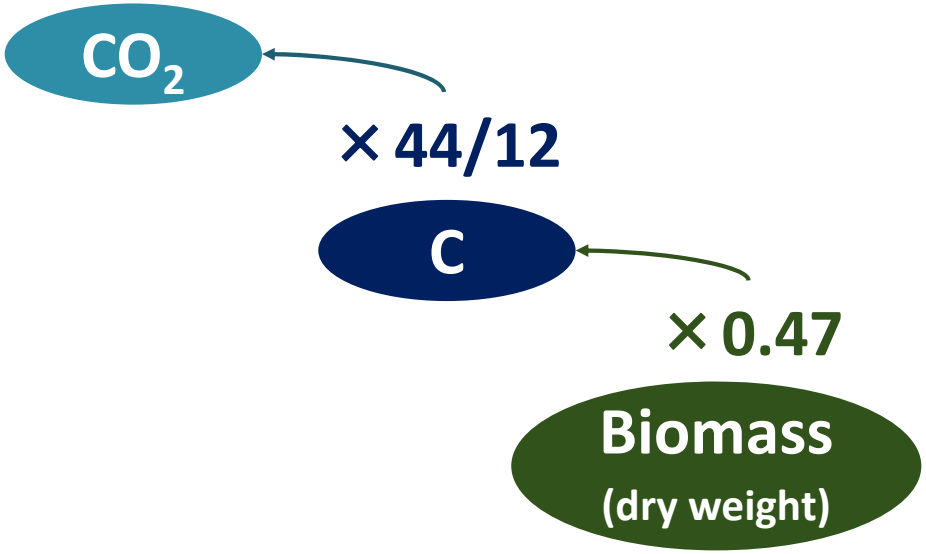
8. Develop allometric equation, BEF and BCEF

Root –Shoot ratio (R)

Root - Shoot ratio (R) is a ration of BGB to AGB. It is difficult to directly measure BGB. After the R is obtained in advance by biomass survey the BGB can be estimated based on the ABG

$$R = \frac{BGB}{AGB}$$

R : Root – Shoot ratio
AGB : Above ground biomass
BGB : Below ground biomass



Estimation of Emission

Direct Estimation

Result of NFI (DBH, Height…) × Allometric equation × FC (0.47) = Carbon stock

Indirect Estimation

Stem Volume × Coefficients BCEF × FC (0.47) = Carbon stock

Kenya's Methodology

Kenya has not yet developed country neither allometoric equation nor BEF,BCEF

For developing FRL in Kenya, Kenya has selected some common equations for AGB

Forest type, Species	Equation
for common trees, *Acacia spp.* and plantation species (*Pinus patula, Eucalyptus and Cupressus*)	$AGB=0.0673*(0.598*D^2H)^{0.976}$ (kg) (Chave et al. 2009, 2014)
Rhizophra spp	$AGB = 0.128 \times DBH^{2.60}$ (Fromard et al. 1998, Komiyama et al. 2008)
Agro-forest	$AGB_{Agro\text{-}forest}=e^{(0.93*\log((d\hat{}2*h))-2.97)}$ (Henry et al. 2009)

For calculation of BGB, Kenya use the root /shoot ratio of BGB to AGB which is provided by IPCC

Forest type	Root/Shoot ratio
Montane Forest	0.27
Coastal forest	0.20 (AGB ≤ 125 (ton/ha) 0.24 (AGB ＞125 (ton/ha)
Mangrove Forest	0.37 and 0.20 (AGB ≤ 125 (ton/ha)), 0.24 (AGB＞125 (ton/ha))
Dryland Forest	0.40 (Kibwezi), 0.27 (Baringo)
Plantation	0.27

CF which Kenya uses is provided by IPCC

Biomass	CF
AGB	0.47 (tonne C (tonne d.m.)$^{-1}$
BGB	0.50 (tonne C (tonne d.m.)$^{-1}$

Kenya's Emission estimate

For develop FRL, Kenya develop country data using result of ICFRA inventory and additional inventory

Kenya's Carbon Stock

Class	Canopy coverage	Volume**	AGB		BGB		TOTAL	
			Biomass stock	Carbon stock	Biomass stock	Carbon stock	Biomass stock	Carbon stock
Montane Forest & Western Rain Forest	Dense	437.86	344.75	162.03	93.08	46.54	437.83	208.57
	Moderate	69.59	58.36	27.43	15.76	7.88	74.12	35.31
	Open	26.23	23.02	10.82	6.22	3.11	29.23	13.93
Coastal forest & Mangrove forest	Dense	97.35	92.82	43.62	27.39	13.70	120.21	57.32
	Moderate	64.53	60.45	28.41	13.64	6.82	74.09	35.23
	Open	41.92	35.24	16.57	7.48	3.74	42.72	20.30
Dryland Forest	Dense	98.55	79.27	37.26	31.29	15.64	110.56	52.90
	Moderate	38.74	33.83	15.90	12.72	6.36	46.55	22.26
	Open	16.00	14.26	6.70	3.85	1.93	18.12	8.63
Plantation	Dense	539.23	436.68	205.24	117.90	58.95	554.58	264.19
	Moderate	137.79	113.54	53.36	30.66	15.33	144.20	68.69
	Open	174.54	138.22	64.96	37.32	18.66	175.54	83.62
*(Agro-forestry)		106.98	74.23	34.89	20.04	10.02	94.27	44.91

* The class of Agro-forestry has been considered to apply for setting FRL. **Volume does not include volume of Climber.

But NFI has not been implemented so the accuracy of the country data is not high because of the small number of inventory data.

GROUP WORK

REDD+ TRAINING ON MEASUREMENT, REPORTING, AND VERIFICATION (MRV)

5TH JULY 2018, NAIBASHA MASADA HOTEL

METHOD OF GROUP WORK

- Theme

  Development for REDD+ Activities in each Ecosystem in Kenya

- Group

  3 Groups × 10 persons / Groups

- Roles

  Chairman, Secretary (PC)/Presenter

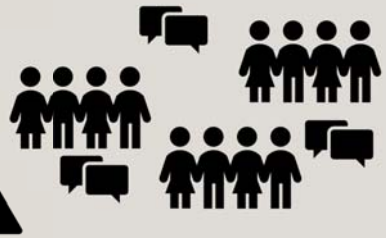
- Time Table
  - 13:30 – 13:40 Introduction
  - 13:40 – 14:40 Group Discussion
  - 14:40 – 15:00 Presentation ×3 Groups

POINTS TO BE KEPT IN MIND FOR DISCUSSION IN GROUP WORK

Free participation

Respect each opinion

Persons who make opinions is not important



DEVELOPMENT FOR REDD+ ACTIVITIES IN EACH ECOSYSTEM IN KENYA

Five activities decided as REDD+ activities

① Reducing emissions from deforestation

② Reducing emissions from forest degradation

③ Conservation of forest carbon stocks

④ Sustainable management of forests

⑤ Enhancement of forest carbon stocks

DRIVERS OF DEFORESTATION AND FOREST DEGRADATION

http://www.jofca.or.jp/seminar/20111007-seminar/20111007seminar03.pdf

NFP

FRAMEWORK OF DISCUSSION

Item	Specification	Note
Target REDD+ activities	*Identifying one or more among from 5 REDD+ activities based on the action mentioned below* *① Reducing emissions from deforestation* *② Reducing emissions from forest degradation* *③ Conservation of forest carbon stocks* *④ Sustainable management of forests* *⑤ Enhancement of forest carbon stocks*	
Target Conservancy	*Selecting one conservancy*	
Target Ecosystem (region)	*Selecting from among Montane forest, Western rainforest, Dryland forest, Costal forest, Mangrove, KFS plantation area*	
Detailed plan of action	*Establishment of artificial forest for charcoal and firewood production in private land*	
Implementation arrangement • Implementation Bodies • Etc.(budget, equipment.)	*KFS as technical assistant* *CFA, Women's group, individual farmers as implementor*	
Assumption	*Possible to obtain good quality seedlings/seeds or produce seedlings. /////*	
Challenges	*Competition with food crop production, Expansion of plantation area to other private land*	
Outputs	*Increasing plantation sites and CO2 absorption*	

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 Naibasha , 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

Question	Answer	
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.

3rd REDD+ Training on Measurement, Reporting, and Verification (MRV) in 2020

Target Participants : 20 persons who participated 1st or 2nd MRV training from HQs and each conservancy in KFS

Date : From 21st to 23rd January 2020

Place : Alps hotel and KFS forest in Nakuru

Day 1: @Alps hotel

Time	Activity	Lecturer/Instructor
8:30 - 9:00	Registration	Ms. Florence
9:00 - 9:20	Orientation and Self-Introduction	Mr. Nduati
9:20 - 10:20	Review of Outline of REDD+ (Background and mechanism of REDD+)	Mr. Kato
10:20 - 11:10	Review of Outline of National Forest Monitoring System (NFMS) of Kenya	Mr. 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. Mwangi and Mr. Sembo
12:30 - 13:30	Lunch Break	
13:30 - 15:30	FRL setting in Kenya (1)	Dr. Kinyanjui,
15:30 - 16:00	Health Break / Tea Break	
16:00 - 17:30	FRL setting in Kenya (2)	Dr. Kinyanjui,

Day 2

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. Ojuang Mr. Sembo and Mr. Y. Sato
9:30 - 10:30 @Alps hotel	Field practice for forest inventory (1) 1. How to use the devices	Mr. Ojuang Mr. Sembo and Mr. Y. Sato
10:30 - 11:30	Tea Break / Transportation to field	
11:30 – 13:00 @KFS forest	Field practice for forest inventory (2) 2. How to set a plot	

Time	Activity	Lecturer/Instructor
13:00 - 14:00	Lunch Break	
14:00 - 16:00 @KFS forest	Field practice for forest inventory (3) 3. How to measure trees	
16:00 – 17:00	Tea Break / Transportation to hotel	

Day3: Alps hotel

Time	Activity	Lecturer/Instructor
8:30 – 9:30	Conversion from volume to biomass amount and carbon stock	Mr. Ojuang
9:30 – 10:00	Introduction of Community Based Forest Biomass Monitoring	Mr. Y. 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. Nduati and Mr. Kato
12:30 - 13:30	Lunch Break	
13:30 - 14:00	Review	Mr. Nduati Mr. Kato
14:00 - 14:30	End of training	Mr. Peter N.

3RD MRV TRAINING IN ALPS HOTEL NAKURU _REGISTRATION LIST 21ST TO 23RD JANUARY 2020

S/No	Name	Designation	County	Conservancy
1	Jane Chepkonga	ACF	Kiambu	Central Highlands
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	Irine 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	Caroline Busuru	ACF	Nandi	North Rift
17	Peter Kirui	Forester	Homabay	Nyanza
18	Winnie Jemosop	Forester	Vihiga	Western
19	Amina Osman	ACF	KFS HQs	KFS HQs
20	Isaac Omoding	ACF	KFS HQs	KFS HQs
21	Peter Nduati	Project Manager	Nairobi	KFS HQs
22	Fredrick Ojuang	CF	Nairobi	KFS HQs
23	Faith Mitwiri	GIS/Remote Sensing	Nairobi	KFS HQs
24	Diana Kishiki	ACF	Nairobi	KFS HQs
25	Dr. Mwangi Kinyanjui	Lecturer	Nyeri	Central Highlands
26	Peter Sirayo	ACF	Nairobi	KFS HQs
27	Richard Ngugi		Nairobi	KFS HQs
28	Joanne Kariuki	Administration Officer	Nairobi	KEFRI
29	Kazuhisa KATO	NFMS/FRL/ MRV Team Leader	Nairobi	KFS HQs
30	Akinobu Sembo	Database	Nairobi	KFS HQs
31	Yoshihiko SATO	NFMS/FRL/MRV Assistant	Nairobi	KFS HQs

Review of Outline of REDD+

The REDD+ Readiness Component
in
the Capacity Development Project for the Sustainable Forest Management
in the Republic of Kenya

By Kazuhisa KATO - Compornent3 Team Leader
2020.1.21

What is REDD Plus?

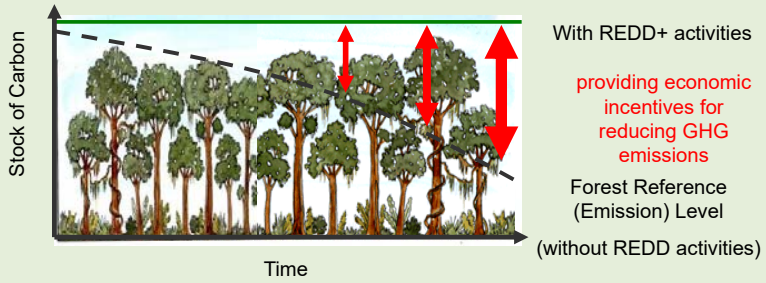
❖REDD+（REDD-plus）Mechanism

The basic concept of REDD+ is to provide economic incentives such as funding to developing countries for activities reducing GHG emissions from deforestation and forest degradation, and maintaining or enhancing carbon stocks through forest conservation.

✓REDD is "Reducing Emissions from Deforestation and Forest Degradation"

✓"+" is forest conservation, sustainable forest management and enhancement of forest carbon sinks

Concept of REDD+



Framework under the United Nation

Over a decade ago, most countries joined an international treaty -- the United Nations Framework Convention on Climate Change (UNFCCC) -- to begin to consider what can be done to mitigate global warming and to cope with whatever temperature increases are inevitable.

In addition to the treaty: the Kyoto Protocol, which has more powerful (and legally binding) measures, was adopted in 1997 and came into force in 2005. the Paris agreement, which has no legal binding, was adopted in 2015 and came into force in 2016 following Kyoto Protocol.

The UNFCCC secretariat supports all institutions involved in the climate change process, particularly the COP, the subsidiary bodies and their Bureau (SBSTA).

【Five activities decided as REDD+ activities】

① Reducing emissions from deforestation

② Reducing emissions from forest degradation

③ Conservation of forest carbon stocks

④ Sustainable management of forests

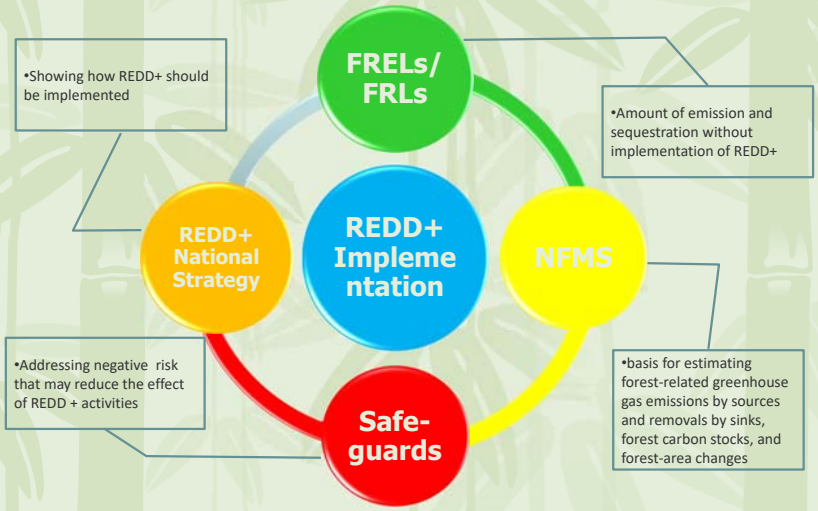
⑤ Enhancement of forest carbon stocks

【Scope of REDD+】

REDD+ is covered by three categories of land use change according to the IPCC Good Practice Guidance for LULUCF:

1. Forests converted to other lands
   - Deforestation
2. Forests remaining as forests
   - Forest degradation
   - Conservation of forest carbon stocks
   - Sustainable management of forests
   - Enhancement of forest carbon stocks in existing forests
3. Other lands converted to forests
   - Enhancement of forest carbon stocks in bare lands

【Requirement for implementation of REDD+】



【The Requirement (1) REDD+ National Strategy】

Points to be Considered on REDD+ National Strategy

- Measures against drivers of deforestation and forest degradation
  - ✓ Since deforestation and forest degradation drivers are different by each country, measures that match the drivers of each country should be applied
  - ✓ In the implementation of REDD + at the national and sub-national levels, "policies and measures (PaMs)" are effective and necessary
- Cross-sectoral initiatives
  - ✓ Cross-sectoral approach with development policies and land-use policies closely related to REDD+ is necessary

Therefore, it is necessary to formulate the REDD + national strategy through the participation of various stakeholders

【The Requirement (2) Safeguards】

The following seven Safeguards should be supported and protected

1. **Actions complement or are consistent with the objectives of national forest programmes and relevant international conventions and agreements;**
2. **Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;**
3. **Respect for the knowledge and rights of indigenous peoples and members of local communities;**
4. **The full and effective participation of relevant stakeholders, in particular, indigenous peoples and local communities;**
5. **Actions are consistent with the conservation of natural forests and biological diversity;**
6. **Actions to address the risks of reversals (related to non-permanence);**
7. **Actions to reduce displacement of emissions (related to leakage) .**

【Issues to be considered for Safeguards】

- How criteria and indicators for each item are set
- How to address safeguard issues
- Safeguard Information System(SIS) (Inter-communicational, Transparent, Accessibility, Easily evaluated by a third party（Check list and the evaluation of results））
- Monitoring system

【The Requirement (3) National Forest Monitoring System (NFMS) 】

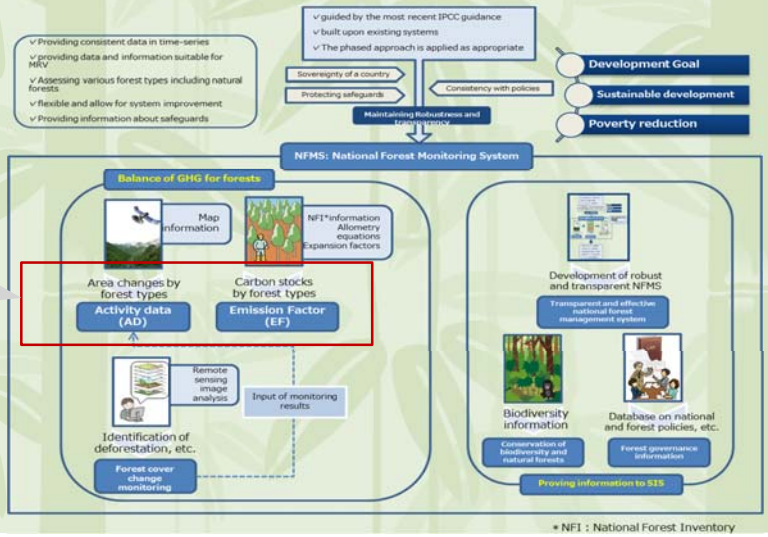
Decision 11/CP.19

2. Decides that the development of Parties' national forest monitoring systems for the monitoring and reporting of the activities,1 as referred to in decision 1/CP.16, paragraph 70, with, if appropriate, subnational monitoring and reporting as an interim measure, should take into account the guidance provided in decision 4/CP.15 and be guided by the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources, and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes;

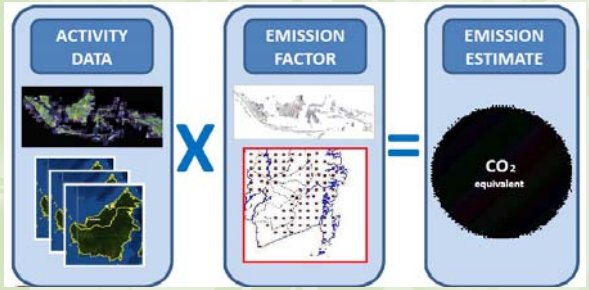
3. Also decides that robust national forest monitoring systems should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes resulting from the implementation of the activities referred to in decision 1/CP.16, paragraph 70, taking into account paragraph 71(b) and (c) consistent with guidance on measuring,reporting and verifying nationally appropriate mitigation actions by developing country Parties agreed by the Conference of the Parties, taking into account methodological guidance in accordance with decision4/CP.15;

【Basic Idea of NFMS 】

Need to Identify each methodologies as Kenya REDD+



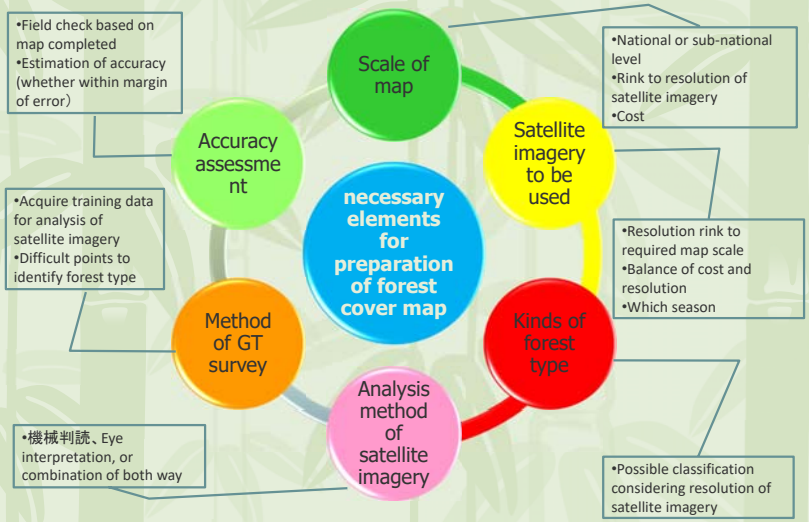
Necessary monitoring based on the estimation method of emission amount】



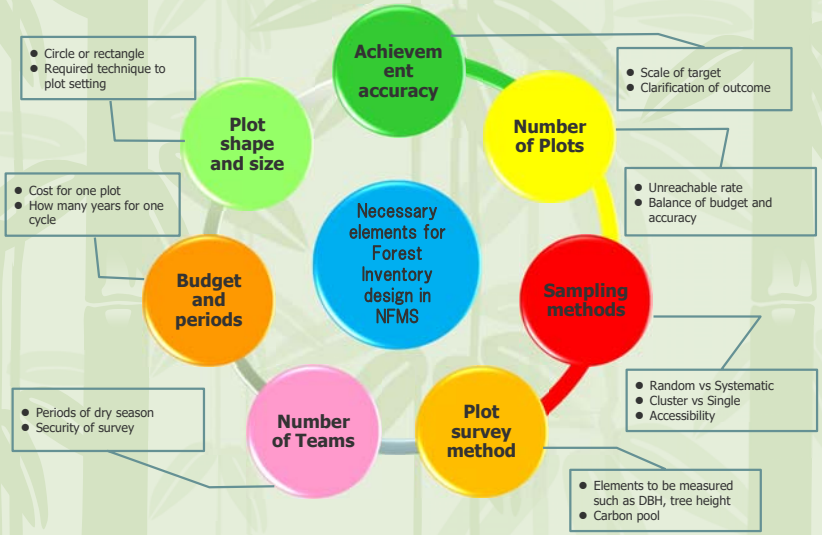
Forest area change (unit:ha) → Preparation of forest cover map

Carbon stock change (unit:CO2 t/ha) → Implementation of forest inventory

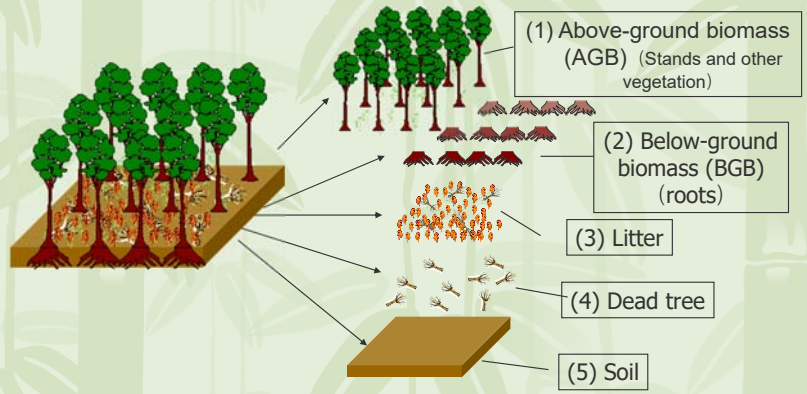
【Points to be considered for preparation of forest cover map】



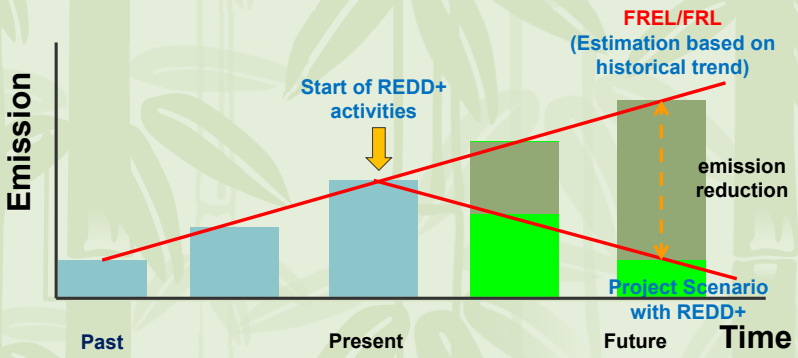
【Points to be considered for design of forest inventory】



【Carbon Pools in a Forest】



【The Requirement (4) FREL/FRL】



- FRELs/FRLs establish business-as-usual (BAU) baselines against which actual emissions are compared.
  ⇒Emission reductions are estimated as the difference between actual emissions and FRELs/FRLs within an established period.
- FRELs/FRLs are benchmarks for assessing each UNFCCC Party's performance and determine its eligibility for international, results-based payment for REDD+

【Common Understanding of What FRELs and FRLs Refer to】

- FRELs (Forest Reference Emission Levels) only count emissions of the greenhouse gases (GHGs) from deforestation and forest degradation.
- FRLs (Forest Reference Levels) count both emissions of GHGs from deforestation and forest degradation and removals of GHGs from the "sink" activities such as enhancement of forest carbon stock.

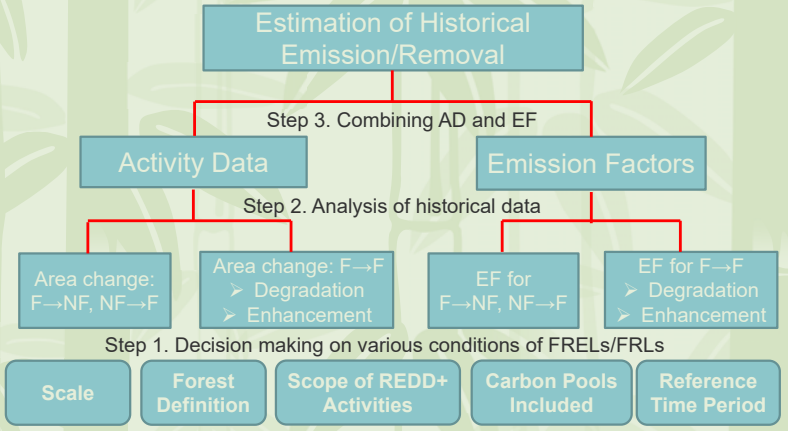
【Outline of Development of FRELs/FRLs】

Development of FRELs/FRLs can be simplified to the 2 components under the UNFCCC guidance:

1. Analysis of Historical Change of Forests
2. Estimation of Future Change of Forests with Adjustment by National Circumstances

Developing country Parties in establishing FRELs/ FRLs should do so transparently taking into account **historic data**, and adjust for **national circumstances** (decision 4/CP.15, paragraph 7)

【Process of Estimating Historical Change】



F: forest
NF: non forest
EF: emission factor

Source: Meridian Institute, 2011 (modified)

【Conditions of FRL in Kenya】

Condition	Decision
Forest definition	a minimum 15% canopy cover; minimum land area of 0.5 ha and minimum height of 2 meters.
Scale	National
Scope of REDD+ Activities	Reducing emissions from deforestation Reducing emissions from forest degradation Sustainable management of forest Enhancement of forest carbon stocks.
GHG Gases	only CO_2
Carbon Pools	Above Ground Biomass (AGB) and Below Ground Biomass (BGB).
Reference period	2002-2018 Data points: 2002, 2006, 2010, 2014, 2018
Construction method	Historical Average of emissions and removals between 2002 and 2018, monitored at 4-year intervals

【Warsaw Framework for REDD+】

(1) modalities for national forest monitoring systems,
(2) the timing and the frequency of presentations of the summary of information on the safeguards,
(3) addressing the drivers of deforestation and forest degradation,
(4) guidelines and procedures for the technical assessment of submissions on proposed REL/RL,
(5) modalities for measuring, reporting and verifying (MRV),
(6) coordination of support for the implementation of activities, including institutional arrangements
(7) work programme on results-based finance

http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf#page=34

【① Modalities for national forest monitoring systems (NFMS)】

Outline：The development of NFMS should take into account the most recent guidance provided in IPCC, and the NFMS should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying.

Function：NFMS should build upon existing systems as appropriate, and enable the assessment of different types of forest in the country, including natural forest, as defined by the Party.

【② The timing and the frequency of presentations of the summary of information on the safeguards】

Outline：Developing country Parties should start providing the summary of information on safeguards in their national communication or communication channel, including via the web platform of the UNFCCC, after the start of the implementation of activities of REDD+. The frequency of subsequent presentations of the summary of information should be consistent with the provisions for submissions of national communications

【③ addressing the drivers of deforestation and forest degradation】

Outline：Encouraging all Parties, relevant organizations, and the private sector and other stakeholders, to continue their work to address drivers of deforestation and forest degradation and to share the results of their work on this matter; and developing country Parties to take note of the information from ongoing and existing work on addressing the drivers of deforestation and forest degradation.

【④ Guidelines and procedures for the technical assessment of submissions on proposed REL/RL

Objectives of technical assessment：To assess the consistency with the guidelines for submissions of information on FREL/FRL, and to offer a facilitative and non-intrusive technical exchange of information keeping the construction and future improvements of FREL/FRL in mind.

Composition of assessment team：Each submission shall be assessed by two LULUCF experts selected from the UNFCCC roster of experts, one from a developed country and one from a developing country. The Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention may nominate one of its experts to participate in the technical assessment as an observer.

Timing and method of publication：Assessment sessions will be organized once a year. Assessment will be done for about a year. the Party may modify its submitted FREL/FRL in response to the technical inputs of the assessment team. Publication of final report on assessment results is made via the web platform on the UNFCCC website.

【⑤ Modalities for measuring, reporting and verifying (MRV)】

Outline：To be consistent with the methodological guidance provided in decision of COP15, and any guidance on the MRV of nationally appropriate mitigation actions (NAMA) . Data and information used in the estimation of forest-related emissions by sources and removals by sinks etc. should be transparent, and consistent over time and with the FREL/FRL

Report：The Data and information will be submitted through the biennial update reports (BUR) and technical annex by Parties. The technical team of experts shall make an analysis and prepare a technical report to be published via the web platform.

【⑥ Coordination of support for the implementation of activities, including institutional arrangements】

Requirement：To designate a national entities or focal points of developing country

Function of the entity：Identify needs and functions related to the coordination of support, strengthen the sharing of relevant information, knowledge, experiences and good practices, identify possible needs and gaps in coordination of support, provide opportunities to exchange information between the relevant bodies, provide information and any recommendations to improve the effectiveness of finance.

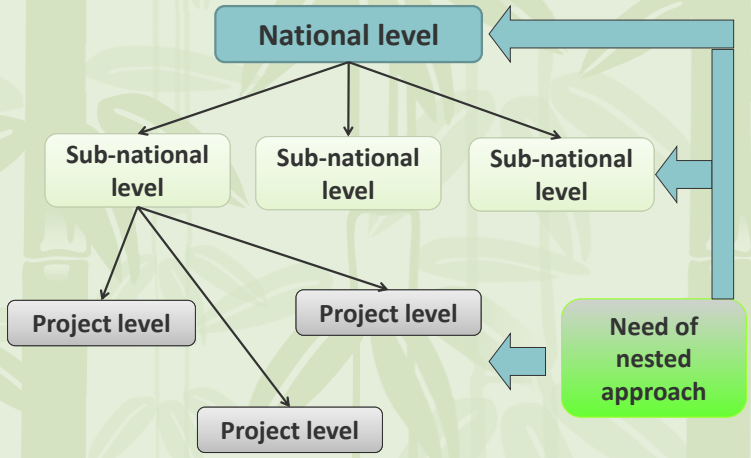
【⑦ Work programme on results-based finance】

Requirement to obtain finance : developing countries seeking to obtain and receive results-based finance of REDD+ activities should meet requirement of The Cancun Agreement, and those actions should be fully measured, reported and verified, the countries should provide the most recent summary of information on the safeguards before they can receive results-based payments;

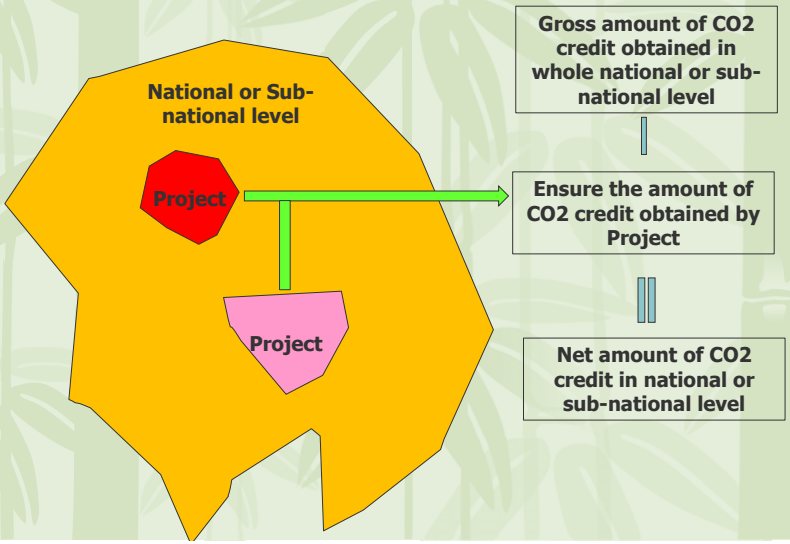
Publication of information : To establish an information hub on the web platform on the UNFCCC website as a means to publish information on the results of the activities, and corresponding results-based payments;

Green Climate Fund : The Green Climate Fund (GCF) plays a role of result-based financing the REDD+ activities.

【Level of REDD+ (Three (actually Two) Classes)】



【Example of Nested Approach】



【Phased approach of REDD+ implementation】

Preparing National REDD+ strategy, improvement of the capabilities required to REDD + implementation

Trial of REDD + activities in accordance with the countries' ability (continuation of capacity building)

Aiming at making markets, the implementation of REDD + activities in the results-based by robust monitoring system

【Example of finance access】

	Phase 1 Readiness	Phase 2 Implementation	Phase 3 Result-based payment	Funding amount	Remark
GCF(Green Climate Fund)	○	○	○	USD 10.3 Billion	Capital increase negotiation was started from 2018
GEF(Green Environmental Fund)	-	○	-	USD 61.65 Billion	Capital increase every 4 years
UN-REDD	●	○	-	USD 323 M	-
FCPF(Forest Carbon Partnership Facility)	● Readiness Fund	-	○ Carbon Fund	RF: USD 430 M CF: USD 900 M	RF: By 2020 CF: By 2025
Bio Carbon Fund-ISFL(Initiative for Sustainable Forest Landscapes)	-	○	○	USD 352 M	Support only for 5 countries
FIP(Forest Investment Program)	○	○	-	USD 736 M	-
CAFI(Central African Forest Initiative)	○	○	-	USD 275 M	Pledged USD500M by 2027
Amazon Fund	-	○	○	1.3 Billion	Norway and Germany freeze funding in 2019
REM(REDD Early Movers)	-	○	○	?	Brazil, Colombia, Ecuador
NICFI(Norwegian Agency for Development Cooperation : Norad)	-	-	○	USD 380 M /year	By 2030
JCM(Joint Crediting Mechanism)	-	-	○	-	-
CORSIA(Carbon Offsetting and Reduction Scheme for International Aviation)	-	-	?	-	Operation period is from 2021 – 35
VCS(Verified Carbon Standard)	-	-	●	-	-

【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

Establishment :
GCF was decided to set up by COP16 under UNFCCC in 2010 to support the efforts of developing countries to respond to the challenge of climate change.

Aim:
To support the efforts of developing countries to reduce the green house gas emission(mitigation) and address climate change impact(adaptation).

Decision making:
GCF Board which normally meets three times per year.

Constitution of the GCF board:
GCF is governed by a 24-member Board , comprised equally of developed and developing countries, representing the United Nations Regional Groups.

Fund resource
USD 10.3 billion had been pledged in 2014 by 43 countries, 3 regions and one city.

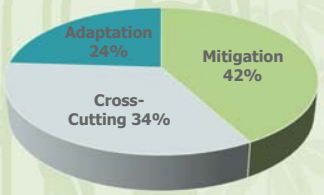
COP16 : ...goal of mobilizing jointly USD 100 billion per year by 2020
COP21 : ...continue the collective mobilization goal through 2025...
...to 2025 set a new collective quantified goal from a floor of USD 100 billion per year

【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

BALANCED PORTFOLIO

The Fund aims for a 50:50 balance between mitigation and adaptation investments over time. It also aims for a floor of 50 percent of the adaptation allocation for particularly vulnerable countries, including Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African States.



Share of funding by 2019
Reference: GCF website

8 impact areas

Mitigation
1. Energy access and power generation
2. Transport
3. Energy efficient buildings, cities and industries
4. Sustainable land use and forest management

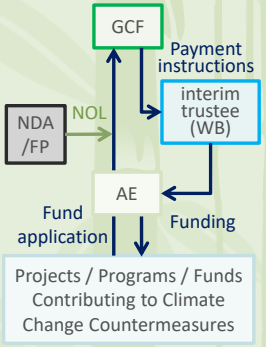
Adaptation
5. Livelihoods of the most vulnerable people
6. Health and food and water security
7. Infrastructure and built environment
8. Ecosystems

【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

Fund application

- In order to apply the GCF funds, it is necessary to submit a Funding Proposal through AE (Accredited Entities) .
- When applying for funding, it is also necessary to submit a "No objection letter(NOL)" from the government of the project country (NDA (National Designated Organization) or Focal Point(FP).
- The funds application is discussed at the GCF Board and when approved, the Payment instructions are sent to GCF's interim trustee. The trustee will then transfer funds to the AE.
- 124 projects have been approved by December 2019 (7 projects are Kenya's project)



【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

Result-based Payment Pilot Project

◆Step to access RBP

Meet the REDD+ requirements as defined by the Warsaw Framework → Submit biennial update report (BUR) → Submit a concept note and funding proposal

◆Framework of RBP pilot project

Project period: Open for 2017-2022 (Submit application by 2020)
Envelope: USD 500 million
Financial Valuation: USD 5/tCO_2e
Eligibility Period: 31 Dec 2013 - 31 Dec 2018
Access Modality: Accredited Entities
Submission: Concept notes and funding proposals
Adoption method: Rolling Basis(Deliberated on a first-come, first-served basis)
Assessment: Scorecard

【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

Result-based Payment Pilot Project

◆Calculation of Result-based payment

STEP1	STEP2	STEP3	STEP4	STEP5
• Emission reduction (ERs) is calculated by AE.	• Calculation of "GCF certified ERs" based on scorecard.	• Calculation of provisional Result-based payment.	• Calculation of value addition of non-carbon benefits	• Calculation of Result-based payment.

◆Approved Result-based payment

Country	AE	Eligibility Period	ER calculated by AE	ER Approved by GCF	Non-carbon benefits	Payment by GCF
Brazil	UNDP	2014-2015	25million/tCO2e	18.8million/tCO2e	2.5%	96million USD
Ecuador	UNDP	2014	4.8million/tCO2e	3.6million/tCO2e	2.5%	18.6million USD
Chile	FAO	2014-2016	14.5million/tCO2e	12.4million/tCO2e	2.5%	63.6million USD
Paraguay	UNEP	2015-2017	18.9million/tCO2e	14.1million/tCO2e	2.5%	50million USD

Review of Outline of National Forest Monitoring System (NFMS)

The REDD+ Readiness Component in
the Capacity Development Project for the Sustainable Forest Management
in the Republic of Kenya

By Kazuhisa KATO – Component 3 Team Leader

2020.1.21

1 UNFCCC Requirements

Mechanism of REDD+

Readiness
(To receive results-based finance, developing country party should have the following in place)

- ☐ A national strategy or action Plan
- ☐ An assessed forest reference emission level and/or Forest reference level
- ☑ A national forest monitoring system (NFMS)
- ☐ A system for providing information on how the safeguards are being addressed and respected

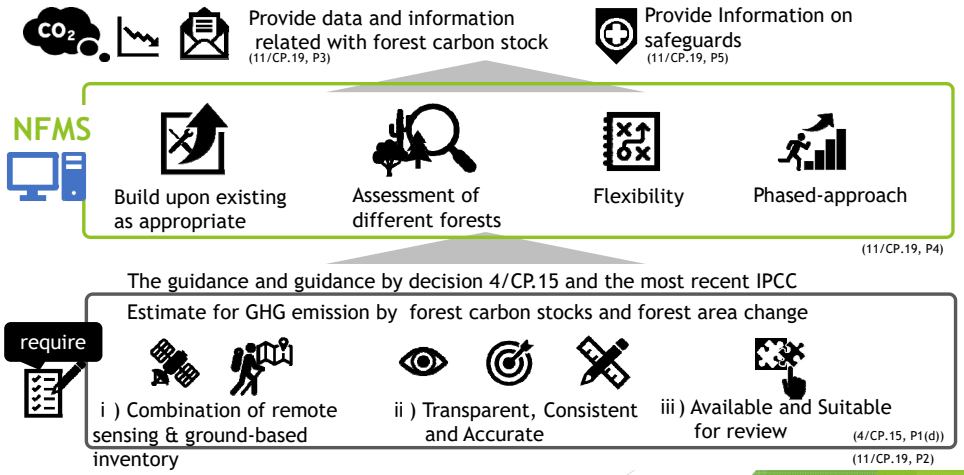
Implementation
(Developing country party undertake the following activities to receive results based finance)

- ☐ Reducing emissions from deforestation
- ☐ Reducing emissions from forest degradation
- ☐ Conservation of forest carbon stocks
- ☐ Sustainable management of forests
- ☐ Enhancement of forest carbon stocks

1/CP.16 The Cancun Agreements Paragraph 70,71

2. Definition of NFMS in UNFCCC

NFMS in UNFCCC decisions



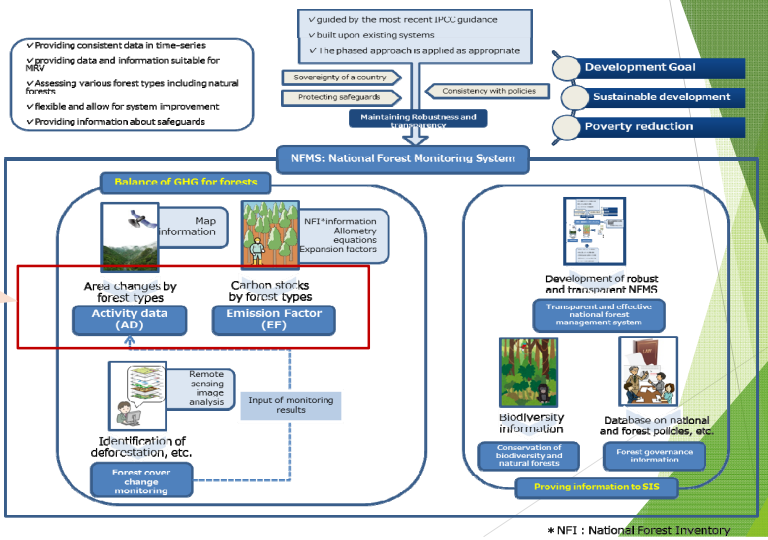
2. Definition of NFMS in UNFCCC

Decision 11/CP.19

2. Decides that the development of Parties' national forest monitoring systems for the monitoring and reporting of the activities,1 as referred to in decision 1/CP.16, paragraph 70, with, if appropriate, subnational monitoring and reporting as an interim measure, should take into account the guidance provided in decision 4/CP.15 and be guided by the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources, and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes;

3. Also decides that robust national forest monitoring systems should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes resulting from the implementation of the activities referred to in decision 1/CP.16, paragraph 70, taking into account paragraph 71(b) and (c) consistent with guidance on measuring,reporting and verifying nationally appropriate mitigation actions by developing country Parties agreed by the Conference of the Parties, taking into account methodological guidance in accordance with decision4/CP.15;

2. Definition of NFMS in UNFCCC



Need to Identify each methodologies as Kenya REDD+

＊NFI : National Forest Inventory

3. Contents of NFMS document draft ver.0

1/2

Chapter	Contents	
Chapter 1	Background and Purpose	
Chapter 2	UNFCCC requirements	
Chapter 3	Basic conditions of NFMS in Kenya	3.1 Scale
		3.2 Forest definition
		3.3 Forest stratification and classification
		3.4 Land use categorization
		3.5 Carbon pool
		3.6 Scope gas
		3.7 Selected activity
		3.8 Definition of national REDD+ activities
Chapter 4	Conceptual design of the NFMS in Kenya	4.1 Purpose of Kenya's NFMS
		4.2 Composition of NFMS
		4.2.1 Monitoring function
		4.2.2 Data management function
		4.3 Phased approach

3. Contents of NFMS document draft ver.0

2/2

Chapter	Contents	
Chapter 5	Monitoring function	5.1 Forest cover area and forest cover change for AD
		5.1.1 Forest cover area by mapping
		5.1.2 Forest cover change area by mapping
		5.1.3 Forest cover change monitoring
		5.2 Forest Carbon stock for emission factors
		5.3 PaMs
		5.4 Biodiversity
		5.5 REDD+ and AR-CDM project for the register
Chapter 6	Data management function by FIP	6.1 Component and contents of the FIP
		6.2 Access right of each content
		6.3 Linkage with FMIS
		6.4 Update and operation
Chapter 7	Institutional arrangement for NFMS	6.1 Institutional arrangement for monitoring function
		6.2 Institutional arrangement for data management function
Chapter 8	Calendar of NFMS	

4. Proposed NFMS in Kenya -Conceptual Design-

Phased Approach

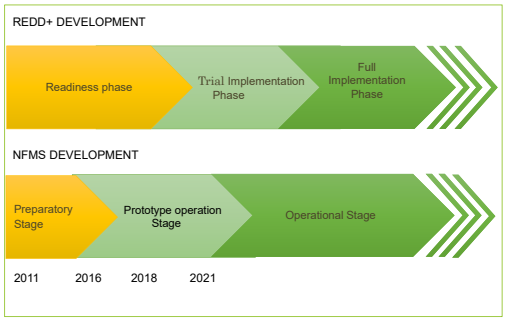


Figure Phased approaches of the development of the REDD+ program and the NFMS in Kenya

The NFMS will be developed in a phased approach that is synchronized with the implementation of the three phases of the REDD+ program, which is depicted in Figure. The criteria that will be used to guide the development through each of these phases include UNFCCC requirements, national policies, the availability of data, operational costs, and the capacities of users of the NFMS to operate the system and use the information provided in a meaningful manner.

4. Proposed NFMS in Kenya -Conceptual Design-

NFMS in Kenya will be established from two aspects.

Monitoring function

It is included estimation of anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks, forest carbon stock and forest area changes, information of policy and measure, biodiversity and registration of forest related project.

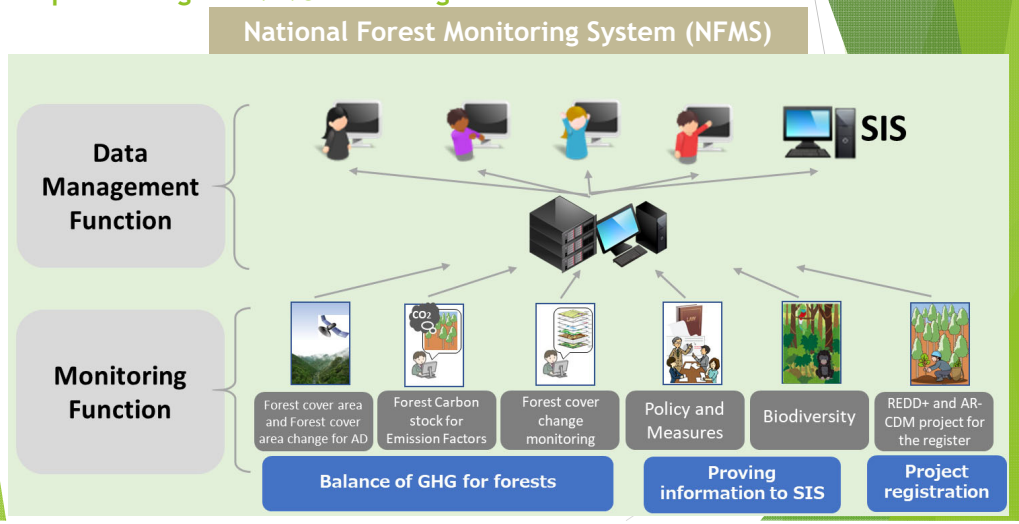
Data management function

It is a database to input the information and data gathered by implementation of the monitoring and provide them for implementing sustainable forest management including REDD+.

All of NFMS in Kenya will be described in detail in the "NFMS document in Kenya" to ensure transparency.

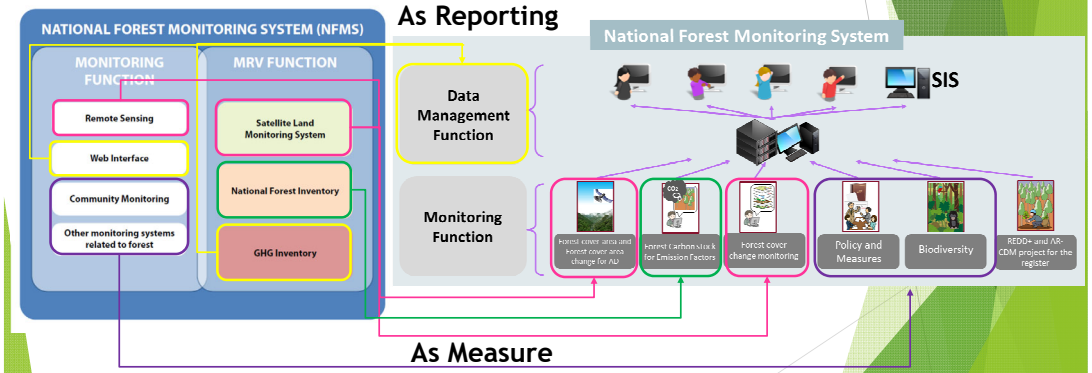
4. Proposed NFMS in Kenya -Conceptual Design-

Conceptual Design of NFMS consisting of two functions



4. Proposed NFMS in Kenya -Conceptual Design-

Comparison between UNREDD strategy NFMS and Proposed NFMS



4. Proposed NFMS in Kenya -Monitoring function-

Item	Information resource	Methodology
Activity Data (AD) by Satellite analysis	Land use / Land cover map	Methodology is Established based on SLEEK map manual
Emission Factor (EF) based on Forest carbon stock	National Forest inventory, Allometric equation	Methodology of NFI will be developed based on ICFRA proposal with modification. Equations have been already selected but it should be developed in Kenya as phased approach
Forest area change Monitoring	Optical and radar satellite imageries	Detect land cover changed area, JJ-FAST and EO Lab can be used.
Policy and Measures	NDC, National REDD+ strategy (NRS) and National Forest Program, etc.	Monitoring Methodology to be developed based on the mainly contents of NRS etc..
Biodiversity	Protected area, management plan, biodiversity assessment etc.	Methodology should be discussed with KWS and NMK as well.
Project registration	Registration form of REDD+, CDM project	Registration and monitoring system should be developed.

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop AD

- Forest Definition:

Minimum surface area	0.5ha
Minimum Height	2m
Minimum Cover	15%

- MAP :

Map	SLEEK MAP
Image	Land Sat image or any available and more aculeate image
Methodology	Wall to Wall Supervised Classification
Time	At the least every four years

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop AD

- Stratification: SLEEK stratification is basically used

forest strata
Montane Forest, Western Rain Forest and Bamboo Forest
Mangrove Forest and Coastal Forest
Dryland Forest

X

Canopy coverage classes
Dense
Moderate
Open

= 9 forest types

forest strata
Plantation

= 1 forest type

Total 10 forest types

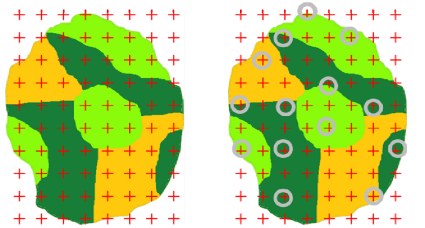
4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- NFI is utilized for developing EF

Sampling Design of NFI

1 Systematic grid spacing for clusters : Distance of 2km-by-2km: (4km^2 grids) over the whole country
2 Stratified sampling method: SLEEK stratification (10 forest types)
3 Random sampling method: The number of clusters to be calculated based on the SLEEK stratification.



