Ministry of Environment
General Directorate of Administration for Nature Conservation and Protection
Forestry Administration and Fisheries Administration
Ministry of Agriculture, Forestry and Fisheries
The Kingdom of Cambodia

PROJECT FOR FACILITATING THE IMPLEMENTATION OF REDD+ STRATEGY AND POLICY FOR CAMBODIA

FINAL REPORT

November 2017

Japan International Cooperation Agency

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Acknowledgement

JICA Technical Assistant Team (JICA TA Team) started its activity in November 2011 almost at the same time Cambodia initiated its REDD+ readiness stage. In 2017, Cambodia completed initial version of National REDD+ Strategy and National Forest Monitoring System Design. And the assessment of Forest Reference Level by UNFCCC is nearly completed.

JICA TA Team terminates its activity in November 2017. This final report covers major events of REDD+ Readiness activities of Cambodia and contribution of JICA TA Team in the past 6 years.

Taking this opportunity, we would like to congratulate the Royal Government of Cambodia on the successful completion of REDD+ readiness stage. And we would like to express our sincere gratitude for kind support from the Cambodian government agencies, officials of both JICA headquarters and Cambodia office, experts of FAO and UNDP, and all the stakeholders.

October 2017

Shigeru ONO
Leader
JICA Technical Assistant Team

Acronyms

AD	Activity Data
AFOLU	Agriculture, Forestry, and Other Land Use
AGB	Aboveground Biomass
AIT	Asian Institute of Technology, Thailand
ALOS	Advanced Land Observing Satellite
AVNIR-2	Advanced Visible and Near Infrared Radiometer-2
BGB	Belowground Biomass
BUR	Biennial Update Report
CAM-REDD	Project for Facilitating the Implementation of REDD+ Strategy and Policy for Cambodia
CCBA	Climate, Community and Biodiversity Alliance
CCCSP	Cambodia Climate Change Strategic Plan
CG	Consultation Group
CH_4	Methane
CO_2	Carbon Dioxide
COP	The Conference of the Parties to the UNFCCC
DF	Deciduous Forest
DW	Dead Wood
EF	Emission Factor
EF	Evergreen Forest
ELC	Economic Land Concession
FA	Forestry Administration of Cambodia
FACCC	Forestry Administration Climate Change Committee
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FFPRI	Forestry and Forest Products Research Institute (of Japan)
FiA	Fisheries Administration of Cambodia
FLEGT	Forest Law Enforcement, Governance and Trade
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
GDANCP	General Directorate of Administration for Nature Conservation and Protection
GCF	Green Climate Fund

GHG	Greenhouse Gas
GIS	Geographic Information System
GMS	Greater Mekong Sub-region
GPG	Good Practice Guidance
GPS	Global Positioning System
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
ITTO	International Tropical Timber Organization
JAXA	Japan Aerospace Exploration Agency
JCC	Joint Coordinating Committee
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
JICA TA Team	JICA Technical Assistant Team
LCCS	Land Cover Classification System
LULUCF	Land Use, Land Use Change and Forestry
MAFF	Ministry of Agriculture, Forestry and Fisheries
MMU	Minimum Mapping Unit
MoE	Ministry of Environment of Cambodia
MRV	Measurement, Reporting and Verification
N_2O	Nitrous Oxide
NC	National Communication
NCCC	National Climate Change Committee
NCSD	National Council for Sustainable Development
NESAP	National Environment Strategy and Action Plan
NF	Non Forest
NFI	National Forest Inventory
NFMA	National Forest Monitoring and Assessment Initiative of FAO
NFMS	National Forest Monitoring System
NFP	National Forest Programme
NGO	Non-Governmental Organizations
NPASMF	National Protected Area Strategic System Management Framework
NPASMP	National Protected Areas Strategic Management Plan

NRS	National REDD+ Strategy
NSDP	National Strategic Development Plan
OF	Other Forest
OJT	On-the-Job Training
PALSAR	Phased Array L Band Synthetic Aperture Radar
PCA	Principal Component Analysis
PDM	Project Design Matrix
PSP	Permanent Sample Plot
QA/QC	Quality Assurance / Quality Control
R/D	Record of Discussion
REDD	Reducing Emissions from Deforestation and Forest Degradation in developing countries
REDD+	Reducing Emissions from Deforestation and Forest Degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
REL	Reference Emission Level
RL	Reference Level
R-PP	Readiness Preparation Proposal
RS	Remote Sensing
RTS	REDD+ Taskforce Secretariat
SE	Semi-evergreen Forest
SIS	Safeguard Information System
SLC	Social Land Concession
SPFF	The Strategic Planning Framework for Fisheries: 2010-2019
TA	Technical Assistant
TCP	Technical Cooperation Programme (of FAO)
TOR	Terms of Reference
TWG	Technical Working Group
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
UN-REDD	United Nations REDD Programme
USAID	United States Agency for International Development
VCS	Verified Carbon Standard