Stratified sampling method Random sampling method

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- Sampling Design of NFI

ICFRA proposal (Cluster sampling method) will be basically used with minor change.

- In the Figure 1, left side figure is for forest except for mangrove, right side figure is for mangrove.
- In case that more than two canopy coverage classes are mixing in a cluster like Figure 2, how the data of different classes should be consolidated?

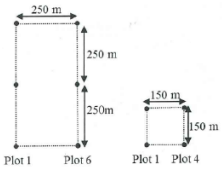
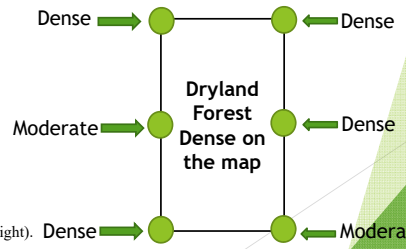


Figure 1 . Cluster designs in Strata 1-3 (left) by ICFRA and in Stratum 4 (right).



In this case, how can the data be compiled? Moderate data is compiled as Dense.

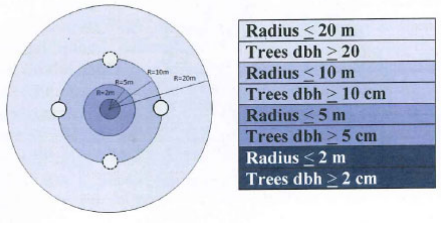
Figure 2. Example of cluster with more than two canopy coverage classes mixed

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- **Plots shape**

ICFRA proposal: Cercle shape is used as mentioned in the following figure. However, since SLEEK stratification is used, it is needed to decide how each shape will be applied to the SLEEK stratification, e.g. left side is for non-forest, right side is for forest.



Radius ≤ 20 m
Trees dbh ≥ 20
Radius ≤ 10 m
Trees dbh ≥ 10 cm
Radius ≤ 5 m
Trees dbh ≥ 5 cm
Radius ≤ 2 m
Trees dbh ≥ 2 cm

Figure . Sample plot design for Stratum 1 and 3

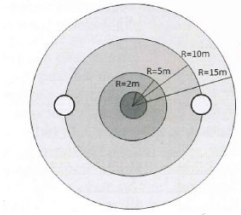


Figure . Sample plot design for Stratum 2 and 4

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya.

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- **Measurement method in the plots:**
- ICFRA proposal: As mentioned in the table

Table .Measurement on the circular sample plots.

	DBH/ diameter (cm)	Height/ length (m)	Plot radius (m)	Plot area (m^2)
Tree	≥ 2	≥ 1.3	2	12.6
Tree	≥ 5	≥ 1.3	5	78.5
Tree	≥ 10	≥ 1.3	10	314.2
Tree (Strata 2 and 4)	≥ 20	≥ 1.3	15	706.9
Tree (Strata 1 and 3)	≥ 20	≥ 1.3	20	1256.6
Climber	≥ 2	≥ 1.3	2	12.6
Climber	≥ 5	≥ 1.3	15	706.9
Bamboo		≥ 1.3	10 or 2 × 2.0	314.2 or 25.13
Lying dead wood	≥ 10	≥ 1.0	15	706.9
Shrub		≥ 1.3	15 or 2 × 2.0	706.9 or 25.13
Stump			15	706.9
Regeneration	< 2	≥ 0.10	2 × 1.5	14.13

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya.

4. Proposed NFMS in Kenya -Monitoring function-

Monitoring function under development -forest cover change monitoring-

- Purpose : to identify deforestation, forest degradation and/or forest increase area for forest management in real time as much as possbile.
- Note : JJ-FAST and EO lab may be used for forest cover change monitoring.
- Procedure : to be identified for what purpose the monitoring result should be used. Then, method of forest cover change monitoring is identified.

4. Proposed NFMS in Kenya -Monitoring function-

Monitoring function under Development -policies and measures (PaMs)

- Purpose : to manage the monitoring for implementation of forest policy (PaMs) on REDD+
- Note : National REDD+ Strategy (NRS) will be developed with support of UNDP through FCPF. PaMs monitoring in NFMS have a close relationship with NRS.
- Procedure : Developing PaMs monitoring after NRS development basically.

  However, In Kenya, the National Forest Programme 2016 – 2030 (NFP) was developed as the basis of forest policies. Therefore, NFP will be probably basis of actions to address deforestation, forest degradation and to increase forest in NRS. Hence, it can be discussed for considering method of monitoring of PaMs in advance e.g. how to monitor the degree of achievement of programme strategies of thematic clusters in NFP related to REDD+ activities. In addition, the consideration can be consulted with UNDP.

4. Proposed NFMS in Kenya -Monitoring function-

Monitoring function under Development -Biodiversity monitoring-

- Purpose: to provide the information on biodiversity for Safeguards Information System (SIS).
- Note : it needs to keep contact in proceeding with KWS and NMK. Method used for biodiversity surveys implemented in Kenya should be followed.
- Procedure : to examine how KFS, KWS and NMK are conducting monitoring activities and how to incorporate that information into the NFMS. Otherwise, there is option that results of biodiversity survey which will be conducted in Kenya by KWS and NMK etc. will be used as results of monitoring in the NFMS.

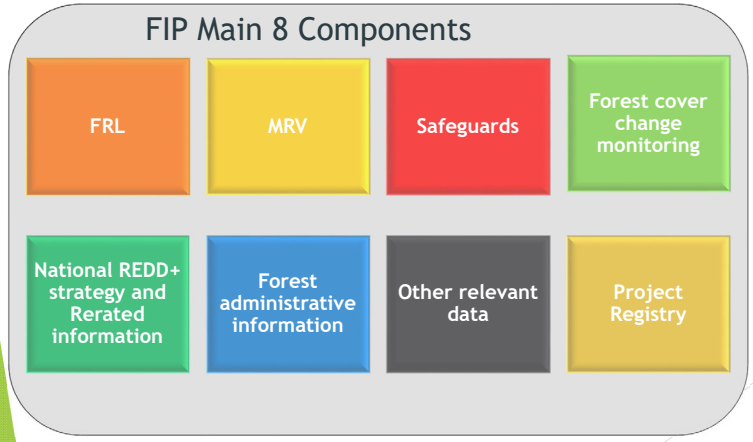
4. Proposed NFMS in Kenya -Monitoring function-

Monitoring function under development -REDDD+ and AR-CDM project-

- Purpose : to avoid double counting of emission reduction for result-based payment by compiling greenhouse gas reduction efforts by REDD+ and AR-CDM projects in NFMS.
- Note : It can be contributed to nested approach of REDD+
- Procedure : It will be identified what kinds of items of project should be provided in the FIP. Then it should be decided what kinds of data in the projects should be monitored.

4. Proposed NFMS in Kenya –Data management function-

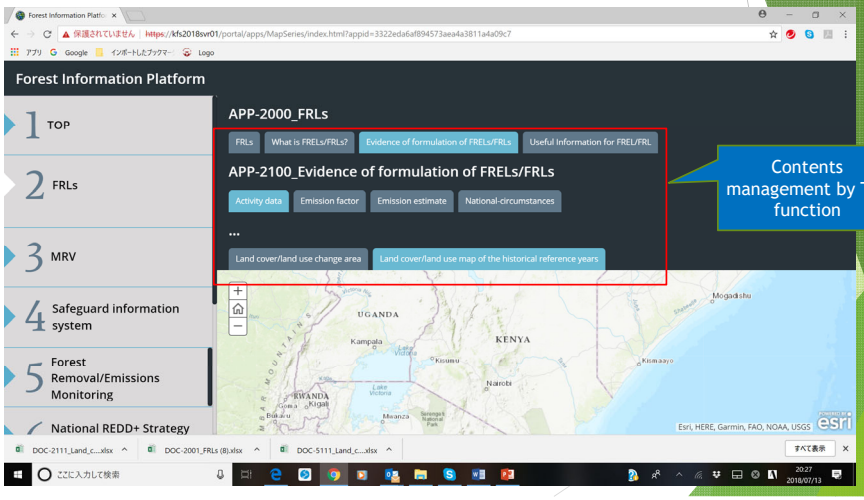
FIP as database in NFMS was developed with 8 components



Concrete objectives of FIP, function of the FIP, Information to be operated in FIP, access right of each content, and system for update and operation of FIP should be mentioned in the NFMS document as well.

4. Proposed NFMS in Kenya –Data management function-

The FIP contents are classified in detail by tab function



4. Proposed NFMS in Kenya –Institutional Arrangement-

Institutional arrangement for implementation of monitoring function and data management function

Institutions to be involved in the following monitoring should be illustrated in the NFMS document

- ✓ Activity Data
- ✓ Emission Factors
- ✓ PaMs
- ✓ Biodiversity
- ✓ REDD+ and AR-CDM project

Note : Maybe institutional arrangement for implantation of monitoring will be established in the NRS. Therefore, the institutional arrangement in the NFMS should follow the institutional arrangement to be mentioned in NRS.

4. Proposed NFMS in Kenya –Calendar of NFMS implementation-

Proposed Calendar

Year	Activity Data By Mapping	Emission Factor by NFI	FREL/FRL	Submission of BUR	remarks
2017	Year 2000, 2014 map				
2018					
2019	○ (for 2018 map, the followings are same)				
2020		○	○ (Reference Period 2002-2018)		Paris Agreement come into force
2021	○			○	
2022					
2023	○			○	
2024					
2025	○			○	
2026					
2027	○			○	
2028					
2029	○			○	
2030		○	○ (Update of FRL)		

Forest Information Platform for NFMS , REDD+ and SFM

21st January 2020

Table of Presentation

- FIP Objectives
- FIP Functional description
- FIP Basic Components
- FIP Main Functions
  - 1. FIP Site Map
  - 2. Management of Inventory Data
- FIP Development Schedule

Implementation Methods of REDD+ Readiness Component

[1] Activities on the NFMS and the Forest Information Platform

[2] Activity on various type of map creation

[3] Activities on FRL

[4] Activity on forest cover change monitoring in the whole of Kenya

[5] Activity on the MRV training

[6] Activities on pilot project for REDD+ (Contribution to Component 2)

Definition of the NFMS in Kenya

Defining the NFMS as methodology and the NFMS as a database (forest information platform)

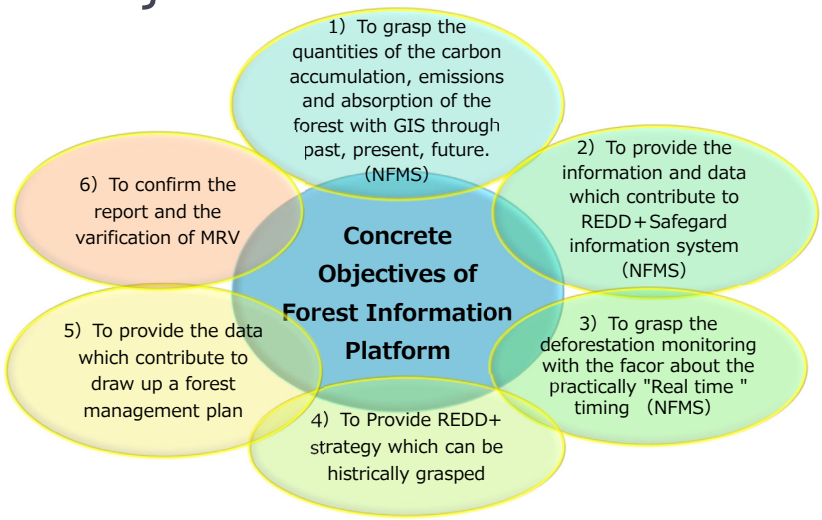
➢ **NFMS**

Methodology of how forests are monitored

➢ **Forest Information Platform**

A database to provide information that does not only include the information identified according to the NFMS but the information necessary for implementing REDD+ and sustainable forest management

FIP Objectives



FIP Functional description

To **replace KFIS's** functionality with the Web Portal Service with ArcGIS Enterprise

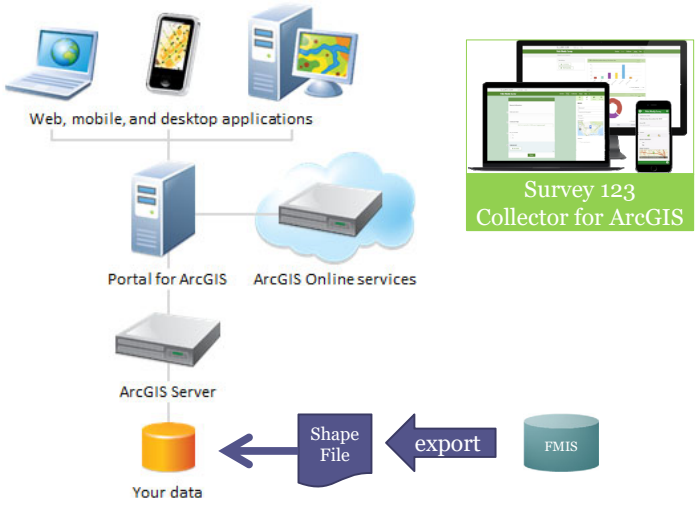
To use the Portal for ArcGIS Server with the limited access to the contents.

To utilize ArcGIS Online as the gateway to the accessible contents .

To support PDA devices for the data collection activities at the field

To support the other external system data with the static link.

FIP Basic Components

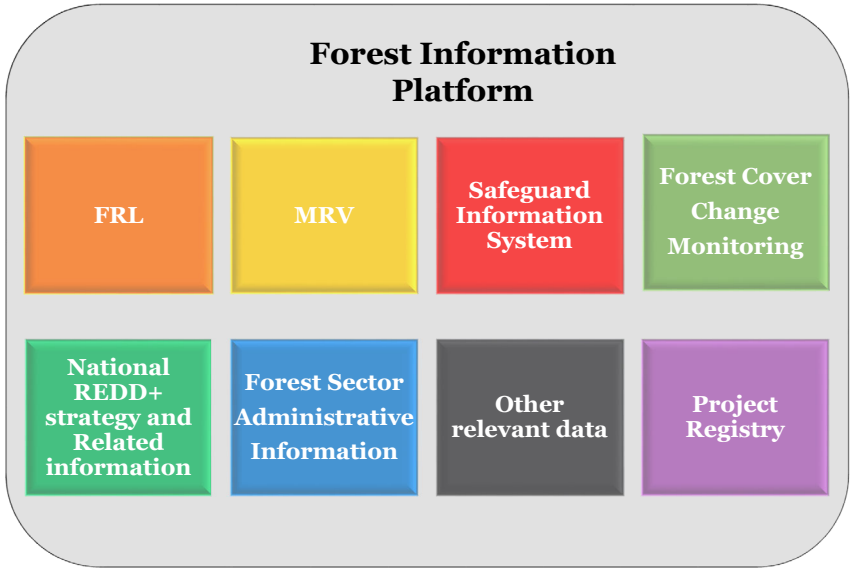


FIP Main Functions

1. FIP Site Map
2. Management of Field Survey Data
3. FMIS Linkage

1． FIP Site Map

FIP Main 8 Components(Draft)

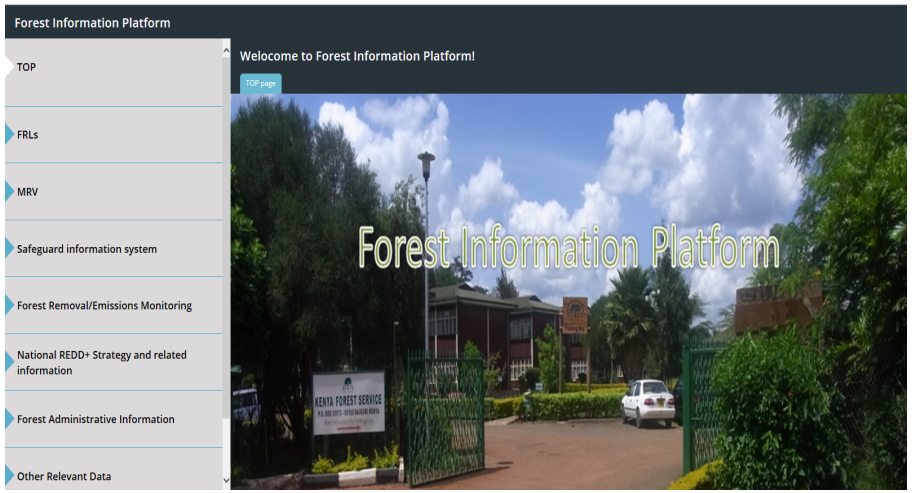


Contents type and persons to access FIP

- 4 type Contents
  ①Description：Explanation of Contents
  ②GIS data
  ③Table：The result of calculation or Inventory
  ④Document
- 4 type persons with access right on FIP
  - FIP Administrator
  - KFS
  - Related Stakeholder
  - General Citizen

Development of FIP

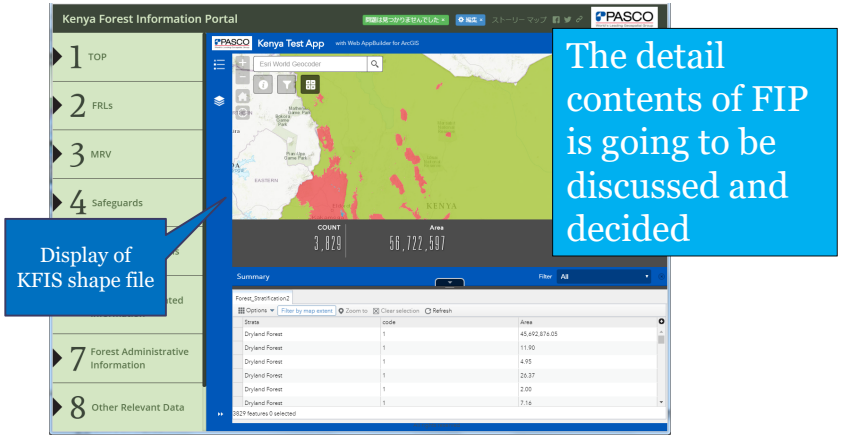
The FIP sample layout as sitemap have been developed



Development of FIP

Updating sample data on FIP including

・Shape file、Document data(word , pdf etc…)、Table data including excel file



2． Management of Field Survey Data

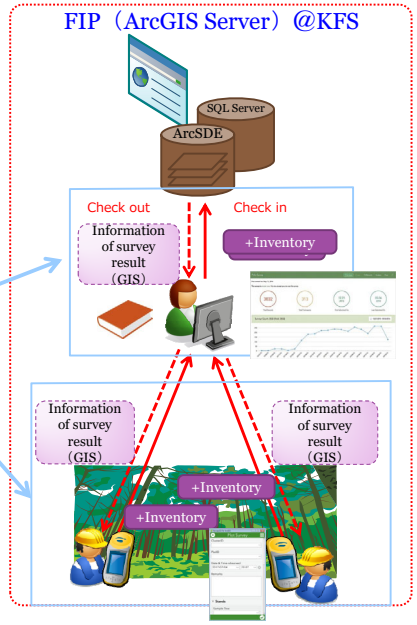
Field Survey Data collection Tool: Survey 123

Survey 123

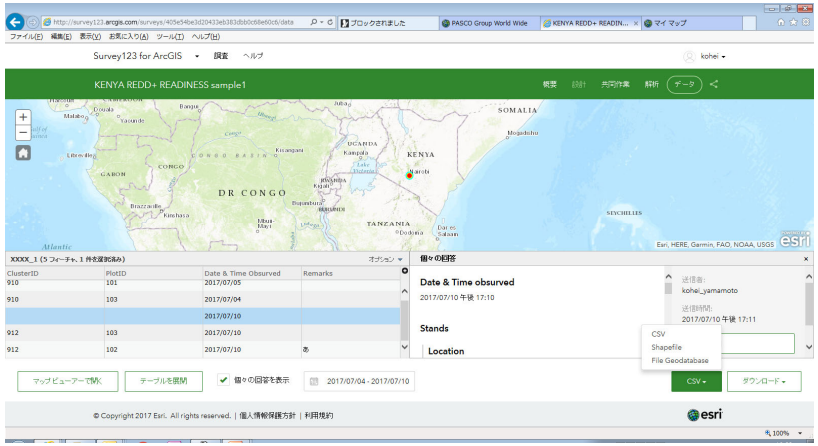
Survey 123 is the software based on ArcGIS Online Solution.

[The merit of Survey 123]
- Centralized management of inventory collect data using administrator's function
- Registration of location information referring Map and Satellite imagery.

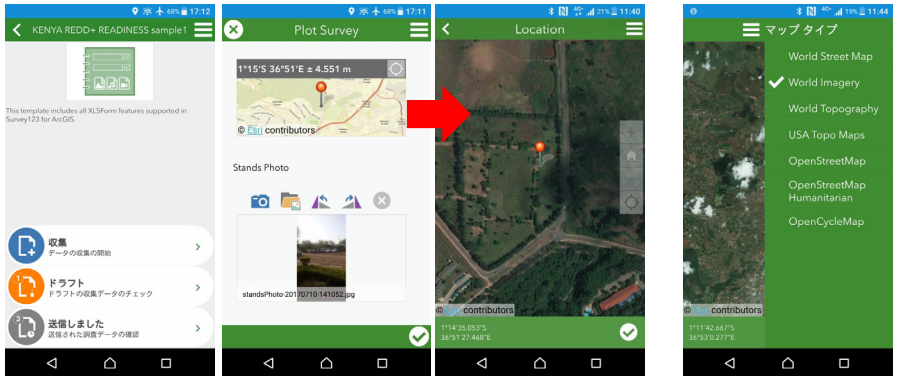
*Interface and function will be developed based on the function of ArcGIS Server



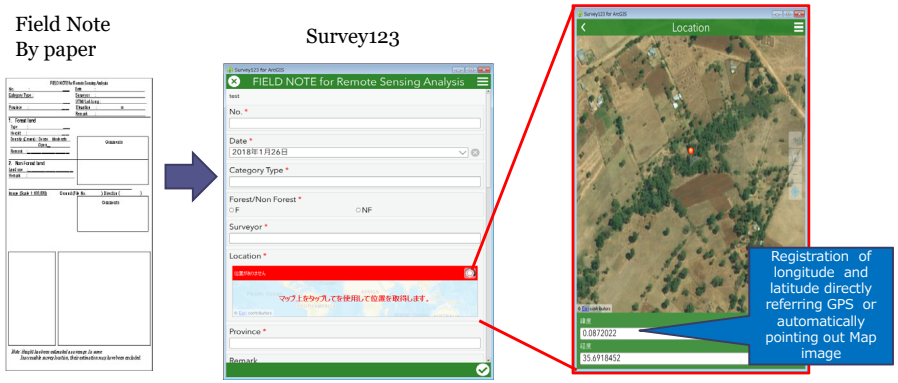
Sample application of survey 123 Administrator's tools



PDA Client

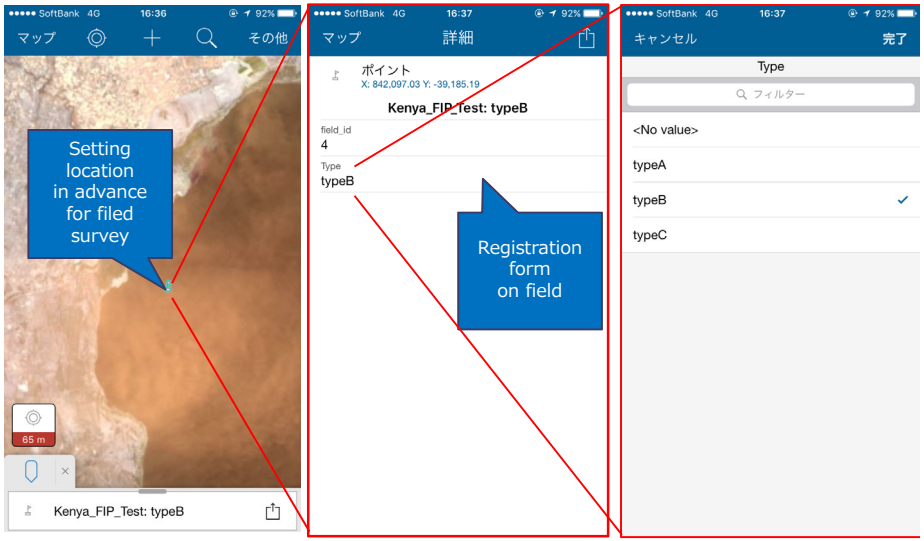


Development of Forest Inventory Collection Tool Based on Remote Sensing Analysis for this year



Field Survey Data collection Tool: Collector for ArcGIS

Development of basic function of Forest Inventory Collection Tool by Collector for ArcGIS



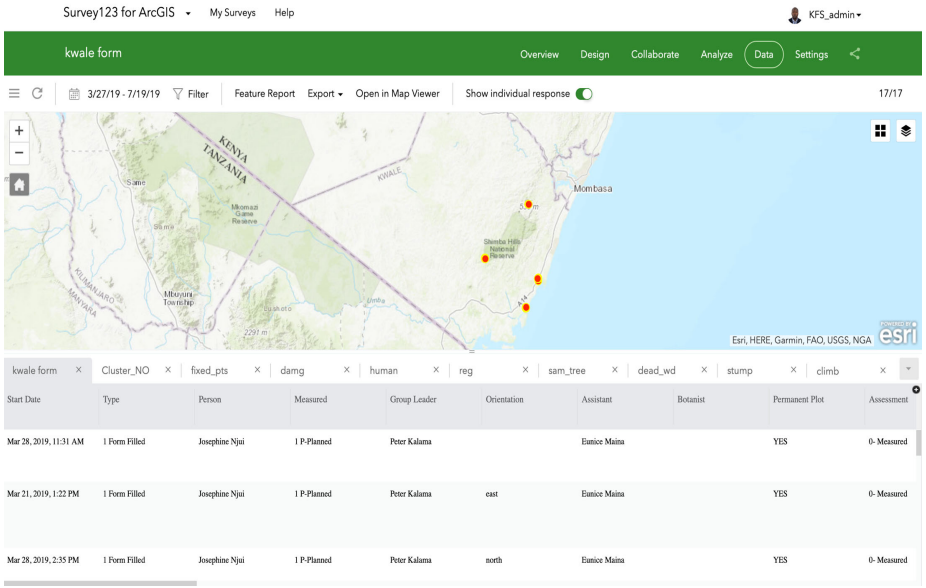
Field Survey Data collection Tool: Summary

- Depending on the intended use of the field survey tool by the Kenya, both Survey123 and Collector for Arc GIS are preferred to utilize together.

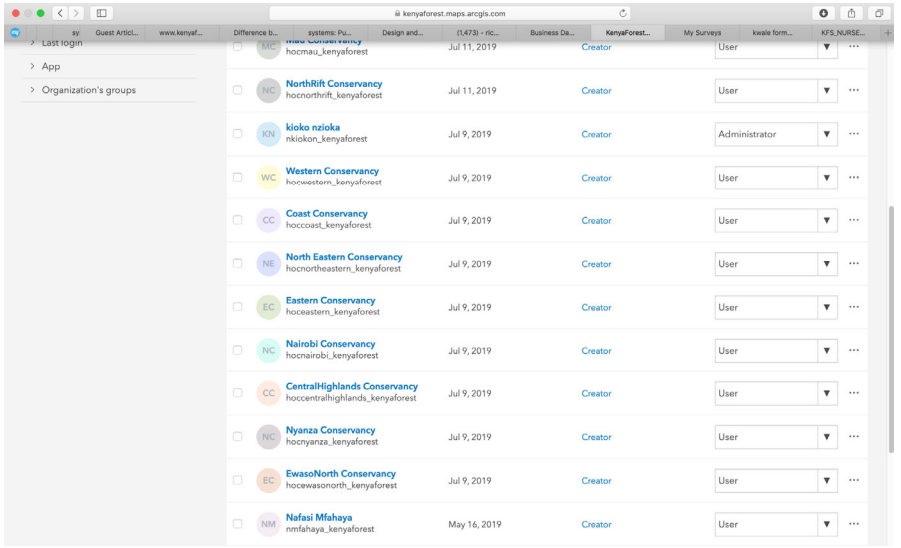
- For the forest inventory research tool, Collector for Arc GIS is preferred because of the function "setting the locations for the research in advance, and register their results.“

- For field survey of remote sensing or Patrol, Survey123 is preferred because of user friendly GUI and easy management of data.

Survey 123

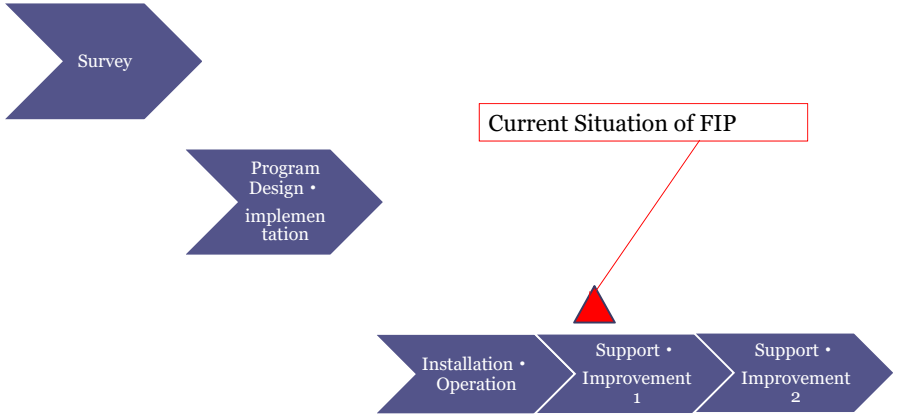


Survey 123



FIP Development Schedule

2016 2017 2018 2019 2020



Questions Comments

- Thank you
- Merci
- Arigatogozaimas
- Gracias

Kenya's Forest Reference Level for REDD+ Implementation

REDD+ STAKEHOLDERS WORKSHOP

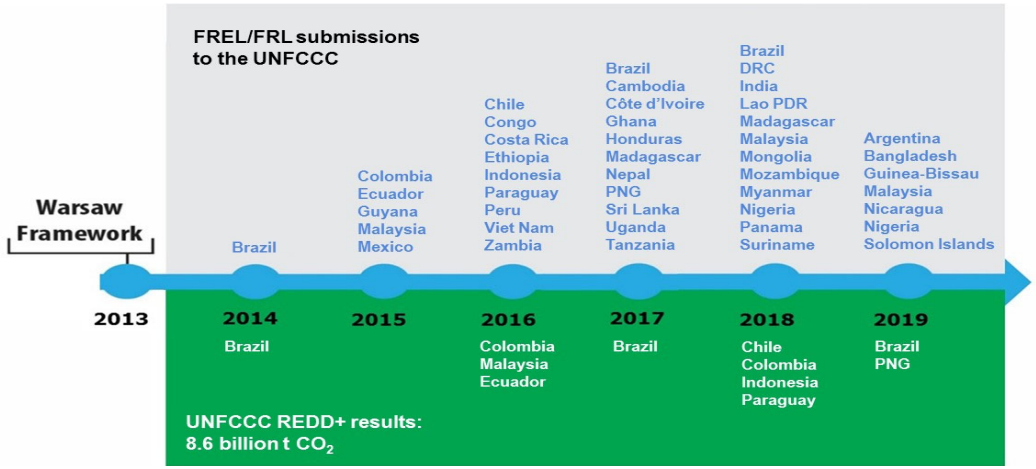
MRV Training Nakuru

BACKGROUND

For a country to participate in REDD+

- National Forest Monitoring System (NFMS)
- National Strategy/ Action plan (NS/AP)
- Safeguard Information System (SIS)
- **Forest Reference Level (FRL)-**
  - **What is the historical trend of emissions so that it can be used as a reference point to judge whether the country is REDUCING EMISSIONS and therefore qualify for REDD+ PAYMENTS**
  - **Has to be submitted to UNFCCC for review**

Global progress



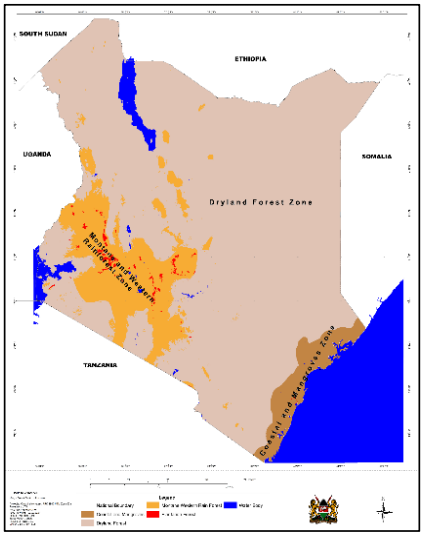
Some decisions that have guided development of the FRL

Discussion	Decision
Approach	National
FRL Activities	that reduce emissions and activities that increase removals thus adding the 'plus' to REDD to make it REDD+.
Pools	AGB and BGB only
Reference Period	2002- 2018 (monitored at 4 year intervals)
Gasses	CO2 only
Forest Definition	tree crown cover ≥ 15%, an area ≥ 0.5 ha and a tree height ≥ 2m.
Forest Strata	4 (Montane & Western Rain Forests, Coastal And Mangrove Forests, Dryland Forests, Public Plantations)
REDD+ Activities	Deforestation, forest degradation, Enhancement of carbon stocks (afforestation and canopy enhancement) and sustainable management of forests (Public plantation forests)
Projection	No Adjustment and based on the historical average

Introduction

- Kenya's current estimate are based on pilot inventory and Public plantations
- ICFRA (Improving Capacity in Forest Resources Assessment) a project funded by Finnish Government assisted Kenya in conducting a Pilot inventory and developing a proposal for National Forest Inventory (NFI)
- Government of Japan through JICA conducted additional plots for pilot inventory
- Note that for Transparency all the documents are available

Stratification of the Forests



Forests have been categorized into strata/ecozones based on climate and Altitude (Wass, 1995)

- Montane Kenya (Mt Kenya, Mau, cherangany, aberdares, Mt Elgon, Leroghi, Matthews range etc) and Western Rain forests – (Kakamega & Nandi forests)
- Coastal (Arabuko sokoke, Boni, Shimba hills etc) and Mangrove forests
- Dryland forests – found in the dry areas
- Plantation forests – Described as management zone set aside by KFs for Public plantation forestry

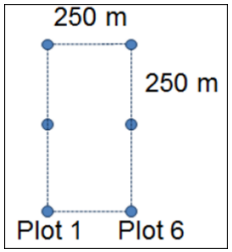
Step by Step Methodology

Sampling Design

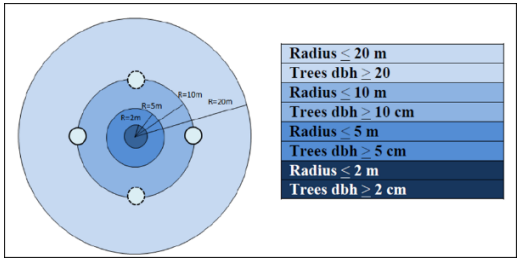
- Based on four strata
- A double stratified two-phase sampling method was used
- Design is systematic cluster sampling where 1st point is randomly selected in phase 1 while in phase 2 the generated points are stratified.
- Stratum for Sampling
  1. Grassland (Dryland Forest)
  2. Forested areas (Western and Rain Forest and Plantation Forest)
  3. Coastal Forests
  4. Mangrove Forests

tep by tep . ethodology

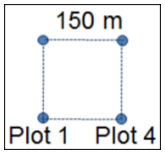
Cluster and Plot Design



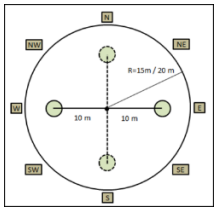
Cluster design for stratum 1 - 3



Plot design for stratum 1 - 3



Cluster design for stratum 4



Location of regeneration subplots (circle) and soil pits (rectangular).

tep by tep . ethodology

Points Collected in Pilot inventory

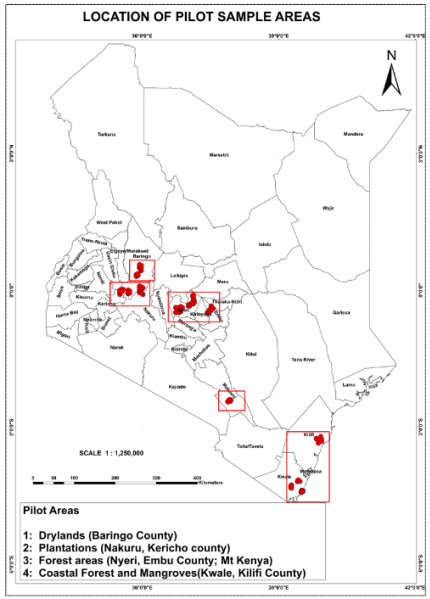
Pilot Areas

1: Dry lands/woodlands (Baringo County)

2: Plantations (Nakuru, Kericho county)

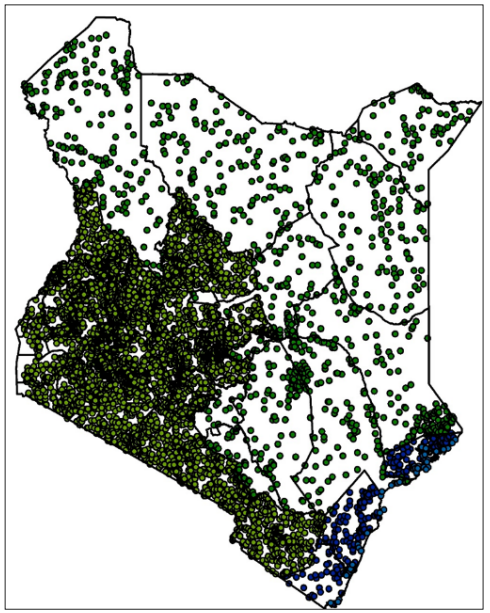
3: Natural Forest areas (Nyeri, Embu County; Mt Kenya)

4: Coastal Forests and Mangroves(Kwale, Kilifi County)



roposed . . .

- Total proposed sample plots 30,978 (approximately 5,000 clusters)



Land cover change Matrix

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					
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)
n No Change (F→F)
dg Forest Degradation (F→F(Degraded))
s Sustainable Management of Forest (F→NF, NF→F)
e Enhancement (F→F(Improved) ,NF→F)
NA Not Available

Assigning Activity Data to REDD+ Activities - Definitions

- Deforestation is conversion of Forests to Non forests in all canopy classes of Montane/Western Rain forest, Coastal and mangrove forests and Dryland forests and is indicated by Red colour
- Degradation is conversion of a forest from a higher canopy class to a lower canopy class for all forests in the strata/ecozones of Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests and is indicated by yellow colour
- Enhancement of Carbon stocks is the conversion of Non forests into forests (afforestation and reforestation) and the improvement of forests from a lower canopy class to a higher canopy class in the strata/ecozones of Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests and is indicated by green colour.
- Sustainable management of forests is the conversion of non-forests into forests and sustainable harvesting (forests into non forests) in public plantation forest areas managed by Kenya Forest Service (KFS) and is indicated by blue colour. This aims at reducing backlogs by replanting and increasing productivity of the public plantation forests.

Assigning Activity Data to REDD+ Activities - Definitions

- Forestlands remaining forestland in the strata/ecozones of Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests which were mapped with a canopy remaining in the same canopy level in the two mapping years (2002 and 2018) do not imply any carbon stock changes and have not been assigned any colour. Similarly plantation forests that did not change in the two time instances (2002 and 2018) do not imply any carbon stock changes and have not been assigned any colour.
- Conversions among non-forests e.g. cropland converted to wetland do not imply any emissions and have not been assigned any colour

Land cover changes 2002-2018

			2018												
			Montane & Western Rain Forest			Costal and Mangroves Forest			Dryland Forest			Plantation	Cropland	Grassland	Wetland	Settlement & Otherland
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
2002	Montane & Western Rain Forest	Dense	772,025	46,912	16,427								167,916	111,437	457	1,039
		Moderate	60,757	59,277	12,190								30,410	53,521	389	87
		Open	23,898	17,630	21,139								13,581	77,873	36	131
	Costal and Mangrove Forest	Dense				84,317	32,686	739					3,747	46,315	712	301
		Moderate				80,975	85,893	3,609					14,242	155,399	1,256	984
		Open				6,195	12,707	367					3,056	15,696	72	126
	Dryland Forest	Dense							216,624	56,911	27,255		50,285	342,844	2,887	4,614
		Moderate							110,576	81,909	27,881		26,971	203,209	2,601	1,828
		Open							40,230	28,313	40,490		10,496	270,156	2,138	5,646
	Plantation											47,740	22,816	8,587	20	17
	Cropland		72,777	8,191	5,583	809	731	127	21,260	8,752	7,273	8,631				
	Grassland		119,848	67,872	50,280	93,653	82,323	12,861	432,319	219,841	202,697	8,652				
	Wetland		238	66	15	555	565	49	2,522	1,074	1,302	20				
	Settlement and Other land		550	143	497	201	284	11	2,921	1,992	9,180	13				

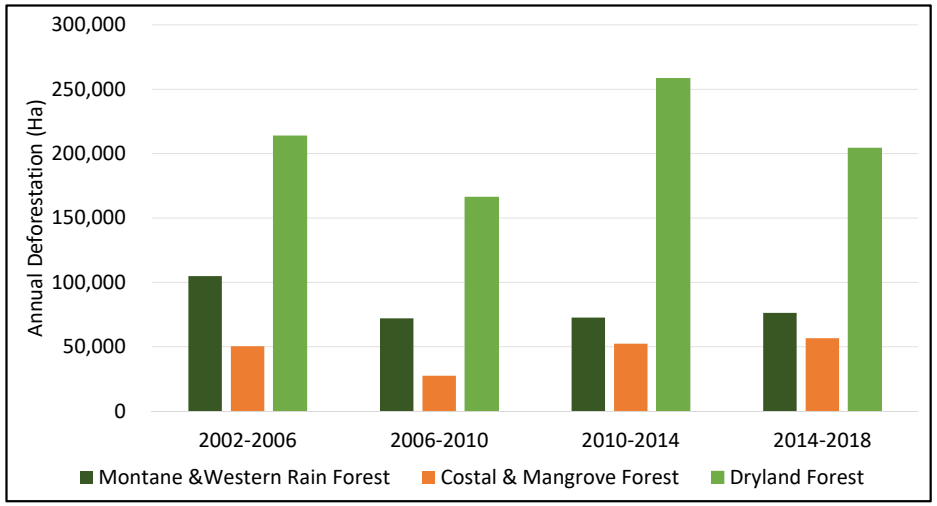
Area of Forestlands remaining Forestlands

Forest strata	Area (ha) of Forestland that remained forestland					Percentage of forestland (based on national land area) that remained forestland				
	2002-2006	2006-2010	2010-2014	2014-2018	Average	2002-2006	2006-2010	2010-2014	2014-2018	Average
Montane &Western Rain Forest	1,067,639	1,033,823	1,081,420	1,086,615	1,067,374	1.80	1.75	1.83	1.84	1.80
Costal & Mangrove Forest	347,841	375,728	365,710	320,549	352,457	0.59	0.63	0.62	0.54	0.60
Dryland Forest	698,714	774,168	820,364	744,965	759,553	1.18	1.31	1.39	1.26	1.28
Plantation	62,292	61,183	64,384	56,315	61,044	0.11	0.10	0.11	0.10	0.10
Total	**2,176,487**	**2,244,903**	**2,331,878**	**2,208,444**	**2,240,428**	**3.68**	**3.79**	**3.94**	**3.73**	**3.78**

Annual Transition Deforestation Vs Afforestation

Forest strata	Area (ha) of Deforestation					Area (ha) of Afforestation				
	2002-2006	2006-2010	2010-2014	2014-2018	Average	2002-2006	2006-2010	2010-2014	2014-2018	Average
Montane &Western Rain Forest	104,874	72,059	72,648	76,322	81,476	63,605	84,547	77,621	67,426	73,300
Costal & Mangrove Forest	50,388	27,463	52,359	56,664	46,719	34,435	49,855	45,374	44,777	43,610
Dryland Forest	213,787	166,164	258,443	204,279	210,668	185,027	269,992	185,429	199,089	209,884
Total	369,049	265,687	383,450	337,265	338,863	283,068	404,394	308,424	311,292	326,794

The Annual Deforestation Rates among strata



Annual Transition Forest Degradation vs Canopy improvement

Forest strata	Area (ha) of Forest Degradation					Area (ha) of Forest enhancement by Canopy improvement				
	2002-2006	2006-2010	2010-2014	2014-2018	Average	2002-2006	2006-2010	2010-2014	2014-2018	Average
Montane &Western Rain Forest	29,655	16,622	19,108	20,461	21,461	18,124	29,473	25,976	15,104	22,169
Costal & Mangrove Forest	9,168	7,634	5,874	22,830	11,377	29,287	12,714	15,138	6,032	15,793
Dryland Forest	18,689	21,016	24,572	43,316	26,898	43,220	29,955	29,353	24,878	31,852
Total	57,512	45,272	49,555	86,607	59,736	90,631	72,142	70,467	46,013	69,813

Annual Transition rates for Plantation forests

Forest strata	Area (ha) of Sustainable Management of forests				
	2002-2006	2006-2010	2010-2014	2014-2018	Average
Harvested area	4,222	3,039	3,155	6,298	4,178
Planted area	2,762	3,955	4,280	2,185	3,296
Net (Deficit/backlog)	-1,460	916	1,125	-4,113	-882

EMISSION FACTORS

Example of Pilot NFI data

		Tree	bamboo	Climber	Total	Tree	bamboo	Total	Total	Tree	bamboo	Total	Total	Total	Total		
Vegetatio	D/M/O	m3ha	bm3ha	cm3ha	cm3ha	above_bic	bbiomass_	AGB	AGB C sto	Below_bi	Below_bi	BGB	BGB C sto	Biomass	C stock to	county	district
Montane	Dense	263.89	1.61		265.49	208.38	0.98	217.24	102.10	77.10	0.36	80.38	37.78	297.62	139.88	Nyeri	Nyeri
Montane	Dense	1,513.97	-	-	1,513.97	1,146.39	-	1,146.39	538.80	424.16	-	424.16	199.36	1,570.56	738.16	Nyeri	Nyeri
Montane	Dense	105.90	-	-	105.90	87.87	-	87.87	41.30	32.51	-	32.51	15.28	120.38	56.58	Nyeri	Nyeri
Montane	Dense	195.91	-		195.91	160.50	-	163.67	76.92	59.39	-	60.56	28.46	224.22	105.38	Nyeri	Nyeri
Montane	Dense	246.38	-	-	246.38	200.15	-	200.15	94.07	74.05	-	74.05	34.81	274.20	128.88	Nyeri	Nyeri
Montane	Dense	361.74	-	-	361.74	288.13	-	288.13	135.42	106.61	-	106.61	50.11	394.74	185.53	Nyeri	Nyeri
Montane	Dense	646.28	-	-	646.28	511.25	-	511.25	240.29	189.16	-	189.16	88.91	700.41	329.19	Nyeri	Nyeri
Montane	Dense	532.79	-		532.79	427.02	-	429.13	201.69	158.00	-	158.78	74.63	587.91	276.32	Nyeri	Nyeri
Montane	Dense	72.25	-	-	72.25	60.93	-	60.93	28.63	22.54	-	22.54	10.59	83.47	39.23	Nyeri	Nyeri

Allometric equations were used to convert measured parameters to Biomass

Emission Calculations - Deforestation

- Deforestation which is conversion of a forest to a non-forest in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests .
  - Instantaneous Oxidation was assumed for all deforestation. Therefore the EF is the difference between the CO_2 value of the initial forest strata/canopy class and the CO_2 value of the non-forest
  - All forest conversions into Croplands, Wetlands and Settlements & Otherlands attain a CO_2 value of Zero after conversion. The EF is the difference between the CO_2 of the former forest and zero
  - All forest conversions into Grasslands attain a CO_2 value of 14.99 Tonnes/ha after conversion. The EF is the difference between the CO_2 of the former forest and 14.99 Tonnes/ha

NB: No data on HWP - Most of the activities that convert forests to non-forests may result to instantaneous oxidation)

Emission Calculations – Forest Degradation

- Forest Degradation is the conversion of a forest from a higher canopy class to a lower canopy class in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests
  - Instantaneous Oxidation was assumed for all degradation. Therefore the EF is the difference between the CO_2 value of the initial forest canopy class and the CO_2 value of the new forest canopy class within a strata

NB: Data on drivers of degradation is not reliable enough to estimate emissions as shown in a preliminary study to this work - Options For Estimating GHG Emissions/Sinks From Forest Degradation, Forest Fires And Forest Revegetation. A Report To Support Establishment Of Kenya's Forest Reference Level

Emissions from sustainable management of forests

- In Sustainable management of forest which is the conversion of non-forests into forestlands in areas designated as Plantation zones, EF were calculated as follows
  - A stock change method was applied and the EF calculated as the difference between the CO_2 value of the pervious non-forest to the CO_2 value of a plantation based on growth rate.
  - A Conversion of a cropland, Wetland and Settlements & Otherlands into a forestland changes carbon stocks from a zero CO_2 value to a CO_2 value to 87.56 Tonnes/ha
  - A conversion of a grassland to a forestland changes carbon stocks from a CO_2 value of 14.99 Tonnes/ha

Enhancement of Carbon Stocks due to afforestation

- Enhancement of Carbon stocks due to conversion of non-forests into forests in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests was calculated as follows
  - A growth factor was adopted for each strata to give the amount of CO_2 gained in a planted/young forest (in this case a forest that is less than 20 years) in the 4 year period.
  - In case the calculation of growth results to a stock which is more than the stock factor of the specific canopy class, a capping was done to retain the stock of the specific canopy class.
  - The EF for conversion of Croplands, Wetlands and Settlements & Otherlands into forestlands was the difference between zero and the CO_2 value after growth of 4 years
  - The EF for conversion of grasslands into Forestlands was the difference between a CO_2 value of 14.99 Tonnes/ha and the CO_2 value of the forest after 4 years of growth

Enhancement of carbon stocks due to canopy improvement

- Enhancement of Carbon stocks due to improvement of Canopy in forests from a lower canopy class to a higher canopy class in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests was calculated as follows
  - A growth factor was adopted for each strata to give the amount of CO_2 gained in an existing forest (in this case a forest that is more than 20 years) in the 4 year period
  - The EF was calculated as the difference between the previous CO_2 value (for year 2002) and the new CO_2 value after forest enhancement (year 2018). In case the calculation of growth results to a stock which is more than the stock factor of the specific canopy class, a capping was done to retain the stock of the specific canopy class.

CALCULATION OF CO2 EQUIVALENTS

Forest strata	Canopy Coverage	ABG	BGB	TOTAL		
		Biomass stock (Tonnes/ha)	Biomass stock (Tonnes/ha)	Biomass stock (Tonnes/ha)	Carbon Stock (Tonnes/ha)	CO_2 (Tonnes/ha)
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	Plantation	324.79	87.69	412.48	193.87	710.84
Cropland		0	0	0	0	0
Grassland					8.7	14.99
Wetland		0	0	0	0	0
Settlements & Otherlands		0	0	0	0	0

Choice of stock change emission factors – Tier 2 and tier 3

1. Stock was obtained from Pilot NFI and allometric equations as simple average of plot data for each strata – tier 3
2. Shoot Root based on IPCC guidelines per forest biome
3. Carbon fraction for AGB and BGB is from IPCC = 0.47
4. CO_2 Calculated from molecular formula of 44/12 (IPCC guideline)
5. The Cropland Carbon Factor obtained from IPCC default values for tier 1 reporting: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Chapter 5 (Cropland) Table 5.8: Default Biomass Stocks Present On Cropland , After Conversion From Forestland
6. The Grassland Carbon Factor obtained from IPCC default values for Tropical Dry Grasslands: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Chapter 6 (Grassland) Table 6.4: Default Biomass Stocks Present On Grassland , After Conversion From Other Land Use
7. Default factors from Wetland, Settlement & Otherlands from IPCC tier 1 reporting

Choice of Root /shoot Ratios

Forest strata	Root shoot ratio	Source in IPCC 2006 guidelines
Montane	0.37	Table 4.4. for Tropical rainforest
Dryland	0.28	Table 4.4. above-ground biomass >20 tonnes ha^{-1}
Coastal and Mangrove	0.2	Table 4.4. above-ground biomass <125 tonnes ha^{-1} for Tropical moist deciduous forest
Plantation	0.27	Table 4.4. for Tropical Mountain systems

Emission Factors for Calculating sequestration due to afforestation (based on IPCC for forests Less than 20yrs)

Forest strata	Biomass gain (Tonnes)			Carbon from Biomass	CO_2 sequestered (Tonnes/	
	IPCC table 4.9 equivalent ABG value	BGB	Total		One year	4 years
Montane	10	3.70	13.70	6.44	23.61	94.44
Dryland	2.4	0.67	3.07	1.44	5.29	21.16
Coastal	5	1.00	6.00	2.82	10.34	41.36
Plantation	10	2.70	12.70	5.97	21.89	87.56

Emission Factors for calculation Sequestration due to Canopy enhancement (Based on IPCC for forests more than 20 yrs)

Forest strata	Biomass gain (Tonnes)			Carbon from Biomass	CO_2 sequestered (Tonnes/	
	IPCC table 4.9 equivalent ABG value	BGB	Total		One year	4years
Montane	3.1	1.15	4.25	2.00	7.32	29.28
Dryland	1.8	0.50	2.30	1.08	3.97	15.88
Coastal	1.3	0.26	1.56	0.73	2.69	10.76
Plantation	10	2.70	12.70	5.97	21.89	87.56

ADOPTED Emission factors for various REDD+ activities

			End Year													
			Montane &Western Rain Forest			Coastal & Mangroves Forest			Dryland Forest			Plantation	Cropland	Grassland	Wetland	Settlement & Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
Start year	Montane &Western Rain Forest	Dense	0	440.00	534.72								577.95	562.96	577.95	577.95
		Moderate	-29.28	0	94.73								137.96	122.96	137.96	137.96
		Open	-29.28	-29.28	0								43.23	28.24	43.23	43.23
	Coastal & Mangroves Forest	Dense				0	86.61	146.04					195.69	180.69	195.69	195.69
		Moderate				-10.75	0	59.44					109.08	94.09	109.08	109.08
		Open				-10.75	-10.75	0					49.64	34.65	49.64	49.64
	Dryland Forest	Dense							0	17.44	62.13		93.60	78.60	93.60	93.60
		Moderate							-15.88	0	44.69		76.15	61.16	76.15	76.15
		Open							-15.88	-15.88	0		31.47	16.47	31.47	31.47
	Plantation											0	710.84	695.85	710.84	710.84
	Cropland		-94.44	-94.44	-43.23	-41.36	-41.36	-41.36	-21.18	-21.18	-21.18	-87.55				
	Grassland		-79.45	-79.45	-28.24	-26.37	-26.37	-26.37	-6.18	-6.18	-6.18	-72.55				
	Wetland		-94.44	-94.44	-43.23	-41.36	-41.36	-41.36	-21.18	-21.18	-21.18	-87.55				
	Settlement & Other land		-94.44	-94.44	-43.23	-41.36	-41.36	-41.36	-21.18	-21.18	-21.18	-87.55				

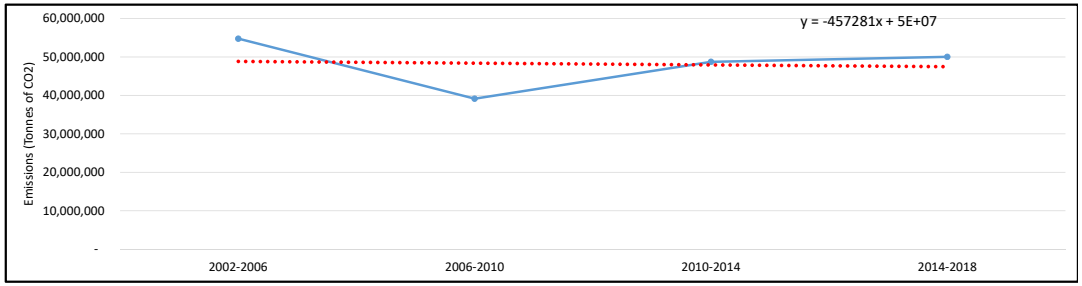
Results

Calculated emissions (CO_2 Tonnes) for 2002-2006

			2006												
			Montane &Western Rain Forest			Coastal & Mangroves Forest			Dryland Forest			Plantation	Cropland	Grassland	Wetland	Settlement & Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open	Dense				
2002	Montane &Western Rain Forest	Dense	0	33,402,790	14,952,439	0	0	0	0	0	0	0	63,970,436	71,655,345	144,916	256,958
		Moderate	-1,079,014	0	1,396,195	0	0	0	0	0	0	0	2,355,007	8,840,448	21,194	34,144
		Open	-734,972	-308,355	0	0	0	0	0	0	0	0	360,219	2,339,276	759	11,540
	Coastal & Mangroves Forest	Dense	0	0	0	0	957,251	465,807	0	0	0	0	480,910	6,577,554	95,791	121,980
		Moderate	0	0	0	-1,083,064	0	1,333,070	0	0	0	0	1,002,960	12,324,488	47,025	113,301
		Open	0	0	0	-129,630	-47,079	0	0	0	0	0	74,933	632,966	1,072	6,353
	Dryland Forest	Dense	0	0	0	0	0	0	0	560,352	1,329,447	0	3,606,220	23,672,823	180,967	230,717
		Moderate	0	0	0	0	0	0	-1,705,968	0	948,998	0	1,313,196	13,483,713	175,828	142,251
		Open	0	0	0	0	0	0	-683,703	-356,075	0	0	272,758	4,091,434	45,693	335,808
	Plantation			0	0	0	0	0	0	0	0	0	3,019,518	8,782,822	6,589	6,398
	Cropland		-3,500,587	-351,190	-114,753	-12,418	-24,117	-4,203	-343,535	-35,565	-115,221	-483,208		0	0	0
	Grassland		-8,255,667	-5,803,365	-936,099	-1,384,632	-1,090,906	-1,077,714	-2,121,493	-816,374	-1,414,338	-400,154		0	0	0
	Wetland		-19,387	-5,729	-1,004	-21,221	-23,838	-15,210	-47,195	-37,433	-38,861	-890		0	0	0
	Settlement & Other land		-43,653	-6,077	-2,081	-10,996	-6,455	-4,761	-36,156	-28,809	-84,815	-347		0	0	0

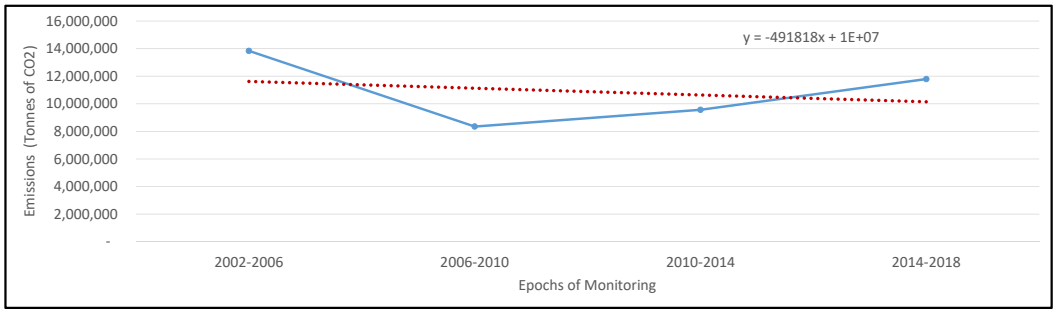
Historical annual emissions from Deforestation

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	average
Montane &Western Rain Forest	37,497,560	26,953,329	27,609,168	28,425,689	30,121,437
Costal & Mangrove Forest	5,369,833	2,838,459	6,066,685	8,997,887	5,818,216
Dryland Forest	11,887,852	9,351,299	15,060,281	12,609,716	12,227,287
Total	**54,755,246**	**39,143,087**	**48,736,134**	**50,033,292**	**48,166,940**



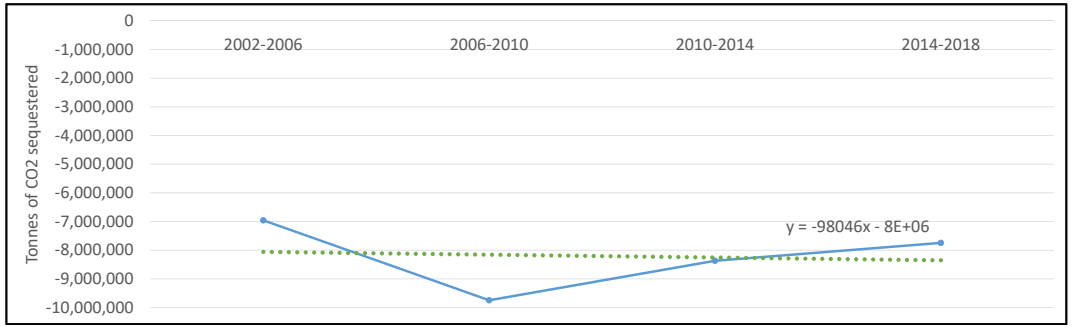
Historical annual emissions from Forest Degradation

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	average
Montane &Western Rain Forest	12,437,856	6,904,687	8,171,469	8,356,545	8,967,639
Costal & Mangrove Forest	689,032	658,228	507,708	1,983,662	959,657
Dryland Forest	709,699	787,686	884,652	1,452,579	958,654
Total	**13,836,587**	**8,350,601**	**9,563,829**	**11,792,785**	**10,885,950**



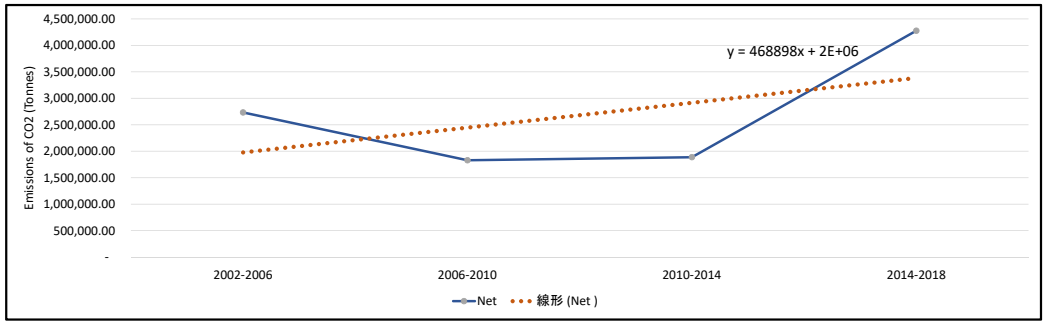
Historical annual sequestration from Afforestation

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	average
Montane &Western Rain Forest	-4,759,898	-6,407,901	-5,807,682	-5,113,591	-5,522,268
Costal & Mangrove Forest	-919,118	-1,344,367	-1,215,551	-1,204,155	-1,170,798
Dryland Forest	-1,279,949	-1,996,239	-1,345,866	-1,427,843	-1,512,474
Total	**-6,958,965**	**-9,748,507**	**-8,369,099**	**-7,745,589**	**-8,205,540**



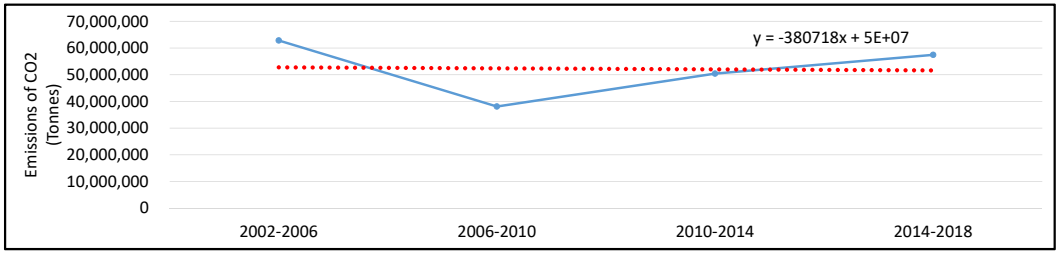
Historical annual emissions from Forest Plantations

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	Average
Harvesting	2,953,832	2,130,667	2,217,234	4,449,483	2,937,804
Replanting	-221,150	-301,355	-329,799	-173,181	-256,371
Net	**2,732,682**	**1,829,312**	**1,887,435**	**4,276,302**	**2,681,433**



Historical annual NET emissions – Kenya's FRL

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**



Uncertainty of the FRL

Uncertainty of AD

- Land cover change analysis done to generate change data – Activity data
- Accuracy assessment was done using collect earth on the random points generated in the change

	V_ID_No	2006 LCLU CODE	2006 Reference	2006 Remark	2010 LCLU CODE	2010 Reference	2010 Remark	2006 - 2010 LCLU Chang	Result	Actual	Check
13	10	OTH	GL		FM	OTH		OTFM	FALSE	GLOT	OK
14	11	OTH	OTH		FM	OTH		OTFM	FALSE	OTOT	OK
15	12	OTH	FO		FM	FM		OTFM	FALSE	FO2M	OK
16	13	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK
17	14	FD	OTH		FD	OTH		FD2D	FALSE	OTOT	OK
18	15	FD	GL		FD	GL		FD2D	FALSE	GLGL	OK
19	16	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK
20	17	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK
21	18	FD	GL		FD	GL		FD2D	FALSE	GLGL	OK
22	19	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK
23	20	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK

Using Olofsson, et al, (2013) formula shown below, the table show here was generated

$$S(\hat{p}_{\cdot j}) = \sqrt{\sum_{i=1}^{q} W_i^2 \frac{\frac{n_{ij}}{n_{i\cdot}}\left(1-\frac{n_{ij}}{n_{i\cdot}}\right)}{n_{i\cdot}-1}}.$$

Summary

Uncertainty (%) of Change map 2002-2006	
Overall Accuracy	41.05
Overall Uncertainty	4.94
Limits	41.05%±4.94%
Uncertainty (%) of Change map 2006-2010	
Overall Accuracy	51.9
Overall Uncertainty	4.03
Limits	51.9%±4.03%
Uncertainty (%) of Change map 2010-2014	
Overall Accuracy	35.75
Overall Uncertainty	2.17
Limits	35.75%±2.17%
Uncertainty (%) of Change map 2014-2018	
Overall Accuracy	30.01
Overall Uncertainty	2.15
Limits	30.01%±2.15%

$$\frac{4.94^2}{41.05^2}+\frac{4.03^2}{51.9^2}+\frac{2.17^2}{35.75^2}+\frac{2.15^2}{30.01^2}$$

Average uncertainty of Ad = 0.029 equivalent to 2.9%

Uncertainty of EF

Strata	Canopy Class	Mean (AGB)	Std Dev	No Samples	Uncertainty	Uncertainty of mean
Montane & Western Rain Forest	Dense	244.80	157.94	8	126.46	44.71
	Moderate	58.43	34.64	7	116.20	43.92
	Open	23.26	13.64	6	114.94	46.92
Coastal & Mangrove forest	Dense	94.63	45.03	18	93.27	21.98
	Moderate	60.45	31.90	12	103.43	29.86
	Open	35.47	34.03	16	188.04	47.01
Dryland Forest	Dense	42.43	32.11	8	148.33	52.44
	Moderate	34.52	15.01	8	85.22	30.13
	Open	14.26	6.89	7	94.70	35.79
Plantation	Plantation	324.79	249.38	36	150.49	25.08

This data does not conform to a minimum sampling size for Uncertainty analysis. A bootstrap simulation was done and Uncertainty calculated as 24.7%

Uncertainty of FRL

The Error propagation formula used

$$SD\ CO_2 = \sqrt{\overline{Total_{carbon}}^{2}_{1\to2}\left[\left(\frac{SD^2_{Emissions_{factor}}}{\overline{Emissions_{factor}}^{2}_{1\to2}}\right)+\left(\frac{SD^2_{Activity_{data}}}{\overline{Activity_{data}}^{2}_{1\to2}}\right)\right]}$$

Filling in numbers

$$Uncertainty\ of\ the\ FRL = \sqrt{52{,}204{,}059^2 * [(0.247^2 + (0.029^2)]}$$

Results

The Uncertainty of this Submission is ± 12,984,983. This implies that the FRL is 52,204,059 ± 12,984,983 t CO2/year:

External validation using the FLINT

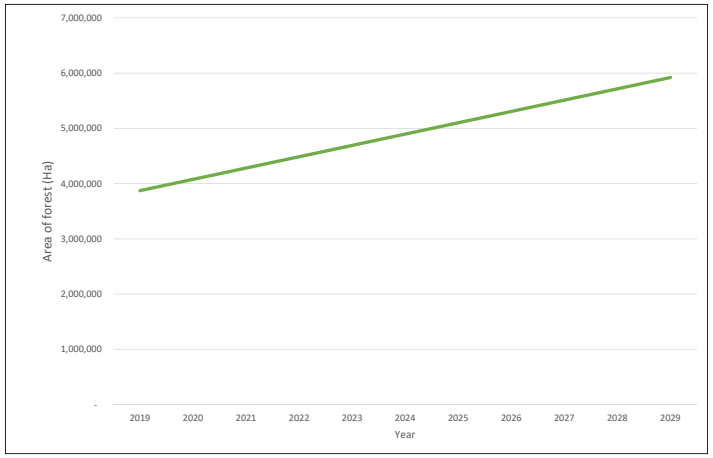
Description	Average CO2 tonnes	% change
FREL Assumptions with Kenyan Forest Strata, V2 (2002 & 2018) - 16yr Interval	**22,068,707**	54%
FREL Assumptions with Kenyan Forest Strata, V2 (2002, 2006, 2010, 2014 & 2018) - 4yr Interval	**47,460,285**	**0%**
FREL Assumptions with Kenyan Forest Strata, V2(2002, 2004, 2006, 2008, 2010, 2012, 2014 & 2018) - 2yr Interval	**70,393,449**	-48%
FREL Assumptions with Kenyan Forest Strata, V2 (all years 2002-2018) - 1yr Interval	**104,044,728**	-119%
Tier 2 Time Series with all Kenya Forest Strata, V2 (all years 1990-2018) - Full	**39,390,373**	17%

What is the future of Forest Cover in Kenya?

Increase with forest conservation?

- Implementation of forest Policies
- Conservation policies
- Climate change policies
- Land conservation policies
- More tree planting in farms
- More trees in dryland areas
- Devolved management systems

Illustration of Vision 2030 targets based on current forest maps

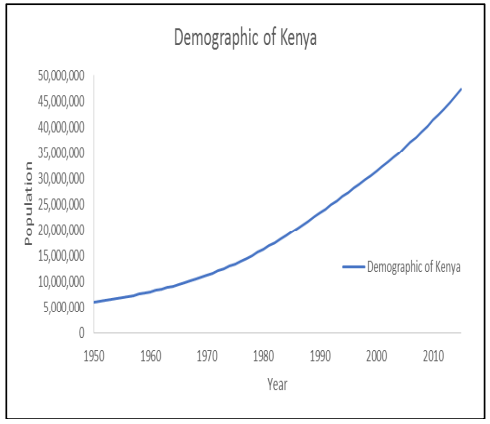


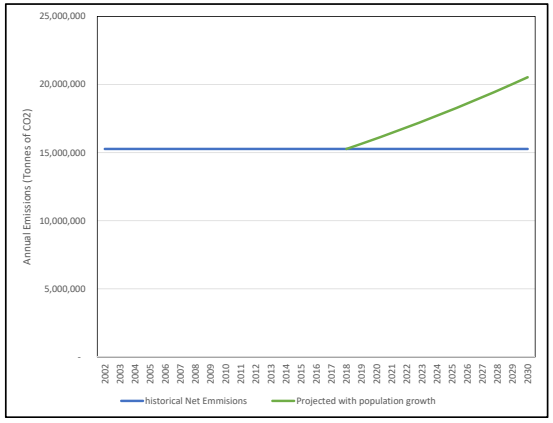
If we increase forest cover today by 204,727 ha without losing any forest to other non forest uses, we will attain the vision 2030 goal of 10% forest

Hindrances/Barriers to forest increase

- Increasing population and their associated developmental needs
- Agricultural expansion
- Urban expansion including infrastructure
- Improved access to formerly pristine forests
- Conflicts of natural resource use
- Weak Enforcement

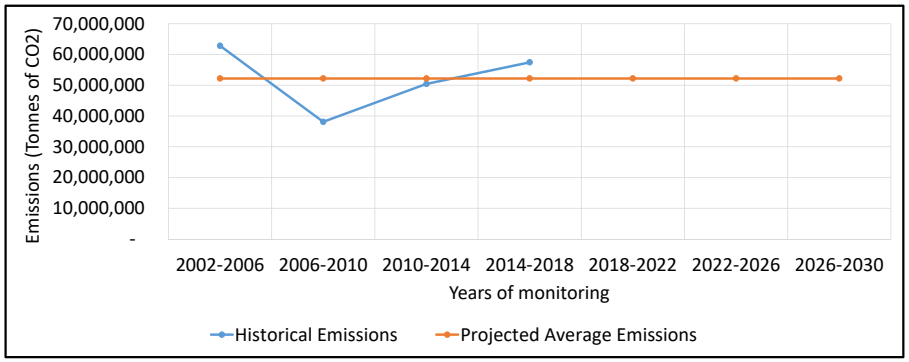
An illustration of Kenya's population growth and how it may increase forest related emissions





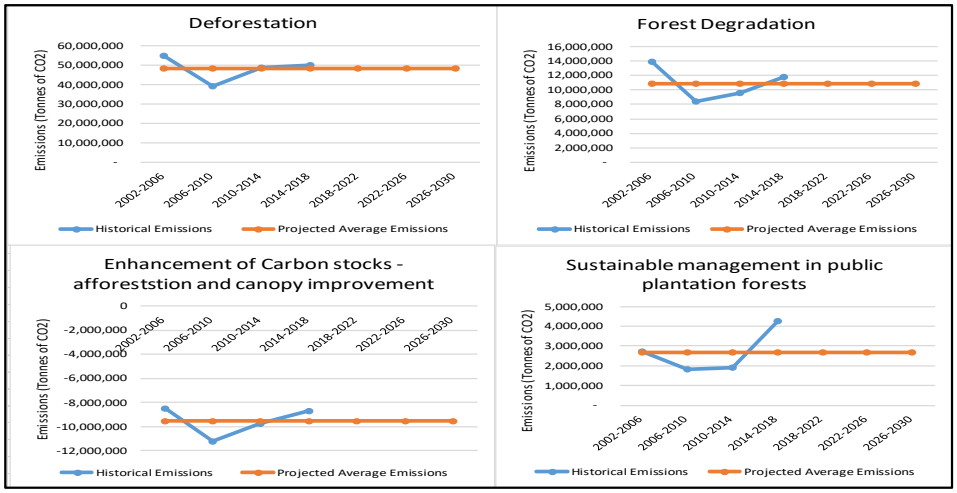
Projected Emissions
(based on historical average without adjustment)

Projection of Net emissions



2002-2006	2006-2010	2010-2014	2014-2018	2018-2022	2022-2026	2026-2030
54,755,246	39,143,087	48,736,134	50,033,292	47,713,595	47,256,314	46,799,033

Projections of emissions by REDD+ Activity



Projections of emissions by REDD+ Activity

REDD+ Activity	2002-2006	2006-2010	2010-2014	2014-2018	2018-2022	2022-2026	2026-2030
Deforestation	48,166,940	48,166,940	48,166,940	48,166,940	48,166,940	48,166,940	48,166,940
Degradation	10,885,950	10,885,950	10,885,950	10,885,950	10,885,950	10,885,950	10,885,950
Sustainable management of forest	2,681,433	2,681,433	2,681,433	2,681,433	2,681,433	2,681,433	2,681,433
Enhancement	-9,530,264	-9,530,264	-9,530,264	-9,530,264	-9,530,264	-9,530,264	-9,530,264
Total (Emission estimates (Net))	52,204,059	52,204,059	52,204,059	52,204,059	52,204,059	52,204,059	52,204,059

Summary

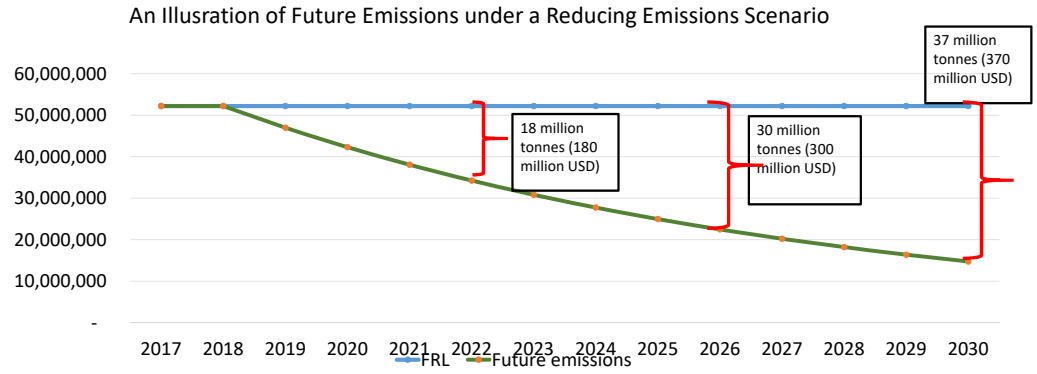
The Forest Reference Level is the

Benchmark against which the success of Reducing Emissions from our forests will be measured

Mizani ambayo itatumika kupima ufanisi wetu katika kupunguza gasi mkaa inayoingia angani tunapoharibu misitu yetu

NEXT steps….

- The efforts will be illustrated in a reduction Emissions from the current historical average of 52,204,059 Tonnes of CO2 per year to a lesser value and justify Kenya's qualification for Results based payments



FLINT DEMO

REPUBLIC OF KENYA

MONITORING REPORTING AND VERIFICATION

FRL Setting in Kenya (AD)

Date: 21st – 23rd January, 2020, Alps Hotel, Nakuru, Kenya

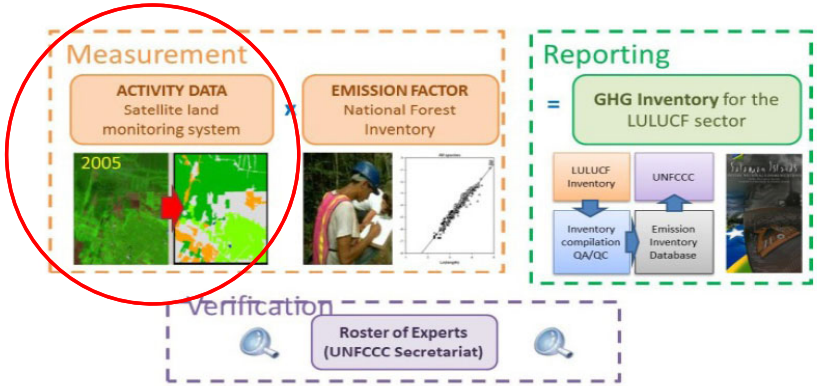
Presented by: ***Faith*** *Mutwiri*

.ntroduction

- Kenya has already submitted FRL and is in the process of Developing NFMS.
- Functions of NFMS is Monitoring and MRV (Measurements, Reporting and Verification**)**
- MRV is more specific to REDD+ and measures;

1. Activity Data (AD) – Satellite Data Remote Sensing
2. Forest Carbon Stock measured through National Forest Inventory (NFI)

Measurement Reporting and Verification



Forest definition

Organizations (Main Contributors)	A single minimum tree crown cover value	A single minimum land area value	A single minimum tree height value
KFS, DRSRS, KEFRI, REDD+, SLEEK, NGHG Inventory	15%	0.5 ha	2 m

–Kenya's definition is informed by global reporting standards and is informed by FAO limits within which countries define their forests;

▪*Forestlands are areas occupied by forests and characterised by tree crown cover ≥ 15%, an area ≥ 0.5 ha and a tree height ≥ 2m. It also includes areas managed for forestry where trees have not attained 2m height but with potential to do so, and areas that are temporarily destocked.(KFS, 2013)*

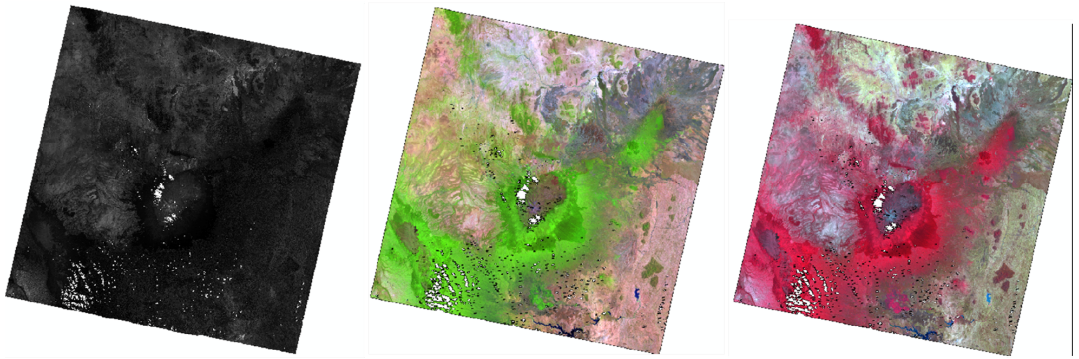
Activity Data generation

- Steps
  - Obtaining satellite images
  - Land Use Land Cover Mapping (including forest Cover mapping)
  - Forest cover changes (Loss or Gain)
  - Generating Activity Data

Satellite images

1. Despite variety of satellite images Kenya chose ***Landsat***

Landsat was selected because it is freely available, historical images are available, has medium resolution and it is already pre- processed.



Land Use Land Cover Classification

- **Land cover classes for LCC Mapping guided by the IPCC classification**

I. Forest
1. Dense Forest > 65% canopy cover
2. Moderate Forest 40 - 65% canopy cover
3. Open Forest 15 - 40% canopy cover

II. Cropland
1. Annual Cropland
2. Perennial cropland

III. Grassland
1. Open Grassland
2. Wooded grassland

IV. Wetland
1. Open Water
2. Vegetated wetland

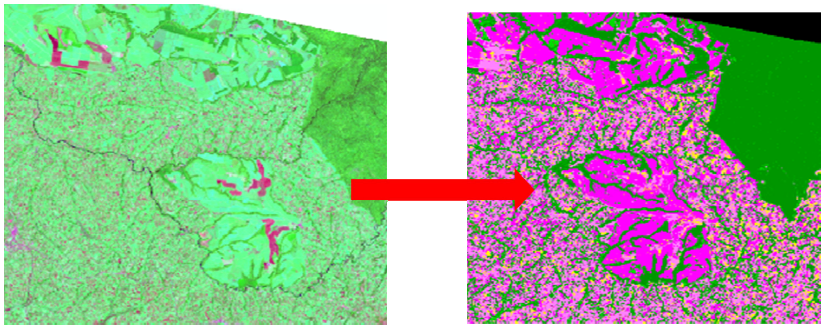
V. Settlement ***(use of Auxiliary Data)***

VI. Other lands

Mapping

2. Landuse Landcover Mapping

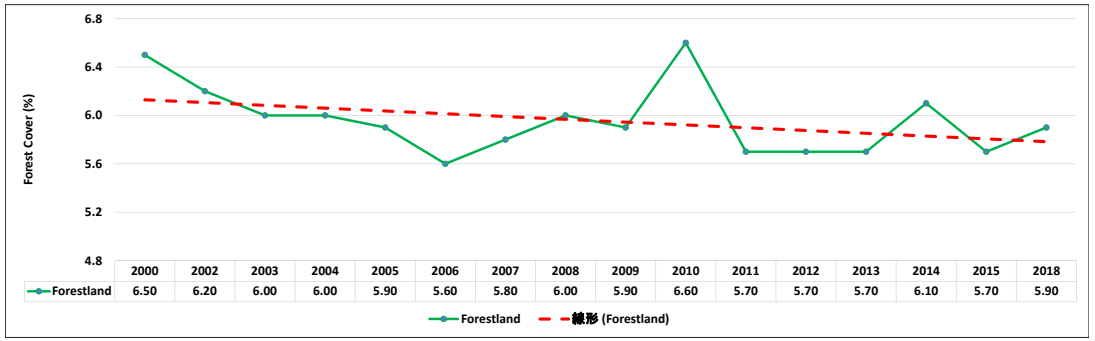
Landsat was selected because it is freely available, historical images are available, has medium resolution and it is already pre- processed.



Proportion Land Cover 2000 - 2018

Land Cover	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2018
Forestland	6.50	6.20	6.00	6.00	5.90	5.60	5.80	6.00	5.90	6.60	5.70	5.70	5.70	6.10	5.70	5.90
Grassland	72.70	71.70	72.90	71.20	72.10	70.20	69.60	70.10	70.90	69.40	70.10	70.70	68.70	69.60	71.00	69.70
Cropland	7.50	8.90	7.60	8.90	8.40	10.30	10.90	10.00	10.10	10.20	11.20	9.60	11.10	10.50	11.40	11.40
Wetland	2.00	2.10	2.10	2.10	2.10	2.10	2.20	2.00	2.10	2.10	2.10	2.20	2.00	2.10	2.10	2.00
Otherland	11.30	11.10	11.40	11.80	11.50	11.80	11.50	11.90	11.00	11.70	10.90	11.80	12.50	11.70	9.80	11.00
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

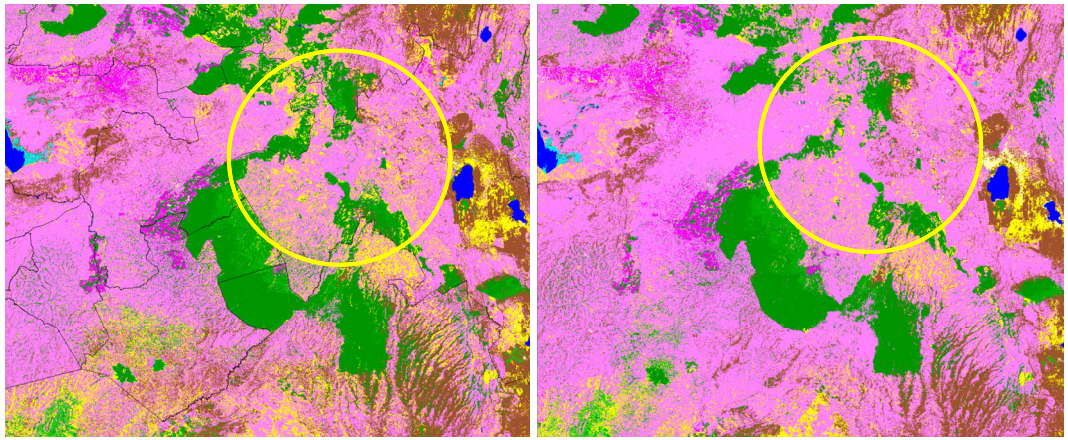
Trends in Forest cover 2000 - 2018



- Generally, forest cover has decreased over the years, 2006 being most depressed
- Most forest land loss is converted to cropland and other lands particularly settlements

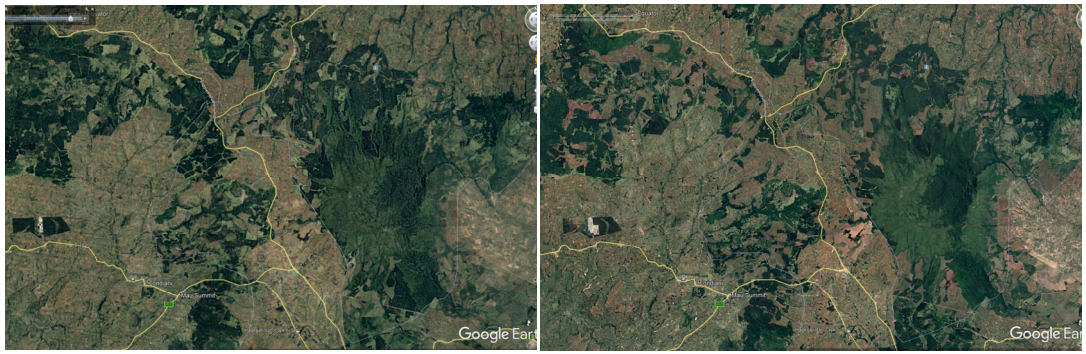
Changes

2. Forest Cover Changes
   - ***Has forest remained the same?? Have we lost forest – to what?***
   - ***Have we gained forest – from what?***



Changes

2010 2016



Activity Data

1. What are REDD+ Activities?

REDD+ Activities are generated from forest losses and gains in terms of Area. Kenya has taken 4 activities out of 5

Area in 20XX			Area in 20XX+(X)														
			Forest												Non Forest		
			Montane Forest/ Western Rain Forest/ Bamboo			Costal Forest and Mangroves			Dryland Forest			Plantation Forest			Grass land	Other Non-forest
			D	M	O	D	M	O	D	M	O	D	M	O		
Forest	Montane Forest/ Western Rain Forest/ Bamboo	D	n	dg	dg										df	df
		M	e	n	dg										df	df
		O	e	e	n										df	df
	Costal Forest and Mangroves	D				n	dg	dg							df	df
		M				e	n	dg							df	df
		O				e	e	n							df	df
	Dryland Forest	D							n	dg	dg				df	df
		M							e	n	dg				df	df
		O							e	e	n				df	df
	Plantation Forest	D										n	s	s	s	s
		M										s	n	s	s	s
		O										s	s	n	s	s
Non Forest	Grass land		e	e	e	e	e	e	e	e	e	s	s	s		
	Other non Forest		e	e	e	e	e	e	e	e	e	s	s	s		

df Deforestation (F→NF)
n No Change (F→F)
dg Forest Degradation (F→F(Degraded))
s Sustainable Management of Forest (F→F, F→NF, NF→F)
e Enhancement (F→F(Improved) ,NF→F)

Activity Data

Assigning Activity Data to REDD+ Activities

Table 4: Land use Change (No of ha) for each forest strata in the 2002-2006 epoch

2002 Forest strata			2006												
			Montane & Western Rain Forest			Costal & Mangrove Forest			Dryland Forest			Plantation forest	Cropland	Grassland	Wetland	Settlement & Otherland
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
Montane Forest & Western Rain Forest /		Dense	773,672	75,916	27,963								110,685	127,283	251	445
		Moderate	36,857	75,670	14,739								17,071	71,895	154	248
		Open	25,105	10,533	27,186								8,333	82,848	18	267
Costal & Mangrove Forests		Dense				114,602	11,053	3,190					2,458	36,401	490	623
		Moderate				100,716	77,558	22,429					9,195	130,990	431	1,039
		Open				12,055	4,378	1,861					1,509	18,267	22	128
Dryland Forest		Dense							303,805	32,124	21,397		38,529	301,166	1,933	2,465
		Moderate							107,414	84,438	21,236		17,244	220,465	2,309	1,868
		Open							43,048	22,420	62,831		8,668	248,377	1,452	10,672
Plantation forest												62,292	4,248	12,622	9	9
Cropland			37,067	3,719	2,655	300	583	102	16,223	1,679	5,441	5,520				
Grassland			103,916	73,048	33,153	52,514	41,374	40,874	343,099	132,028	228,734	5,515				
Wetland			205	61	23	513	576	368	2,229	1,768	1,835	10				
Settlement & Other land			462	64	48	266	156	115	1,707	1,360	4,005	4				

FOREST INVENTORY

BY

FREDRICK B. OJUANG

IS A QUANTITATIVE AND QUALITATIVE METHOD OF UNDERTAKING FOREST STOCK BY MEASURING AND ANALYZING INFORMATION

TYPES OF INVENTORY

1. Forest Inventory:

- Forest Management Inventory

- Forest Exploitation Inventory (Sales)

USED FOR:

1. PLANNING FOR FOREST MANAGEMENT UNITS

2. ANALYSIS AND (DETERMINATION) OF WOOD SUPPLY AND VOLUME YIELD

3. CALCULATION OF FOREST VOLUMES BY SAMPLING TEMPORARY OR PERMANENT PLOTS

4. IDENTIFICATION OF VOLUMES OF EACH TREE USING GIS AND REGISTER

METHODOLOGY:

1. Development of forest type maps using aerial photographs
2. 2. Carried out by counting (complete Enumeration) and comprehensive survey

2. NATIONAL FOREST INVENTORY

1. Carried out by statistical sampling method at country level
2. Actual measurement of fixed plots.
3. Offers advantage of chronological track
4. Carried at an interval of 5-10 years

OBJECTIVES

1. To collect forest data over the country using uniform definitions.
2. Accountability of global environmental issues
3. International reporting for the global conventions on climate change and Kyoto protocol,
4. Process for forest sustainable management and REDD+ etc.

TYPE OF PLOTS AND SHAPES

1.Temporary Sample Plot

2. Permanent Sample Plot

RECTANGULAR PLOT

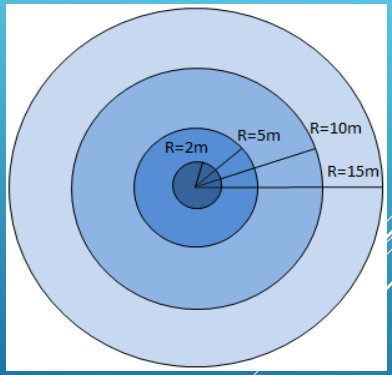
i. Has the advantage that the perimeter is a straight line.
ii. It is easy to see trees which are inside or outside the edge.
iii. Theoretically has more edge effect than circular plots.

CIRCULAR PLOT

i. Theoretically this is the shape that minimizes edge effect more
ii. You can easily determine whether a tree is inside or outside
iii. It is easy to change the plot radius and still maintain control, projection and area depending on the slope
iv. **But** You can easily allow trees which are on the edge to be counted inside if you do not check.

CIRCULAR PLOT (ICFRA)

Concentric Sample plot



- **Field Tree Measurements**

1. TREES, SHRUBS, REGENERATIONS, DEAD WOODS, STUMPS AND BAMBOOS
2. SPECIES, DIAMETER AT BREAST HEIGHT AND TREE HEIGHT

3. IN PERMANENT SAMPLE PLOTS - DIRECTION OF EVERY TALLY TREE, DISTANCE OF THE TALLY TREE FROM THE PLOT CENTRE, DIAMETER AT BREAST HEIGHT, BASE DIAMETER, TOTAL HEIGHT AND BOLE HEIGHT
4. THREE FIXED POINTS MARKED AND THEIR DIRECTIONS AND DISTANCES RECORDED FOR FUTURE REFERENCE AND IDENTIFICATION.

REGENERATION PLOTS.

1. The circular subplots with a radius of 1.5 m is placed along the East and west directions 10m away from the plot center
2. Each species is identified, enumerated and booked separately.

CONCENTRIC DESIGN

The sample plot has a 15m radius with four concentric sub-plots inside.

1. Large trees whose dbh ≥20cm are measured from a 15 m radius
2. Trees whose dbh ≥ 10cm are measured from a 10 meter radius subplot
3. Trees whose dbh ≥5cm are measured from 5meter radius
4. While trees whose dbh ≥2cm are measured from 2 meter radius
5. Seedlings of h ≥ 1.5m are enumerated per species within 2m concentric subplots.
6. Bamboo measurements are carried out within a 10 m radius
7. while lianas were measured from the 5m radius subplots. (ICFRA Field Manual, 2013)

THIS DESIGN AIMS AT INCREASING THE ACCURACY OF THE MEASUREMENTS AND SAMPLING INTENSITY OF LARGE TREES AND SIMULTANEOUSLY SAVING TIME.

1. THE DESIGN ENSURES THAT SMALL TREES ARE MEASURED IN SMALL PLOT AREA AND LARGE TREES IN LARGE PLOT AREA.

NB. TROPICAL AND SUBTROPICAL NATURAL FORESTS ARE CHARACTERIZED BY NEGATIVE EXPONENTIAL DIAMETER DISTRIBUTION WHEREBY MORE SMALL SIZE TREES AND THE NUMBER OF TREES DECREASES WITH INCREASING TREE SIZE.

END

Forest Inventory Tools & Equipment

BY

Fredrick B. Ojuang

DIAMETER MEASUREMENTS

1. Diameter tape
2. Caliper

i. The point of measurement is taken at 1.3m (DBH) consistently

ii. Place caliper at the right angle to the longitudinal axis of the tree

iii. Apply the correct pressure at the moment of measurement

iv. The bar of the caliper is pressed against the stem

v. For elliptical cross section of a stem, two caliper readings at right angles are taken and the average recorded.

Height measurement

1. Suunto

i. Hypsometer

ii. Clinometer

2. Vertex

3. Lacer Ace

4. Graduated pole (Extendable)

Graduated pole (Extendable)

1. Applicable where there are no Hypsometers
2. Very useful in measuring small trees in experimental plots
3. Useful in dry wood lands where trees are relatively short

Errors in Height Measurements

1. Incorrect identification of top and bottom of the tree
2. Incorrect estimation of horizontal distance
3. Mismatch of hypsometer scale and actual distance used- shorter distances than that of the scale will result in height over estimates and vice – versa.
4. A leaning tree towards the observer will cause an over estimates and vice- versa.

Dead wood Measurements

1. These are tree parts that are lying on the ground, usually the crew identifies the wood parts lying inside the plot.
2. The two diameters are measured and the length of the log
3. The species is identified

Other Equipment for Height Measurement

1. Vertex
2. Lacer Ace

Booking Materials

1. Tablets
2. Phones
3. PDAs
4. Tough pads – ragged tablets

END

Other Inventory Equipment

1. GPS
2. Silver compass
3. Suunto compass
4. Densiometer

Working with Survey 123

22nd Jan. 2020

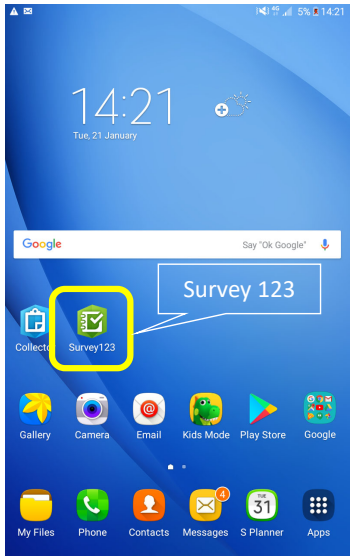
Kenya Forest Service

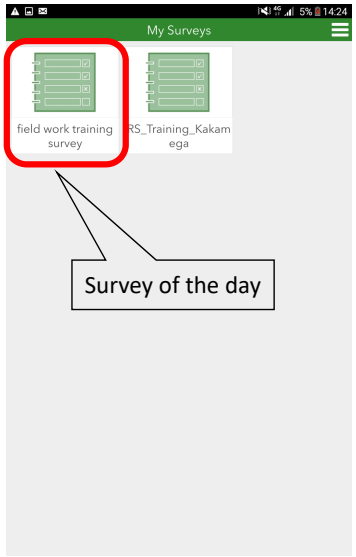
CADEP

Colleting information

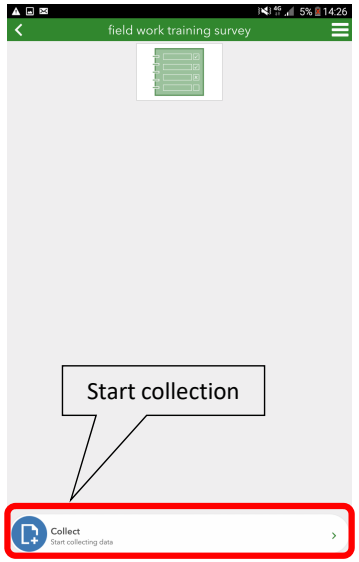
- Plot information
  - Group ID
  - Survey date
  - Coordination of Central cluster
  - County name
  - Forest strata
  - Canopy Cover (Center, North, South, East, West)
- Trees in plot zone
  - Radius (Target trees are depends on distance and their DBH)
  - Tree no. / Stem no.
  - DBH
  - Height (Every 3-5 trees)

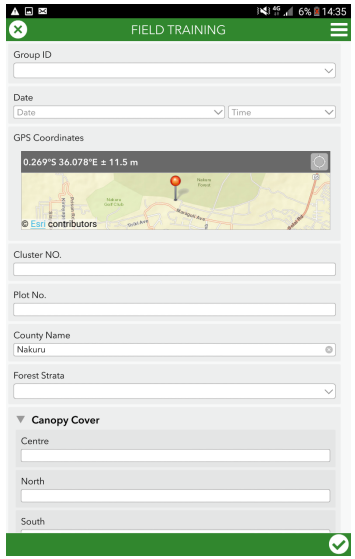
Start Survey 123 and select survey



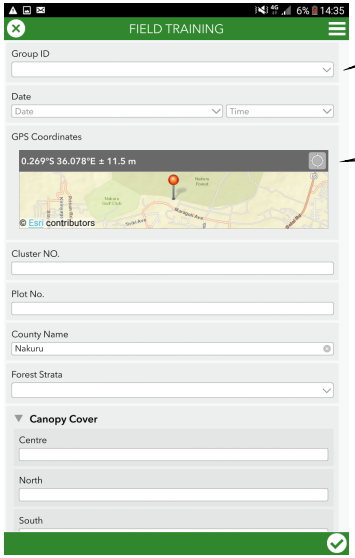


Start your survey





Plot information (input once)



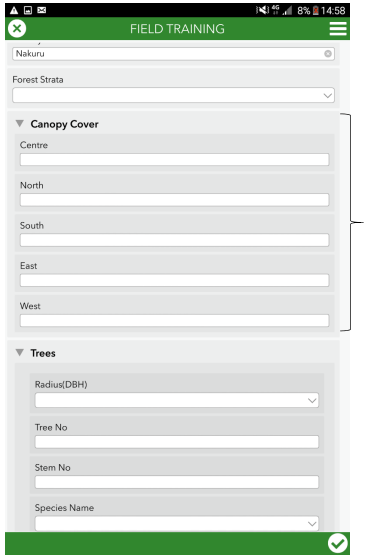
Select your group

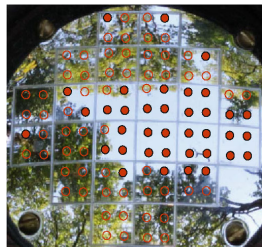
Get coordination in the center (tap this mark)

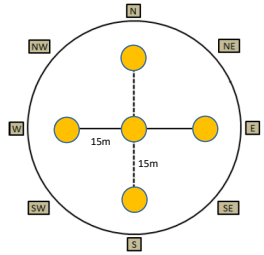
Getting signal

Not accessing to GNSS (Position anchored)

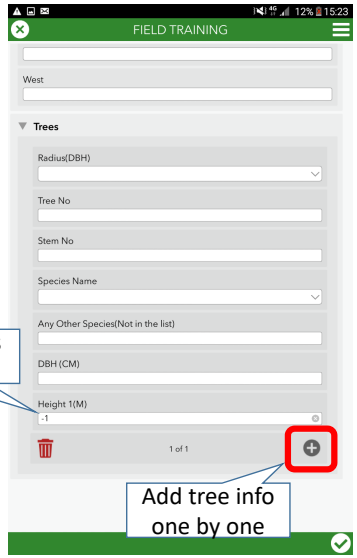
Plot information -Canopy Cover-





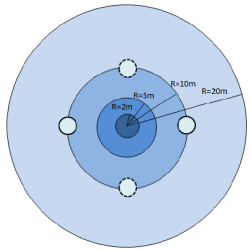


Tree information (all target trees)



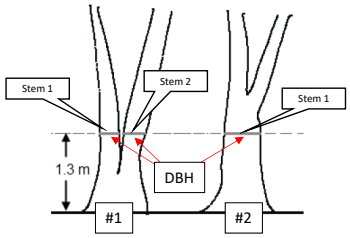
Every 3-5 trees (not all)

Add tree info one by one



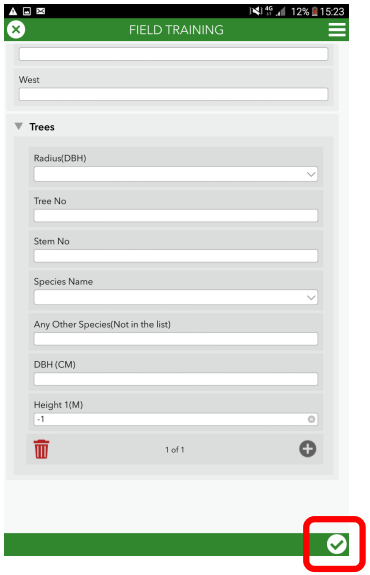
Target Tree

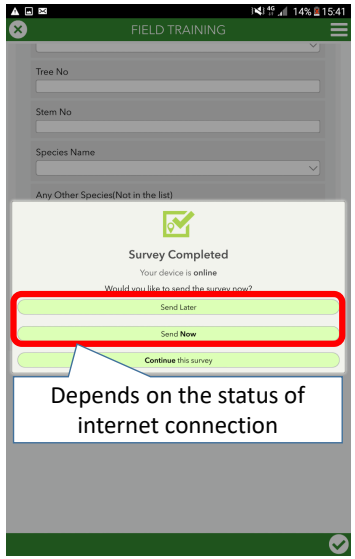
Radius ≤ 20 m
Trees dbh ≥ 20
Radius ≤ 10 m
Trees dbh ≥ 10 cm
Radius ≤ 5 m
Trees dbh ≥ 5 cm
Radius ≤ 2 m
Trees dbh ≥ 2 cm



Tree No., Stem and DBH

Upload the data (end of survey)





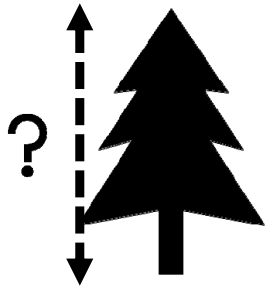
Depends on the status of internet connection

How to use the devices (Manual of Vertex IV)

CADEP-SFM
Yoshihiko SATO

Contents

- What is Vertex IV
- How to use Vertex
  1. Start/End the Transponder
  2. To measure Horizontal Distance
  3. To measure tree Height



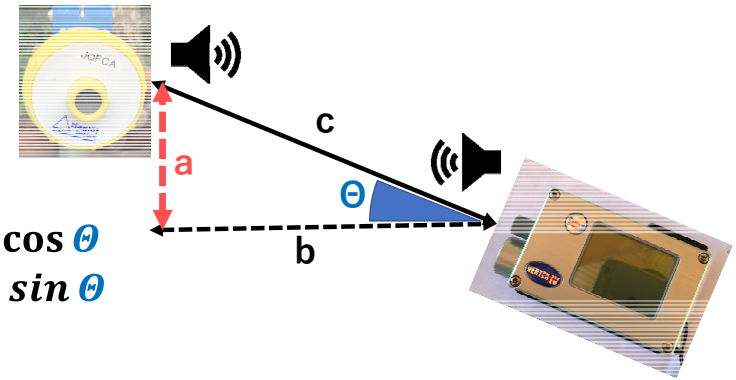
What is Vertex IV

- The Vertex IV is primarily designed to measure the height of standing objects, and most often trees.
- The instrument can also be used to measure distance, horizontal distance, angle and inclination.
- The Vertex instrument has with its ultrasonic measuring technique

Left : Vertex IV
Right : Transponder T3

What is Vertex IV

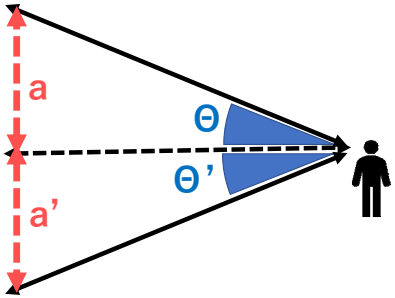
Ultrasonic waves :Distance measurement (c)
Decline (of Vertex IV) :Degree measurement (Θ)



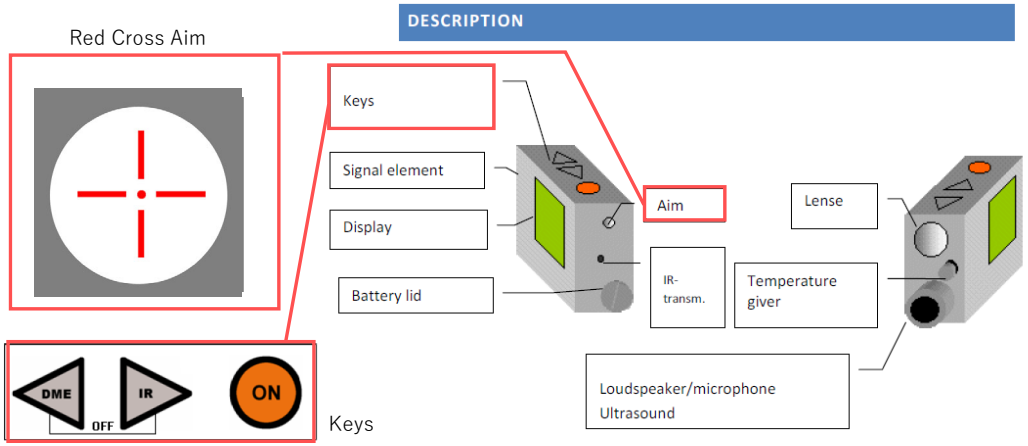
$$b = c \times \cos\theta$$
$$a = b \times \sin\theta$$

What is Vertex IV

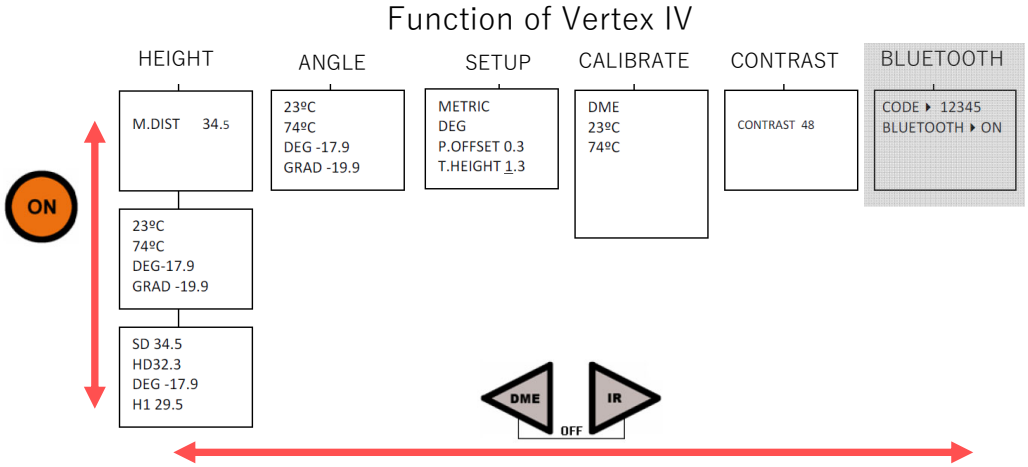
Urtrasonic waves (from Tranponder) :Distance measurement (c)
Decline (of Vertex IV) :Degree measurement (Θ)



What is Vertex IV

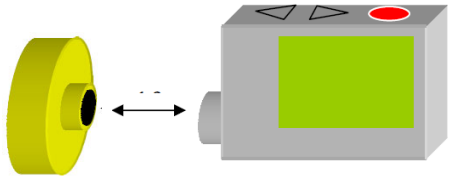


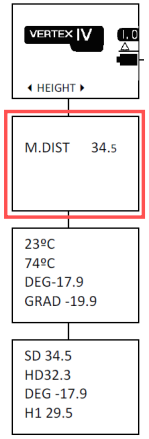
What is Vertex IV



To Use Vertex

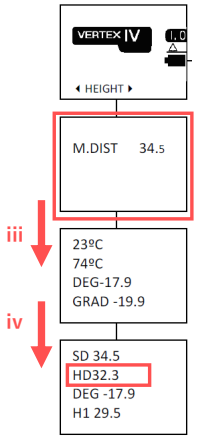
1. Start/End the Transponder
   i. Turn on Vertex
   ii. Set Vertex at "M.DIST" in HEIGHT
   iii. Turn on Transponder (trigger "ON" key until 2 signals beep)
   iv. Turn off Transponder (trigger "ON" key until 4 signals beep)





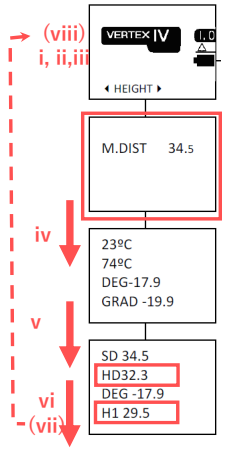
How to use Vertex

2. To measure Horizontal Distance (HD)
   i. Set Transponrder at 1.3m height
   ii. Set Vertex at “M.DIST” in “HEIGHT”
   iii. trigger “ON” key to aim at Transponder for few seconds until 3 signals beep of Transponder
   iv. trigger “ON” key to aim at Transponder until red cross goes out



How to use Vertex

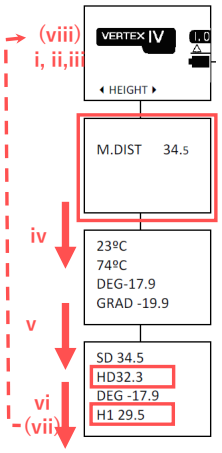
3. To measure Trees Height
   i. Walk To see the top of tree for a suitable distance from the object – for optimal result accuracy, a distance equal to the approximate height.
   ii. To set Transponrder at 1.3m height
   iii. Set Vertex at “M.DIST” in “HEIGHT”
   iv. trigger “ON” key to aim at Transponder for few seconds until 3 signals beep of Transponder



How to use Vertex

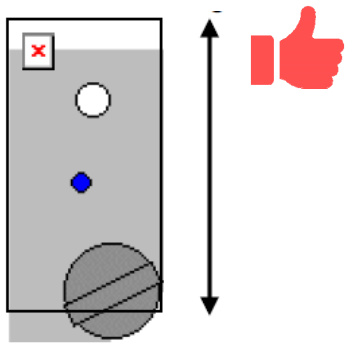
3. To measure Trees Height
   v. trigger “ON” key to aim at Transponder until red cross goes out for getting “HD”
   vi. trigger “ON” key to aim at the top of tree until red cross goes out for getting “H”
   vii. Repeat iv. for 2/3 times for accuracy, “H2”, “H3”,,,,
   viii. Turn off Vertex (Press “DME”key and “IR”key)

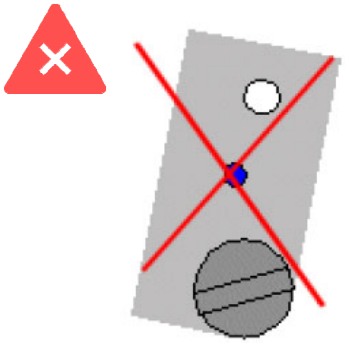
Move to next tree



Attention!!!

When measuring heights, it is important to hold the instrument as straight as possible



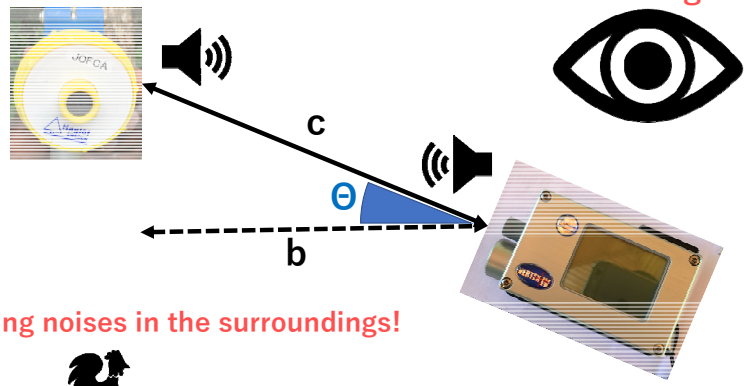


Attention!!!

Keep the straight position!

Attention!!!

Be sure to see the target!



Disturbing noises in the surroundings!

TECHNICAL SPECIFICATION

Distance with directed T3 transponder

:30 m or better in good conditions.

SIGN	Means
SD	Slope Distance
HD	Horizontal Distance
DEG	Degrees
GRAD	Gradients
P.OFFSET	Pivot Offset
T.HEIGHT	Transponder Height
M.DIST	Manual Distance
DME	Distance Measuring
BAF	Basal Area Factor
IR	Infrared light

Reference : Vertex IV and Transponder T3 manual January 2007, v.1.0

BIOMASS ESTIMATION

BY

Fredrick B. Ojuang

There are two approaches for estimating biomass

1. Direct Method

2. Indirect Method

Direct Method (Destructive Method)

This involve harvesting of samples and sometimes the whole plants.

1. They achieve high level of accuracy
2. They are also costly in terms of human labour and Finances

Destructive Methods

1. Take various measurements(DBH, Height of individual trees, Crown diameter)
2. Cut down the tree and proceed with its dissection by categories of diameters
3. Separate the various components(trunks, branches , twigs and leaves)
4. Collect data on dimensions(lengths, diameters etc.)
5. Weigh the green components (before drying)
6. Take green samples (Discs on stem and branch wood, portions of the leaves)
7. Weigh the green samples
8. Dry the samples in an oven to a constant weight

For trunks and large branches

9. Weigh the wet mass in the field after cutting the stem, taking into account the size
10. Take and weigh the samples in-situ
11. Weigh the samples after drying

Calculate Total Dry Weight (Biomass) of Sample Tree

$$TDW = TFW \times \frac{SDW}{SFW}$$

TDW: Total Dry Weight of each component
TFW: Total fresh weight of each component
SDW: Sub- sample dry weight of each component
SFW: Sub-sample fresh weight of each component

Dry Weight = Biomass

Calculation of Total Dry Weight (Biomass) Of Sample Tree (*in red*)

	Stem	Branches Large + small	Leaves	Roots Large + small	Total
Total fresh weight of sample by parts (kg)	7650.5	3241.9	140.7	692.0	11725.0
Fresh weight of sub-sample (g)	1989.8	1343.5	483.0	1677.3	
Dry weight of sub-sample (g)	1301.2	862.3	246.5	1118.4	
Dry weight /Fresh weight of sub-sample	0.654	0.642	0.510	0.667	
Total dry weight by tree parts (kg/tree)	5002.9	2080.7	71.8	461.4	7616.9

Development of Allometric Equations

Biomass Expansion Factor(BEF) – Expand merchantable Volume to total volume to account for non- merchantable components of the tree, stand and forest

Biomass Conversion Expansion Factor(BCEF)- Convert directly merchantable volume to total biomass (Dry weight) to account for non-merchantable components of the tree, stand and forest.

Develop Allometric Equation, BEF & BCEF

Allometric Equation $y = a\,X^{b}$

y: Biomass

a: Parameter (e.g. DBH, DBH^2, D^2H etc)

a, b: Coefficient

Develop Allometric Equation, BEF and BCEF

Biomass Expansion Factor:

A factor that converts the stem biomass into the biomass of the whole tree, including branches, leaves etc…

$$BEF = \frac{TDWa}{TDWs}$$

BEF: Biomass Expansion Factor

TDWa: Total Dry Weight of AGB

TDWs: Total Dry Weight of Stem

Calculation of Carbon Stock with BEF

$$C = (V \times WD \times BEF) \times CF$$

C: Carbon (Mg- C)

V: Volume (M^3)

WD: Wood Density(Mg/M^3)

BEF: Biomass Expansion Factor

CF: Carbon Factor

Develop Allometric Equation of BCEF

Biomass Conversion and Expansion Factor:

A factor that converts directly the trunk volume into the biomass of the whole tree

$$BCEF = \frac{AGB}{V}$$

$$= \frac{V \times WD \times BEF}{V}$$

$$= WD \times BEF$$

BCEF: Biomass Conversion and Expansion Factor

AGB: Above Ground Biomass V: Volume

WD: Wood Density BEF: Biomass Expansion Factor

Calculation of Carbon Stock with BCEF

$$C = (V \times BCEF) \times CF$$

C: Carbon (Mg-C)

V: Volume (M^3)

BCEF: Biomass Conversion and Expansion Factor

CF: Carbon factor

Estimation of Emission

Direct Method

Result From NFI (DBH, Height..)	X	Allometric Equation	X	FC 0.47	=	Carbon Stock

Indirect Method (Non Destructive)

1. They involve the use of biomass prediction equations from pre-established allometric equations.
2. The biomass is estimated from visual estimates and measurements of physical parameters without breaching the physical integrity of the plant.
3. The method are cost effective but less precise

Indirect Method

Stem Volume	X	Coefficients BCEF	X	FC 0.47	=	Carbon Stock

Kenya has not yet developed Country Allometric Equation or BEF and BCEF

END

CONSIDERATION OF PARTICIPATORY COMMUNITY MONITORING IN KENYA

3RD MRV TRAINING

CADEP-SFM COMPONENT3

CONTENTS

1. BACKGROUND

National Forest Monitoring System (Decision 4/CP.15)

1. Requests developing country Parties, on the basis of work conducted on the methodological issues set out in decision 2/CP.13, paragraphs 7 and 11, to take the following guidance into account for activities relating to decision 2/CP.13, and without prejudging any further relevant decisions of the Conference of the Parties, in particular those relating to measurement and reporting

(d) To establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems and, if appropriate, sub-national systems as part of national monitoring systems that:

(i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

(ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;

(iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties

1. BACKGROUND

National Forest Monitoring System (Decision 4/CP.15)

3. Encourages , as appropriate, the development of guidance for effective engagement of indigenous peoples and local communities in monitoring and reporting;

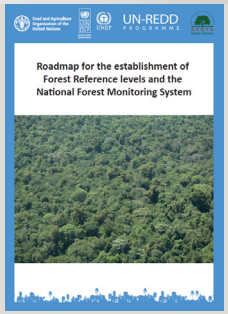
1. BACKGROUND

1. Necessity of forest monitoring
   a. For incentive in REDD+
   b. Management of forest resources
   c. Effective use of forest resources
2. Difficulties of forest monitoring
   a. Monitoring of forest ecosystem with diversity
   b. Capacity of personnel, equipment, and economic under the national scale of implementation
   c. To Ensure the implementation with continuity, transparency and consistency

1. BACKGROUND

Roadmap (2017) :Participatory Community Monitoring, P40

- Such communities described as individuals or groups with a stake, interest or right in the forest may include private companies, civil society organizations, indigenous people, forest dwelling communities, forest adjacent communities and small holder farmers.
- The use of such groups may potentially reduce some costs and enable more frequent measurements and collection of ancillary data and information since the communities live with or adjacent to the forest resource. Their participation is also potential incentive or motivation to enhance their positive participation in REDDD+ implementation.



2. WHAT IS CBFBM

Consideration of Community Based Forest Biomass Monitoring (CBFBM)

- What is CBFBM
- Case study of Community Carbon Accounting (CCA) Action Research Project by IGES*
  - Objective of the project
  - The manual
  - Summary of the policy brief

*IGES: Institute for Global Environmental Strategies, Japan

2. WHAT IS CBFBM

- Community Based Forest Biomass Monitoring (CBFBM) is the monitoring of forest biomass by communities.
- Recognizing the need for full and effective engagement of indigenous peoples and local communities in, and the potential contribution of their knowledge to, monitoring and reporting of activities relating to decision 1/CP.13, paragraph 1 (d) (iii), (Decision 4/CP.15)

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

4.1 Objective of the project

- The objective of project is to develop and verify various approaches to involve local communities in estimating forest stock changes in the five countries (Papua New Guinea (PNG), Cambodia, Indonesia, Lao PDR and Viet Nam).
- The project published POLICY BRIEF OF COMMUNITY BASED FOREST BIOMASS MONITORING FOR REDD+(2012) and COMMUNITY BASED FOREST BIOMASS MONITORING TRAINING OF TRAINERS MANUAL(2014) .

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

4.2 The manual

- The manual is divided into four key learning blocks that integrate the key elements and levels of the CBFBM process.

LEARNING BLOCK 1: Fundamentals of Community Based Forest Biomass Monitoring (CBFBM)
LEARNING BLOCK 2: Feasibility Assessment and stakeholder engagement for CBFBM
LEARNING BLOCK 3: Technical tool box
LEARNING BLOCK 4: an appropriate CBFBM community training

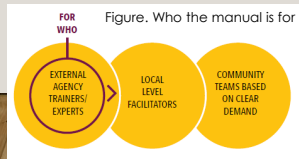


Figure. Who the manual is for

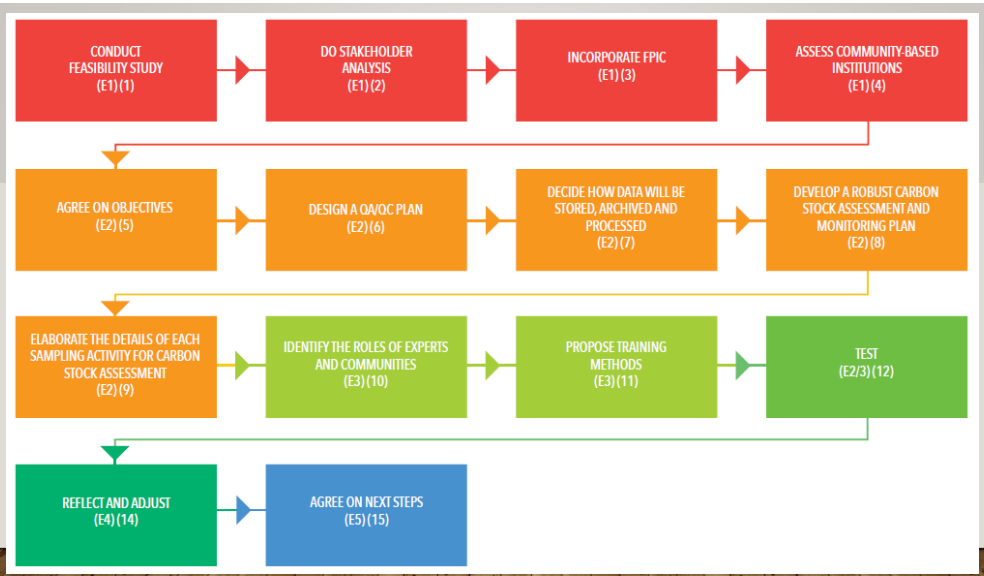


Figure. Key elements and steps of the CBFBM development process

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

4.3 Summary of the policy brief

- Participation in local community forest monitoring is an effective tool, allowing the community not only to take responsibility for REDD + but also to receive payments for activities.
- The community-participation carbon measurement project shows that the appropriate training support program will enable the community to carry out forest measurement necessary for accurately and accurately estimating changes in forest carbon stocks.
- REDD + implementing countries should consider incorporating community-based forest monitoring into national forest monitoring systems and safeguard information systems.
- By participating in a community that is close to forests, some monitoring items can be measured more efficiently than external experts, and the transparency of monitoring is improved.

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

4.3 Summary of the policy brief

Table. Estimated carbon stocks derived from community measurements and published estimates in literature

Area of project	Forest type and condition	Estimates from community measurements	Estimates described in literature for similar types of forests
Madang in Papua New Guinea	Mainly natural raw wet tropical Lowland forest	129.5 ± **75.8** tC / ha	106.3 ± **22.7** tC / ha – State and forest types are the same (Fox et al. 2010)
Mondulkiri Province in Cambodia	Deciduous forest	Rectangular plot – 75.5 ± **19.6** Circular plot – 72.2 ± **23** tC / ha	73.8 ± **8.6** (std.error) – Same forest parcel (Vathana 2010)
Special Region of Yogyakarta and Central	1. Afforested land in dry land 2. Resident's garden	1. 32.1 ± **22.5** tC / ha 2. 34.2 ± **20.6** tC / ha	1. No data available 2. 35.3 ± **21.2** tC / ha – Lamburia

Note: All figures show mean ± standard deviation unless otherwise stated

4. HOW ABOUT KENYA (DISCUSSION)

- The necessity of Participatory Community Monitoring (PCM) in Kenya
- Potential for community participation of monitoring
- How to introduce and conduct PCM
  - Training
  - Equipment
  - …
- How to adjust and improve the methodology of CBFBM in Kenya

4. HOW ABOUT KENYA (DISCUSSION)

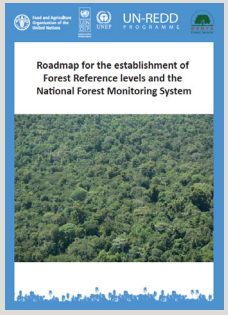
Roadmap (2017) : Capacity Building for NFMS/RL for REDD+ in Kenya, P13

b. Participatory Community Monitoring

- The data collection for REDD+ will be relatively straightforward, focusing on easily measured properties of the forest such as species name, DBH and density (number of trees per sampling plot). Local communities need to be trained on measurement protocols, data recording and management and analysis (review) of results. Initial establishment of the sampling plots needs to be supported by professional foresters or a certified implementing partner.
- There are some activities under REDD+ that do not directly relate to measurement of trees, but which would require the involvement of communities, such as patrolling for encroachment, fires, illegal grazing and illegal logging; assessment of biodiversity and other ecosystem properties.

Challenges to Participatory Community Monitoring

- There is a need to formulate a strategy for CFAs to be able to effectively fulfil their potential to contribute to the NFMS and to participate in REDD+ more broadly.



THANK YOU FOR YOUR ATTENTION

Reference:

- POLICY BRIEF OF COMMUNITY BASED FOREST BIOMASS MONITORING FOR REDD+(2012)
- COMMUNITY BASED FOREST BIOMASS MONITORING TRAINING OF TRAINERS MANUAL(2014)
- FAO 2017: Roadmap for the establishment of Forest Reference levels and the National Forest Monitoring System

GROUP WORK

3RD REDD+ TRAINING ON MEASUREMENT, REPORTING, AND VERIFICATION (MRV)

CADEP-SFM, 23TH JANUARY 2020, ALPS HOTEL IN NAKURU

METHOD OF GROUP WORK

Theme	Analysis of land use / land cover change (2002-2006, 2006-2010, 2010-2014, 2014-2018) by each county for Development of REDD+ Activities
Materials	• The LU/LC (Land Use / Land Cover) change map of Kenya • Internet for Information collection
Group	4 Groups × 5 persons / Groups
Roles	Chairman, Secretary (PC)/Presenter
Time Table	• 10:30 – 10:40 Introduction • 10:40 – 11:40 Group Discussion • 11:40 – 12:30 Presentation(10minutes) ×4 Groups

POINTS TO BE KEPT IN MIND FOR DISCUSSION IN GROUP WORK

Free participation

Respect each opinion

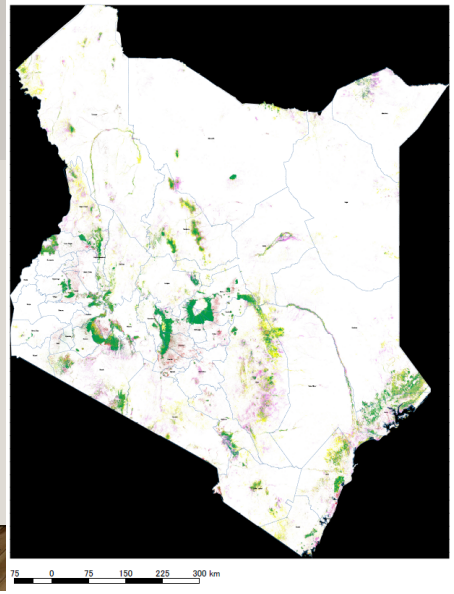
Persons who make opinions is not important

LU/LC CHANGE MAP

Period of 4 years; 2002 - 2006, 2006 - 2010, 2010 - 2014, 2014 - 2018

			20XX+4									
			1	2	3	4	5	6	7	8	9	10
			Dense Forest	Moderate Forest	Open Forest	Wooded Grassland	Open Grassland	Perennial Cropland	Annual Cropland	Vegetated Wetland	Open Water	Otherland
20XX	1	Dense Forest	1	2	3	4	5	6	7	8	9	10
	2	Moderate Forest	11	12	13	14	15	16	17	18	19	20
	3	Open Forest	21	22	23	24	25	26	27	28	29	30
	4	Wooded Grassland	31	32	33	34	35	36	37	38	39	40
	5	Open Grassland	41	42	43	44	45	46	47	48	49	50
	6	Perennial Cropland	51	52	53	54	55	56	57	58	59	60
	7	Annual Cropland	61	62	63	64	65	66	67	68	69	70
	8	Vegetated Wetland	71	72	73	74	75	76	77	78	79	80
	9	Open Water	81	82	83	84	85	86	87	88	89	90
	10	Otherland	91	92	93	94	95	96	97	98	99	100

2002 – 2006 LU/LC chnage



No	Forest Cover Change	The Legend of Forest Cover Change Map
1	Forest remaining as Forest (No Change)	Forest (No Change)
2	Forest remaining as Forest (Degradation)	Forest (Degradation)
3	Forest remaining as Forest (Enhancement)	Forest (Enhancement)
4	Cropland converted to Forest	Cropland to Forest
5	Grassland converted to Forest	Grassland to Forest
6	Other Land uses converted to Forest	Wetland and Other Lands to Forest
7	Forest converted to Cropland	Forest to Cropland
8	Forest converted to Grassland	Forest to Grassland
9	Forest converted to Other Land uses	Forest to Wetland and Other Lands

FOREST COVER CHANGE 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

ANALYSIS OF LU/LC CHANGE MAP

1. Select 2 counties at the least for analysis
2. Peruse the LU/LC change maps
3. Summarize What LU/LC change especially occurs in each county in Which period
4. Discuss Why the change occurs in the county (resource; own experience, statistical data, study paper, Government policy and strategy, condition of agriculture, report and etc.)
5. How to develop the activity for
   - Increasing forest cover
   - Tackling deforestation drivers
   - Tackling forest degradation drivers

DEVELOPMENT FOR REDD+ ACTIVITIES IN EACH ECOSYSTEM IN KENYA

Five activities decided as REDD+ activities

① Reducing emissions from deforestation

② Reducing emissions from forest degradation

③ Conservation of forest carbon stocks

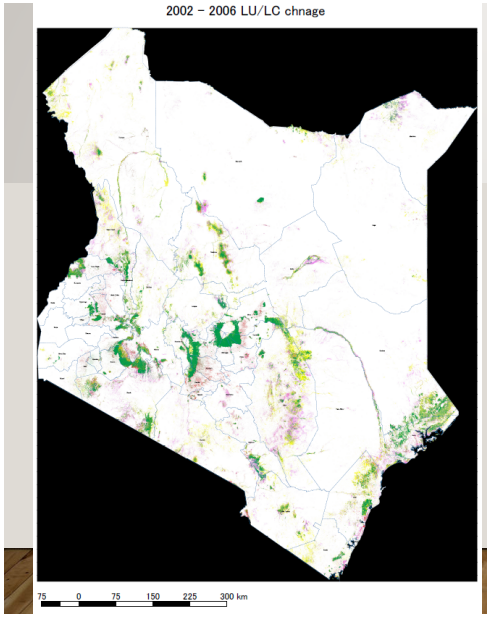
④ Sustainable management of forests

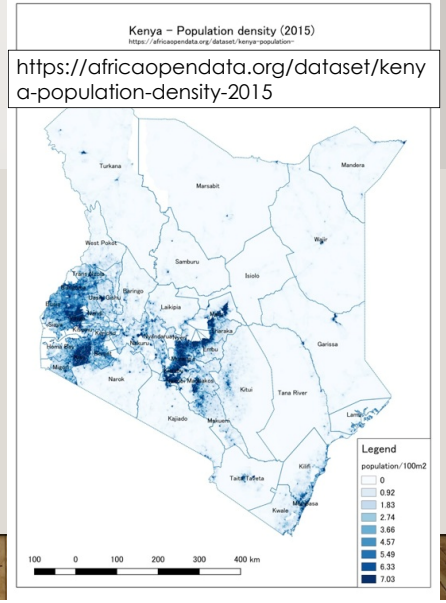
⑤ Enhancement of forest carbon stocks

DRIVERS OF DEFORESTATION AND FOREST DEGRADATION

http://www.jofca.or.jp/seminar/20111007-seminar/20111007seminar03.pdf

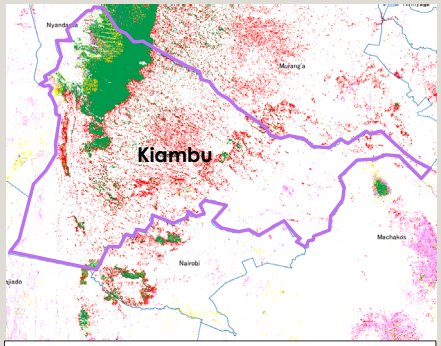
NFP



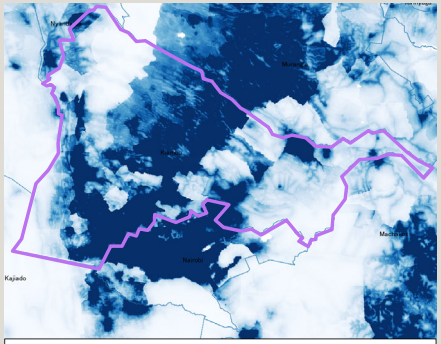


https://africaopendata.org/dataset/kenya-population-density-2015

(E.G.) :KIAMBU COUNTY



Period: 2002-2006



https://africaopendata.org/dataset/kenya-population-density-2015

FRAMEWORK OF DISCUSSION

Item	County1	County2
Target County	*Kiambu*	
What LU/LC change occur especially in What period	*In all period, the change between Forest and Cropland is found in a small area, and the change occurs reversibly, and the Land Cover / Land Use Change is very fluid.*	
In What forest strata the change occur especially	*(Selecting from among Montane forest, Western rainforest, Dryland forest, Costal forest, Mangrove, KFS plantation area)*	
Why the change occure (Driver Analysis)	*The increase in demand for food and firewood materials (household fuels) due to population growth has led to the conversion of forest to cropland, and is feared to lead to deforestation and forest degradation. (reference)* • *The condition of population concentrate: https://africaopendata.org/dataset/kenya-population-density-2015* • ,,, • ,,,	
Activity for the driver	• *(Increasing forest cover)* • *(Tackling deforestation drivers)* • *(Tackling forest degradation drivers)*	

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

Target Participants : 20 persons who participated 1st or 2nd MRV training from HQs and each conservancy in KFS

Date : From 7th to 9th July 2021

Place : Alps hotel and KFS forest in Nakuru

Day 1: @Alps hotel

Time	Activity	Lecturer/Instructor
8:30 - 9:00	Registration	Ms. Veronica Syombua
9:00 - 9:15	Orientation and Self-Introduction	Mr. Peter Nduati
9:15 - 9:30	Outline of CADEP and Forest Management in Japan	Mr. Keiichi Takahata
9:30 - 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 Mr. Akinobu Sembo
12:30 - 13:30	Lunch Break	
13:30 - 15:30	FRL setting in Kenya (1)	Dr. Kinyanjui Mwangi Ms. Faith Mutwiri
15:30 - 16:00	Health Break / Tea Break	
16:00 - 17:30	FRL setting in Kenya (2)	Dr. Kinyanjui Mwangi Ms. Faith Mutwiri

Day 2

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 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 Mr. Yoshihiko Sato
10:30 - 11:30	Tea Break / Transportation to field	

Time	Activity	Lecturer/Instructor
11:30 – 13:00 @KFS forest	Field practice for forest inventory (2) 2. How to set a plot	
13:00 - 14:00	Lunch Break	
14:00 - 16:00 @KFS forest	Field practice for forest inventory (3) 3. How to measure trees	
16:00 – 17:00	Tea Break / Transportation to hotel	

Day3: @Alps hotel

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

2021 MRV TRAINING_PARTICIPANTS' LIST

S/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
21	Peter Nduati	Instructor	Nairobi	Karura
22	Yoshihiko Sato	#N/A	#N/A	#N/A
23	Kazuhisa Kato	#N/A	#N/A	#N/A
24	Sato Kei	#N/A	#N/A	#N/A
25	Mwangi Kinyanjui	Instructor	Karatina	Central Highlands
26	Faith Mutwiri	Instructor	Nairobi	Karura
27	Sembo Akinobu	#N/A	#N/A	#N/A
28	Peter Sirayo	Instructor	Nairobi	Karura
29	Diana Kishiki	Instructor	Nairobi	Karura
30	Veronica Syombua	Instructor	Nairobi	Karura
31	Jonathan Kool	security		
32	Beatrice Lenasieku	security		
33	-	-	-	-
34	Peter Mumo Nwanzia	driver	-	-
35	Benjamin Kivinbu Mbaci	driver	-	-
36	Fedrick Ojuang	Instructor	Nairobi	Karura

Capacity Development Project for Sustainable Forest Management

1 Outline of CADEP
2 Forest management in Japan
3 Introducing Drone

Keiichi TAKAHATA
Chief Advisor, CADEP-SFM
7th July 2021

Capacity Development Project for Sustainable Forest Management in Kenya

Overall Goal

Sustainable forest management is promoted in Kenya towards the national forest cover target of 10%

Project Purpose

Capacity at the national and county level for sustainable forest management is strengthened

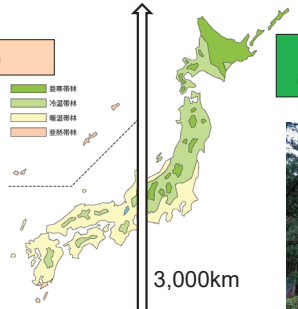
African Initiative for Combating Desertification

KEFRI

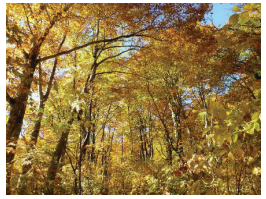
Component 1	Component 2	Component 3	Component 4	Component 5
Policy Support (MoEF)	Forestry Extension in ASALs (KFS)	REDD+ Readiness (KFS)	Tree Breeding (KEFRI)	Reginal Cooperation (KEFRI)

Forest in Japan

Natural forest (area; 60%, volume; 40%)



Plantation (area; 40%, volume; 60%)



Plantation management 1

- ○ Field survey (Assessment)
- ○ Tender
- ○ Buyer is fixed

(Sawmiller, logging company, timber market company)

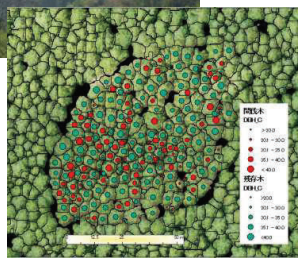
Plantation management 2

STATION	SUB-COMPARTMENT	SPECIES	YOP	DENSITY	M.DBH	M.HT	AREA	volume
IRANGI	RUIKITHIA 2F	V.KEN	1958	225	322.8	20.5	5.3	403.0472
IRANGI	THAMBANA 1A	E.SAL	1980				3.5	
IRANGI	THAMBANA 1B	V.KEN	1991	175	313.4	15.8	3	181.1048
IRANGI	THAMBANA 1C	E.SAL	1983	125	386.4	35.2	13.4	1320.453
IRANGI	THAMBANA 1E	V.KEN	1982	—	—	—	1.4	
IRANGI	THAMBANA 1F	V.KEN	1983	—	—	—	4.4	
IRANGI	THAMBANA 1H	V.KEN	1953	500	278	21.3	3.8	386.5763
IRANGI	THAMBANA 1I	F.MIC	1960	75	353	20.1	4.9	265.0342
IRANGI	THAMBANA 1J	V.KEN	1982	100	535	30	53	5533.233
IRANGI	THAMBANA 1K	V.KEN	1971	250	245.5	20.7	9.3	589.5492

Using Drone for forest resource survey

Require time and labour

How about accuracy for volume?



精密樹冠解析と間伐木の自動選別

革新的技術・緊急展開事業（農林水産技術会議補助事業 平成28年度～平成30年度）

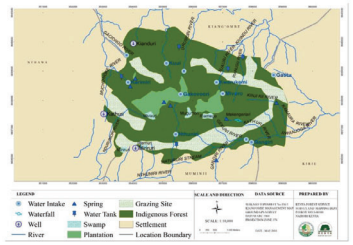
Forest disaster by typhoon

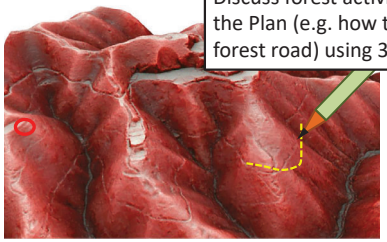
<photo on the ground>

<photo from drone>

(Idea) making Forest Management Plan in Kenya

Photo and map; Kiang'ombee Hill PFMP





Discuss forest activity to list in the Plan (e.g. how to make forest road) using 3D image

Review of Outline of REDD+

The REDD+ Readiness Component
in
the Capacity Development Project for the Sustainable Forest Management
in the Republic of Kenya

By Kazuhisa KATO - Compornent3 Team Leader
2021.7.7

What is REDD Plus?

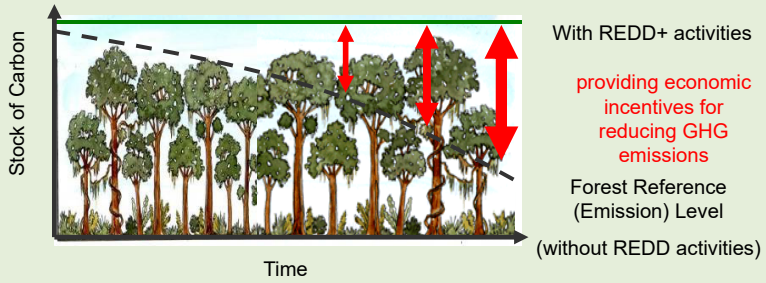
❖REDD+（REDD-plus）Mechanism

The basic concept of REDD+ is to provide economic incentives such as funding to developing countries for activities reducing GHG emissions from deforestation and forest degradation, and maintaining or enhancing carbon stocks through forest conservation.

✓REDD is "Reducing Emissions from Deforestation and Forest Degradation"

✓"+" is forest conservation, sustainable forest management and enhancement of forest carbon sinks

Concept of REDD+



Framework under the United Nation

Over a decade ago, most countries joined an international treaty -- the United Nations Framework Convention on Climate Change (UNFCCC) -- to begin to consider what can be done to mitigate global warming and to cope with whatever temperature increases are inevitable.

In addition to the treaty: the Kyoto Protocol, which has more powerful (and legally binding) measures, was adopted in 1997 and came into force in 2005. the Paris agreement, which has no legal binding, was adopted in 2015 and came into force in 2016 following Kyoto Protocol.

The UNFCCC secretariat supports all institutions involved in the climate change process, particularly the COP, the subsidiary bodies and their Bureau (SBSTA).

【Five activities decided as REDD+ activities】

① Reducing emissions from deforestation

② Reducing emissions from forest degradation

③ Conservation of forest carbon stocks

④ Sustainable management of forests

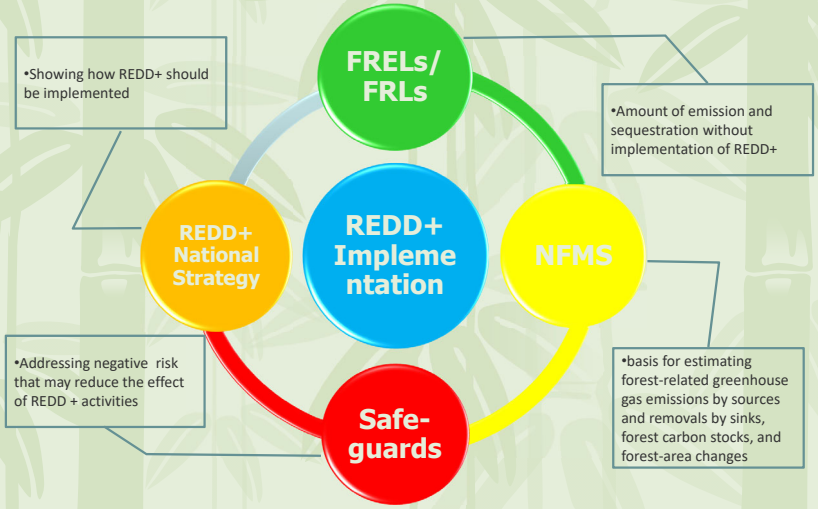
⑤ Enhancement of forest carbon stocks

【Scope of REDD+】

REDD+ is covered by three categories of land use change according to the IPCC Good Practice Guidance for LULUCF:

1. Forests converted to other lands
   - Deforestation
2. Forests remaining as forests
   - Forest degradation
   - Conservation of forest carbon stocks
   - Sustainable management of forests
   - Enhancement of forest carbon stocks in existing forests
3. Other lands converted to forests
   - Enhancement of forest carbon stocks in bare lands

【Requirement for implementation of REDD+】



【The Requirement (1) REDD+ National Strategy】

Points to be Considered on REDD+ National Strategy

- Measures against drivers of deforestation and forest degradation
  - ✓ Since deforestation and forest degradation drivers are different by each country, measures that match the drivers of each country should be applied
  - ✓ In the implementation of REDD + at the national and sub-national levels, "policies and measures (PaMs)" are effective and necessary
- Cross-sectoral initiatives
  - ✓ Cross-sectoral approach with development policies and land-use policies closely related to REDD+ is necessary

Therefore, it is necessary to formulate the REDD + national strategy through the participation of various stakeholders

【The Requirement (2) Safeguards】

The following seven Safeguards should be supported and protected

1. Actions complement or are consistent with the objectives of national forest programmes and relevant international conventions and agreements;
2. Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;
3. Respect for the knowledge and rights of indigenous peoples and members of local communities;
4. The full and effective participation of relevant stakeholders, in particular, indigenous peoples and local communities;
5. Actions are consistent with the conservation of natural forests and biological diversity;
6. Actions to address the risks of reversals (related to non-permanence);
7. Actions to reduce displacement of emissions (related to leakage)

【Issues to be considered for Safeguards】

- How criteria and indicators for each item are set
- How to address safeguard issues
- Safeguard Information System(SIS) (Inter-communicational, Transparent, Accessibility, Easily evaluated by a third party（Check list and the evaluation of results））
- Monitoring system

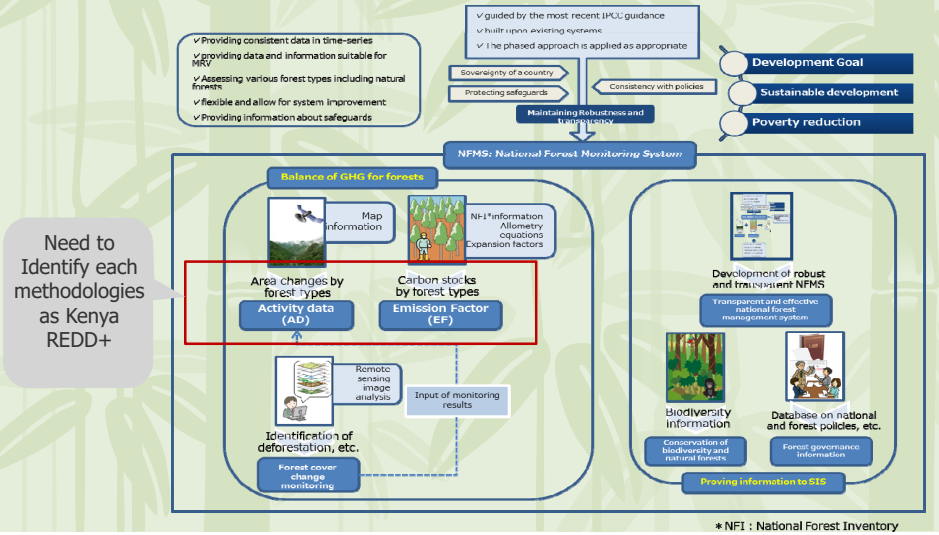
【The Requirement (3) National Forest Monitoring System (NFMS) 】

Decision 11/CP.19

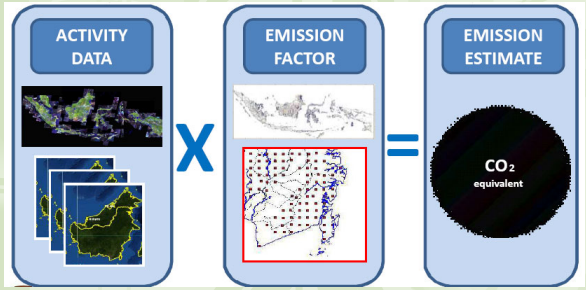
2. Decides that the development of Parties' national forest monitoring systems for the monitoring and reporting of the activities,1 as referred to in decision 1/CP.16, paragraph 70, with, if appropriate, subnational monitoring and reporting as an interim measure, should take into account the guidance provided in decision 4/CP.15 and be guided by the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources, and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes;

3. Also decides that robust national forest monitoring systems should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes resulting from the implementation of the activities referred to in decision 1/CP.16, paragraph 70, taking into account paragraph 71(b) and (c) consistent with guidance on measuring,reporting and verifying nationally appropriate mitigation actions by developing country Parties agreed by the Conference of the Parties, taking into account methodological guidance in accordance with decision4/CP.15;

【Basic Idea of NFMS 】



Necessary monitoring based on the estimation method of emission amount】



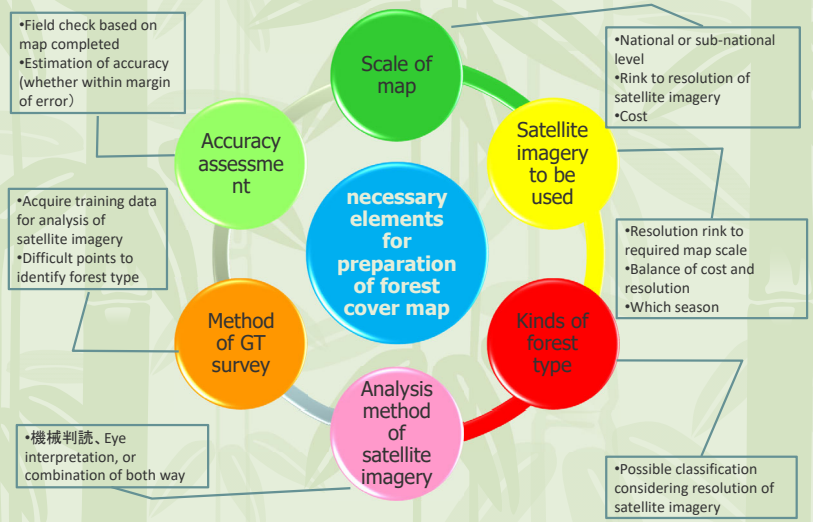
Forest area change (unit:ha)

Carbon stock change (unit:CO2 t/ha)

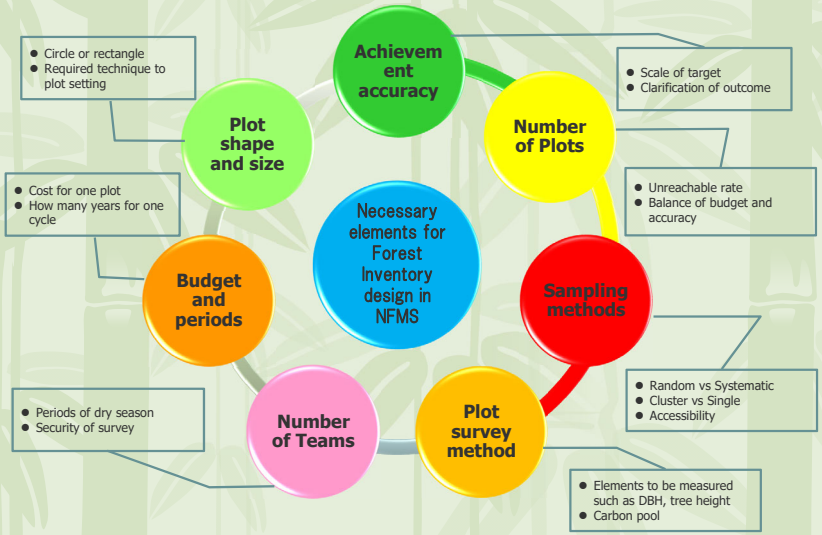
Preparation of forest cover map

Implementation of forest inventory

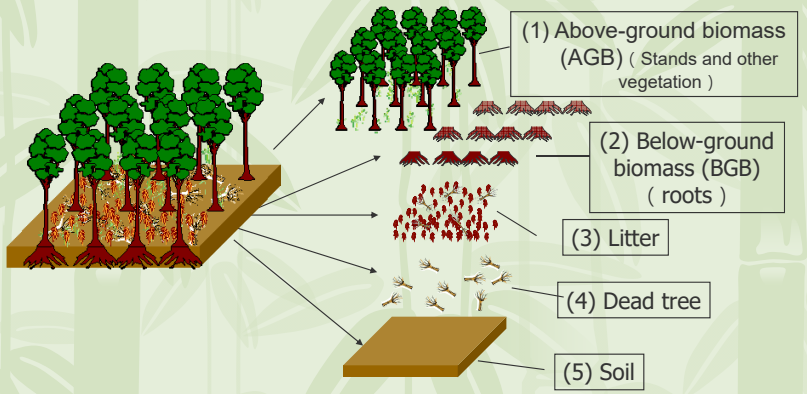
【Points to be considered for preparation of forest cover map】



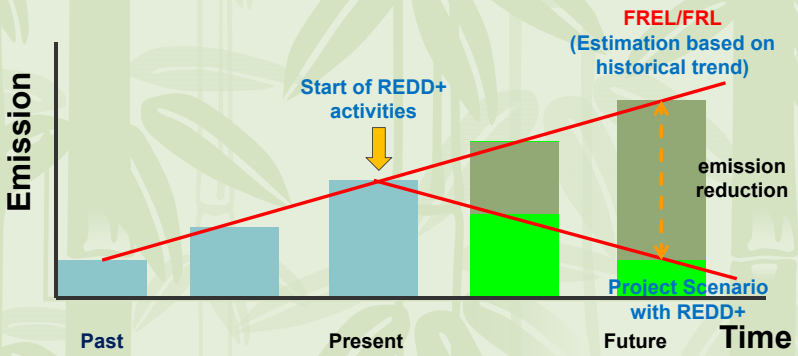
【Points to be considered for design of forest inventory】



【Carbon Pools in a Forest】



【The Requirement (4) FREL/FRL】



- FRELs/FRLs establish business-as-usual (BAU) baselines against which actual emissions are compared.
  ⇒Emission reductions are estimated as the difference between actual emissions and FRELs/FRLs within an established period.
- FRELs/FRLs are benchmarks for assessing each UNFCCC Party's performance and determine its eligibility for international, results-based payment for REDD+

【Common Understanding of What FRELs and FRLs Refer to】

- FRELs (Forest Reference Emission Levels) only count emissions of the greenhouse gases (GHGs) from deforestation and forest degradation.
- FRLs (Forest Reference Levels) count both emissions of GHGs from deforestation and forest degradation and removals of GHGs from the "sink" activities such as enhancement of forest carbon stock.

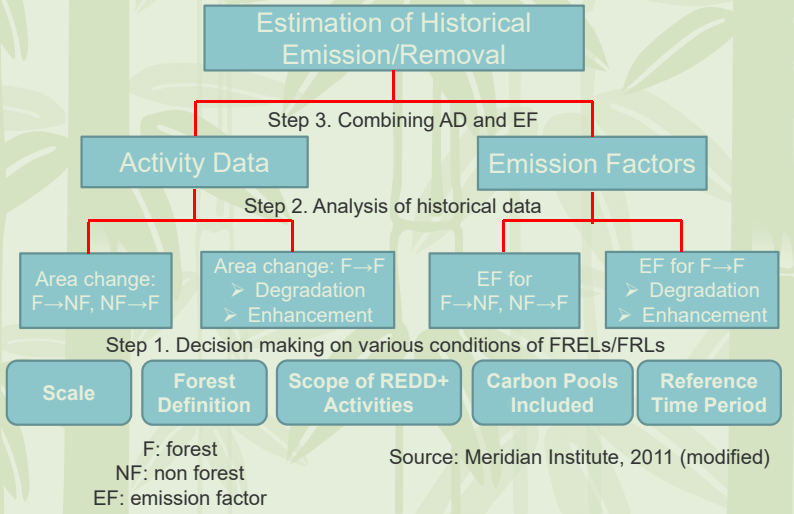
【Outline of Development of FRELs/FRLs】

Development of FRELs/FRLs can be simplified to the 2 components under the UNFCCC guidance:

1. Analysis of Historical Change of Forests
2. Estimation of Future Change of Forests with Adjustment by National Circumstances

Developing country Parties in establishing FRELs/ FRLs should do so transparently taking into account **historic data**, and adjust for **national circumstances** (decision 4/CP.15, paragraph 7)

【Process of Estimating Historical Change】



F: forest
NF: non forest
EF: emission factor

Source: Meridian Institute, 2011 (modified)

【Conditions of FRL in Kenya】

Condition	Decision
Forest definition	a minimum 15% canopy cover; minimum land area of 0.5 ha and minimum height of 2 meters.
Scale	National
Scope of REDD+ Activities	Reducing emissions from deforestation Reducing emissions from forest degradation Sustainable management of forest Enhancement of forest carbon stocks.
GHG Gases	only CO_2
Carbon Pools	Above Ground Biomass (AGB) and Below Ground Biomass (BGB).
Reference period	2002-2018 Data points: 2002, 2006, 2010, 2014, 2018
Construction method	Historical Average of emissions and removals between 2002 and 2018, monitored at 4-year intervals

【Warsaw Framework for REDD+】

(1) modalities for national forest monitoring systems,
(2) the timing and the frequency of presentations of the summary of information on the safeguards,
(3) addressing the drivers of deforestation and forest degradation,
(4) guidelines and procedures for the technical assessment of submissions on proposed REL/RL,
(5) modalities for measuring, reporting and verifying (MRV),
(6) coordination of support for the implementation of activities, including institutional arrangements
(7) work programme on results-based finance

http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf#page=34

【① Modalities for national forest monitoring systems (NFMS)】

Outline：The development of NFMS should take into account the most recent guidance provided in IPCC, and the NFMS should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying.

Function：NFMS should build upon existing systems as appropriate, and enable the assessment of different types of forest in the country, including natural forest, as defined by the Party.

【② The timing and the frequency of presentations of the summary of information on the safeguards】

Outline：Developing country Parties should start providing the summary of information on safeguards in their national communication or communication channel, including via the web platform of the UNFCCC, after the start of the implementation of activities of REDD+. The frequency of subsequent presentations of the summary of information should be consistent with the provisions for submissions of national communications

【③ addressing the drivers of deforestation and forest degradation】

Outline：Encouraging all Parties, relevant organizations, and the private sector and other stakeholders, to continue their work to address drivers of deforestation and forest degradation and to share the results of their work on this matter; and developing country Parties to take note of the information from ongoing and existing work on addressing the drivers of deforestation and forest degradation.

【④ Guidelines and procedures for the technical assessment of submissions on proposed REL/RL

Objectives of technical assessment：To assess the consistency with the guidelines for submissions of information on FREL/FRL, and to offer a facilitative and non-intrusive technical exchange of information keeping the construction and future improvements of FREL/FRL in mind.

Composition of assessment team：Each submission shall be assessed by two LULUCF experts selected from the UNFCCC roster of experts, one from a developed country and one from a developing country. The Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention may nominate one of its experts to participate in the technical assessment as an observer.

Timing and method of publication：Assessment sessions will be organized once a year. Assessment will be done for about a year. the Party may modify its submitted FREL/FRL in response to the technical inputs of the assessment team. Publication of final report on assessment results is made via the web platform on the UNFCCC website.

【⑤ Modalities for measuring, reporting and verifying (MRV)】

Outline：To be consistent with the methodological guidance provided in decision of COP15, and any guidance on the MRV of nationally appropriate mitigation actions (NAMA) . Data and information used in the estimation of forest-related emissions by sources and removals by sinks etc. should be transparent, and consistent over time and with the FREL/FRL

Report：The Data and information will be submitted through the biennial update reports (BUR) and technical annex by Parties. The technical team of experts shall make an analysis and prepare a technical report to be published via the web platform.

【⑥ Coordination of support for the implementation of activities, including institutional arrangements】

Requirement：To designate a national entities or focal points of developing country

Function of the entity：Identify needs and functions related to the coordination of support, strengthen the sharing of relevant information, knowledge, experiences and good practices, identify possible needs and gaps in coordination of support, provide opportunities to exchange information between the relevant bodies, provide information and any recommendations to improve the effectiveness of finance.

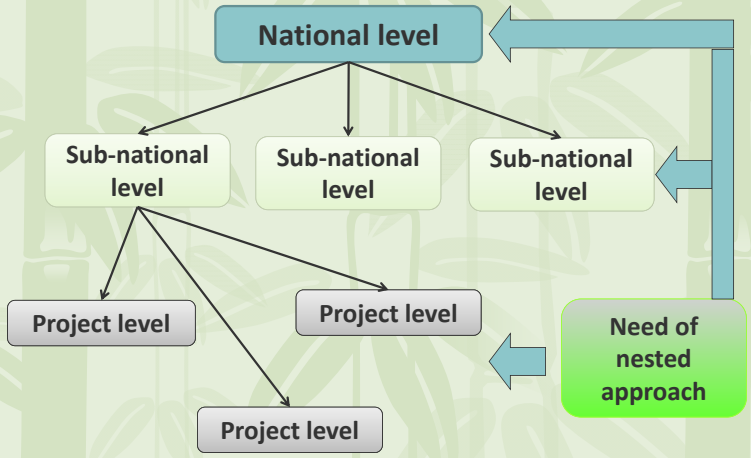
【⑦ Work programme on results-based finance】

Requirement to obtain finance : developing countries seeking to obtain and receive results-based finance of REDD+ activities should meet requirement of The Cancun Agreement, and those actions should be fully measured, reported and verified, the countries should provide the most recent summary of information on the safeguards before they can receive results-based payments;

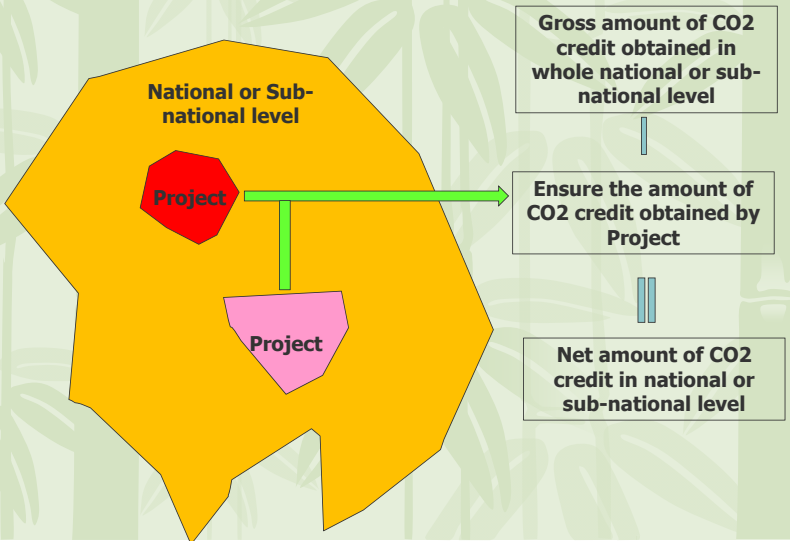
Publication of information : To establish an information hub on the web platform on the UNFCCC website as a means to publish information on the results of the activities, and corresponding results-based payments;

Green Climate Fund : The Green Climate Fund (GCF) plays a role of result-based financing the REDD+ activities.

【Level of REDD+ (Three (actually Two) Classes)】



【Example of Nested Approach】



【Phased approach of REDD+ implementation】

Preparing National REDD+ strategy, improvement of the capabilities required to REDD + implementation

Trial of REDD + activities in accordance with the countries' ability (continuation of capacity building)

Aiming at making markets, the implementation of REDD + activities in the results-based by robust monitoring system

【Example of finance access】

	Phase 1 Readiness	Phase 2 Implementation	Phase 3 Result-based payment	Funding amount	Remark
GCF(Green Climate Fund)	○	○	○	USD 10.3 Billion USD 9.8Billion	Initial resource mobilization 10.3billion, first replenishment 9.8billion.
GEF(Global Environment Facility)	-	○	-	USD 3.3 Billion	GEF 7 period (2018 – 2020)
UN-REDD	●	○	-	USD 323 M	-
FCPF(Forest Carbon Partnership Facility)	● Readiness Fund	-	○ Carbon Fund	RF: USD 430 M CF: USD 900 M	RF: By 2020 CF: By 2025
Bio Carbon Fund-ISFL(Initiative for Sustainable Forest Landscapes)	-	○	○	USD 352 M	Support only for 5 countries
FIP(Forest Investment Program)	○	○	-	USD 736 M	-
CAFI(Central African Forest Initiative)	○	○	-	USD 275 M	Pledged USD500M by 2027
Amazon Fund	-	○	○	1.3 Billion	Norway and Germany freeze funding in 2019
REM(REDD Early Movers)	-	○	○	?	Brazil, Colombia, Ecuador
NICFI(Norwegian Agency for Development Cooperation：Norad)	-	-	○	USD 380 M /year	By 2030
JCM(Joint Crediting Mechanism)	-	-	○	-	-
CORSIA(Carbon Offsetting and Reduction Scheme for International Aviation)	-	-	○ (Architecture for REDD+ Transactions :ART)	?	Operation period is from 2021 – 35

【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

Establishment :
GCF was decided to set up by COP16 under UNFCCC in 2010 to support the efforts of developing countries to respond to the challenge of climate change.

Aim:
To support the efforts of developing countries to reduce the green house gas emission(mitigation) and address climate change impact(adaptation).

Decision making:
GCF Board which normally meets three times per year.

Constitution of the GCF board:
GCF is governed by a 24-member Board , comprised equally of developed and developing countries, representing the United Nations Regional Groups.

Fund resource
Initial Resource Mobilization: USD 10.3 billion had been pledged in 2014 by 43 countries, 3 regions and one city.
GCF's first replenishment(2020-2023) : USD 9.8 billion had been pledged in 2019 by 31 countries, 2 cities

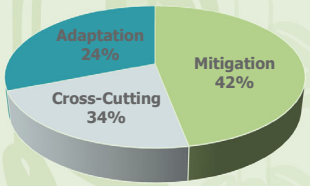
COP16 : ...goal of mobilizing jointly USD 100 billion per year by 2020
COP21 : ...continue the collective mobilization goal through 2025...
...to 2025 set a new collective quantified goal from a floor of USD 100 billion per year

【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

BALANCED PORTFOLIO

The Fund aims for a 50:50 balance between mitigation and adaptation investments over time. It also aims for a floor of 50 percent of the adaptation allocation for particularly vulnerable countries, including Least Developed Countries (LDCs), Small Island Developing States (SIDS), and African States.



Share of funding by 2021
Reference: GCF website

8 impact areas

Mitigation
1. Energy access and power generation
2. Transport
3. Energy efficient buildings, cities and industries
4. Sustainable land use and forest management

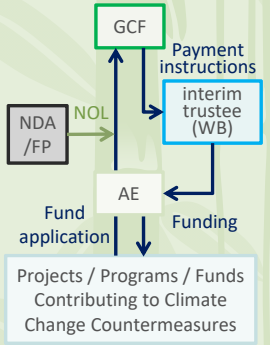
Adaptation
5. Livelihoods of the most vulnerable people
6. Health and food and water security
7. Infrastructure and built environment
8. Ecosystems

【Green Climate Fund (GCF)】

GREEN CLIMATE FUND

Fund application

- In order to apply the GCF funds, it is necessary to submit a Funding Proposal through AE (Accredited Entities).
- When applying for funding, it is also necessary to submit a "No objection letter(NOL)" from the government of the project country (NDA (National Designated Organization) or Focal Point(FP).
- The funds application is discussed at the GCF Board and when approved, the Payment instructions are sent to GCF's interim trustee. The trustee will then transfer funds to the AE.
- 177 projects have been approved by June 2021 (Of these projects, one is in Kenya and 11 include Kenya)



【Green Climate Fund (GCF)】

Result-based Payment Pilot Project

◆Step to access RBP

Meet the REDD+ requirements as defined by the Warsaw Framework → Submit biennial update report (BUR) → Submit a concept note and funding proposal

◆Framework of RBP pilot project

Project period: Open for 2017-2022 (Submit application by 2020)
Envelope: USD 500 million
Financial Valuation: USD 5/tCO_2e
Eligibility Period: 31 Dec 2013 - 31 Dec 2018
Access Modality: Accredited Entities
Submission: Concept notes and funding proposals
Adoption method: Rolling Basis(Deliberated on a first-come, first-served basis)
Assessment: Scorecard

【Green Climate Fund (GCF)】

Result-based Payment Pilot Project

◆Calculation of Result-based payment

STEP1	STEP2	STEP3	STEP4	STEP5
• Emission reduction (ERs) is calculated by AE.	• Calculation of "GCF certified ERs" based on scorecard.	• Calculation of provisional Result-based payment.	• Calculation of value addition of non-carbon benefits	• Calculation of Result-based payment(5USD/t CO2e).

◆Approved Result-based payment

Country	AE	Eligibility Period	ER calculated by AE	Score	ER Certified by GCF	Non-carbon benefits	Payment by GCF
Brazil	UNDP	2014-2015	25million tCO2e	36/48	18.8million tCO2e	2.5%	96million USD
Ecuador	UNDP	2014	4.8million tCO2e	36/48	3.6million tCO2e	2.5%	18.6million USD
Chile	FAO	2014-2016	14.5million tCO2e	41/48	12.4million tCO2e	2.5%	63.6million USD
Paraguay	UNEP	2015-2017	18.9million tCO2e	36/48	14.1million tCO2e	2.5%	50million USD
Colombia	FAO	205-2016	7.0million tCO2e	38/48	5.5million tCO2e	2.5%	28.2millon USD
Indonesia	UNDP	2014-2016	27.0million tCO2e	36/48	20.3million tCO2e	2.5%	103.8million USD
Argentina	FAO	2014-2016	18.7million tCO2e	41/48	18.7(16.0?)million tCO2e	2.5%	82.0million USD
Costa rica	UNDP	2014-2015	14.1million tCO2e	36/48	10.6million tCO2e	2.5%	54.1million USD

Review of Outline of National Forest Monitoring System (NFMS)

The REDD+ Readiness Component in
the Capacity Development Project for the Sustainable Forest Management
in the Republic of Kenya

By Kazuhisa KATO – Component 3 Team Leader

2021.7.7

1 UNFCCC Requirements

Mechanism of REDD+

Readiness
(To receive results-based finance, developing country party should have the following in place)

- ☐ A national strategy or action Plan
- ☐ An assessed forest reference emission level and/or Forest reference level
- ☑ A national forest monitoring system (NFMS)
- ☐ A system for providing information on how the safeguards are being addressed and respected

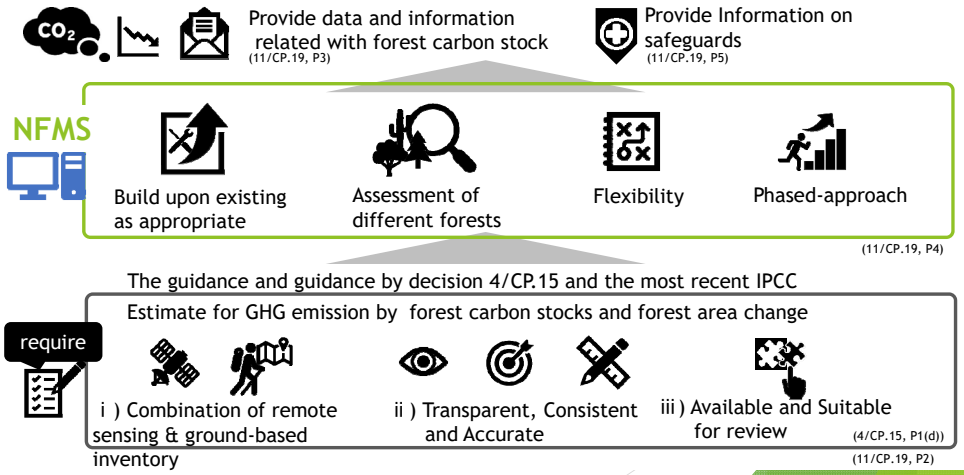
Implementation
(Developing country party undertake the following activities to receive results based finance)

- ☐ Reducing emissions from deforestation
- ☐ Reducing emissions from forest degradation
- ☐ Conservation of forest carbon stocks
- ☐ Sustainable management of forests
- ☐ Enhancement of forest carbon stocks

1/CP.16 The Cancun Agreements Paragraph 70,71

2. Definition of NFMS in UNFCCC

NFMS in UNFCCC decisions



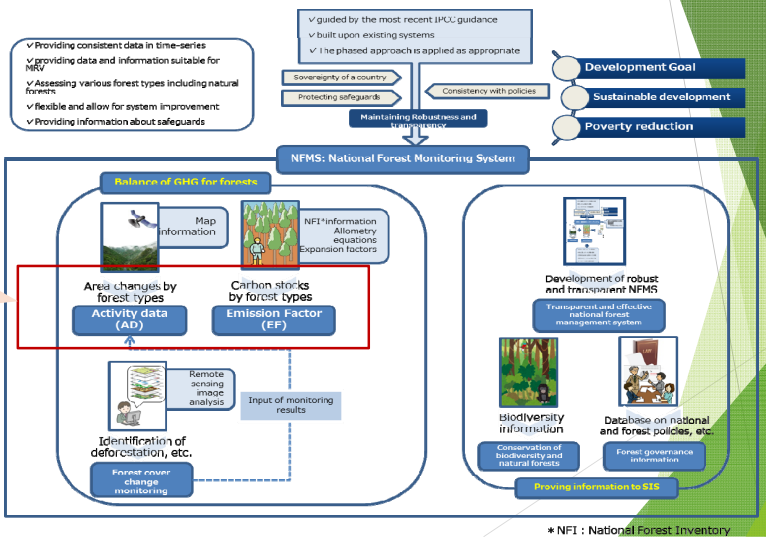
2. Definition of NFMS in UNFCCC

Decision 11/CP.19

2. Decides that the development of Parties' national forest monitoring systems for the monitoring and reporting of the activities,1 as referred to in decision 1/CP.16, paragraph 70, with, if appropriate, subnational monitoring and reporting as an interim measure, should take into account the guidance provided in decision 4/CP.15 and be guided by the most recent Intergovernmental Panel on Climate Change guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources, and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes;

3. Also decides that robust national forest monitoring systems should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes resulting from the implementation of the activities referred to in decision 1/CP.16, paragraph 70, taking into account paragraph 71(b) and (c) consistent with guidance on measuring,reporting and verifying nationally appropriate mitigation actions by developing country Parties agreed by the Conference of the Parties, taking into account methodological guidance in accordance with decision4/CP.15;

2. Definition of NFMS in UNFCCC



Need to Identify each methodologies as Kenya REDD+

3. Contents of NFMS document ver.1 draft

1/2

Chapter	Contents	
Chapter 1	Background and Purpose of NFMS Document	1.1 Background
		1.2 Milestones in Forest Sector Legal Legislation
		1.3 The Purpose of the NFMS document
Chapter 2	UNFCCC requirements	
Chapter 3	Basic conditions of NFMS in Kenya	3.1 Land use categorization
		3.2 Forest Definition
		3.3 Forest Stratification
		3.3.1 Montane and western rain forests
		3.3.2 Coastal and Mangrove Forests
		3.3.3 Dryland forests
		3.3.4 Plantation forests
		3.4 Carbon pools
		3.5 Scope gas
		3.6 REDD+ in Kenya
		3.6.1 Scale
		3.6.2 Selected REDD+ activity
		3.6.3 Definition of REDD+ activities
Chapter 4	Conceptual design of the NFMS in Kenya	4.1 Objective of Kenya's NFMS
		4.2 Composition of NFMS
		4.2.1 Monitoring function
		4.2.2 Data management function
		4.3 The Phased Approach to NFMS implementation

3. Contents of NFMS document ver.1 draft

2/2

Chapter	Contents	
Chapter 5	Monitoring function	5.1 Forest cover area and forest cover change for AD
		5.1.1 Forest cover area based on SLEEK programme
		5.1.2 Forest cover change area based on Land cover / Land use change maps
		5.2 Forest Carbon stock for emission factors
		5.2.1 National forest inventory
		5.2.2 Conversion of the inventory data into carbon stock data
		5.3 Forest cover change monitoring
		5.3.1 Detection of deforestation area using radar image (ALOS-2) by JICA-JAXA Forest Early Warning System in the Tropics（JJ-FAST）
		5.3.2 Detection of deforestation area using optical image (Sentinel 2) by NRTFAS
		5.3.3 Field report by ground truth using Survey 123
		5.3 Policies and Measures (PaMs)
		5.4 Biodiversity
		5.5 REDD+ and AR-CDM project
Chapter 6	Data management function by FIP	6.1 Component and contents of the FIP
		6.2 Access right of each content
		6.3 Linkage with FMIS
		6.4 Operation of FIP
Chapter 7	Institutional arrangement for NFMS	7.1 Institutional arrangement for monitoring function
		7.2 Institutional arrangement for data management function
Chapter 8	Calendar of NFMS	

4. Proposed NFMS in Kenya -Conceptual Design-

Phased Approach

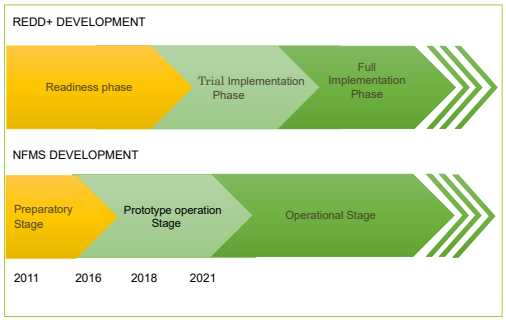


Figure Phased approaches of the development of the REDD+ program and the NFMS in Kenya

The NFMS will be developed in a phased approach that is synchronized with the implementation of the three phases of the REDD+ program, which is depicted in Figure. The criteria that will be used to guide the development through each of these phases include UNFCCC requirements, national policies, the availability of data, operational costs, and the capacities of users of the NFMS to operate the system and use the information provided in a meaningful manner.

4. Proposed NFMS in Kenya -Conceptual Design-

NFMS in Kenya will be established from two aspects.

Monitoring function

It is included estimation of anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks, forest carbon stock and forest area changes, information of policy and measure, biodiversity and forest related project of REDD+ and A/R CDM.

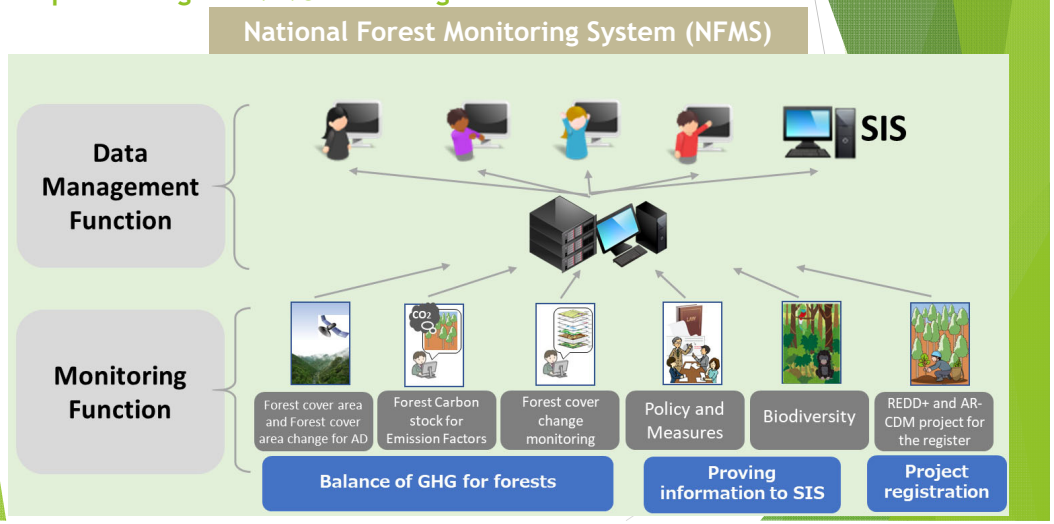
Data management function

It is a database to input the information and data gathered by implementation of the monitoring and provide them for implementing sustainable forest management including REDD+.

All of NFMS in Kenya will be described in detail in the "NFMS document in Kenya" to ensure transparency.

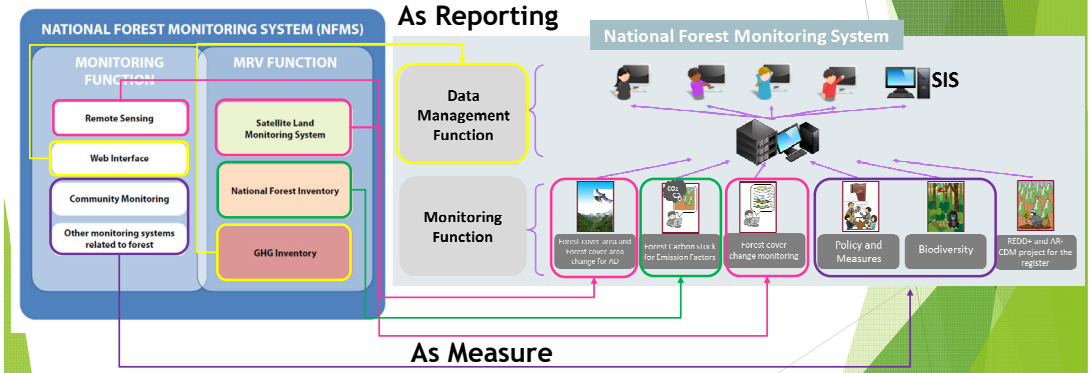
4. Proposed NFMS in Kenya -Conceptual Design-

Conceptual Design of NFMS consisting of two functions



4. Proposed NFMS in Kenya -Conceptual Design-

Comparison between UNREDD strategy NFMS and Proposed NFMS



4. Proposed NFMS in Kenya -Monitoring function-

Item	Information resources	Methodology
Activity Data (AD) by Satellite analysis	Land use / Land cover map	Methodology is Established based on SLEEK map manual
Emission Factor (EF) based on Forest carbon stock	National Forest inventory, Allometric equation	Methodology of NFI will be developed based on ICFRA proposal with modification. Equations have been already selected but it should be developed in Kenya as phased approach
Forest area change Monitoring	Optical and radar satellite imageries	Detect land cover changed area, JJ-FAST and Near Real Time Forest Alert System (NRTFAS) can be used.
Policy and Measures	NDC, National REDD+ strategy (NRS) and National Forest Program, etc.	Monitoring Methodology to be developed based on the mainly contents of NRS etc..
Biodiversity	Protected area, management plan, biodiversity assessment etc.	Methodology is established based on ICFRA and the monitoring through implementation of NFI.
Project information	Project proponent of each REDD+ and A/R CDM project	Registration and monitoring system should be developed.

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop AD

- Forest Definition:

Minimum surface area	0.5ha
Minimum Height	2m
Minimum Cover	15%

- MAP :

Map	SLEEK MAP
Image	Land Sat image or any available and more aculeate image
Methodology	Wall to Wall Supervised Classification (using algorism named Random Forest)
Time	At the least every two years

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop AD

- Stratification: SLEEK stratification is basically used

forest strata
Montane Forest, Western Rain Forest and Bamboo Forest
Mangrove Forest and Coastal Forest
Dryland Forest

X

Canopy coverage classes
Dense
Moderate
Open

= 9 forest types

forest strata
Plantation

= 1 forest type

Total 10 forest types

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- NFI is utilized for developing EF

Sampling Design of NFI

1 Systematic grid spacing for clusters : Distance of 1 km-by-1 km: (1 km^2 grids) over the whole country

2 Stratified random sampling method: SLEEK stratification (10 forest types)

3 Random sampling method: The number of clusters to be calculated based on the SLEEK stratification.

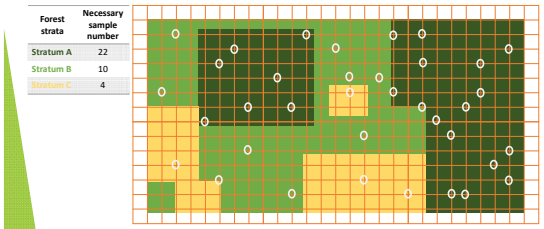


Image of stratified random sampling

Strata		Total required No. of clusters
Montane and western rain forests	Dense	160
	Moderate	135
	Open	56
Coastal & Mangrove Forest	Dense	87
	Moderate	46
	Open	134
Dryland forests	Dense	220
	Moderate	73
	Open	90
Plantation forests land		226
Total		1,227

Use of standard Equation for the calculation of necessary number of clusters

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- Sampling Design of NFI

ICFRA proposal (Cluster sampling method) will be basically used with minor change.

- In the Figure 1, left side figure is for Montane forests and western rain forests, and Dryland forests, right side figure is for Coastal and mangrove forests and Plantation forest land
- In case that more than two canopy coverage classes are mixing in a cluster like Figure 2, how the data of different classes should be consolidated?

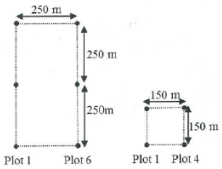
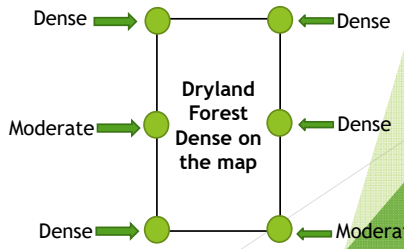


Figure 1 . Cluster designs



In this case, the data is compiled as the canopy class on the map.

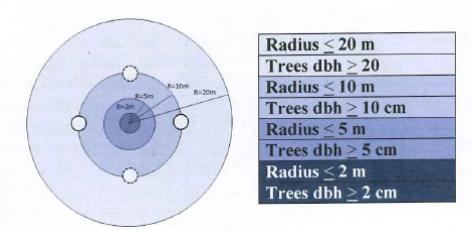
Figure 2. Example of cluster with more than two canopy coverage classes mixed

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- **Plots shape**

ICFRA proposal: Cercle shape is used as mentioned in the following figure. However, since SLEEK stratification is used, left side figure will be applied to Dryland forests, right side figure will be applied to Montane forests and western rain forests, Coastal and mangrove forests, and Plantation forest land.



Radius ≤ 20 m
Trees dbh ≥ 20
Radius ≤ 10 m
Trees dbh ≥ 10 cm
Radius ≤ 5 m
Trees dbh ≥ 5 cm
Radius ≤ 2 m
Trees dbh ≥ 2 cm

Figure . Sample plot design for Dryland forests

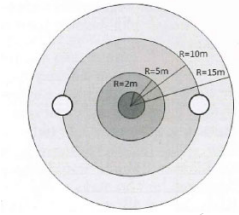


Figure . Sample plot design for forest types except for Dryland forests

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya.

4. Proposed NFMS in Kenya -Monitoring function-

Methodology to develop EF

- **Measurement method in the plots:**
- ICFRA proposal: As mentioned in the table

Table .Measurement on the circular sample plots.

	DBH/ diameter (cm)	Height/ length (m)	Plot radius (m)	Plot area (m^2)
Tree	≥ 2	≥ 1.3	2	12.6
Tree	≥ 5	≥ 1.3	5	78.5
Tree	≥ 10	≥ 1.3	10	314.2
Tree (Strata 2 and 4)	≥ 20	≥ 1.3	15	706.9
Tree (Strata 1 and 3)	≥ 20	≥ 1.3	20	1256.6
Climber	≥ 2	≥ 1.3	2	12.6
Climber	≥ 5	≥ 1.3	15	706.9
Bamboo		≥ 1.3	10 or 2 × 2.0	314.2 or 25.13
Lying dead wood	≥ 10	≥ 1.0	15	706.9
Shrub		≥ 1.3	15 or 2 × 2.0	706.9 or 25.13
Stump			15	706.9
Regeneration	< 2	≥ 0.10	2 × 1.5	14.13

*ICFRA 2016. Proposal for National Forest Resources Assessment (NFRA) in Kenya.

4. Proposed NFMS in Kenya -Monitoring function-

Forest cover change monitoring

- Purpose : to identify deforestation for forest management in real time as much as possible.
- Method : JJ-FAST by developed JAXA and JICA, and Near Real Time Forest Alert System (NRTFAS) developed by Forest 2020 will be used for forest cover change monitoring. The deforestation alert information detected by JJ-FAST and NRTFAS are validated in the field by KFS rangers using mobile smartphone or tablet device equipped with an application that utilizes Survey123.
- Issues : to be identified for what purpose the monitoring result should be used.

4. Proposed NFMS in Kenya -Monitoring function-

Policies and measures (PaMs)

- Purpose : to manage the monitoring for implementation of forest policy (PaMs) on REDD+
- Note : National REDD+ Strategy (NRS) will be developed with support of UNDP through FCPF. PaMs monitoring in NFMS have a close relationship with NRS.
- Procedure : Developing PaMs monitoring after NRS development basically.

  However, In Kenya, the National Forest Programme 2016 – 2030 (NFP) was developed as the basis of forest policies. Therefore, how to monitor the degree of achievement of programme strategies of thematic clusters in NFP related to REDD+ activities has initially been considered.

4. Proposed NFMS in Kenya -Monitoring function-

Biodiversity monitoring

- Purpose : to provide the information on biodiversity for Safeguards Information System (SIS).
- Methodology: basically the monitoring through implementation of NFI based on ICFRA manual.
- Issues : to examine how KWS and NMK can contribute the monitoring activities to incorporate information/data into the NFMS to be obtained through biodiversity survey which will be conducted by KWS and NMK.

4. Proposed NFMS in Kenya -Monitoring function-

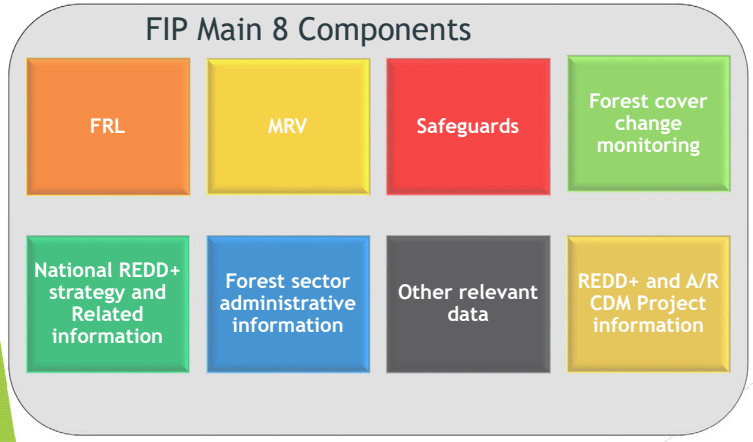
REDD+ and AR-CDM project

- Purpose : to avoid double counting of emission reduction for result-based payment by compiling greenhouse gas reduction efforts by REDD+ and AR-CDM projects in NFMS.
- Note : It can be contributed to nested approach of REDD+
- Method : The following data/information should be monitored by collecting them from each project proponent.

  Name of Project, Implementer, Location of the project (County, Sub-County, Location), Area (ha), Start date of the project, End date of the project (expected), Target emission reduction amount (CO2t), Actual emission reduction amount (CO2t), Quantities for which payments ware received (CO2t, Year), Entity paying for results, Kinds of activities, Monitoring method, and Pools measured

4. Proposed NFMS in Kenya –Data management function-

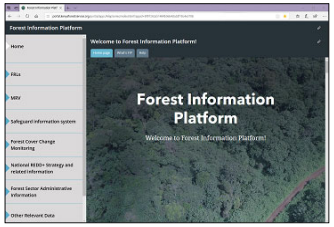
FIP as database in NFMS was developed with 8 components

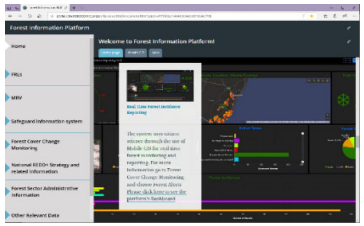


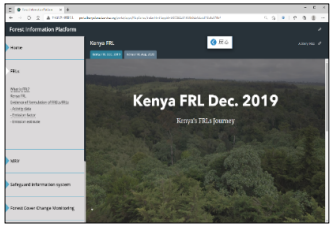
Concrete objectives of FIP, function of the FIP, Information to be operated in FIP, access right of each content, and system for update and operation of FIP should be mentioned in the NFMS document as well.

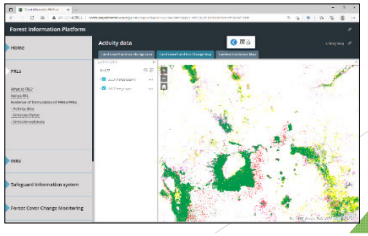
4. Proposed NFMS in Kenya –Data management function-

The FIP contents are classified in detail









4. Proposed NFMS in Kenya –Institutional Arrangement-

Institutional arrangement for implementation of monitoring function and data management function are illustrated in the NFMS document.

e.g.

Item	Activity/Data Type	Lead Institution	Mandated institutions	
			Institutions	Role
Forest cover area based on SLEEK programme	Creation, authorization and publication of the Land cover/Land use (LCLU) map	SLEEK	KFS	Creation of the LCLU map
			KEFRI	
			Survey of Kenya	
			DRSRS	
			JKUAT	Undertaking accuracy assessment on products developed (QA/QC)
			SLLEK	Authorization and publication of LCLU map
National forest inventory (NFI)	Implementation of the NFI	KFS	KFS	Carry out NFI
			KEFRI	Support NFI
			Universities	Carry out QA/QC
			County Government	Involvement to Forest Inventory

Note : institutional arrangement for implantation of monitoring will be also established in the NRS. Therefore, the institutional arrangement in the NFMS should harmonize the institutional arrangement to be mentioned in NRS.

4. Proposed NFMS in Kenya –Calendar of NFMS implementation-

Proposed Calendar

Year	Forest cover area and forest cover change area for AD	Forest Carbon stock for Emission factor	FREL/FRL	Submission of NC and BUR	Remarks
		NFI			
2017	Land cover/Land use map in Year 2000, 2014				
2018	The map in Year 2015				
2019	The map in Year 2018				
2020			○ (Period 2002-2018)		Paris Agreement came into force
2021	The map in Year 2020				
2022				BUR	
2023	The map in Year 2022	First NFI			
2024				NC/BTR	
2025	The map in Year 2024				
2026				BTR	
2027	The map in Year 2026				
2028		Second NFI		NC/BTR	
2029	The map in Year 2028				
2030				BTR	Finish year of Vision2030

Forest Information Platform for NFMS , REDD+ and SFM

7th July 2021

Table of Presentation

- FIP Objectives
- FIP Functional description
- FIP Basic Components
- FIP Main Functions
  - 1. FIP Site Map
  - 2. Management of Inventory Data
- FIP Development Schedule

Implementation Methods of REDD+ Readiness Component

[1] Activities on the NFMS and the Forest Information Platform

[2] Activity on various type of map creation

[3] Activities on FRL

[4] Activity on forest cover change monitoring in the whole of Kenya

[5] Activity on the MRV training

[6] Activities on pilot project for REDD+ (Contribution to Component 2)

Definition of the NFMS in Kenya

Defining the NFMS as methodology and the NFMS as a database (forest information platform)

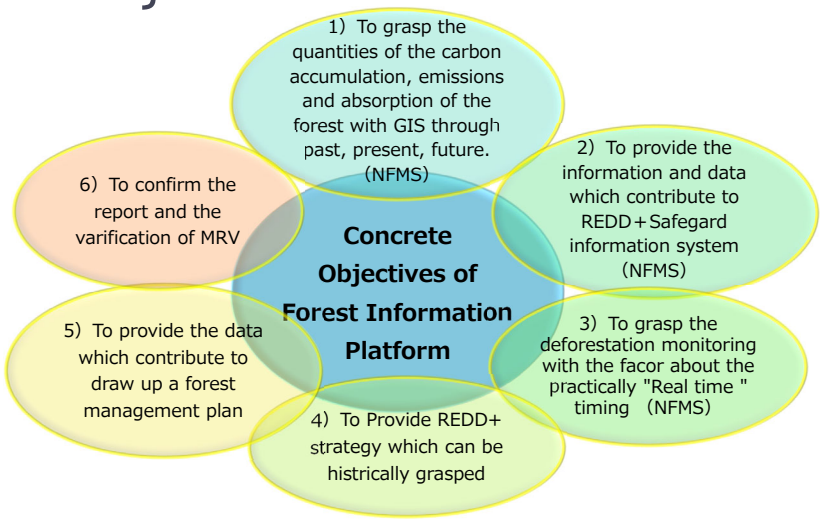
➢ **NFMS**

Methodology of how forests are monitored

➢ **Forest Information Platform**

A database to provide information that does not only include the information identified according to the NFMS but the information necessary for implementing REDD+ and sustainable forest management

FIP Objectives



FIP Functional description

To **replace KFIS's** functionality with the Web Portal Service with ArcGIS Enterprise

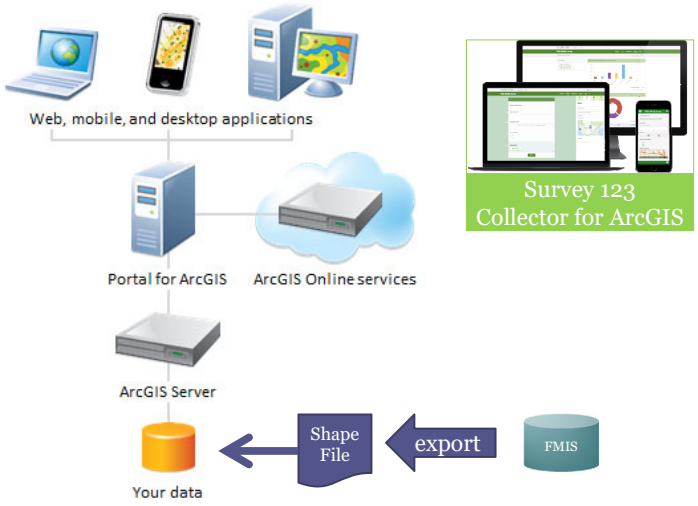
To use the Portal for ArcGIS Server with the limited access to the contents.

To utilize ArcGIS Online as the gateway to the accessible contents .

To support PDA devices for the data collection activities at the field

To support the other external system data with the static link.

FIP Basic Components



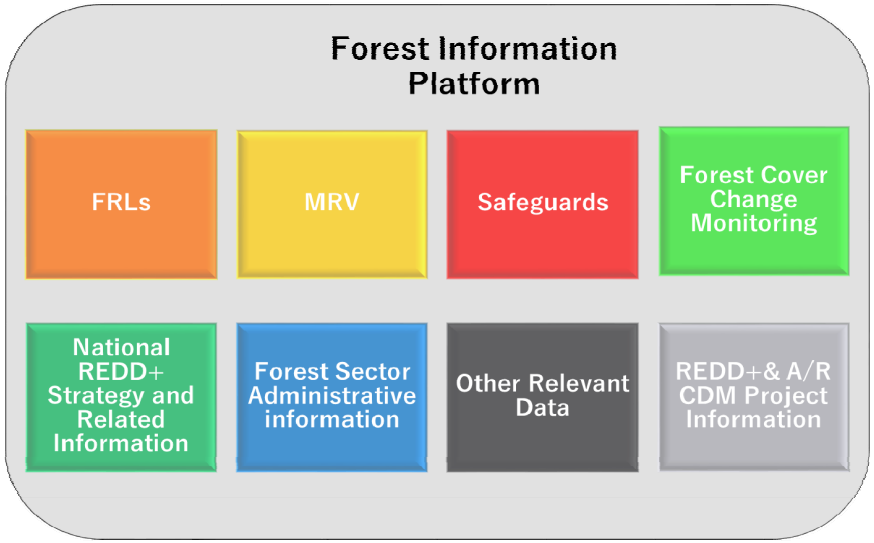
FIP Main Functions

1. FIP Site Map

2. Management of Field Survey Data

1． FIP Site Map

FIP Main 8 Components

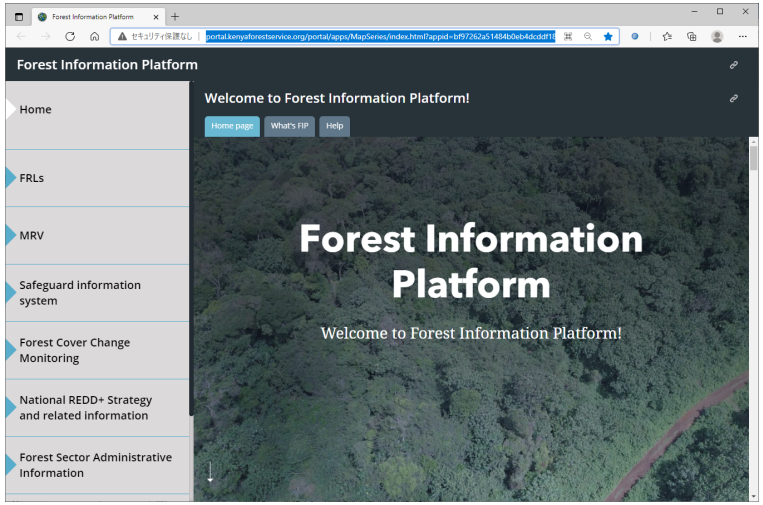


Contents type and persons to access FIP

- 4 type Contents
  ①Description：Explanation of Contents
  ②GIS data
  ③Table：The result of calculation or Inventory
  ④Document
- 2 type persons with access right on FIP and base data
  - FIP Administrator
  - General Citizen

Development of FIP

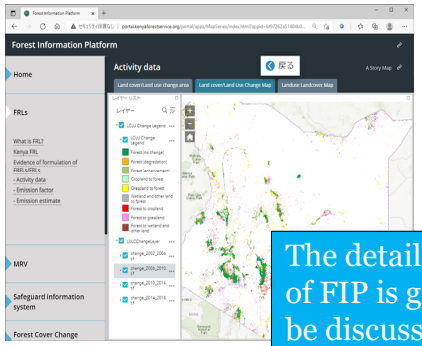
The FIP sample layout as sitemap have been developed

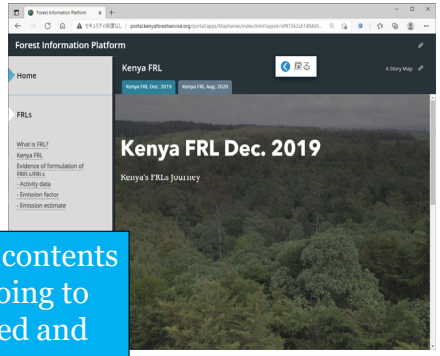


Development of FIP

Updating information on FIP including

- Shape file, Document data(word , pdf etc…), Table data like excel file





The detail contents of FIP is going to be discussed and decided

2． Management of Field Survey Data

Field Survey Data collection Tool: Survey 123

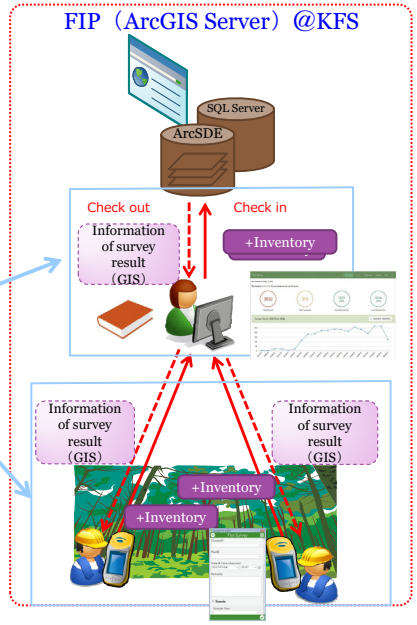
Survey 123

Survey 123 is the software based on ArcGIS Online Solution.

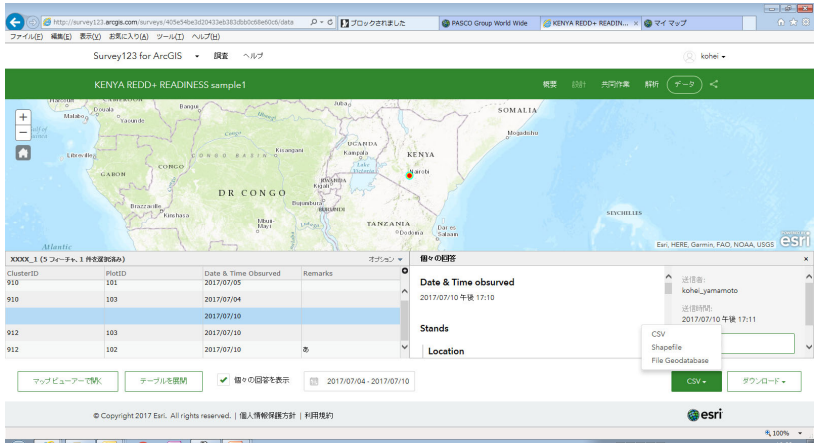
[The merit of Survey 123]

- Centralized management of inventory collect data using administrator's function
- Registration of location information referring Map and Satellite imagery.

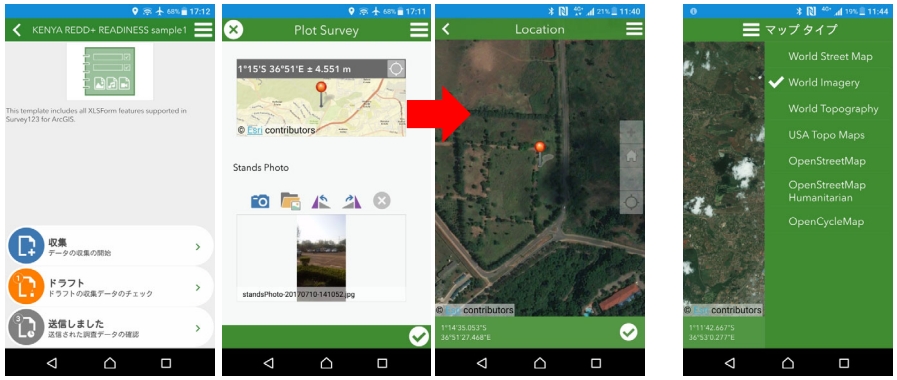
*Interface and function will be developed based on the function of ArcGIS Server



Sample application of survey 123 Administrator's tools



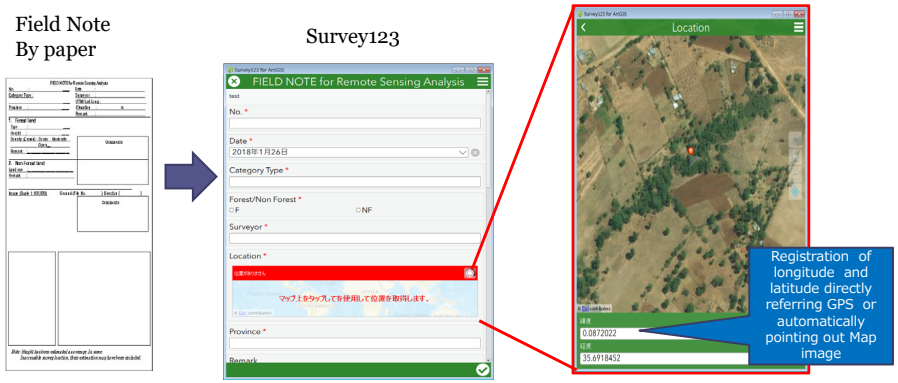
PDA Client



Development of Forest Inventory Collection Tool Based on Remote Sensing Analysis for this year

Field Note
By paper

Survey123

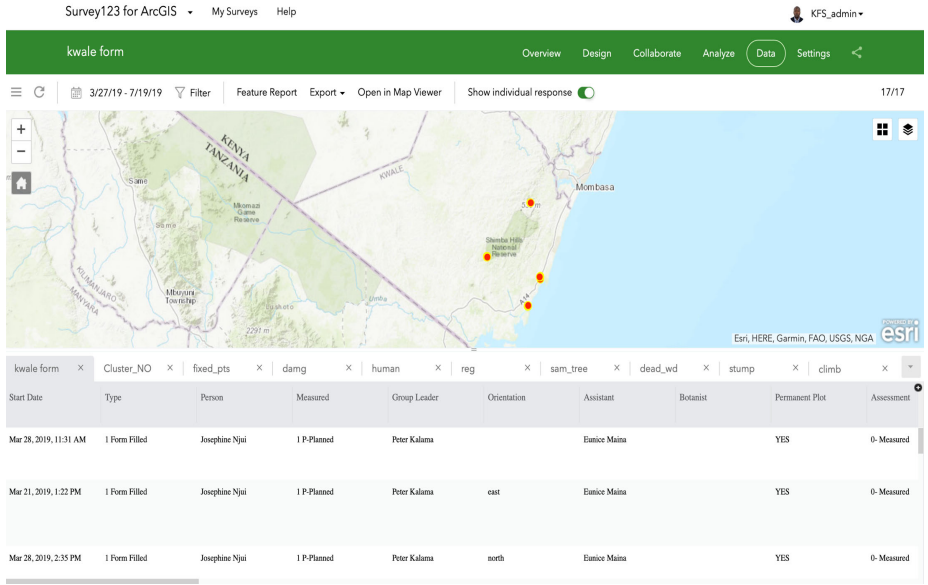


Field Survey Data collection Tool: Summary

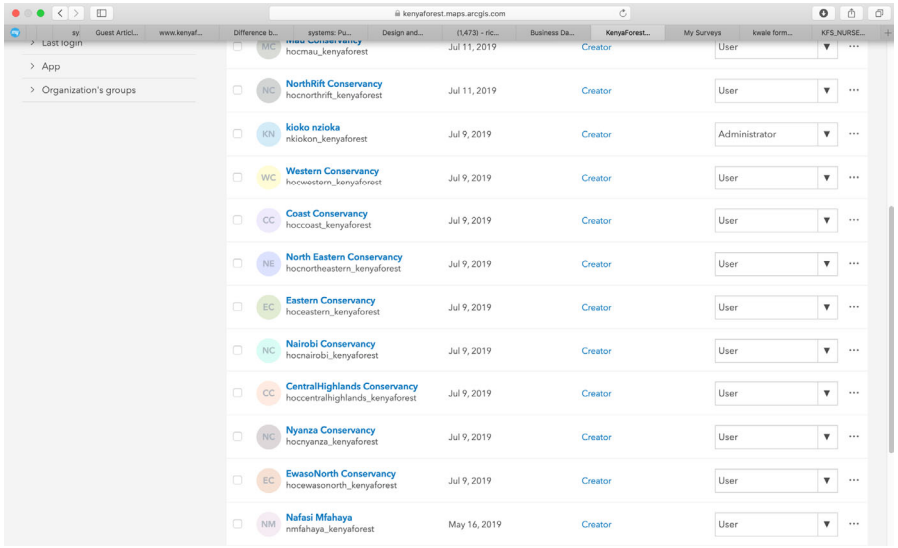
- Depending on the intended use of the field survey tool by the Kenya, Survey123 are preferred to utilize.

- For field survey of remote sensing or Patrol, Survey123 is preferred because of user friendly GUI and easy management of data.

Survey 123

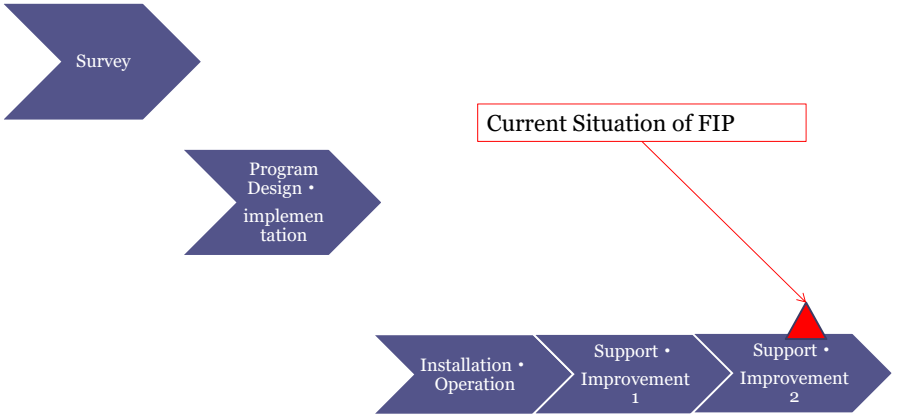


Survey 123



FIP Development Schedule

2016 2017 2018 2019 2020/21



Live DEMO

Questions Comments

- Thank you
- Merci
- Arigatogozaimas
- Gracias

Kenya's Forest Reference Level for REDD+ Implementation

MRV Training Nakuru

BACKGROUND

For a country to participate in REDD+

- National Forest Monitoring System (NFMS)
- National Strategy/ Action plan (NS/AP)
- Safeguard Information System (SIS)
- **Forest Reference Level (FRL)-**
  - **What is the historical trend of emissions so that it can be used as a reference point to judge whether the country is REDUCING EMISSIONS and therefore qualify for REDD+ PAYMENTS**
- **Has to be submitted to UNFCCC for review**

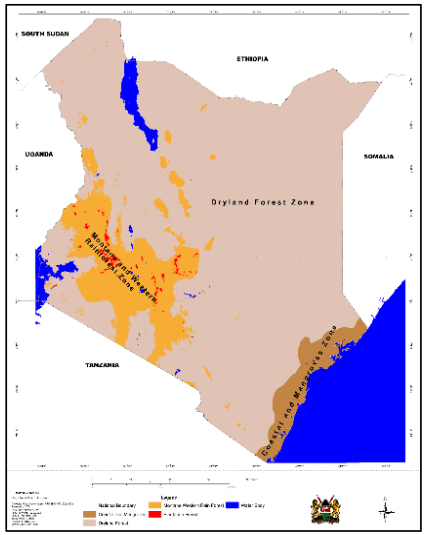
Global progress

https://redd.unfccc.int/fact-sheets.html

Some decisions that have guided development of the FRL

Discussion	Decision
Approach	National
FRL Activities	that reduce emissions and activities that increase removals thus adding the 'plus' to REDD to make it REDD+.
Pools	AGB and BGB only
Reference Period	2002- 2018 (monitored at 4 year intervals)
Gasses	CO2 only
Forest Definition	tree crown cover ≥ 15%, an area ≥ 0.5 ha and a tree height ≥ 2m.
Forest Strata	4 (Montane & Western Rain Forests, Coastal And Mangrove Forests, Dryland Forests, Public Plantations)
REDD+ Activities	Deforestation, forest degradation, Enhancement of carbon stocks (afforestation and canopy enhancement) and sustainable management of forests (Public plantation forests)
Projection	No Adjustment and based on the historical average

Stratification of the Forests



Forests have been categorized into strata/ecozones based on climate and Altitude (Wass, 1995)

- Montane Kenya (Mt Kenya, Mau, cherangany, aberdares, Mt Elgon, Leroghi, Matthews range etc) and Western Rain forests – (Kakamega & Nandi forests)
- Coastal (Arabuko sokoke, Boni, Shimba hills etc) and Mangrove forests
- Dryland forests – found in the dry areas
- Plantation forests – Described as management zone set aside by KFs for Public plantation forestry

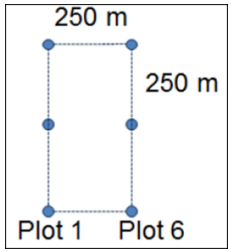
Step by Step Methodology

Sampling Design

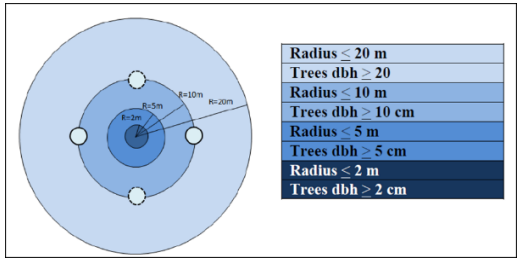
- Based on four strata
- A double stratified two-phase sampling method was used
- Design is systematic cluster sampling where 1st point is randomly selected in phase 1 while in phase 2 the generated points are stratified.
- Stratum for Sampling
  1. Dryland Forest
  2. Western and Rain Forest and Plantation Forest
  3. Coastal Forests and Mangrove Forests
  4. Public Plantation forests

tep by tep . ethodology

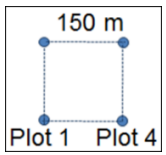
Cluster and Plot Design



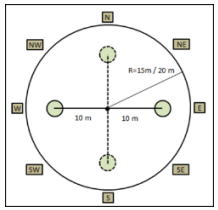
Cluster design for stratum 1 & 2



Plot design for stratum 1 - 3



Cluster design for stratum 3&4



Location of regeneration subplots (circle) and soil pits (rectangular).

tep by tep . ethodology

Points Collected in Pilot inventory

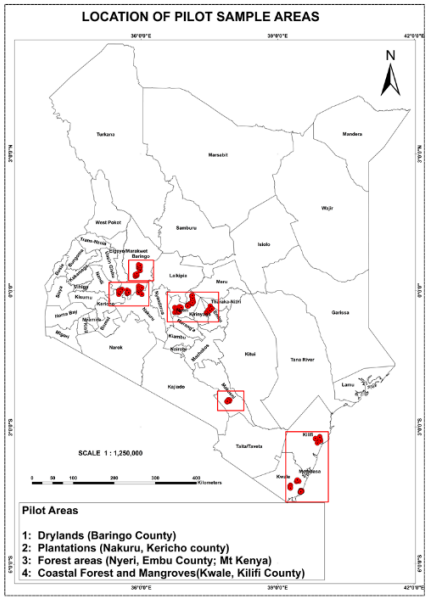
Pilot Areas

1: Dry lands/woodlands (Baringo County)

2: Plantations (Nakuru, Kericho county)

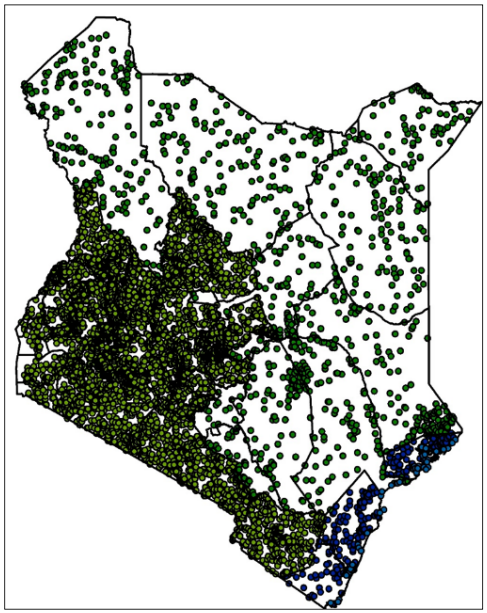
3: Natural Forest areas (Nyeri, Embu County; Mt Kenya)

4: Coastal Forests and Mangroves(Kwale, Kilifi County)



roposed . . .

- Total proposed sample plots 30,978 (approximately 5,000 clusters)



Assigning Activity Data to REDD+ Activities - Definitions

- Deforestation is conversion of Forests to Non forests in all canopy classes of Montane/Western Rain forest, Coastal and mangrove forests and Dryland forests and is indicated by Red colour
- Degradation is conversion of a forest from a higher canopy class to a lower canopy class for all forests in the strata/ecozones of Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests and is indicated by yellow colour
- Enhancement of Carbon stocks is the conversion of Non forests into forests (afforestation and reforestation) and the improvement of forests from a lower canopy class to a higher canopy class in the strata/ecozones of Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests and is indicated by green colour.
- Sustainable management of forests is the conversion of non-forests into forests and sustainable harvesting (forests into non forests) in public plantation forest areas managed by Kenya Forest Service (KFS) and is indicated by blue colour. This aims at reducing backlogs by replanting and increasing productivity of the public plantation forests.

Assigning Activity Data to REDD+ Activities - Definitions

- Forestlands remaining forestland in the strata/ecozones of Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests which were mapped with a canopy remaining in the same canopy level in the two mapping years (2002 and 2018) do not imply any carbon stock changes and have not been assigned any colour. Similarly plantation forests that did not change in the two time instances (2002 and 2018) do not imply any carbon stock changes and have not been assigned any colour.
- Conversions among non-forests e.g. cropland converted to wetland do not imply any emissions and have not been assigned any colour

Land cover change Matrix

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					
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)
n No Change (F→F)
dg Forest Degradation (F→F(Degraded))
s Sustainable Management of Forest (F→NF, NF→F)
e Enhancement (F→F(Improved) ,NF→F)
NA Not Available

Example - Land cover changes 2002-2018

			2018												
			Montane & Western Rain Forest			Costal and Mangroves Forest			Dryland Forest			Plantation	Cropland	Grassland	Wetland	Settlement & Otherland
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
2002	Montane & Western Rain Forest	Dense	772,025	46,912	16,427								167,916	111,437	457	1,039
		Moderate	60,757	59,277	12,190								30,410	53,521	389	87
		Open	23,898	17,630	21,139								13,581	77,873	36	131
	Costal and Mangrove Forest	Dense				84,317	32,686	739					3,747	46,315	712	301
		Moderate				80,975	85,893	3,609					14,242	155,399	1,256	984
		Open				6,195	12,707	367					3,056	15,696	72	126
	Dryland Forest	Dense							216,624	56,911	27,255		50,285	342,844	2,887	4,614
		Moderate							110,576	81,909	27,881		26,971	203,209	2,601	1,828
		Open							40,230	28,313	40,490		10,496	270,156	2,138	5,646
	Plantation											47,740	22,816	8,587	20	17
	Cropland		72,777	8,191	5,583	809	731	127	21,260	8,752	7,273	8,631				
	Grassland		119,848	67,872	50,280	93,653	82,323	12,861	432,319	219,841	202,697	8,652				
	Wetland		238	66	15	555	565	49	2,522	1,074	1,302	20				
	Settlement and Other land		550	143	497	201	284	11	2,921	1,992	9,180	13				

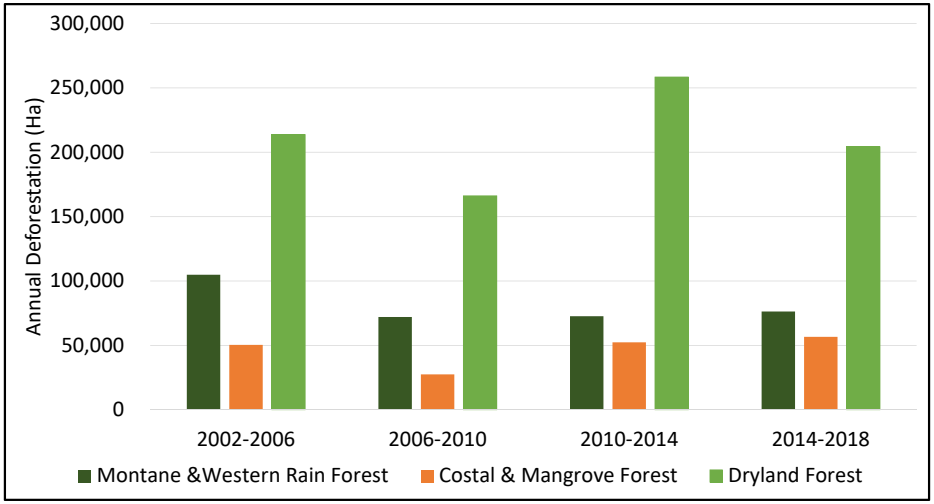
Area of Forestlands remaining Forestlands

Forest strata	Area (ha) of Forestland that remained forestland					Percentage of forestland (based on national land area) that remained forestland				
	2002-2006	2006-2010	2010-2014	2014-2018	Average	2002-2006	2006-2010	2010-2014	2014-2018	Average
Montane &Western Rain Forest	1,067,639	1,033,823	1,081,420	1,086,615	1,067,374	1.80	1.75	1.83	1.84	1.80
Costal & Mangrove Forest	347,841	375,728	365,710	320,549	352,457	0.59	0.63	0.62	0.54	0.60
Dryland Forest	698,714	774,168	820,364	744,965	759,553	1.18	1.31	1.39	1.26	1.28
Plantation	62,292	61,183	64,384	56,315	61,044	0.11	0.10	0.11	0.10	0.10
Total	**2,176,487**	**2,244,903**	**2,331,878**	**2,208,444**	**2,240,428**	**3.68**	**3.79**	**3.94**	**3.73**	**3.78**

Annual Transition Deforestation Vs Afforestation

Forest strata	Area (ha) of Deforestation					Area (ha) of Afforestation				
	2002-2006	2006-2010	2010-2014	2014-2018	Average	2002-2006	2006-2010	2010-2014	2014-2018	Average
Montane &Western Rain Forest	104,874	72,059	72,648	76,322	81,476	63,605	84,547	77,621	67,426	73,300
Costal & Mangrove Forest	50,388	27,463	52,359	56,664	46,719	34,435	49,855	45,374	44,777	43,610
Dryland Forest	213,787	166,164	258,443	204,279	210,668	185,027	269,992	185,429	199,089	209,884
Total	369,049	265,687	383,450	337,265	338,863	283,068	404,394	308,424	311,292	326,794

The Annual Deforestation Rates among strata



Annual Transition Forest Degradation vs Canopy improvement

Forest strata	Area (ha) of Forest Degradation					Area (ha) of Forest enhancement by Canopy improvement				
	2002-2006	2006-2010	2010-2014	2014-2018	Average	2002-2006	2006-2010	2010-2014	2014-2018	Average
Montane &Western Rain Forest	29,655	16,622	19,108	20,461	21,461	18,124	29,473	25,976	15,104	22,169
Costal & Mangrove Forest	9,168	7,634	5,874	22,830	11,377	29,287	12,714	15,138	6,032	15,793
Dryland Forest	18,689	21,016	24,572	43,316	26,898	43,220	29,955	29,353	24,878	31,852
Total	57,512	45,272	49,555	86,607	59,736	90,631	72,142	70,467	46,013	69,813

Annual Transition rates for Plantation forests

Forest strata	Area (ha) of Sustainable Management of forests				
	2002-2006	2006-2010	2010-2014	2014-2018	Average
Harvested area	4,222	3,039	3,155	6,298	4,178
Planted area	2,762	3,955	4,280	2,185	3,296
Net (Deficit/backlog)	-1,460	916	1,125	-4,113	-882

EMISSION FACTORS

Example of Pilot NFI data

		Tree	bamboo	Climber	Total	Tree	bamboo	Total	Total	Tree	bamboo	Total	Total	Total	Total		
Vegetatio	D/M/O	m3ha	bm3ha	cm3ha	cm3ha	above_bic	bbiomass	AGB	AGB C sto	Below_bic	Below_bic	BGB	BGB C sto	Biomass	C stock to	county	district
Montane	Dense	263.89	1.61		265.49	208.38	0.98	217.24	102.10	77.10	0.36	80.38	37.78	297.62	139.88	Nyeri	Nyeri
Montane	Dense	1,513.97	-	-	1,513.97	1,146.39	-	1,146.39	538.80	424.16	-	424.16	199.36	1,570.56	738.16	Nyeri	Nyeri
Montane	Dense	105.90	-	-	105.90	87.87	-	87.87	41.30	32.51	-	32.51	15.28	120.38	56.58	Nyeri	Nyeri
Montane	Dense	195.91	-		195.91	160.50	-	163.67	76.92	59.39	-	60.56	28.46	224.22	105.38	Nyeri	Nyeri
Montane	Dense	246.38	-	-	246.38	200.15	-	200.15	94.07	74.05	-	74.05	34.81	274.20	128.88	Nyeri	Nyeri
Montane	Dense	361.74	-	-	361.74	288.13	-	288.13	135.42	106.61	-	106.61	50.11	394.74	185.53	Nyeri	Nyeri
Montane	Dense	646.28	-	-	646.28	511.25	-	511.25	240.29	189.16	-	189.16	88.91	700.41	329.19	Nyeri	Nyeri
Montane	Dense	532.79	-		532.79	427.02	-	429.13	201.69	158.00	-	158.78	74.63	587.91	276.32	Nyeri	Nyeri
Montane	Dense	72.25	-	-	72.25	60.93	-	60.93	28.63	22.54	-	22.54	10.59	83.47	39.23	Nyeri	Nyeri

Allometric equations were used to convert measured parameters to Biomass

Emission Factors - Deforestation

- Deforestation which is conversion of a forest to a non-forest in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests .
  - Instantaneous Oxidation was assumed for all deforestation. Therefore the EF is the difference between the CO_2 value of the initial forest strata/canopy class and the CO_2 value of the non-forest
  - All forest conversions into Croplands, Wetlands and Settlements & Otherlands attain a CO_2 value of Zero after conversion. The EF is the difference between the CO_2 of the former forest and zero
  - All forest conversions into Grasslands attain a CO_2 value of 14.99 Tonnes/ha after conversion. The EF is the difference between the CO_2 of the former forest and 14.99 Tonnes/ha

NB: No data on HWP - Most of the activities that convert forests to non-forests may result to instantaneous oxidation)

Emission Factors – Forest Degradation

- Forest Degradation is the conversion of a forest from a higher canopy class to a lower canopy class in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests
  - Instantaneous Oxidation was assumed for all degradation. Therefore the EF is the difference between the CO_2 value of the initial forest canopy class and the CO_2 value of the new forest canopy class within a strata

NB: Data on drivers of degradation is not reliable enough to estimate emissions as shown in a preliminary study to this work - Options For Estimating GHG Emissions/Sinks From Forest Degradation, Forest Fires And Forest Revegetation. A Report To Support Establishment Of Kenya's Forest Reference Level

Emission Factors in sustainable management of forests

- In Sustainable management of forest which is the conversion of non-forests into forestlands in areas designated as Plantation zones, EF were calculated as follows
  - A stock change method was applied and the EF calculated as the difference between the CO_2 value of the pervious non-forest to the CO_2 value of a plantation based on growth rate.
  - A Conversion of a cropland, Wetland and Settlements & Otherlands into a forestland changes carbon stocks from a zero CO_2 value to a CO_2 value to 87.56 Tonnes/ha
  - A conversion of a grassland to a forestland changes carbon stocks from a CO_2 value of 14.99 Tonnes/ha

Emission Factors in afforestation

- Enhancement of Carbon stocks due to conversion of non-forests into forests in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests was calculated as follows
  - A growth factor was adopted for each strata to give the amount of CO_2 gained in a planted/young forest (in this case a forest that is less than 20 years) in the 4 year period.
  - In case the calculation of growth results to a stock which is more than the stock factor of the specific canopy class, a capping was done to retain the stock of the specific canopy class.
  - The EF for conversion of Croplands, Wetlands and Settlements & Otherlands into forestlands was the difference between zero and the CO_2 value after growth of 4 years
  - The EF for conversion of grasslands into Forestlands was the difference between a CO_2 value of 14.99 Tonnes/ha and the CO_2 value of the forest after 4 years of growth

Emission Factors in canopy improvement

- Enhancement of Carbon stocks due to improvement of Canopy in forests from a lower canopy class to a higher canopy class in Montane/Western Rain forests, Coastal and mangrove forests and Dryland forests was calculated as follows
  - A growth factor was adopted for each strata to give the amount of CO_2 gained in an existing forest (in this case a forest that is more than 20 years) in the 4 year period
  - The EF was calculated as the difference between the previous CO_2 value (for year 2002) and the new CO_2 value after forest enhancement (year 2018). In case the calculation of growth results to a stock which is more than the stock factor of the specific canopy class, a capping was done to retain the stock of the specific canopy class.

CALCULATION OF CO2 EQUIVALENTS

Forest strata	Canopy Coverage	ABG	BGB	TOTAL		
		Biomass stock (Tonnes/ha)	Biomass stock (Tonnes/ha)	Biomass stock (Tonnes/ha)	Carbon Stock (Tonnes/ha)	CO_2 (Tonnes/ha)
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	Plantation	324.79	87.69	412.48	193.87	710.84
Cropland		0	0	0	0	0
Grassland					8.7	14.99
Wetland		0	0	0	0	0
Settlements & Otherlands		0	0	0	0	0

Choice of stock change emission factors – Tier 2 and tier 3

1. Stock was obtained from Pilot NFI and allometric equations as simple average of plot data for each strata – tier 3
2. Shoot Root based on IPCC guidelines per forest biome
3. Carbon fraction for AGB and BGB is from IPCC = 0.47
4. CO_2 Calculated from molecular formula of 44/12 (IPCC guideline)
5. The Cropland Carbon Factor obtained from IPCC default values for tier 1 reporting: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Chapter 5 (Cropland) Table 5.8: Default Biomass Stocks Present On Cropland , After Conversion From Forestland
6. The Grassland Carbon Factor obtained from IPCC default values for Tropical Dry Grasslands: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Chapter 6 (Grassland) Table 6.4: Default Biomass Stocks Present On Grassland , After Conversion From Other Land Use
7. Default factors from Wetland, Settlement & Otherlands from IPCC tier 1 reporting

Choice of Root /shoot Ratios

Forest strata	Root shoot ratio	Source in IPCC 2006 guidelines
Montane	0.37	Table 4.4. for Tropical rainforest
Dryland	0.28	Table 4.4. above-ground biomass >20 tonnes ha^{-1}
Coastal and Mangrove	0.2	Table 4.4. above-ground biomass <125 tonnes ha^{-1} for Tropical moist deciduous forest
Plantation	0.27	Table 4.4. for Tropical Mountain systems

Emission Factors for Calculating sequestration due to afforestation (based on IPCC for forests Less than 20yrs)

Forest strata	Biomass gain (Tonnes)			Carbon from Biomass	CO_2 sequestered (Tonnes/	
	IPCC table 4.9 equivalent ABG value	BGB	Total		One year	4 years
Montane	10	3.70	13.70	6.44	23.61	94.44
Dryland	2.4	0.67	3.07	1.44	5.29	21.16
Coastal	5	1.00	6.00	2.82	10.34	41.36
Plantation	10	2.70	12.70	5.97	21.89	87.56

Emission Factors for calculation Sequestration due to Canopy enhancement (Based on IPCC for forests more than 20 yrs)

Forest strata	Biomass gain (Tonnes)			Carbon from Biomass	CO_2 sequestered (Tonnes/	
	IPCC table 4.9 equivalent ABG value	BGB	Total		One year	4years
Montane	3.1	1.15	4.25	2.00	7.32	29.28
Dryland	1.8	0.50	2.30	1.08	3.97	15.88
Coastal	1.3	0.26	1.56	0.73	2.69	10.76
Plantation	10	2.70	12.70	5.97	21.89	87.56

Results

ADOPTED Emission factors for various REDD+ activities

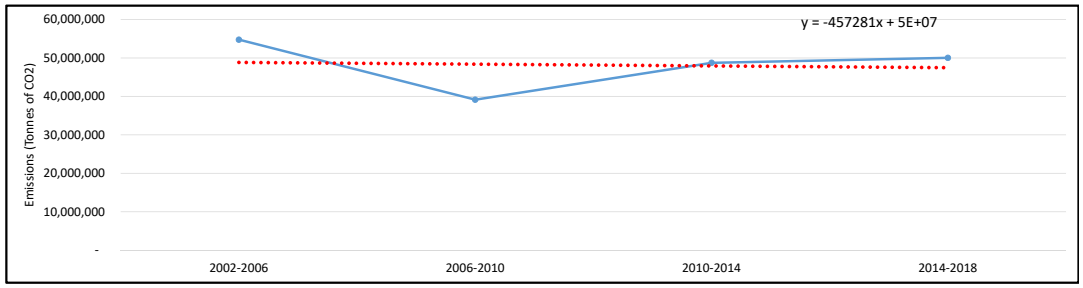
			End Year												
			Montane &Western Rain Forest			Coastal & Mangroves Forest			Dryland Forest			Plantation	Cropland	Grassland	Wetland	Settlement & Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
Start year	Montane &Western Rain Forest	Dense	0	440.00	534.72								577.95	562.96	577.95	577.95
		Moderate	-29.28	0	94.73								137.96	122.96	137.96	137.96
		Open	-29.28	-29.28	0								43.23	28.24	43.23	43.23
	Coastal & Mangroves Forest	Dense				0	86.61	146.04					195.69	180.69	195.69	195.69
		Moderate				-10.75	0	59.44					109.08	94.09	109.08	109.08
		Open				-10.75	-10.75	0					49.64	34.65	49.64	49.64
	Dryland Forest	Dense							0	17.44	62.13		93.60	78.60	93.60	93.60
		Moderate							-15.88	0	44.69		76.15	61.16	76.15	76.15
		Open							-15.88	-15.88	0		31.47	16.47	31.47	31.47
	Plantation											0	710.84	695.85	710.84	710.84
	Cropland		-94.44	-94.44	-43.23	-41.36	-41.36	-41.36	-21.18	-21.18	-21.18	-87.55				
	Grassland		-79.45	-79.45	-28.24	-26.37	-26.37	-26.37	-6.18	-6.18	-6.18	-72.55				
	Wetland		-94.44	-94.44	-43.23	-41.36	-41.36	-41.36	-21.18	-21.18	-21.18	-87.55				
	Settlement & Other land		-94.44	-94.44	-43.23	-41.36	-41.36	-41.36	-21.18	-21.18	-21.18	-87.55				

Calculated emissions (CO_2 Tonnes) for 2002-2006

			2006													
			Montane &Western Rain Forest			Coastal & Mangroves Forest			Dryland Forest			Plantation	Cropland	Grassland	Wetland	Settlement & Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open	Dense				
2002	Montane &Western Rain Forest	Dense	0	33,402,790	14,952,439	0	0	0	0	0	0	0	63,970,436	71,655,345	144,916	256,958
		Moderate	-1,079,014	0	1,396,195	0	0	0	0	0	0	0	2,355,007	8,840,448	21,194	34,144
		Open	-734,972	-308,355	0	0	0	0	0	0	0	0	360,219	2,339,276	759	11,540
	Coastal & Mangroves Forest	Dense	0	0	0	0	957,251	465,807	0	0	0	0	480,910	6,577,554	95,791	121,980
		Moderate	0	0	0	-1,083,064	0	1,333,070	0	0	0	0	1,002,960	12,324,488	47,025	113,301
		Open	0	0	0	-129,630	-47,079	0	0	0	0	0	74,933	632,966	1,072	6,353
	Dryland Forest	Dense	0	0	0	0	0	0	0	560,352	1,329,447	0	3,606,220	23,672,823	180,967	230,717
		Moderate	0	0	0	0	0	0	-1,705,968	0	948,998	0	1,313,196	13,483,713	175,828	142,251
		Open	0	0	0	0	0	0	-683,703	-356,075	0	0	272,758	4,091,434	45,693	335,808
	Plantation			0	0	0	0	0	0	0	0	0	3,019,518	8,782,822	6,589	6,398
	Cropland		-3,500,587	-351,190	-114,753	-12,418	-24,117	-4,203	-343,535	-35,565	-115,221	-483,208		0	0	0
	Grassland		-8,255,667	-5,803,365	-936,099	-1,384,632	-1,090,906	-1,077,714	-2,121,493	-816,374	-1,414,338	-400,154		0	0	0
	Wetland		-19,387	-5,729	-1,004	-21,221	-23,838	-15,210	-47,195	-37,433	-38,861	-890		0	0	0
	Settlement & Other land		-43,653	-6,077	-2,081	-10,996	-6,455	-4,761	-36,156	-28,809	-84,815	-347		0	0	0

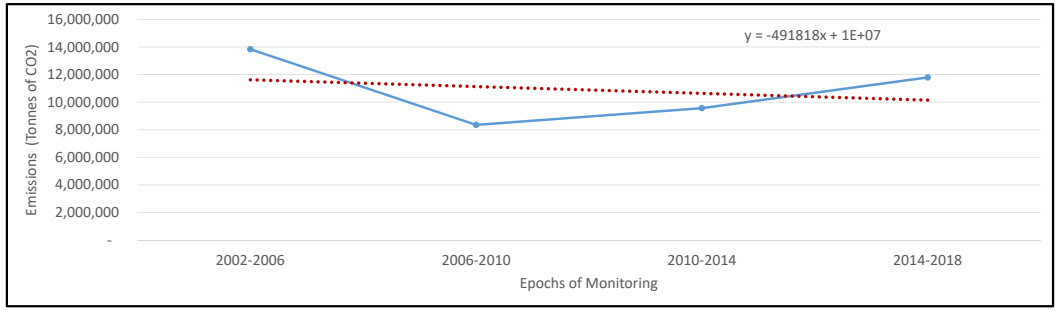
Historical annual emissions from Deforestation

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	average
Montane &Western Rain Forest	37,497,560	26,953,329	27,609,168	28,425,689	30,121,437
Costal & Mangrove Forest	5,369,833	2,838,459	6,066,685	8,997,887	5,818,216
Dryland Forest	11,887,852	9,351,299	15,060,281	12,609,716	12,227,287
Total	**54,755,246**	**39,143,087**	**48,736,134**	**50,033,292**	**48,166,940**



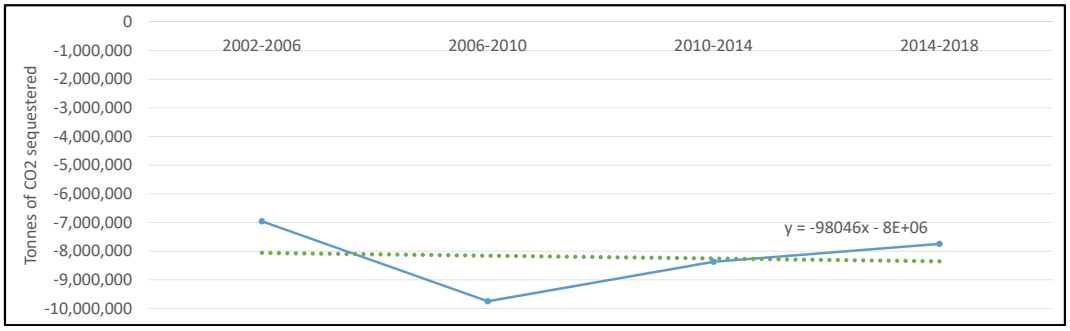
Historical annual emissions from Forest Degradation

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	average
Montane &Western Rain Forest	12,437,856	6,904,687	8,171,469	8,356,545	8,967,639
Costal & Mangrove Forest	689,032	658,228	507,708	1,983,662	959,657
Dryland Forest	709,699	787,686	884,652	1,452,579	958,654
Total	**13,836,587**	**8,350,601**	**9,563,829**	**11,792,785**	**10,885,950**



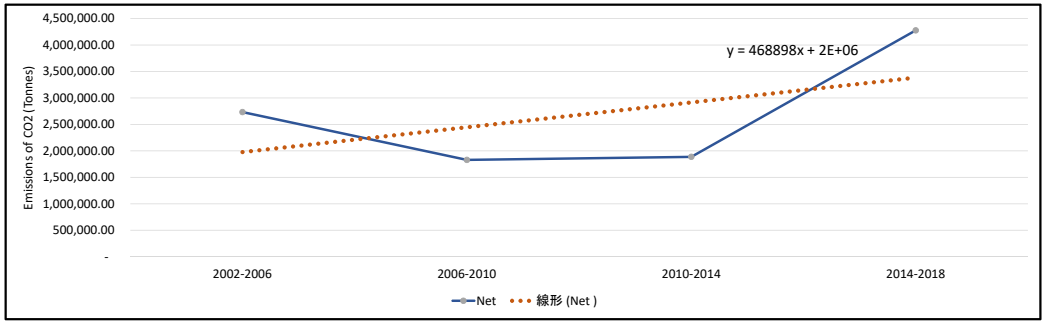
Historical annual sequestration from Afforestation

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	average
Montane &Western Rain Forest	-4,759,898	-6,407,901	-5,807,682	-5,113,591	-5,522,268
Costal & Mangrove Forest	-919,118	-1,344,367	-1,215,551	-1,204,155	-1,170,798
Dryland Forest	-1,279,949	-1,996,239	-1,345,866	-1,427,843	-1,512,474
Total	**-6,958,965**	**-9,748,507**	**-8,369,099**	**-7,745,589**	**-8,205,540**



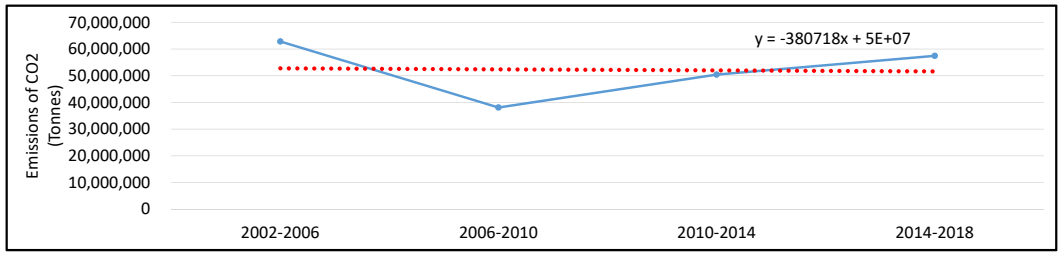
Historical annual emissions from Forest Plantations

Forest strata	Emissions (Tonnes of CO_2)				
	2002-2006	2006-2010	2010-2014	2014-2018	Average
Harvesting	2,953,832	2,130,667	2,217,234	4,449,483	2,937,804
Replanting	-221,150	-301,355	-329,799	-173,181	-256,371
Net	**2,732,682**	**1,829,312**	**1,887,435**	**4,276,302**	**2,681,433**



Historical annual NET emissions – Kenya's FRL

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**



Uncertainty of the FRL

Uncertainty of AD

- Land cover change analysis done to generate change data – Activity data
- Accuracy assessment was done using collect earth on the random points generated in the change

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2			2006			2010			2006 - 2010			
3	V_ID_No	LCLU CODE	Reference	Remark	LCLU CODE	Reference	Remark	LCLU Chang	Result	Actual	Check	
13	10	OTH	GL		FM	OTH		OTFM	FALSE	GLOT	OK	
14	11	OTH	OTH		FM	OTH		OTFM	FALSE	OTOT	OK	
15	12	OTH	FO		FM	FM		OTFM	FALSE	FO2M	OK	
16	13	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK	
17	14	FD	OTH		FD	OTH		FD2D	FALSE	OTOT	OK	
18	15	FD	GL		FD	GL		FD2D	FALSE	GLGL	OK	
19	16	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK	
20	17	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK	
21	18	FD	GL		FD	GL		FD2D	FALSE	GLGL	OK	
22	19	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK	
23	20	FD	FD		FD	FD		FD2D	TRUE	FD2D	OK	

Using Olofsson, et al, (2013) formula shown below, the table show here was generated

$$S(\hat{p}_{\cdot j}) = \sqrt{\sum_{i=1}^{q} W_i^2 \frac{\frac{n_{ij}}{n_{i\cdot}}\left(1-\frac{n_{ij}}{n_{i\cdot}}\right)}{n_{i\cdot}-1}}.$$

Summary

Uncertainty (%) of Change map 2002-2006	
Overall Accuracy	41.05
Overall Uncertainty	4.94
Limits	41.05%±4.94%
Uncertainty (%) of Change map 2006-2010	
Overall Accuracy	51.9
Overall Uncertainty	4.03
Limits	51.9%±4.03%
Uncertainty (%) of Change map 2010-2014	
Overall Accuracy	35.75
Overall Uncertainty	2.17
Limits	35.75%±2.17%
Uncertainty (%) of Change map 2014-2018	
Overall Accuracy	30.01
Overall Uncertainty	2.15
Limits	30.01%±2.15%

$$\frac{4.94^2}{41.05^2}+\frac{4.03^2}{51.9^2}+\frac{2.17^2}{35.75^2}+\frac{2.15^2}{30.01^2}$$

Average uncertainty of Ad = 0.029 equivalent to 2.9%

Uncertainty of EF

Strata	Canopy Class	Mean (AGB)	Std Dev	No Samples	Uncertainty	Uncertainty of mean
Montane & Western Rain Forest	Dense	244.80	157.94	8	126.46	44.71
	Moderate	58.43	34.64	7	116.20	43.92
	Open	23.26	13.64	6	114.94	46.92
Coastal & Mangrove forest	Dense	94.63	45.03	18	93.27	21.98
	Moderate	60.45	31.90	12	103.43	29.86
	Open	35.47	34.03	16	188.04	47.01
Dryland Forest	Dense	42.43	32.11	8	148.33	52.44
	Moderate	34.52	15.01	8	85.22	30.13
	Open	14.26	6.89	7	94.70	35.79
Plantation	Plantation	324.79	249.38	36	150.49	25.08

This data does not conform to a minimum sampling size for Uncertainty analysis. A bootstrap simulation was done and Uncertainty calculated as 24.7%

Uncertainty of FRL

The Error propagation formula used

$$SD\,CO_2 = \sqrt{\overline{Total_{carbon}}^{2}_{1\to2}\left[\left(\frac{SD^2_{Emissions_{factor}}}{\overline{Emissions_{factor}}^{2}_{1\to2}}\right)+\left(\frac{SD^2_{Activity_{data}}}{\overline{Activity_{data}}^{2}_{1\to2}}\right)\right]}$$

Filling in numbers

$$Uncertainty\ of\ the\ FRL = \sqrt{52{,}204{,}059^2 * [(0.247^2 + (0.029^2)]}$$

Results

The Uncertainty of this Submission is ± 12,984,983. This implies that the FRL is 52,204,059 ± 12,984,983 t CO2/year:

External validation using the FLINT

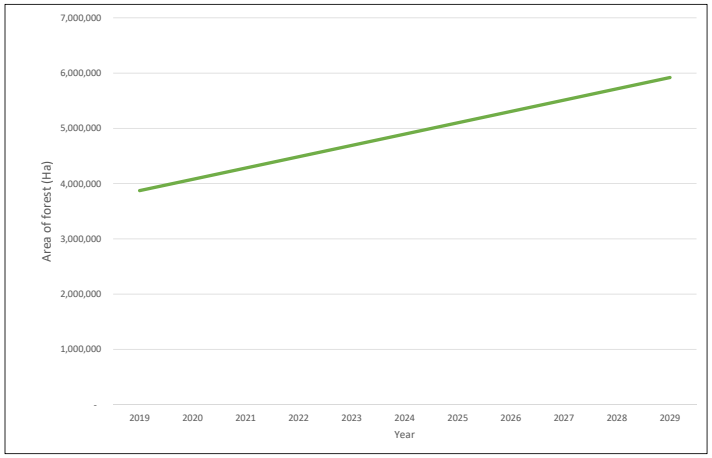
Description	Average CO2 tonnes	% change
FREL Assumptions with Kenyan Forest Strata, V2 (2002 & 2018) - 16yr Interval	22,068,707	54%
FREL Assumptions with Kenyan Forest Strata, V2 (2002, 2006, 2010, 2014 & 2018) - 4yr Interval	**47,460,285**	**0%**
FREL Assumptions with Kenyan Forest Strata, V2(2002, 2004, 2006, 2008, 2010, 2012, 2014 & 2018) - 2yr Interval	70,393,449	-48%
FREL Assumptions with Kenyan Forest Strata, V2 (all years 2002-2018) - 1yr Interval	104,044,728	-119%
Tier 2 Time Series with all Kenya Forest Strata, V2 (all years 1990-2018) - Full	39,390,373	17%

What is the future of Forest Cover in Kenya?

Increase with forest conservation?

- Implementation of forest Policies
- Conservation policies
- Climate change policies
- Land conservation policies
- More tree planting in farms
- More trees in dryland areas
- Devolved management systems

Illustration of Vision 2030 targets based on current forest maps

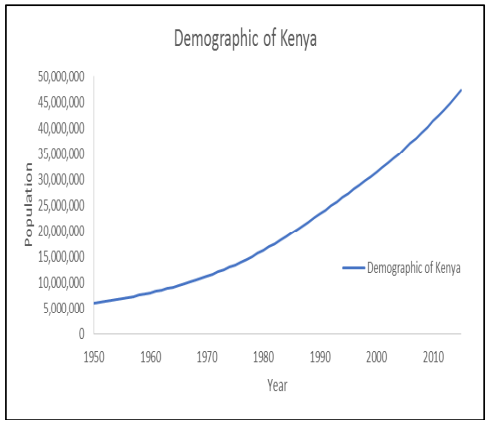


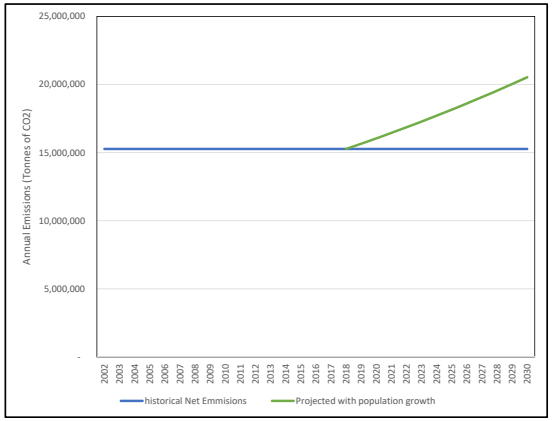
If we increase forest cover today by 204,727 ha without losing any forest to other non forest uses, we will attain the vision 2030 goal of 10% forest

Hindrances/Barriers to forest increase

- Increasing population and their associated developmental needs
- Agricultural expansion
- Urban expansion including infrastructure
- Improved access to formerly pristine forests
- Conflicts of natural resource use
- Weak Enforcement

An illustration of Kenya's population growth and how it may increase forest related emissions

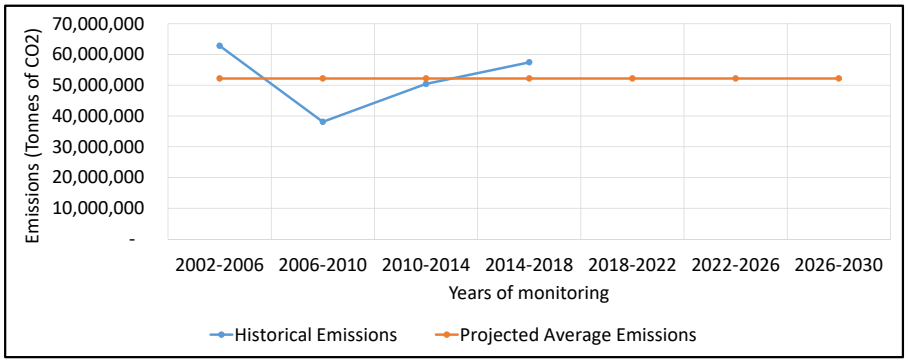




Projected Emissions

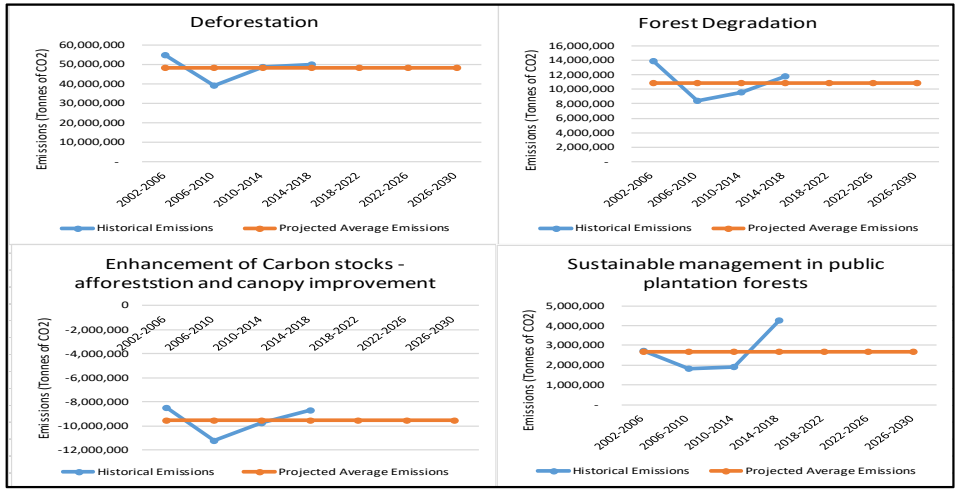
(based on historical average without adjustment)

Projection of Net emissions



2002-2006	2006-2010	2010-2014	2014-2018	2018-2022	2022-2026	2026-2030
54,755,246	39,143,087	48,736,134	50,033,292	47,713,595	47,256,314	46,799,033

Projections of emissions by REDD+ Activity



Projections of emissions by REDD+ Activity

REDD+ Activity	2002-2006	2006-2010	2010-2014	2014-2018	2018-2022	2022-2026	2026-2030
Deforestation	48,166,940	48,166,940	48,166,940	48,166,940	48,166,940	48,166,940	48,166,940
Degradation	10,885,950	10,885,950	10,885,950	10,885,950	10,885,950	10,885,950	10,885,950
Sustainable management of forest	2,681,433	2,681,433	2,681,433	2,681,433	2,681,433	2,681,433	2,681,433
Enhancement	-9,530,264	-9,530,264	-9,530,264	-9,530,264	-9,530,264	-9,530,264	-9,530,264
Total (Emission estimates (Net))	52,204,059	52,204,059	52,204,059	52,204,059	52,204,059	52,204,059	52,204,059

Summary

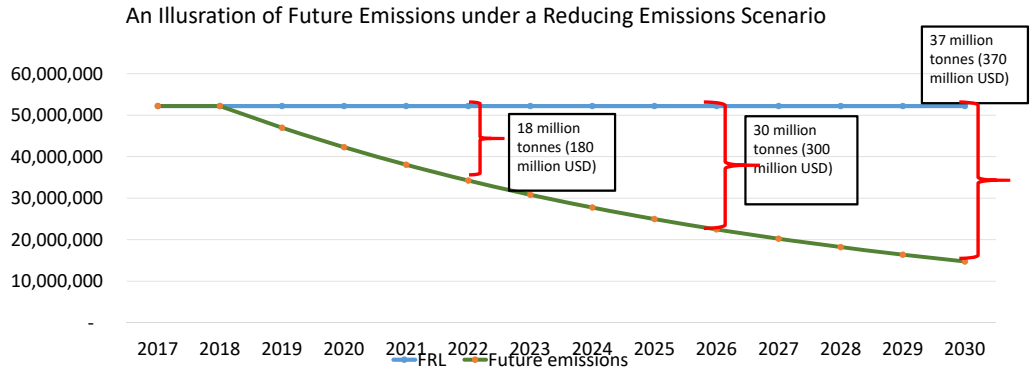
The Forest Reference Level is the

Benchmark against which the success of Reducing Emissions from our forests will be measured

Mizani ambayo itatumika kupima ufanisi wetu katika kupunguza Hewa ya mkaa inayoingia angani tunapoharibu misitu yetu

NEXT steps….

- The efforts will be illustrated in a reduction Emissions from the current historical average of 52,204,059 Tonnes of CO2 per year to a lesser value and justify Kenya's qualification for Results based payments



REDD+ STRATEGIC OPTIONS

REPUBLIC OF KENYA

MONITORING REPORTING AND VERIFICATION

FRL Setting in Kenya (AD)

Date: 7th – 9th July, 2021, Alps Hotel, Nakuru, Kenya

Presented by: ***Faith*** *Mutwiri*

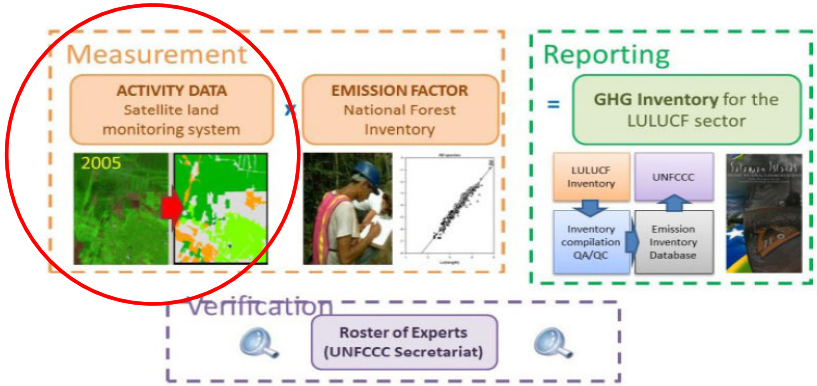
.ntroduction

- Kenya has already submitted FRL and is in the process of Developing NFMS.
- Functions of NFMS is Monitoring and MRV (Measurements, Reporting and Verification**)**
- MRV is more specific to REDD+ and measures;

1. Activity Data (AD) – Satellite Data Remote Sensing

2. Forest Carbon Stock measured through National Forest Inventory (NFI)

Measurement Reporting and Verification



Forest definition

Organizations (Main Contributors)	A single minimum tree crown cover value	A single minimum land area value	A single minimum tree height value
KFS, DRSRS, KEFRI, REDD+, SLEEK, NGHG Inventory	15%	0.5 ha	2 m

–Kenya's definition is informed by global reporting standards and is informed by FAO limits within which countries define their forests;

▪*Forestlands are areas occupied by forests and characterised by tree crown cover ≥ 15%, an area ≥ 0.5 ha and a tree height ≥ 2m. It also includes areas managed for forestry where trees have not attained 2m height but with potential to do so, and areas that are temporarily destocked.(KFS, 2013)*

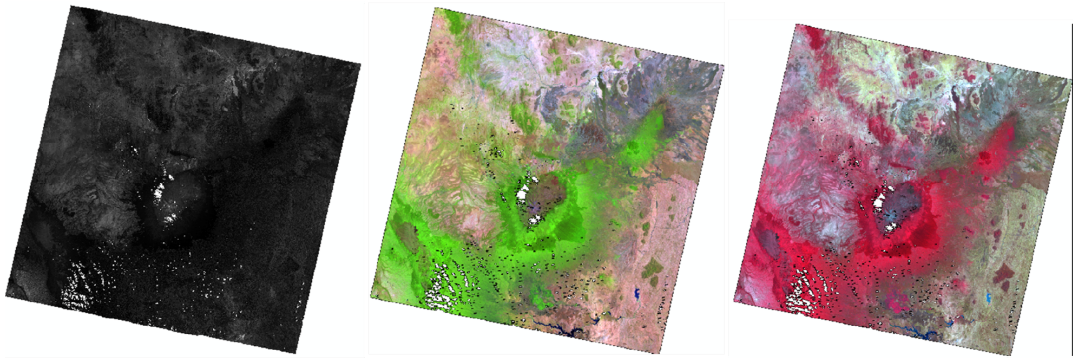
Activity Data generation

- Steps
  - Obtaining satellite images
  - Land Use Land Cover Mapping (including forest Cover mapping)
  - Forest cover changes (Loss or Gain)
  - Generating Activity Data

Satellite images

1. Despite variety of satellite images Kenya chose ***Landsat***

Landsat was selected because it is freely available, historical images are available, has medium resolution and it is already pre- processed.



Land Use Land Cover Classification

- **Land cover classes for LCC Mapping guided by the IPCC classification**

I. Forest
1. Dense Forest > 65% canopy cover
2. Moderate Forest 40 - 65% canopy cover
3. Open Forest 15 - 40% canopy cover

II. Cropland
1. Annual Cropland
2. Perennial cropland

III. Grassland
1. Open Grassland
2. Wooded grassland

IV. Wetland
1. Open Water
2. Vegetated wetland

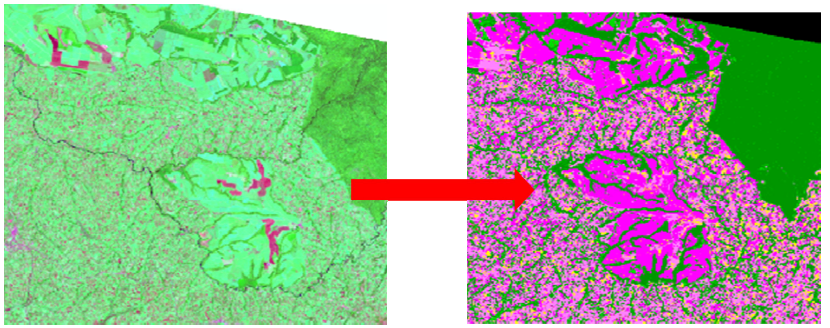
V. Settlement ***(use of Auxiliary Data)***

VI. Other lands

Mapping

2. Landuse Landcover Mapping

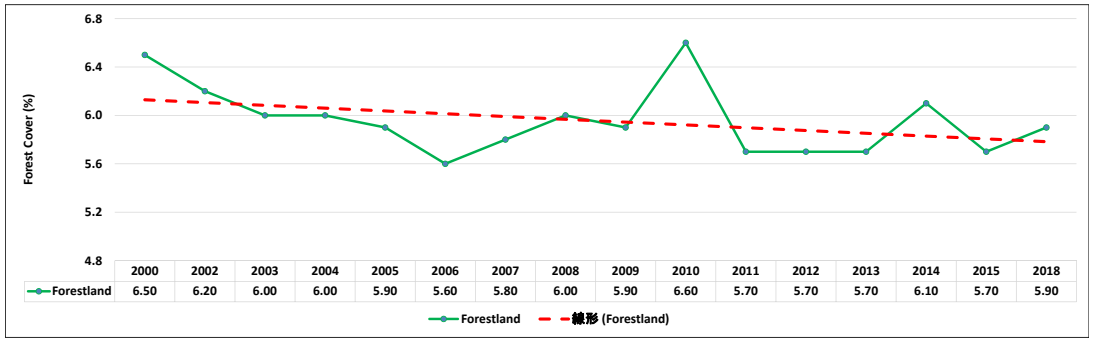
Landsat was selected because it is freely available, historical images are available, has medium resolution and it is already pre- processed.



Proportion Land Cover 2000 - 2018

Land Cover	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2018
Forestland	6.50	6.20	6.00	6.00	5.90	5.60	5.80	6.00	5.90	6.60	5.70	5.70	5.70	6.10	5.70	5.90
Grassland	72.70	71.70	72.90	71.20	72.10	70.20	69.60	70.10	70.90	69.40	70.10	70.70	68.70	69.60	71.00	69.70
Cropland	7.50	8.90	7.60	8.90	8.40	10.30	10.90	10.00	10.10	10.20	11.20	9.60	11.10	10.50	11.40	11.40
Wetland	2.00	2.10	2.10	2.10	2.10	2.10	2.20	2.00	2.10	2.10	2.10	2.20	2.00	2.10	2.10	2.00
Otherland	11.30	11.10	11.40	11.80	11.50	11.80	11.50	11.90	11.00	11.70	10.90	11.80	12.50	11.70	9.80	11.00
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

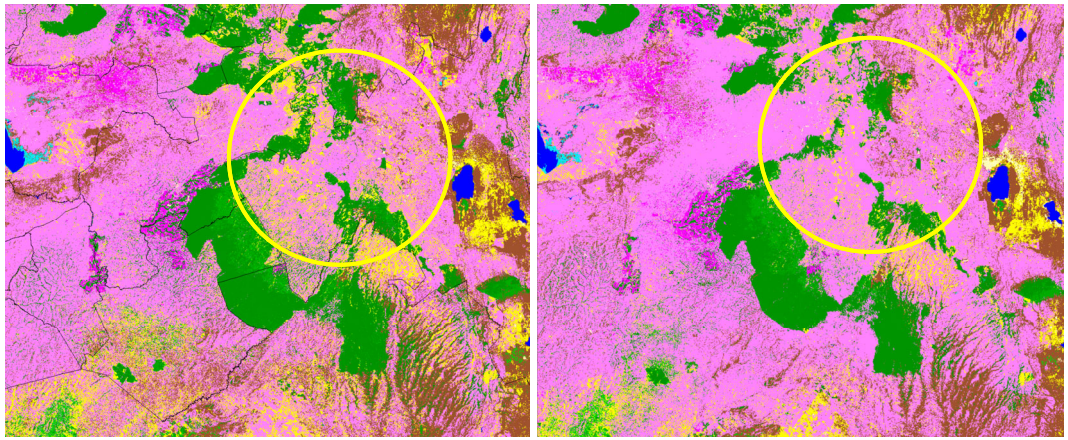
Trends in Forest cover 2000 - 2018



- Generally, forest cover has decreased over the years, 2006 being most depressed
- Most forest land loss is converted to cropland and other lands particularly settlements

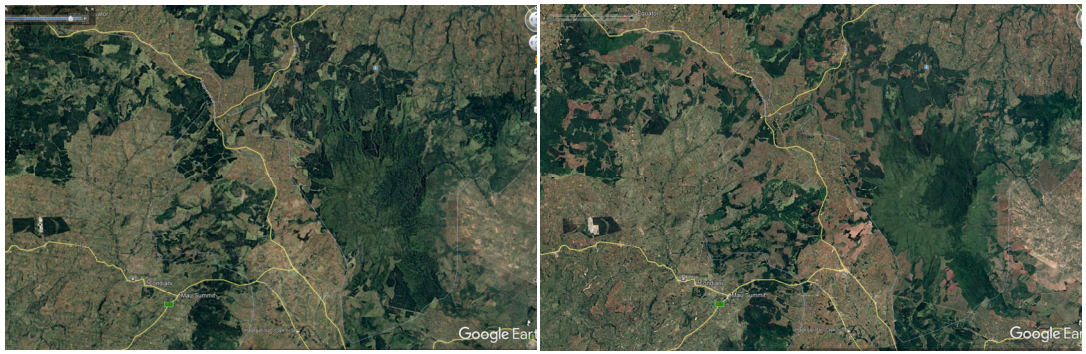
Changes

2. Forest Cover Changes
   - ***Has forest remained the same?? Have we lost forest – to what?***
   - ***Have we gained forest – from what?***



Changes

2010 2016



Activity Data

1. What are REDD+ Activities?

REDD+ Activities are generated from forest losses and gains in terms of Area. Kenya has taken 4 activities out of 5

Area in 20XX			Area in 20XX+(X)														
			Forest												Non Forest		
			Montane Forest/ Western Rain Forest/ Bamboo			Costal Forest and Mangroves			Dryland Forest			Plantation Forest			Grass land	Other Non-forest
			D	M	O	D	M	O	D	M	O	D	M	O		
Forest	Montane Forest/ Western Rain Forest/ Bamboo	D	n	dg	dg										df	df
		M	e	n	dg										df	df
		O	e	e	n										df	df
	Costal Forest and Mangroves	D				n	dg	dg							df	df
		M				e	n	dg							df	df
		O				e	e	n							df	df
	Dryland Forest	D							n	dg	dg				df	df
		M							e	n	dg				df	df
		O							e	e	n				df	df
	Plantation Forest	D										n	s	s	s	s
		M										s	n	s	s	s
		O										s	s	n	s	s
Non Forest	Grass land		e	e	e	e	e	e	e	e	e	s	s	s		
	Other non Forest		e	e	e	e	e	e	e	e	e	s	s	s		

df Deforestation (F→NF)
n No Change (F→F)
dg Forest Degradation (F→F(Degraded))
s Sustainable Management of Forest (F→F, F→NF, NF→F)
e Enhancement (F→F(Improved) ,NF→F)

Activity Data

Assigning Activity Data to REDD+ Activities

Table 4: Land use Change (No of ha) for each forest strata in the 2002-2006 epoch

2002 Forest strata			2006												
			Montane & Western Rain Forest			Costal & Mangrove Forest			Dryland Forest			Plantation forest	Cropland	Grassland	Wetland	Settlement & Otherland
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
Montane Forest & Western Rain Forest /		Dense	773,672	75,916	27,963								110,685	127,283	251	445
		Moderate	36,857	75,670	14,739								17,071	71,895	154	248
		Open	25,105	10,533	27,186								8,333	82,848	18	267
Costal & Mangrove Forests		Dense				114,602	11,053	3,190					2,458	36,401	490	623
		Moderate				100,716	77,558	22,429					9,195	130,990	431	1,039
		Open				12,055	4,378	1,861					1,509	18,267	22	128
Dryland Forest		Dense							303,805	32,124	21,397		38,529	301,166	1,933	2,465
		Moderate							107,414	84,438	21,236		17,244	220,465	2,309	1,868
		Open							43,048	22,420	62,831		8,668	248,377	1,452	10,672
Plantation forest												62,292	4,248	12,622	9	9
Cropland			37,067	3,719	2,655	300	583	102	16,223	1,679	5,441	5,520				
Grassland			103,916	73,048	33,153	52,514	41,374	40,874	343,099	132,028	228,734	5,515				
Wetland			205	61	23	513	576	368	2,229	1,768	1,835	10				
Settlement & Other land			462	64	48	266	156	115	1,707	1,360	4,005	4				

FOREST INVENTORY

BY

FREDRICK B. OJUANG

IS A QUANTITATIVE AND QUALITATIVE METHOD OF UNDERTAKING FOREST STOCK BY MEASURING AND ANALYZING INFORMATION

TYPES OF INVENTORY

1. Forest Inventory:

- Forest Management Inventory

- Forest Exploitation Inventory (Sales)

USED FOR:

1. PLANNING FOR FOREST MANAGEMENT UNITS

2. ANALYSIS AND (DETERMINATION) OF WOOD SUPPLY AND VOLUME YIELD

3. CALCULATION OF FOREST VOLUMES BY SAMPLING TEMPORARY OR PERMANENT PLOTS

4. IDENTIFICATION OF VOLUMES OF EACH TREE USING GIS AND REGISTER

METHODOLOGY:

1. Development of forest type maps using aerial photographs
2. 2. Carried out by counting (complete Enumeration) and comprehensive survey

2. NATIONAL FOREST INVENTORY

1. Carried out by statistical sampling method at country level
2. Actual measurement of fixed plots.
3. Offers advantage of chronological track
4. Carried at an interval of 5-10 years

OBJECTIVES

1. To collect forest data over the country using uniform definitions.
2. Accountability of global environmental issues
3. International reporting for the global conventions on climate change and Kyoto protocol,
4. Process for forest sustainable management and REDD+ etc.

TYPE OF PLOTS AND SHAPES

1.Temporary Sample Plot

2. Permanent Sample Plot

RECTANGULAR PLOT

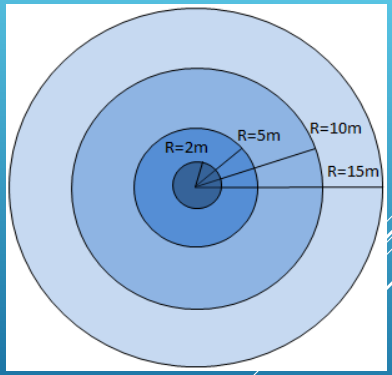
i. Has the advantage that the perimeter is a straight line.
ii. It is easy to see trees which are inside or outside the edge.
iii. Theoretically has more edge effect than circular plots.

CIRCULAR PLOT

i. Theoretically this is the shape that minimizes edge effect more
ii. You can easily determine whether a tree is inside or outside
iii. It is easy to change the plot radius and still maintain control, projection and area depending on the slope
iv. **But** You can easily allow trees which are on the edge to be counted inside if you do not check.

CIRCULAR PLOT (ICFRA)

Concentric Sample plot



- **Field Tree Measurements**

1. TREES, SHRUBS, REGENERATIONS, DEAD WOODS, STUMPS AND BAMBOOS
2. SPECIES, DIAMETER AT BREAST HEIGHT AND TREE HEIGHT

3. IN PERMANENT SAMPLE PLOTS - DIRECTION OF EVERY TALLY TREE, DISTANCE OF THE TALLY TREE FROM THE PLOT CENTRE, DIAMETER AT BREAST HEIGHT, BASE DIAMETER, TOTAL HEIGHT AND BOLE HEIGHT
4. THREE FIXED POINTS MARKED AND THEIR DIRECTIONS AND DISTANCES RECORDED FOR FUTURE REFERENCE AND IDENTIFICATION.

REGENERATION PLOTS.

1. The circular subplots with a radius of 1.5 m is placed along the East and west directions 10m away from the plot center
2. Each species is identified, enumerated and booked separately.

CONCENTRIC DESIGN

The sample plot has a 15m radius with four concentric sub-plots inside.

1. Large trees whose dbh ≥20cm are measured from a 15 m radius
2. Trees whose dbh ≥ 10cm are measured from a 10 meter radius subplot
3. Trees whose dbh ≥5cm are measured from 5meter radius
4. While trees whose dbh ≥2cm are measured from 2 meter radius
5. Seedlings of h ≥ 1.5m are enumerated per species within 2m concentric subplots.
6. Bamboo measurements are carried out within a 10 m radius
7. while lianas were measured from the 5m radius subplots. (ICFRA Field Manual, 2013)

THIS DESIGN AIMS AT INCREASING THE ACCURACY OF THE MEASUREMENTS AND SAMPLING INTENSITY OF LARGE TREES AND SIMULTANEOUSLY SAVING TIME.

1. THE DESIGN ENSURES THAT SMALL TREES ARE MEASURED IN SMALL PLOT AREA AND LARGE TREES IN LARGE PLOT AREA.

NB. TROPICAL AND SUBTROPICAL NATURAL FORESTS ARE CHARACTERIZED BY NEGATIVE EXPONENTIAL DIAMETER DISTRIBUTION WHEREBY MORE SMALL SIZE TREES AND THE NUMBER OF TREES DECREASES WITH INCREASING TREE SIZE.

END

Forest Inventory Tools & Equipment

BY

Fredrick B. Ojuang

DIAMETER MEASUREMENTS

1. Diameter tape
2. Caliper

i. The point of measurement is taken at 1.3m (DBH) consistently

ii. Place caliper at the right angle to the longitudinal axis of the tree

iii. Apply the correct pressure at the moment of measurement

iv. The bar of the caliper is pressed against the stem

v. For elliptical cross section of a stem, two caliper readings at right angles are taken and the average recorded.

Height measurement

1. Suunto

i. Hypsometer

ii. Clinometer

2. Vertex

3. Lacer Ace

4. Graduated pole (Extendable)

Graduated pole (Extendable)

1. Applicable where there are no Hypsometers
2. Very useful in measuring small trees in experimental plots
3. Useful in dry wood lands where trees are relatively short

Errors in Height Measurements

1. Incorrect identification of top and bottom of the tree
2. Incorrect estimation of horizontal distance
3. Mismatch of hypsometer scale and actual distance used- shorter distances than that of the scale will result in height over estimates and vice – versa.
4. A leaning tree towards the observer will cause an over estimates and vice- versa.

Dead wood Measurements

1. These are tree parts that are lying on the ground, usually the crew identifies the wood parts lying inside the plot.
2. The two diameters are measured and the length of the log
3. The species is identified

Other Equipment for Height Measurement

1. Vertex
2. Lacer Ace

Booking Materials

1. Tablets
2. Phones
3. PDAs
4. Tough pads – ragged tablets

END

Other Inventory Equipment

1. GPS
2. Silver compass
3. Suunto compass
4. Densiometer

Working with Survey 123

8th Jul. 2021

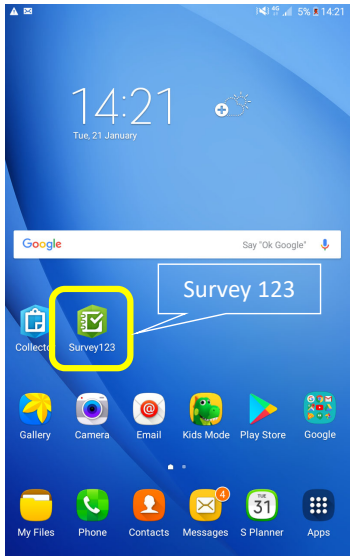
Kenya Forest Service

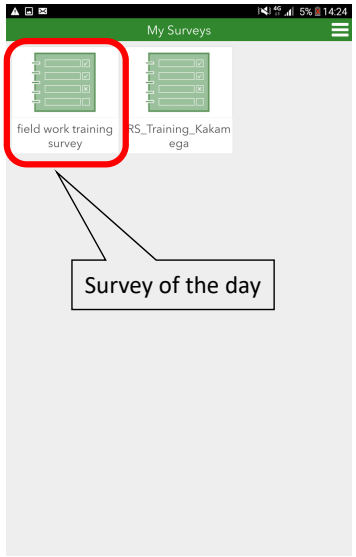
CADEP

Colleting information

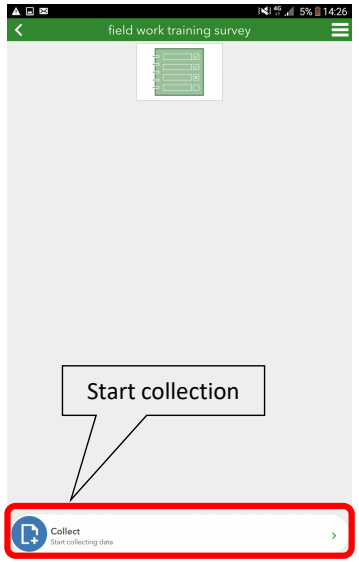
- Plot information
  - Group ID
  - Survey date
  - Coordination of Central cluster
  - County name
  - Forest strata
  - Canopy Cover (Center, North, South, East, West)
- Trees in plot zone
  - Radius (Target trees are depends on distance and their DBH)
  - Tree no. / Stem no.
  - DBH
  - Height (Every 3-5 trees)

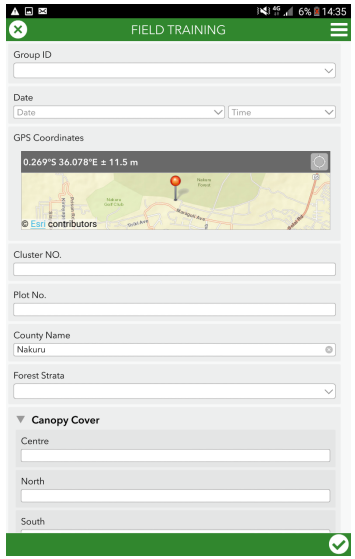
Start Survey 123 and select survey



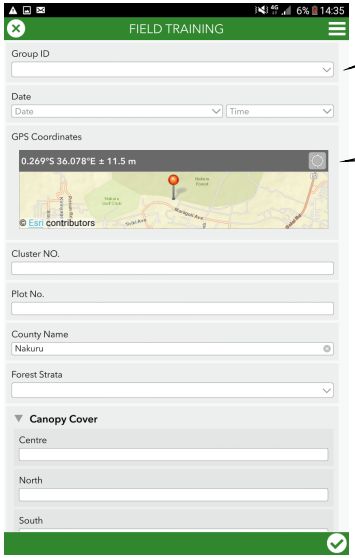


Start your survey





Plot information (input once)



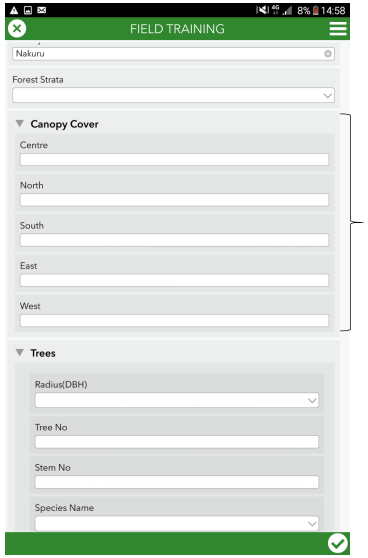
Select your group

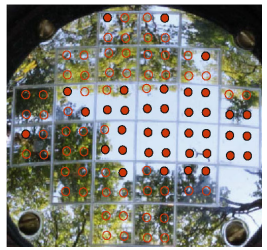
Get coordination in the center (tap this mark)

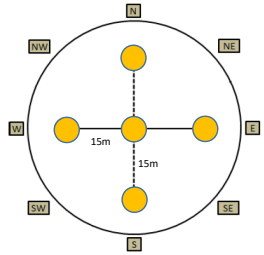
Getting signal

Not accessing to GNSS (Position anchored)

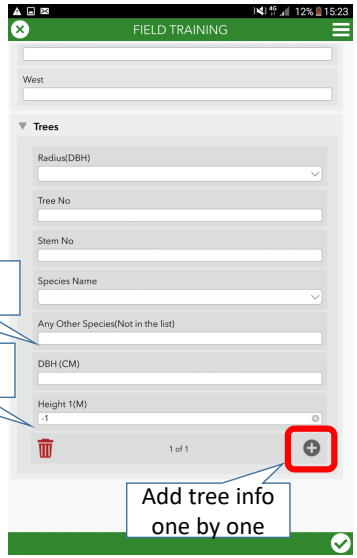
Plot information -Canopy Cover-







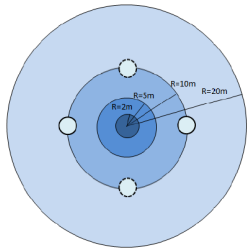
Tree information (all target trees)



DBH (mm) (not cm)

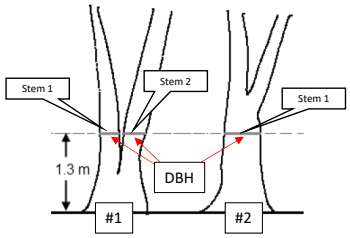
Every 3-5 trees (not all)

Add tree info one by one



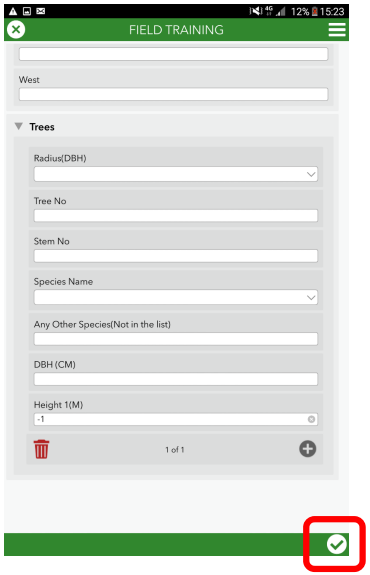
Target Tree

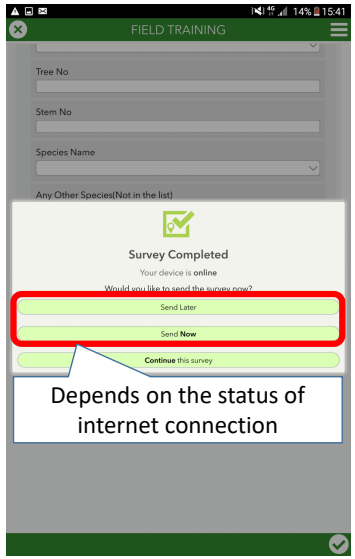
Radius ≤ 20 m
Trees dbh ≥ 20
Radius ≤ 10 m
Trees dbh ≥ 10 cm
Radius ≤ 5 m
Trees dbh ≥ 5 cm
Radius ≤ 2 m
Trees dbh ≥ 2 cm



Tree No., Stem and DBH

Upload the data (end of survey)





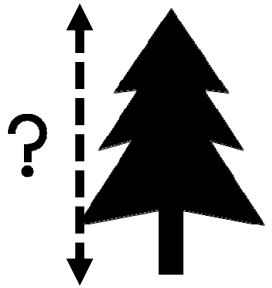
Depends on the status of internet connection

How to use the devices (Manual of Vertex IV)

CADEP-SFM
Yoshihiko SATO

Contents

- What is Vertex IV
- How to use Vertex
  1. Start/End the Transponder
  2. To measure Horizontal Distance
  3. To measure tree Height



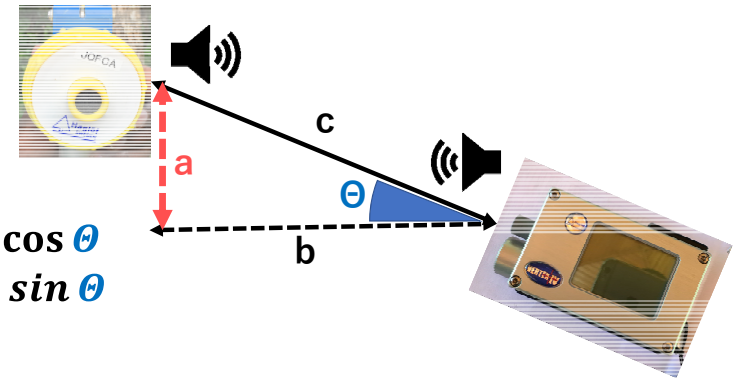
What is Vertex IV

- The Vertex IV is primarily designed to measure the height of standing objects, and most often trees.
- The instrument can also be used to measure distance, horizontal distance, angle and inclination.
- The Vertex instrument has with its ultrasonic measuring technique

Left : Vertex IV
Right : Transponder T3

What is Vertex IV

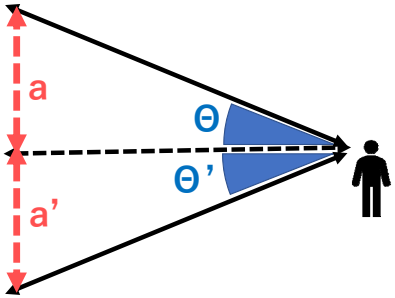
Ultrasonic waves :Distance measurement (c)
Decline (of Vertex IV) :Degree measurement (Θ)



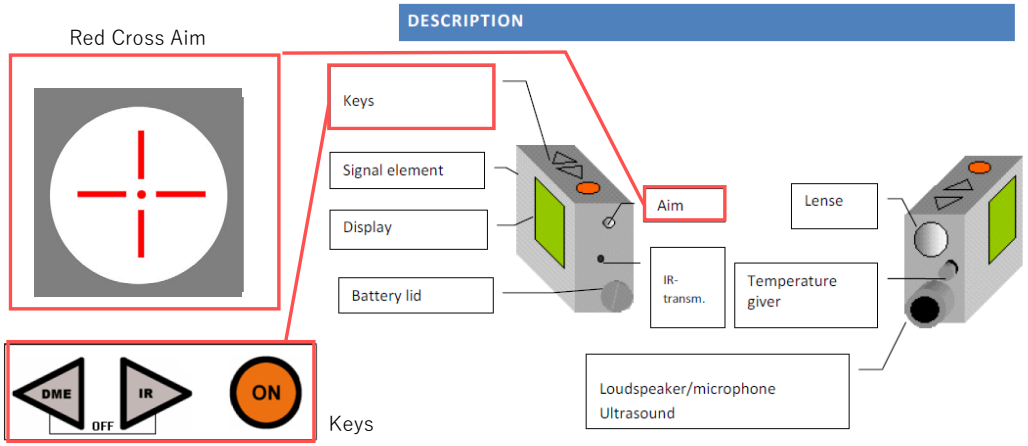
$$b = c \times \cos\theta$$
$$a = b \times \sin\theta$$

What is Vertex IV

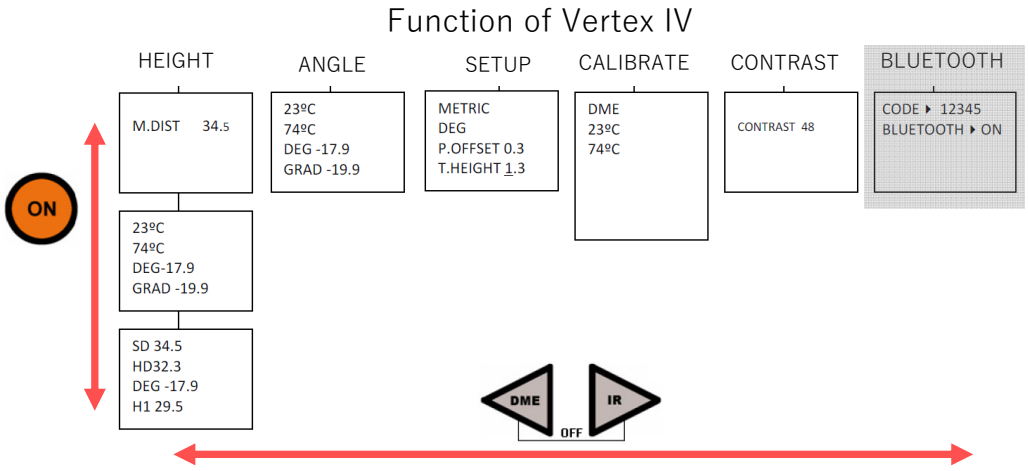
Urtrasonic waves (from Tranponder) :Distance measurement (c)
Decline (of Vertex IV) :Degree measurement (Θ)



What is Vertex IV

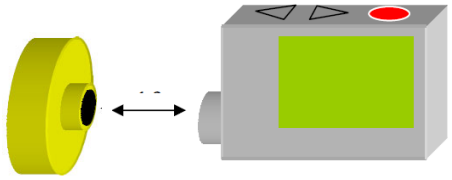


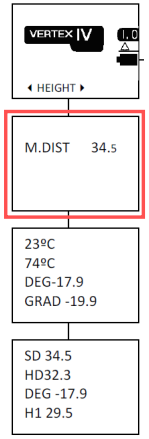
What is Vertex IV



To Use Vertex

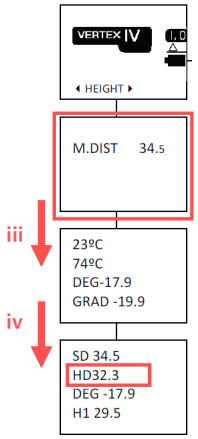
1. Start/End the Transponder
   i. Turn on Vertex
   ii. Set Vertex at "M.DIST" in HEIGHT
   iii. Turn on Transponder (trigger "ON" key until 2 signals beep)
   iv. Turn off Transponder (trigger "ON" key until 4 signals beep)





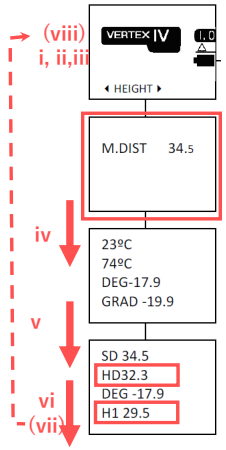
How to use Vertex

2. To measure Horizontal Distance (HD)
   i. Set Transponrder at 1.3m height
   ii. Set Vertex at “M.DIST” in “HEIGHT”
   iii. trigger “ON” key to aim at Transponder for few seconds until 3 signals beep of Transponder
   iv. trigger “ON” key to aim at Transponder until red cross goes out



How to use Vertex

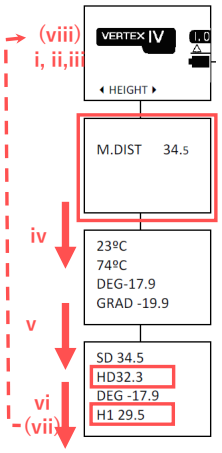
3. To measure Trees Height
   i. Walk To see the top of tree for a suitable distance from the object – for optimal result accuracy, a distance equal to the approximate height.
   ii. To set Transponrder at 1.3m height
   iii. Set Vertex at “M.DIST” in “HEIGHT”
   iv. trigger “ON” key to aim at Transponder for few seconds until 3 signals beep of Transponder



How to use Vertex

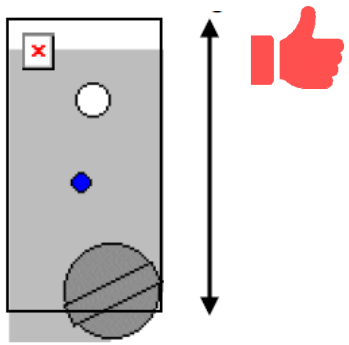
3. To measure Trees Height
   v. trigger “ON” key to aim at Transponder until red cross goes out for getting “HD”
   vi. trigger “ON” key to aim at the top of tree until red cross goes out for getting “H”
   vii. Repeat iv. for 2/3 times for accuracy, “H2”, “H3”,,,,
   viii. Turn off Vertex (Press “DME”key and “IR”key)

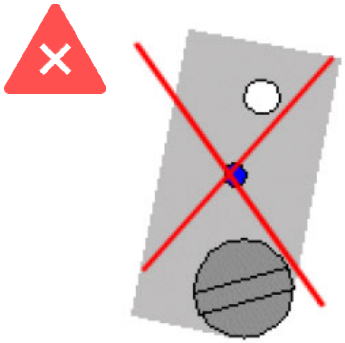
Move to next tree



Attention!!!

When measuring heights, it is important to hold the instrument as straight as possible



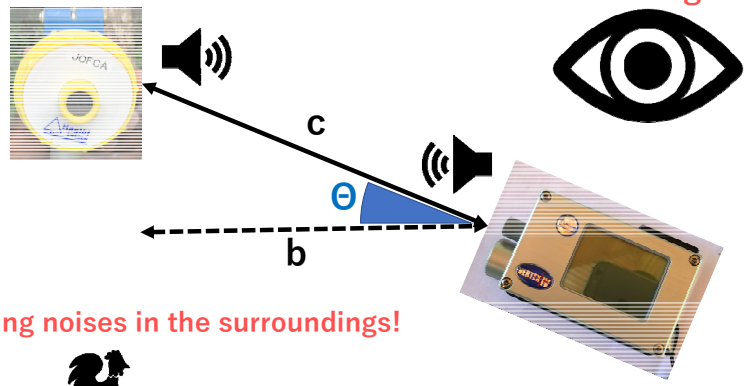


Attention!!!

Keep the straight position!

Attention!!!

Be sure to see the target!



Disturbing noises in the surroundings!

TECHNICAL SPECIFICATION

Distance with directed T3 transponder

:30 m or better in good conditions.

SIGN	Means
SD	Slope Distance
HD	Horizontal Distance
DEG	Degrees
GRAD	Gradients
P.OFFSET	Pivot Offset
T.HEIGHT	Transponder Height
M.DIST	Manual Distance
DME	Distance Measuring
BAF	Basal Area Factor
IR	Infrared light

Reference : Vertex IV and Transponder T3 manual January 2007, v.1.0

BIOMASS ESTIMATION

BY

Fredrick B. Ojuang

There are two approaches for estimating biomass

1. Direct Method

2. Indirect Method

Direct Method (Destructive Method)

This involve harvesting of samples and sometimes the whole plants.

1. They achieve high level of accuracy
2. They are also costly in terms of human labour and Finances

Destructive Methods

1. Take various measurements(DBH, Height of individual trees, Crown diameter)
2. Cut down the tree and proceed with its dissection by categories of diameters
3. Separate the various components(trunks, branches , twigs and leaves)
4. Collect data on dimensions(lengths, diameters etc.)
5. Weigh the green components (before drying)
6. Take green samples (Discs on stem and branch wood, portions of the leaves)
7. Weigh the green samples
8. Dry the samples in an oven to a constant weight

For trunks and large branches

9. Weigh the wet mass in the field after cutting the stem, taking into account the size
10. Take and weigh the samples in-situ
11. Weigh the samples after drying

Calculate Total Dry Weight (Biomass) of Sample Tree

$$TDW = TFW \times \frac{SDW}{SFW}$$

TDW: Total Dry Weight of each component
TFW: Total fresh weight of each component
SDW: Sub- sample dry weight of each component
SFW: Sub-sample fresh weight of each component

Dry Weight = Biomass

Calculation of Total Dry Weight (Biomass) Of Sample Tree (*in red*)

	Stem	Branches Large + small	Leaves	Roots Large + small	Total
Total fresh weight of sample by parts (kg)	7650.5	3241.9	140.7	692.0	11725.0
Fresh weight of sub-sample (g)	1989.8	1343.5	483.0	1677.3	
Dry weight of sub-sample (g)	1301.2	862.3	246.5	1118.4	
Dry weight /Fresh weight of sub-sample	0.654	0.642	0.510	0.667	
Total dry weight by tree parts (kg/tree)	5002.9	2080.7	71.8	461.4	7616.9

Development of Allometric Equations

Biomass Expansion Factor(BEF) – Expand merchantable Volume to total volume to account for non- merchantable components of the tree, stand and forest

Biomass Conversion Expansion Factor(BCEF)- Convert directly merchantable volume to total biomass (Dry weight) to account for non-merchantable components of the tree, stand and forest.

Develop Allometric Equation, BEF & BCEF

Allometric Equation $y = a\,X^{b}$

y: Biomass

a: Parameter (e.g. DBH, DBH^2, D^2H etc)

a, b: Coefficient

Develop Allometric Equation, BEF and BCEF

Biomass Expansion Factor:

A factor that converts the stem biomass into the biomass of the whole tree, including branches, leaves etc…

$$BEF = \frac{TDWa}{TDWs}$$

BEF: Biomass Expansion Factor

TDWa: Total Dry Weight of AGB

TDWs: Total Dry Weight of Stem

Calculation of Carbon Stock with BEF

$$C = (V \times WD \times BEF) \times CF$$

C: Carbon (Mg- C)

V: Volume (M^3)

WD: Wood Density(Mg/M^3)

BEF: Biomass Expansion Factor

CF: Carbon Factor

Develop Allometric Equation of BCEF

Biomass Conversion and Expansion Factor:

A factor that converts directly the trunk volume into the biomass of the whole tree

$$BCEF = \frac{AGB}{V}$$

$$= \frac{V \times WD \times BEF}{V}$$

$$= WD \times BEF$$

BCEF: Biomass Conversion and Expansion Factor

AGB: Above Ground Biomass V: Volume

WD: Wood Density BEF: Biomass Expansion Factor

Calculation of Carbon Stock with BCEF

$$C = (V \times BCEF) \times CF$$

C: Carbon (Mg-C)

V: Volume (M^3)

BCEF: Biomass Conversion and Expansion Factor

CF: Carbon factor

Estimation of Emission

Direct Method

Result From NFI (DBH, Height..)	X	Allometric Equation	X	FC 0.47	=	Carbon Stock

Indirect Method (Non Destructive)

1. They involve the use of biomass prediction equations from pre-established allometric equations.
2. The biomass is estimated from visual estimates and measurements of physical parameters without breaching the physical integrity of the plant.
3. The method are cost effective but less precise

Indirect Method

Stem Volume	X	Coefficients BCEF	X	FC 0.47	=	Carbon Stock

Kenya has not yet developed Country Allometric Equation or BEF and BCEF

END

CONSIDERATION OF PARTICIPATORY COMMUNITY MONITORING IN KENYA

4TH MRV TRAINING

CADEP-SFM COMPONENT3

CONTENTS

1. BACKGROUND

National Forest Monitoring System (Decision 4/CP.15)

1. Requests developing country Parties, on the basis of work conducted on the methodological issues set out in decision 2/CP.13, paragraphs 7 and 11, to take the following guidance into account for activities relating to decision 2/CP.13, and without prejudging any further relevant decisions of the Conference of the Parties, in particular those relating to measurement and reporting

(d) To establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems and, if appropriate, sub-national systems as part of national monitoring systems that:

(i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

(ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;

(iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties

1. BACKGROUND

National Forest Monitoring System (Decision 4/CP.15)

3. Encourages , as appropriate, the development of guidance for effective engagement of indigenous peoples and local communities in monitoring and reporting;

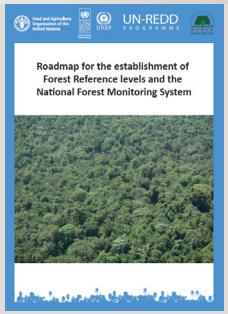
1. BACKGROUND

1. Necessity of forest monitoring
   a. For incentive in REDD+
   b. Management of forest resources
   c. Effective use of forest resources
2. Difficulties of forest monitoring
   a. Monitoring of forest ecosystem with diversity
   b. Capacity of personnel, equipment, and economic under the national scale of implementation
   c. To Ensure the implementation with continuity, transparency and consistency

1. BACKGROUND

Roadmap (2017) :Participatory Community Monitoring, P40

- Such communities described as individuals or groups with a stake, interest or right in the forest may include private companies, civil society organizations, indigenous people, forest dwelling communities, forest adjacent communities and small holder farmers.
- The use of such groups may potentially reduce some costs and enable more frequent measurements and collection of ancillary data and information since the communities live with or adjacent to the forest resource. Their participation is also potential incentive or motivation to enhance their positive participation in REDDD+ implementation.



2. WHAT IS CBFBM

Consideration of Community Based Forest Biomass Monitoring (CBFBM)

- What is CBFBM
- Case study of Community Carbon Accounting (CCA) Action Research Project by IGES*
  - Objective of the project
  - The manual
  - Summary of the policy brief

*IGES: Institute for Global Environmental Strategies, Japan

2. WHAT IS CBFBM

- Community Based Forest Biomass Monitoring (CBFBM) is the monitoring of forest biomass by communities.
- Recognizing the need for full and effective engagement of indigenous peoples and local communities in, and the potential contribution of their knowledge to, monitoring and reporting of activities relating to decision 1/CP.13, paragraph 1 (d) (iii), (Decision 4/CP.15)

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

3.1 Objective of the project

- The objective of project is to develop and verify various approaches to involve local communities in estimating forest stock changes in the five countries (Papua New Guinea (PNG), Cambodia, Indonesia, Lao PDR and Viet Nam).
- The project published POLICY BRIEF OF COMMUNITY BASED FOREST BIOMASS MONITORING FOR REDD+(2012) and COMMUNITY BASED FOREST BIOMASS MONITORING TRAINING OF TRAINERS MANUAL(2014) .

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

3.2 The manual

- The manual is divided into four key learning blocks that integrate the key elements and levels of the CBFBM process.

LEARNING BLOCK 1: Fundamentals of Community Based Forest Biomass Monitoring (CBFBM)
LEARNING BLOCK 2: Feasibility Assessment and stakeholder engagement for CBFBM
LEARNING BLOCK 3: Technical tool box
LEARNING BLOCK 4: an appropriate CBFBM community training

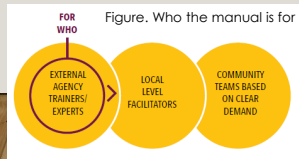


Figure. Who the manual is for

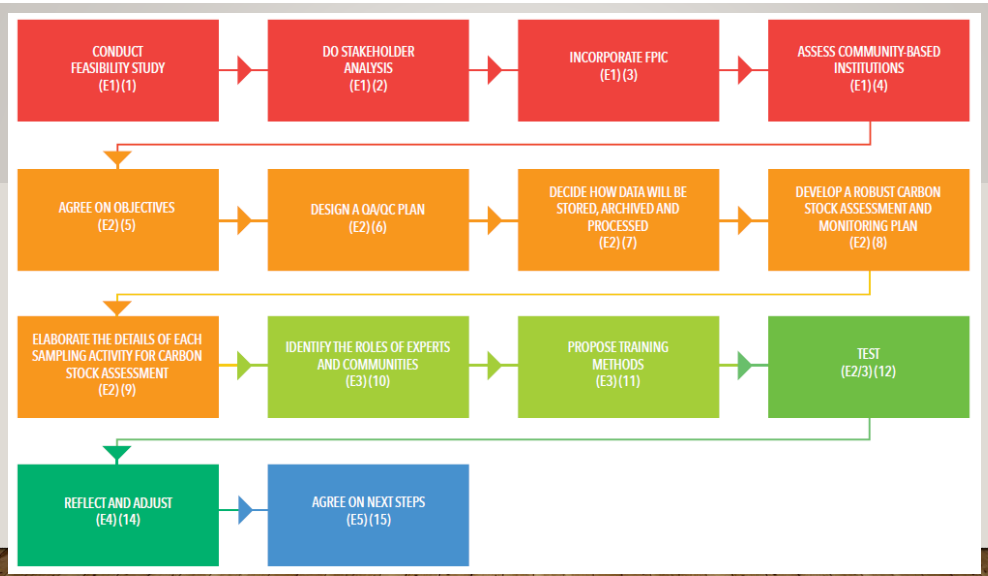


Figure. Key elements and steps of the CBFBM development process

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

3.3 Summary of the policy brief

- Participation in local community forest monitoring is an effective tool, allowing the community not only to take responsibility for REDD + but also to receive payments for activities.
- The community-participation carbon measurement project shows that the appropriate training support program will enable the community to carry out forest measurement necessary for accurately and accurately estimating changes in forest carbon stocks.
- REDD + implementing countries should consider incorporating community-based forest monitoring into national forest monitoring systems and safeguard information systems.
- By participating in a community that is close to forests, some monitoring items can be measured more efficiently than external experts, and the transparency of monitoring is improved.

3. CASE STUDY OF COMMUNITY CARBON ACCOUNTING ACTION RESEARCH PROJECT BY IGES

3.3 Summary of the policy brief

Table. Estimated carbon stocks derived from community measurements and published estimates in literature

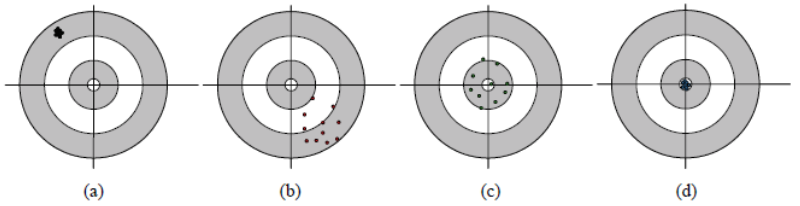
Area of project	Forest type and condition	Estimates from community measurements	Estimates described in literature for similar types of forests
Madang in Papua New Guinea	Mainly natural raw wet tropical Lowland forest	129.5 ± **75.8** tC / ha	106.3 ± **22.7** tC / ha – State and forest types are the same (Fox et al. 2010)
Mondulkiri Province in Cambodia	Deciduous forest	Rectangular plot – 75.5 ± **19.6** Circular plot – 72.2 ± **23** tC / ha	73.8 ± **8.6** (std.error) – Same forest parcel (Vathana 2010)
Special Region of Yogyakarta and Central	1. Afforested land in dry land 2. Resident's garden	1. 32.1 ± **22.5** tC / ha 2. 34.2 ± **20.6** tC / ha	1. No data available 2. 35.3 ± **21.2** tC / ha – Lamburia

Note: All figures show mean ± standard deviation unless otherwise stated

UNCERTAINTY

Figure 3.2 Illustration of accuracy and precision

(a) inaccurate but precise; (b) inaccurate and imprecise; (c) accurate but imprecise; and (d) precise and accurate



4. HOW ABOUT KENYA (DISCUSSION)

- The necessity of Participatory Community Monitoring (PCM) in Kenya
- Potential for community participation of monitoring
- How to introduce and conduct PCM
  - Training
  - Equipment
  - …
- How to adjust and improve the methodology of CBFBM in Kenya

4. HOW ABOUT KENYA (DISCUSSION)

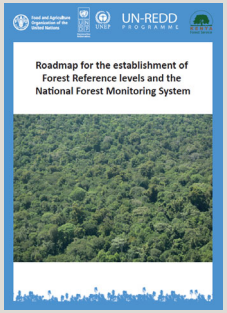
Roadmap (2017) : Capacity Building for NFMS/RL for REDD+ in Kenya, P13

b. Participatory Community Monitoring

- The data collection for REDD+ will be relatively straightforward, focusing on easily measured properties of the forest such as species name, DBH and density (number of trees per sampling plot). Local communities need to be trained on measurement protocols, data recording and management and analysis (review) of results. Initial establishment of the sampling plots needs to be supported by professional foresters or a certified implementing partner.
- There are some activities under REDD+ that do not directly relate to measurement of trees, but which would require the involvement of communities, such as patrolling for encroachment, fires, illegal grazing and illegal logging; assessment of biodiversity and other ecosystem properties.

Challenges to Participatory Community Monitoring

- There is a need to formulate a strategy for CFAs to be able to effectively fulfil their potential to contribute to the NFMS and to participate in REDD+ more broadly.



4. HOW ABOUT KENYA (DISCUSSION)

- What is the strength of the community on the forest monitoring ?
- What is the Feasible activity in Participatory Community Monitoring ?
- How to support the community by KFS ?

THANK YOU FOR YOUR ATTENTION

Reference:

- POLICY BRIEF OF COMMUNITY BASED FOREST BIOMASS MONITORING FOR REDD+(2012)
- COMMUNITY BASED FOREST BIOMASS MONITORING TRAINING OF TRAINERS MANUAL(2014)
- FAO 2017: Roadmap for the establishment of Forest Reference levels and the National Forest Monitoring System

GROUP WORK

3RD REDD+ TRAINING ON MEASUREMENT, REPORTING, AND VERIFICATION (MRV)

CADEP-SFM, 23TH JANUARY 2020, ALPS HOTEL IN NAKURU

METHOD OF GROUP WORK

Theme	Analysis of land use / land cover change (2002-2006, 2006-2010, 2010-2014, 2014-2018) by each county for Development of REDD+ Activities
Materials	• The LU/LC (Land Use / Land Cover) change map of Kenya • Internet for Information collection
Group	4 Groups × 5 persons / Groups
Roles	Chairman, Secretary (PC)/Presenter
Time Table	• 10:30 – 10:40 Introduction • 10:40 – 11:40 Group Discussion • 11:40 – 12:30 Presentation(10minutes) ×4 Groups

POINTS TO BE KEPT IN MIND FOR DISCUSSION IN GROUP WORK

With COVID-19 protocol

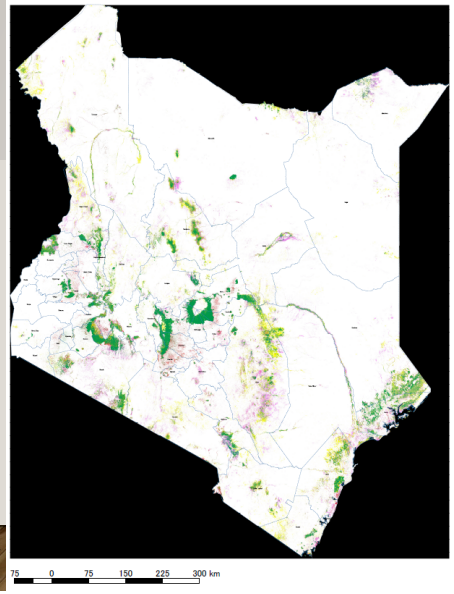
- Free participation
- Respect each opinion
- Persons who make opinions is not important

LU/LC CHANGE MAP

Period of 4 years; 2002 - 2006, 2006 - 2010, 2010 - 2014, 2014 - 2018

			20XX+4									
			1	2	3	4	5	6	7	8	9	10
			Dense Forest	Moderate Forest	Open Forest	Wooded Grassland	Open Grassland	Perennial Cropland	Annual Cropland	Vegetated Wetland	Open Water	Otherland
20XX	1	Dense Forest	1	2	3	4	5	6	7	8	9	10
	2	Moderate Forest	11	12	13	14	15	16	17	18	19	20
	3	Open Forest	21	22	23	24	25	26	27	28	29	30
	4	Wooded Grassland	31	32	33	34	35	36	37	38	39	40
	5	Open Grassland	41	42	43	44	45	46	47	48	49	50
	6	Perennial Cropland	51	52	53	54	55	56	57	58	59	60
	7	Annual Cropland	61	62	63	64	65	66	67	68	69	70
	8	Vegetated Wetland	71	72	73	74	75	76	77	78	79	80
	9	Open Water	81	82	83	84	85	86	87	88	89	90
	10	Otherland	91	92	93	94	95	96	97	98	99	100

2002 – 2006 LU/LC chnage



No	Forest Cover Change	The Legend of Forest Cover Change Map
1	Forest remaining as Forest (No Change)	Forest (No Change)
2	Forest remaining as Forest (Degradation)	Forest (Degradation)
3	Forest remaining as Forest (Enhancement)	Forest (Enhancement)
4	Cropland converted to Forest	Cropland to Forest
5	Grassland converted to Forest	Grassland to Forest
6	Other Land uses converted to Forest	Wetland and Other Lands to Forest
7	Forest converted to Cropland	Forest to Cropland
8	Forest converted to Grassland	Forest to Grassland
9	Forest converted to Other Land uses	Forest to Wetland and Other Lands

FOREST COVER CHANGE 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

ANALYSIS OF LU/LC CHANGE MAP

1. Select 2 counties at the least for analysis
2. Peruse the LU/LC change maps
3. Summarize What LU/LC change especially occurs in each county in Which period
4. Discuss Why the change occurs in the county (resource; own experience, statistical data, study paper, Government policy and strategy, condition of agriculture, report and etc.)
5. How to develop the activity for
   - Increasing forest cover
   - Tackling deforestation drivers
   - Tackling forest degradation drivers

DEVELOPMENT FOR REDD+ ACTIVITIES IN EACH ECOSYSTEM IN KENYA

Five activities decided as REDD+ activities

① Reducing emissions from deforestation

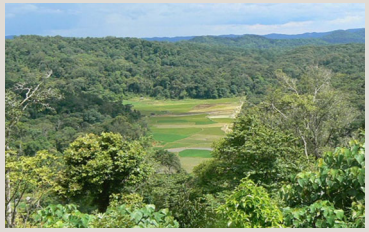
② Reducing emissions from forest degradation

③ Conservation of forest carbon stocks

④ Sustainable management of forests

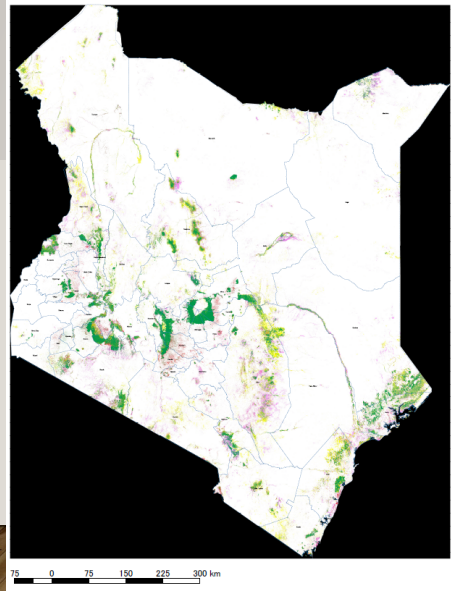
⑤ Enhancement of forest carbon stocks

DRIVERS OF DEFORESTATION AND FOREST DEGRADATION

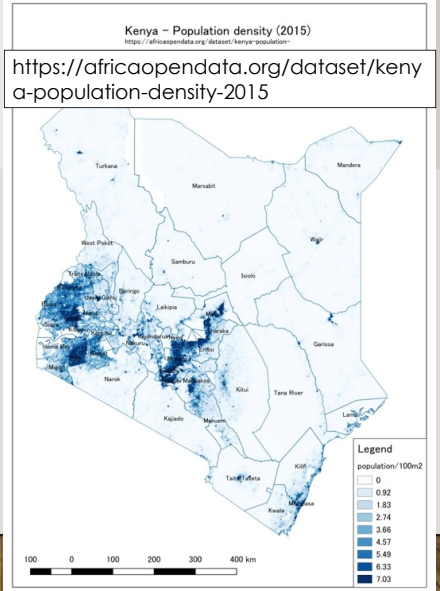


http://www.jofca.or.jp/seminar/20111007-seminar/20111007seminar03.pdf

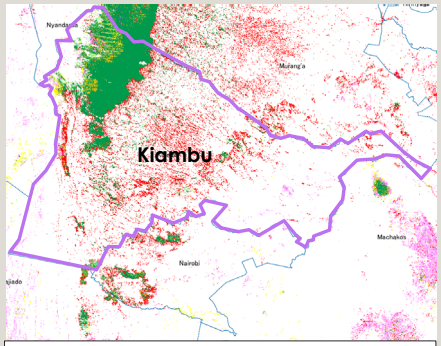
NFP



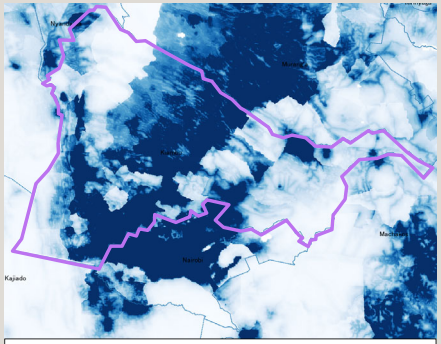
https://africaopendata.org/dataset/kenya-population-density-2015



(E.G.) :KIAMBU COUNTY

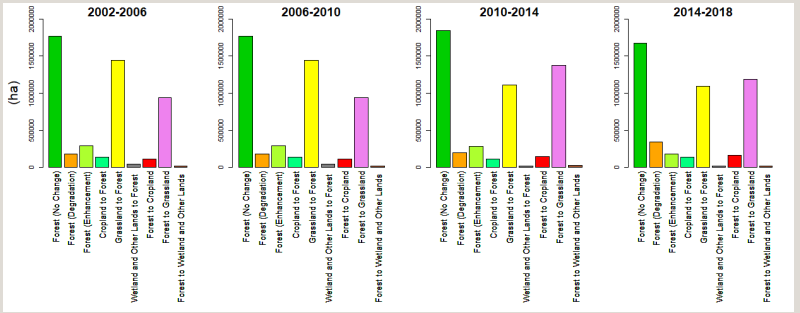


Period: 2002-2006

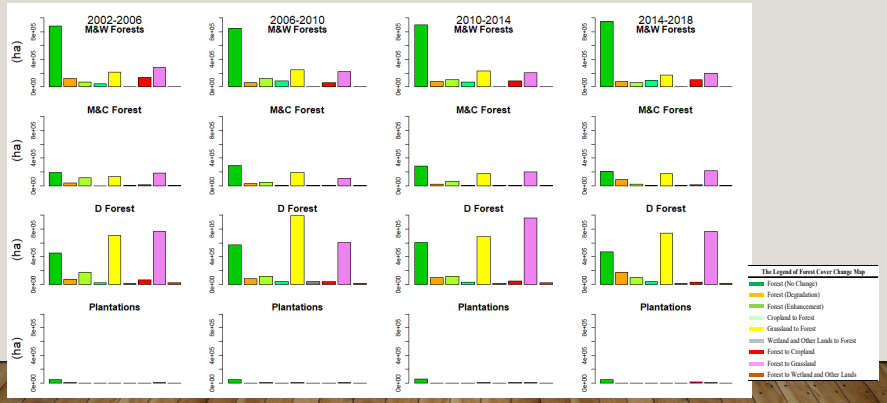


https://africaopendata.org/dataset/kenya-population-density-2015

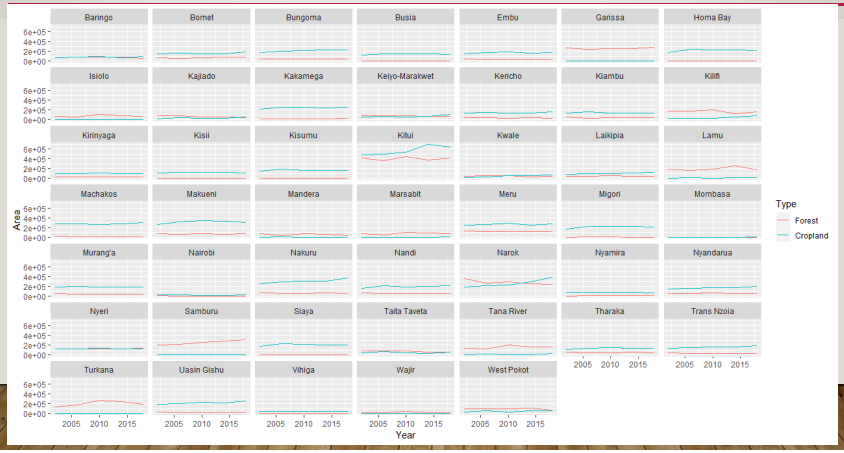
AREA OF LAND COVER / LAND USE CHANGE CLASSIFICATION



AREA OF LAND COVER / LAND USE CHANGE CLASSIFICATION BY FOREST STRATA



FLUCTUATION OF FOREST LAND AND CROPLAND AREA BY EACH COUNTY



FRAMEWORK OF DISCUSSION

Item	County1	County2
Target County	*Kiambu*	
What LU/LC change occur especially in What period	*In all period, the change between Forest and Cropland is found in a small area, and the change occurs reversibly, and the Land Cover / Land Use Change is very fluid.*	
In What forest strata the change occur especially	*(Selecting from among Montane forest, Western rainforest, Dryland forest, Costal forest, Mangrove, KFS plantation area)*	
Why the change occure (Driver Analysis)	*The increase in demand for food and firewood materials (household fuels) due to population growth has led to the conversion of forest to cropland, and is feared to lead to deforestation and forest degradation. (reference)* • *The condition of population concentrate: https://africaopendata.org/dataset/kenya-population-density-2015* • *,,,* • *,,,*	
Activity for the driver	• *(Increasing forest cover)* • *(Tackling deforestation drivers)* • *(Tackling forest degradation drivers)*	

1) PDM-Version 0 (February 2016)

Annex1 Project Design Matrix

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

Version 0

Implementing Agency: MENRRDA (Ministry of Environment, Natural Resources and Regional Development Authorities), KFS (Kenya Forest Service), KEFRI (Kenya Forestry Research Institute) and County Governments

Dated February 2016

Target Group: Direct Beneficiaries: Staff of implementing agencies and collaborating organizations

Indirect Beneficiaries: Population of pilot counties and activity areas of NGO/CBO/private entities in Output 2

Period of Project: May, 2016 – May, 2021 (5 years)

Project Site: Nationwide, and ASALs (Arid and Semi-arid Lands) for Output 2 and Output 4. Model Site: Pilot counties for Output 2 will be selected in project activities.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Sustainable forest management is promoted in Kenya towards the national forest cover target of 10%.	1 Result-based payment for REDD+ from international community is provided for Kenya. 2 50% of ASAL counties introduce the activities promoted by the Project.	・Citation in public documents ・Observation of activities			
Project Purpose					
National capacity at the national and county level for sustainable forest management is strengthened.	1 70% of direct beneficiaries recognize the improvement of policy implementation. 2 At least 2 other counties refer to the forest management & implementation plan as a good example to emulate for forest management. 3 The developed National Forest Monitoring System is utilized in Kenya. 4 At least 2 countries adopt the technologies transferred by the regional cooperation. 5 Two areas of REDD+ readiness stage, namely the establishment of NFMS (National Forest Monitoring System) and FRL (Forest Reference Level), are completed. 6 Improved seedlings are provided to at least 3 other counties and 5 entities of NGO, CBO (Community-based Organization) or private sector.	・Project reports ・Citation in public documents ・Interview ・Operation of NFMS ・Report to UNFCCC (United Nations Framework Convention on Climate Change)	・There is no major changes of government institutional arrangement on forest and climate change policy.		
Outputs					
Output 1 (Policy Support) Implementing and monitoring capacities of forest-related policies/strategies at the national level are enhanced.	1-2 The proposed monitoring mechanism is acknowledged useful for managing policy/strategy implementation. 1-2 70% of stakeholders recognize the recommendation prepared by the Project applicable and effective. 1-3 50% of development partners recognize the improvement of donor coordination.	・Remarks and interview ・Project reports ・Interview	・Relevant policies currently under deliberation (National Forest Policy, Forest Conservation & Management Bill, National Climate Change Framework Policy, etc.) are finalized.		
Output 2 (Pilot Implementation through County Governments and Private Sector) Capacities of selected county governments, private sector, NGO and CBO are enhanced through implementing pilot forest management activities.	2-1 At least 2 counties develop forest management & implementation plans including the establishment of the clonal seed orchards. 2-2 Possible collaboration with private sectors for forest management activities is proposed. 2-3 A report on possible REDD+ activities at a project level is prepared based on the pilot implementation.	・Observation of activities at field based on the plan. ・Project reports ・Proposal/report submitted			
Output 3 (REDD+ Readiness) Technical capacities for REDD+ readiness activities in KFS are strengthened.	3-1 NFMS is established. 3-2 FRL is established in consultation with other stakeholders. 3-3 Land Use Map of 2020 is created. 3-4 Annual forest cover monitoring is conducted until the end of project.	・Public document ・Creation of the map ・Project reports.			
Output 4 (Tree Breeding) The capacity of breeding techniques for drought tolerant trees in KEFRI is improved.	4-1 Plus trees of Melia volkensii and Acacia tortilis are selected in the seed orchards and stands in Tiva and Kibwezi. 4-2 Researchers of KEFRI acquire the skills of artificial crossing technique. 4-3 Tree seed orchards of Melia volkensii are established in the pilot counties.	・Project reports ・Visit/observation of the tree ・Interview of researchers ・Demonstration of the techniques			
Output 5 (Regional Cooperation) 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-Sahara Africa.	5-1 Database on strengthening the resilience to climate change and drought in Sub-Saharan Africa is referred to by neighboring countries. 5-2 70% of participating countries evaluate the regional coordination useful.	・Access data of the website ・Records of the meetings. ・Project reports ・Interview of participating countries.			

Activities	Inputs		Important Assumption
	The Japanese Side	The Kenyan Side	
Output 1 (Policy Support) 1-1 Review existing/planned forest-related policies/strategies. 1-2 Conduct gap analysis between the existing forest-related policies/strategies and their actual implementation at field level. 1-3 Develop a monitoring mechanism of forest-related policy/strategy implementation through stakeholder consultation. 1-4 Practice and strengthen the monitoring mechanism to manage forest-related policies/strategies in MENRRDA and KFS. 1-5 Harmonize development partners' activities. 1-6 Prepare a recommendation to the policy level based on project field activities utilizing NFMS (National Forest Monitoring System). Output 2 (Pilot Implementation through County Governments and Private Sector) 2-1 Conduct a feasibility study and examine the approach for pilot implementation. 2-2 Assist the pilot counties to prepare and carry out a forest management & implementation plan for promoting forest by utilizing the improved seedlings. 2-3 Design and implement a scheme to work with private sector to promote the use of improved seedlings. 2-4 Collaborate with NGO and CBO for pilot activities to expand the use of improved seedlings. 2-5 Examine the feasibility of making REDD+ pilot projects (county/project level) from among the pilot implementation conducted above, and formulate Project Document and match investors if feasible. Output 3 (REDD+ Readiness) 3-1 Design, develop and test the NFMS for Kenya. 3-2 Operationalize the NFMS. 3-3 Conduct accuracy assessment of 2014 Land Use (LU) Map which is developed by DRSRS (Directorate of Resource Surveys & Remote Sensing). 3-4 Create LU change (LUC) map and Forest Cover Change Map using 4 historical data of LU maps (1990, 2000, 2010, 2014). 3-5 Collect information on emission factors and develop 2014 Carbon Map. 3-6 Analyze the land use changes based on 4 histrical data of LU maps. 3-7 Develop and evaluate FRL (Forest Reference Level) with stakeholders. 3-8 Operate yearly forest cover change monitoring. 3-9 Create 2020 Land Use Map. 3-10 Train C/P for new technology or methodology of MRV and test them for future development of MRV system in Kenya. Output 4 (Tree Breeding) 4-1 Improve the quality of clonal seed orchards of Melia volkensii. 4-2 Study of artificial crossing toward 2nd generation of Melia volkensii. 4-3 Improve the seedling seed stands of Acacia tortilis. 4-4 Support to establish clonal seed orchards in the pilot counties. 4-5 Train improved seed and seedling suppliers. Output 5 (Regional Cooperation) 5-1 Design the scope and prepare a TOR of regional cooperation by networking with related countries. 5-2 Hold regional cooperation meetings and forum. 5-3 Collect good practice information for strengthening the resilience to climate change and drought in Sub-Saharan Africa from Kenya and surrounding countries. 5-4 Accumulate the collected information, and establish the database on KEFRI's website. 5-5 Share the collected knowledge with and transfer technologies to other countries in Sub-Sahara Africa.	1 Personal 【Long-term expert】 (1) Chief adviser/Forest policy (2) Regional cooperation/Coordinator (3) Forestry Extension 【Short-term expert (Consultant)】 (1) NFMS /FRL/MRV (Measurement, Reporting and Verification) (2) Tree breeding (3) Experts as necessary 2 Counterpart Training 3 Machinery, Equipment and Materials (1) Equipment for NFMS (2) Equipment for tree breeding extension (3) Equipment for information sharing (4) Vehicles (5) Other necessary machinery, equipment and materials for the implementation of the project 4 Supplementary budget for local expenditure	【Project management unit】 (1) Project Director - MENRRDA (2) Director, KFS (3) Director, KEFRI 【OUTPUT Level】 (1) Project Manager - MENRRDA (2) Component managers – MENRRDA, KFS, KEFRI (3) Counterpart/Administrative personnel 【Administrative staff】 (1) Secretary (2) Driver (3) Other staff 2 Land and Facilities (1) Project office in Nairobi (MENRRDA, (2) Land and nursery for forest tree seed and seedling activities 3 Administrative and Operational Cost	・Ongoing relevant initiatives such as 1) formulation of national forest programme, 2) revision of Kenya NFMS Road Map, 3) upscaling of forest inventory to national level, are cooperative with the Project. ・Data from collaborating institutions including DRSRS and RCMRD (Regional Center for Mapping of Resources for Development) are made available. ・Selection of pilot county governments is completed timely for efficient activity operation.
			Pre-Conditions
			・Devolution of forest extension functions is agreed between KFS and county governments by March 2016 as stated by relevant acts.
			<Issues and countermesures>

2) PDM-Version 1 (November 2016)

Annex 1 Project Design Matrix (PDM)

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

Version 1

Implementing Agency: MENR (Ministry of Environment and Natural Resources), KFS (Kenya Forest Service), KEFRI (Kenya Forestry Research Institute) and County Governments

Dated: 9 November,2016

Target Group: Direct Beneficiaries: Staff of implementing agencies and collaborating organizations

Indirect Beneficiaries: Population of pilot Counties and activity areas of NGO/CBO/private entities in Output 2

Period of Project: June, 2016 – June, 2021 (5 years)

Project Site: Nationwide, and ASALs (Arid and Semi-arid Lands) for Output 2 and Output 4. Model Site: Pilot Counties for Output 2 will be selected in project activities.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Sustainable forest management is promoted in Kenya towards the national forest cover target of 10%.	1 Result-based payment for REDD+ from international community is provided for Kenya. 2 50% of ASAL counties introduce the activities promoted by the Project.	・Citation in public documents ・Observation of activities			
Project Purpose					
Capacity at the national and county level for sustainable forest management is strengthened.	1 70% of direct beneficiaries recognize the improvement of policy implementation. 2 At least 2 other Counties refer to the forest management & implementation plan as a good example to emulate for forest management. 3 The developed National Forest Monitoring System is utilized in Kenya. 4 At least 2 Countries adopt the technologies transferred by the regional cooperation. 5 Two areas of REDD+ readiness stage, namely the establishment of NFMS (National Forest Monitoring System) and FRL (Forest Reference Level), are completed. 6 Improved seed/seedlings are provided to at least 3 other Counties and 5 entities of NGO, CBO (Community-based Organization) or private sector.	・Project reports ・Citation in public documents ・Interview ・Operation of NFMS ・Report to UNFCCC (United Nations Framework Convention on Climate Change)	・There is no major changes of government institutional arrangement on forest and climate change policy.		
Outputs					
Output 1 (Policy Support) Implementing and monitoring capacities of forest-related policies/strategies at the national level are enhanced.	1-1 The participatory monitoring process is functional based on the National Forest Programme results framework. 1-2 70% of stakeholders recognize the recommendation prepared by the Project as applicable and effective. 1-3 70% of development partners recognize other partners forest related activities.	・Remarks and interview ・Project reports ・Interview	・Relevant policies currently under deliberation (National Forest Policy, Forest Conservation & Management Bill, National Climate Change Framework Policy, etc.) are finalized.		
Output 2 (Pilot Implementation through County Governments and Private Sector) Capacities of selected County governments, private sector, NGO and CBO are enhanced through implementing pilot forest management activities.	2-1 2 Counties develop forest management & implementation plans. 2-2 Collaboration with private sector is promoting for forest management activities. 2-3 A report on possible REDD+ activities at a project level is prepared based on the pilot implementation.	・Observation of activities at field based on the plan. ・Project reports ・Proposal/report submitted			
Output 3 (REDD+ Readiness) Technical capacities for REDD+ readiness activities in KFS are strengthened.	3-1 NFMS is established. 3-2 FRL is established in consultation with other stakeholders. 3-3 Land Use Map of 2020 is created. 3-4 Annual forest cover monitoring is conducted until the end of project.	・Public document ・Creation of the map ・Project reports.			
Output 4 (Tree Breeding) The capacity of breeding techniques for drought tolerant trees in KEFRI is improved.	4-1 Plus trees of Melia volkensii and Acacia tortilis are selected in the seed orchards and stands in Tiva and Kibwezi. 4-2 Researchers of KEFRI acquire the skills of artificial crossing technique. 4-3 Tree seed orchards of Melia volkensii are established in the pilot Counties.	・Project reports ・Visit/observation of the tree ・Interview of researchers ・Demonstration of the techniques			
Output 5 (Regional Cooperation) 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-Sahara Africa.	5-1 Database on strengthening the resilience to climate change and drought in Sub-Saharan Africa is referred to by neighbouring countries. 5-2 70% of participating countries evaluate the regional cooperation useful.	・Access data of the website ・Records of the meetings. ・Project reports ・Interview of participating countries.			

Activities	Inputs		Important Assumption
	The Japanese Side	The Kenyan Side	
Output 1 (Policy Support)			
1-1 Review existing/planned forest-related policies/strategies.	1 Personal	【Project management unit】	・Ongoing relevant initiatives such as 1) formulation of national forest programme, 2) revision of Kenya NFMS Road Map, 3) upscaling of forest inventory to national level, are cooperative with the Project.
1-2 Conduct gap analysis between the existing forest-related policies/strategies and their actual implementation at field level.	【Long-term expert】	(1) Project Director - MENR	
1-3 Support participatory monitoring process of forest-related policy/strategy.	(1) Chief adviser/Forest policy	(2) Director, KFS	
1-4 Compile and facilitate information sharing on existing forest related partner's activities.	(2) Regional cooperation/Coordinator	(3) Director, KEFRI	
1-5 Prepare policy briefs based on project field activities utilizing NFMS (National Forest Monitoring System).	(3) Forestry Extension	【OUTPUT Level】	
	【Short-term expert (Consultant)】	(1) Project Manager - MENR	
Output 2 (Pilot Implementation through County Governments and Private Sector)	(1) NFMS /FRL/MRV (Measurement, Reporting and Verification)	(2) Component managers – MENR, KFS,	
2-1 Conduct a feasibility study and examine the approach for pilot implementation and select pilot Counties.	(2) Tree breeding	(3) Counterpart/Administrative personnel	・Data from collaborating institutions including DRSRS and RCMRD (Regional Center for Mapping of Resources for Development) are made available.
2-2 Assist the pilot counties to promote sustainable forest management.	(3) Experts as necessary	【Administrative staff】	
2-3 Design and implement a scheme to work with private sector to promote the use of improved seedlings.	2 Counterpart Training	(1) Secretary	
2-4 Collaborate with NGO and CBO for pilot activities to expand the use of improved seedlings.	3 Machinery, Equipment and Materials	(2) Driver	
2-5 Examine the feasibility of making REDD+ pilot projects (county/project level) from among the pilot implementation conducted above, and formulate Project Document and match investors if feasible.	(1) Equipment for NFMS	(3) Other staff	
	(2) Equipment for tree breeding extension	2 Land and Facilities	・Selection of pilot County governments is completed timely for efficient activity operation.
	(3) Equipment for information sharing	(1) Project office in Nairobi (MENR, KFS, KEFRI)	
	(4) Vehicles	(2) Land and nursery for forest tree seed and seedling activities	
	(5) Other necessary machinery, equipment and		
Output 3 (REDD+ Readiness)			
3-1 Design, develop and test the NFMS for Kenya.	4 Supplementary budget for local expenditure		
3-2 Operationalize the Forest Information Platform.		3 Administrative and Operational Cost	
3-3 Conduct accuracy assessment of 2014 Land Cover/Land Use Map which is developed by SLEEK (System for Land-Based Emission Estimation in Kenya).			
3-4 Create land cover/land use change maps using 4 historical data of land cover/land use maps.			
3-5 Collect information on emission factors,set emission factors and develop 2014 Carbon Map.			**Pre-Conditions**
3-6 Analyse the land cover/land use changes based on the 4 time historical data of land cover/land use maps.			・Devolution of forest extension functions is agreed between KFS and county governments by March 2016 as stated by relevant acts.
3-7 Develop and evaluate FRL (Forest Reference Level) with stakeholders.			
3-8 Operate yearly forest cover change monitoring.			
3-9 Create 2020 Land Cover/Land Use Map.			
3-10 Train C/P for new technology or methodology of MRV (Measurement Reporting Verification) and test them for future development of MRV system in Kenya			
Output 4 (Tree Breeding)			
4-1 Improve the quality of clonal seed orchards of Melia volkensii.			
4-2 Study of artificial crossing toward 2nd generation of Melia volkensii.			
4-3 Improve the seedling seed stands of Acacia tortilis.			
4-4 Support to establish clonal seed orchards in the pilot Counties.			**<Issues and countermeasures>**
4-5 Train improved seed and seedling suppliers.			
Output 5 (Regional Cooperation)			
5-1 Design the scope and prepare a TOR of regional cooperation by networking with related countries.			
5-2 Hold regional cooperation meetings and forum.			
5-3 Collect good practice information for strengthening the resilience to climate change and drought in Sub-Saharan Africa from Kenya and surrounding countries.			
5-4 Accumulate the collected information, and establish the database on KEFRI's website.			
5-5 Share the collected knowledge with and transfer technologies to other countries in Sub-Sahara Africa.			
5-6 Improve access to finance to combat desertification.			

3) PDM-Version 2 (December 2017)

Project Design Matrix (PDM)

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

Version 2

Implementing Agency: MENR (Ministry of Environment and Natural Resources), KFS (Kenya Forest Service), KEFRI (Kenya Forestry Research Institute) and County Governments

Dated: 5 December 2017

Target Group: Direct Beneficiaries: Staff of implementing agencies and collaborating organizations

Indirect Beneficiaries: Population of pilot Counties and activity areas of NGO/CBO/private entities in Output 2

Period of Project: June, 2016 – June, 2021 (5 years)

Project Site: Nationwide, and ASALs (Arid and Semi-arid Lands) for Output 2 and Output 4. Model Site: Embu County and Taita Taveta County are as Pilot Counties for Output 2.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
Sustainable forest management is promoted in Kenya towards the national forest cover target of 10%.	1 Result-based payment for REDD+ from international community is provided for Kenya. 2 50% of ASAL counties introduce the activities promoted by the Project.	・Citation in public documents ・Observation of activities			
Project Purpose					
Capacity at the national and county level for sustainable forest management is strengthened.	1 70% of direct beneficiaries recognize the improvement of policy implementation. 2 At least 2 other Counties refer to the forest management & implementation plan as a good example to emulate for forest management. 3 The developed National Forest Monitoring System is utilized in Kenya. 4 At least 2 Countries adopt the technologies transferred by the regional cooperation. 5 Two areas of REDD+ readiness stage, namely the establishment of NFMS (National Forest Monitoring System) and FRL (Forest Reference Level), are completed. 6 Improved seeds/seedlings are provided to at least 3 other Counties and 5 entities of NGO, CBO (Community-based Organization) or private sector.	・Project reports ・Citation in public documents ・Interview ・Operation of NFMS ・Report to UNFCCC (United Nations Framework Convention on Climate Change)	・There is no major changes of government institutional arrangement on forest and climate change policy.		
Outputs					
Output 1 (Policy Support) Implementing and monitoring capacities of forest-related policies/strategies at the national level are enhanced.	1-1 The participatory monitoring process is functional based on the National Forest Programme results framework. 1-2 70% of stakeholders recognize the recommendation prepared by the Project as applicable and effective. 1-3 70% of development partners recognize other partners forest related activities.	・Remarks and interview ・Project reports ・Interview	・Relevant policies currently under deliberation (National Forest Policy, Forest Conservation & Management Bill, National Climate Change Framework Policy, etc.) are finalized.		
Output 2 (Pilot Implementation through County Governments and Private Sector) Capacities of selected County governments, private sector, NGO and CBO are enhanced through implementing pilot forest management activities.	2-1 Two Counties develop forest management & implementation plans. 2-2 Collaboration with private sector is promoted for forest management activities. 2-3 A report on possible REDD+ activities at a project level is prepared based on the pilot implementation.	・Observation of activities at field based on the plan. ・Project reports ・Proposal/report submitted			
Output 3 (REDD+ Readiness) Technical capacities for REDD+ readiness activities in KFS are strengthened.	3-1 NFMS is established. 3-2 FRL is established in consultation with other stakeholders. 3-3 Land Use Map of 2020 is created. 3-4 Annual forest cover monitoring is conducted until the end of project.	・Public document ・Creation of the map ・Project reports.			
Output 4 (Tree Breeding) The capacity of breeding techniques for drought tolerant trees in KEFRI is improved.	4-1 Plus trees of Melia volkensii and Acacia tortilis are selected in the seed orchards and stands in Tiva and Kibwezi. 4-2 Researchers of KEFRI acquire the skills of artificial crossing technique.	・Project reports ・Visit/observation of the tree ・Interview of researchers ・Demonstration of the techniques			
Output 5 (Regional Cooperation) 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-Sahara Africa.	5-1 Database on strengthening the resilience to climate change and drought in Sub-Saharan Africa is referred to by neighbouring countries. 5-2 70% of participating countries evaluate the regional cooperation useful.	・Access data of the website ・Records of the meetings. ・Project reports ・Interview of participating countries.			

Activities	Inputs		Important Assumption
	The Japanese Side	The Kenyan Side	
Output 1 (Policy Support) 1-1 Review existing/planned forest-related policies/strategies. 1-2 Conduct gap analysis between the existing forest-related policies/strategies and their actual implementation at field level. 1-3 Support planning and monitoring of National Forest Progarmme. 1-4 Compile and facilitate information sharing on existing forest related partner's activities. 1-5 Prepare policy briefs based on project field activities utilizing NFMS (National Forest Monitoring System). Output 2 (Pilot Implementation through County Governments and Private Sector) 2-1 Conduct a feasibility study and examine the approach for pilot implementation and select pilot Counties. 2-2 Assist the pilot counties to promote sustainable forest management. 2-3 Design and implement a scheme to work with private sector to promote the use of improved seedlings. 2-4 Collaborate with NGO and CBO for pilot activities to expand the use of improved seedlings. 2-5 Examine the feasibility of making REDD+ pilot projects (county/project level) from among the pilot implementation conducted above, and formulate Project Document and match investors if feasible. Output 3 (REDD+ Readiness) 3-1 Design, develop and test the NFMS for Kenya. 3-2 Operationalize the Forest Information Platform. 3-3 Conduct accuracy assessment of 2014 Land Cover/Land Use Map which is developed by SLEEK (System for Land-Based Emission Estimation in Kenya). 3-4 Create land cover/land use change maps using 4 historical data of land cover/land use maps. 3-5 Collect information on emission factors,set emission factors and develop 2014 Carbon Map. 3-6 Analyse the land cover/land use changes based on the 4 time historical data of land cover/land use maps. 3-7 Develop and evaluate FRL (Forest Reference Level) with stakeholders. 3-8 Operate yearly forest cover change monitoring. 3-9 Create 2020 Land Cover/Land Use Map. 3-10 Train C/P for new technology or methodology of MRV (Measurement Reporting Verification) and test them for future development of MRV system in Kenya Output 4 (Tree Breeding) 4-1 Improve the quality of clonal seed orchards of Melia volkensii. 4-2 Study of artificial crossing toward 2nd generation of Melia volkensii. 4-3 Improve the seedling seed stands of Acacia tortilis. Output 5 (Regional Cooperation) 5-1 Design the scope and prepare a TOR of regional 5-2 Hold regional cooperation meetings and forum. 5-3 Collect good practice information for strengthening the resilience to climate change and drought in Sub- 5-4 Accumulate the collected information, and establish the 5-5 Share the collected knowledge with and transfer technologies to other countries in Sub-Sahara Africa. 5-6 Improve access to finance to combat desertification.	1 Personal 【Long-term expert】 (1) Chief adviser/Forest policy (2) Regional cooperation/Coordinator (3) Forestry Extension 【Short-term expert (Consultant)】 (1) NFMS /FRL/MRV (Measurement, Reporting and Verification) (2) Tree breeding (3) Experts as necessary 2 Counterpart Training 3 Machinery, Equipment and Materials (1) Equipment for NFMS (2) Equipment for tree breeding extension (3) Equipment for information sharing (4) Vehicles (5) Other necessary machinery, equipment and 4 Supplementary budget for local expenditure	1 Personal 【Project management unit】 (1) Project Director - MENR (2) Director, KFS (3) Director, KEFRI 【OUTPUT Level】 (1) Project Manager - MENR (2) Component managers – MENR, KFS, KEFRI (3) Counterpart/Administrative personnel 【Administrative staff】 (1) Secretary (2) Driver (3) Other staff 2 Land and Facilities (1) Project office in Nairobi (MENR, KFS, KEFRI) (2) Land and nursery for forest tree seed and seedling activities 3 Administrative and Operational Cost	・Ongoing relevant initiatives such as 1) formulation of national forest programme, 2) revision of Kenya NFMS Road Map, 3) upscaling of forest inventory to national level, are cooperative with the Project. ・Data from collaborating institutions including DRSRS and RCMRD (Regional Center for Mapping of Resources for Development) are made available. ・Selection of pilot County governments is completed timely for efficient activity operation.
			Pre-Conditions ・Devolution of forest extension functions is agreed between KFS and county governments by March 2016 as stated by relevant acts.
			<Issues and countermeasures>

4) PDM-Version 3 (August 2019)

Project Design Matrix

Project Title: Capacity Development Project for Sustainable Forest Management in the Republic of Kenya — Version 3

Implementing Agency: MoEF (Ministry of Environment and Forestry), KFS (Kenya Forest Service), KEFRI (Kenya Forestry Research Institute) and County Governments — Dated: 30 August 2019

Target Group: Direct Beneficiaries: Staff of implementing agencies and collaborating organizations

Indirect Beneficiaries: Population of pilot Counties and activity areas of NGO/CBO/private entities in Output 2

Period of Project: June, 2016 – June, 2021 (5 years)

Project Site: Nationwide, and ASALs (Arid and Semi-arid Lands) for Output 2 and Output 4. Model Site: Embu County and Taita Taveta County are as Pilot Counties for Output 2.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Sustainable forest management is promoted in Kenya towards the national forest cover target of 10%.	1 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. 2 50% of ASAL counties introduce the activities promoted by the Project. 3 National Forest Programme is updated.	• Citation in public documents • Operation of NFMS • Observation of activities	
Project Purpose Capacity at the national and county level for sustainable forest management is strengthened.	1 70% of direct beneficiaries recognize the improvement of policy implementation. 2 At least 3 entities (government, private, NGO/CBO) and individuals newly start growing of improved Melia volkensii in the ASALs. 3 REDD+ readiness process is advanced by the establishment of NFMS and FRL (Forest Reference Level). 4 KEFRI as AI-CD (African Initiative for Combatting Desertification) Regional Hub holds at least 5 Regional/National meetings, workshops and trainings for knowledge sharing. 5 Distribution system of seeds and seedlings of improved *Melia volkensii* is improved.	• Project reports • Citation in public documents • Interview	• There is no major changes of government institutional arrangement on forest and climate change policy.
Outputs Output 1 (Policy Support) Implementing and monitoring capacities of forest-related policies/strategies at the national level are enhanced.	1-1 Monitoring and evaluation process of the National Forest Programme is established. 1-2 70% of stakeholders recognize the recommendation prepared by the Project as applicable and effective.	• Remarks and interview • Project reports • Interview	• Relevant policies currently under deliberation (National Forest Policy, Forest Conservation & Management Bill, National Climate Change Framework Policy, etc.) are finalized.
Output 2 (Forestry Extension in ASALs through public, private and NGOs/CBOs partnership) Capacities of public and private sectors, and NGOs/CBOs to promote tree growing in ASALs are enhanced through forestry extension activities.	2-1 PFMP (Participatory Forest Management Plan), FFS (Farmer Field School) and other forestry extension approaches are applied in a strategic and coordinated manner in the Pilot Counties. 2-2 Collaboration among private and public sectors, and NGOs/CBOs is enhanced to promote tree growing in ASALs 2-3 More than 10 times of seminars/trainings for related stakeholders are held to promote improved Melia volkensii growing.	• Observation of activities at field based on the plan. • Project reports • Proposal/report submitted	
Output 3 (REDD+ Readiness) Technical capacities for REDD+ readiness activities and forest monitoring for sustainable forest management in KFS are strengthened.	3-1 The methodology of forest monitoring under the NFMS is established and documented. 3-2 Forest Information Platform as data management function of the NFMS is developed. 3-3 FRL is established in consultation with other stakeholders for submission to the UNFCCC by the Kenyan Government. 3-4 Creation of Land Cover/Land Use Map of 2020 is undertaken.	• Project reports • Report to UNFCCC (United Nations Framework Convention on Climate Change)	
Output 4 (Tree Breeding) The capacity of breeding techniques for drought tolerant trees in KEFRI is improved.	4-1 Plus trees of *Melia volkensii* and *Acacia tortilis* are selected in the seed orchards and stands in Tiva and Kibwezi. 4-2 Researchers of KEFRI acquire the skills of artificial crossing technique.	• Project reports • Visit/observation of the tree • Interview of researchers • Demonstration of the techniques	
Output 5 (Regional Cooperation) 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-Sahara Africa.	5-1 Database on good practices to strengthen the resilience to climate change and drought in Sub-Saharan Africa is established to be referred by Kenya and other neighbouring countries. 5-2 70% of participating countries evaluate the regional cooperation useful.	• Access data of the website • Records of the meetings. • Project reports • Interview of participating countries.	

Activities	Inputs: The Japanese Side	Inputs: The Kenyan Side	Important Assumption
Output 1 (Policy Support) 1-1 Review existing/planned forest-related policies/strategies. 1-2 Conduct gap analysis between the existing forest-related policies/strategies and their actual implementation at field level. 1-3 Support planning and monitoring of National Forest Programme. 1-4 Prepare policy briefs based on project field activities utilizing NFMS. Output 2 (Forestry Extension in ASALs through public, private and NGOs/CBOs partnership) 2-1 Conduct a feasibility study and examine the approach for pilot implementation and select pilot Counties. 2-2 Assist formulation and implementation of PFMP in the pilot Counties 2-3 Support farmers to conduct FFS in strategic collaboration with implementation of PFMP in the Pilot Counties 2-4 Promote collaboration among government institutions, private entities and NGOs/CBOs in enhancing tree growing in ASALs 2-5 Promote tree growing of improved *Melia volkensii* in ASALs Output 3 (REDD+ Readiness) 3-1 Design, develop and test the NFMS for Kenya. 3-2 Operationalize the Forest Information Platform. 3-3 Conduct accuracy assessment of 2014 Land Cover/Land Use Map which is developed by SLEEK (System for Land-Based Emission Estimation in Kenya). 3-4 Create land cover/land use change maps using 4 historical data of land cover/land use maps. 3-5 Collect information on emission factors, set emission factors and develop 2014 Carbon 3-6 Analyse the land cover/land use changes based on the 4 time historical data of land cover/land use maps. 3-7 Develop and evaluate FRL with stakeholders. 3-8 Strengthen capacities for creating 2020 Land Cover/Land Use Map. 3-9 Train C/P for new technology or methodology of MRV (Measurement Reporting Verification) and test them for future development of MRV system in Kenya. Output 4 (Tree Breeding) 4-1 Improve the quality of clonal seed orchards of *Melia volkensii*. 4-2 Study of artificial crossing toward 2nd generation of *Melia volkensii*. 4-3 Improve the seedling seed stands of *Acacia tortilis*. Output 5 (Regional Cooperation) 5-1 Design the scope and prepare a TOR of regional cooperation by networking with related countries. 5-2 Hold regional cooperation meetings and forum. 5-3 Collect good practice information for strengthening the resilience to climate change and drought in Sub-Saharan Africa from Kenya and surrounding countries. 5-4 Accumulate the collected information, and establish the database on KEFRI's website. 5-5 Share the collected knowledge and technologies with other countries in Sub-Sahara 5-6 Improve access to finance to combat desertification.	1 Personal 【Long-term expert】 (1) Chief adviser/Forest policy (2) Regional cooperation/Coordinator (3) Forestry Extension 【Short-term expert (Consultant)】 (1) NFMS/FRL/MRV (Measurement, Reporting and Verification) (2) Tree breeding (3) Experts as necessary 2 Counterpart Training 3 Machinery, Equipment and Materials (1) Equipment for NFMS (2) Equipment for tree breeding extension (3) Equipment for information sharing (4) Vehicles (5) Other necessary machinery, equipment and 4 Supplementary budget for local expenditure	【Project management unit】 (1) Project Director - MENR (2) Director, KFS (3) Director, KEFRI 【OUTPUT Level】 (1) Project Manager - MENR (2) Component managers – MENR, (3) Counterpart/Administrative personnel 【Administrative staff】 (1) Secretary (2) Driver (3) Other staff 2 Land and Facilities (1) Project office in Nairobi (MENR, (2) Land and nursery for forest tree seed 3 Administrative and Operational Cost	• Ongoing relevant initiatives such as 1) formulation of national forest programme, 2) revision of Kenya NFMS Road Map, 3) upscaling of forest inventory to national level, are cooperative with the Project. • Data from collaborating institutions including DRSRS and RCMRD (Regional Centre for Mapping of Resources for Development) are made available. • Selection of pilot County governments is completed timely for efficient activity operation.
			Pre-Conditions • Devolution of forest extension functions is agreed between KFS and county governments by March 2016 as stated by relevant acts.
			<Issues and countermeasures>

5) PDM-Version 4 (January 2020)

Project Design Matrix

Project Title: Capacity Development Project for Sustainable Forest Management in the Republic of Kenya
Implementing Agency: MoEF (Ministry of Environment and Forestry), KFS (Kenya Forest Service), KEFRI (Kenya Forestry Research Institute) and County Governments
Target Group: Direct Beneficiaries: Staff of implementing agencies and collaborating organizations
Indirect Beneficiaries: Population of pilot Counties and activity areas of NGO/CBO/private entities in Output 2
Period of Project: June, 2016 – October 2021 (5 years and 4 months)
Project Site: Nationwide, and ASALs (Arid and Semi-arid Lands) for Output 2 and Output 4. Model Site: Embu County and Taita Taveta County are as Pilot Counties for Output 2.

Version 4
Dated: Jan 28 2020

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Sustainable forest management is promoted in Kenya towards the national forest cover target of 10%.	1 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. 2 50% of ASAL counties introduce the activities promoted by the Project. 3 National Forest Programme is updated.	・Citation in public documents ・Operation of NFMS ・Observation of activities	
Project Purpose Capacity at the national and county level for sustainable forest management is strengthened.	1 70% of direct beneficiaries recognize the improvement of policy implementation. 2 At least 3 entities (government, private, NGO/CBO) and individuals newly start growing of improved Melia volkensii in the ASALs. 3 REDD+ readiness process is advanced by the establishment of NFMS and FRL (Forest Reference Level). 4 KEFRI as AI-CD (African Initiative for Combatting Desertification) Regional Hub holds at least 5 Regional/National meetings, workshops and trainings for knowledge sharing. 5 Distribution system of seeds and seedlings of improved *Melia volkensii* is improved.	・Project reports ・Citation in public documents ・Interview	・There is no major changes of government institutional arrangement on forest and climate change policy.
Outputs Output 1 (Policy Support) Implementing and monitoring capacities of forest-related policies/strategies at the national level are enhanced.	1-1 Monitoring and evaluation process of the National Forest Programme is established. 1-2 70% of stakeholders recognize the recommendation prepared by the Project as applicable and effective.	・Remarks and interview ・Project reports ・Interview	・Relevant policies currently under deliberation (National Forest Policy, Forest Conservation & Management Bill, National Climate Change Framework Policy, etc.) are finalized.
Output 2 (Forestry Extension in ASALs through public, private and NGOs/CBOs partnership) Capacities of public and private sectors, and NGOs/CBOs to promote tree growing in ASALs are enhanced through forestry extension activities.	2-1 PFMP (Participatory Forest Management Plan), FFS (Farmer Field School) and other forestry extension approaches are applied in a strategic and coordinated manner in the Pilot Counties. 2-2 Collaboration among private and public sectors, and NGOs/CBOs is enhanced to promote tree growing in ASALs 2-3 More than 10 times of seminars/trainings for related stakeholders are held to promote improved Melia volkensii growing.	・Observation of activities at field based on the plan. ・Project reports ・Proposal/report submitted	
Output 3 (REDD+ Readiness) Technical capacities for REDD+ readiness activities and forest monitoring for sustainable forest management in KFS are strengthened.	3-1 The methodology of forest monitoring under the NFMS is established and documented. 3-2 Forest Information Platform as data management function of the NFMS is developed. 3-3 FRL is established in consultation with other stakeholders for submission to the UNFCCC by the Kenyan Government. 3-4 Creation of Land Cover/Land Use Map of 2020 is undertaken.	・Project reports ・Report to UNFCCC (United Nations Framework Convention on Climate Change)	
Output 4 (Tree Breeding) The capacity of breeding techniques for drought tolerant trees in KEFRI is improved.	4-1 Plus trees of *Melia volkensii* and *Acacia tortilis* are selected in the seed orchards and stands in Tiva and Kibwezi. 4-2 Researchers of KEFRI acquire the skills of artificial crossing technique.	・Project reports ・Visit/observation of the tree ・Interview of researchers ・Demonstration of the techniques	
Output 5 (Regional Cooperation) 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-Sahara Africa.	5-1 Database on good practices to strengthen the resilience to climate change and drought in Sub-Saharan Africa is established to be referred by Kenya and other neighbouring countries. 5-2 70% of participating countries evaluate the regional cooperation useful.	・Access data of the website ・Records of the meetings. ・Project reports ・Interview of participating countries.	

Activities	Inputs		Important Assumption
	The Japanese Side	The Kenyan Side	
Output 1 (Policy Support) 1-1 Review existing/planned forest-related policies/strategies. 1-2 Conduct gap analysis between the existing forest-related policies/strategies and their actual implementation at field level. 1-3 Support planning and monitoring of National Forest Programme and other forest-related policies/laws. 1-4 Release policy briefs based on project activities.	1 Personal 【Long-term expert】 (1) Chief adviser/Forest policy (2) Regional cooperation/Coordinator (3) Forestry Extension	【Project management unit】 (1) Project Director - MENR (2) Director, KFS (3) Director, KEFRI	・Ongoing relevant initiatives such as 1) formulation of national forest programme, 2) revision of Kenya NFMS Road Map, 3) upscaling of forest inventory to national level, are cooperative with the Project.
Output 2 (Forestry Extension in ASALs through public, private and NGOs/CBOs partnership) 2-1 Conduct a feasibility study and examine the approach for pilot implementation and select pilot Counties. 2-2 Assist formulation and implementation of PFMP in the pilot Counties 2-3 Support farmers to conduct FFS in strategic collaboration with implementation of PFMP in the Pilot Counties 2-4 Promote collaboration among government institutions, private entities and NGOs/CBOs in enhancing tree growing in ASALs 2-5 Promote tree growing of improved *Melia volkensii* in ASALs	【Short-term expert (Consultant)】 (1) NFMS/FRL/MRV (Measurement, Reporting and Verification) (2) Tree breeding (3) Experts as necessary 2 Counterpart Training 3 Machinery, Equipment and Materials (1) Equipment for NFMS (2) Equipment for tree breeding extension (3) Equipment for information sharing (4) Vehicles (5) Other necessary machinery, equipment and	【OUTPUT Level】 (1) Project Manager - MENR (2) Component managers – MENR, KFS, (3) Counterpart/Administrative personnel 【Administrative staff】 (1) Secretary (2) Driver (3) Other staff 2 Land and Facilities (1) Project office in Nairobi (MENR, KFS, (2) Land and nursery for forest tree seed 3 Administrative and Operational Cost	・Data from collaborating institutions including DRSRS and RCMRD (Regional Centre for Mapping of Resources for Development) are made available. ・Selection of pilot County governments is completed timely for efficient activity operation.
Output 3 (REDD+ Readiness) 3-1 Design, develop and test the NFMS for Kenya. 3-2 Operationalize the Forest Information Platform. 3-3 Conduct accuracy assessment of 2014 Land Cover/Land Use Map which is developed by SLEEK (System for Land-Based Emission Estimation in Kenya). 3-4 Create land cover/land use change maps using 4 historical data of land cover/land use maps. 3-5 Collect information on emission factors, set emission factors and develop 2014 Carbon Map. 3-6 Analyse the land cover/land use changes based on the 4 time historical data of land cover/land use maps. 3-7 Develop and evaluate FRL with stakeholders. 3-8 Strengthen capacities for creating 2020 Land Cover/Land Use Map. 3-9 Train C/P for new technology or methodology of MRV (Measurement Reporting Verification) and test them for future development of MRV system in Kenya.	4 Supplementary budget for local expenditure		**Pre-Conditions** ・Devolution of forest extension functions is agreed between KFS and county goverrnments by March 2016 as stated by relevant acts.
Output 4 (Tree Breeding) 4-1 Improve the quality of clonal seed orchards of *Melia volkensii* . 4-2 Study of artificial crossing toward 2nd generation of *Melia volkensii* . 4-3 Improve the seedling seed stands of *Acacia tortilis* .			
Output 5 (Regional Cooperation) 5-1 Design the scope and prepare a TOR of regional cooperation by networking with related countries. 5-2 Hold regional cooperation meetings and forum. 5-3 Collect good practice information for strengthening the resilience to climate change and drought in Sub-Saharan Africa from Kenya and surrounding countries. 5-4 Accumulate the collected information, and establish the database on KEFRI's website. 5-5 Share the collected knowledge and technologies with other countries in Sub-Sahara Africa. 5-6 Improve access to finance to combat desertification.			**<Issues and countermeasures>**