VCU	Verified Carbon Unit
VVB	Validation and Verification Body
WB	World Bank
WCS	Wildlife Conservation Society

Map of Cambodia

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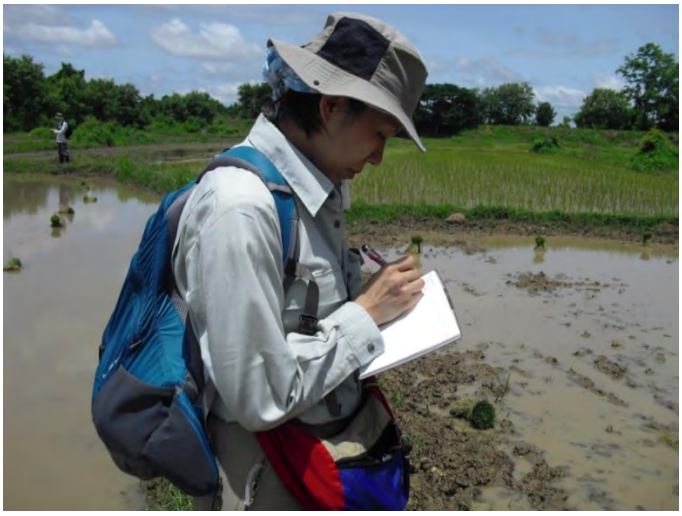
Photo 12 Field check of land use/ cover July 2014 Kratie	

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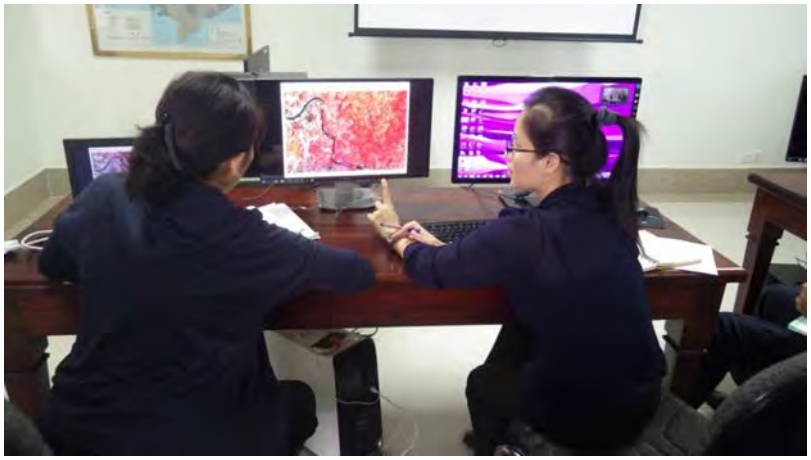
Photo 21 Training on the practical use of eCognition June 2016 FA REDD+ Center, Phnom Penh	

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Reducing Emission from Deforestation and Forest Degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) is a mechanism to use financial incentives to reduce greenhouse gases emitted by deforestation and forest degradation. Value of forest resources has long since been recognized by the Cambodian government and sustainable use of natural resources is listed as one of four Rectangles[1] of "Rectangular Strategy for Growth, Employment, Equity and Efficiency" of Cambodia.

Cambodia considers REDD+ as an effective measure to mitigate deforestation and forest degradation and in 2009 a REDD+ Roadmap, which states actions to be taken to become REDD+ ready, was completed. In order to implement actions identified in the roadmap, multiple development partners including JICA pledged support. JICA's support for Cambodian REDD+ started in June 2011 as the Project for Facilitating the Implementation of REDD+ Strategy and Policy. And in November 2011, JICA Technical Assistant Team (JICA TA Team) for MRV/REL began its activities in Cambodia.

In the past 6 years, Cambodia made great progress in its REDD+ activities including submission of FRL to UNFCCC, preparation of a National REDD+ Strategy (NRS), design of a National Forest Monitoring System (NFMS) and its components, the improvement in land use/cover assessment techniques, land use/cover assessments using the improved techniques, and implementation of REDD+ demonstration projects. Prototype design of a Safeguard Information System (SIS) was also worked out.

REDD+ activities is usually divided in three phases. The first phase is REDD+ readiness phase and the second is demonstration or implementation phase. Cambodia is now in the transition stage from Phase I to Phase II although some part of activities of Phase II has already been implemented.

JICA TA Team completes its mission in November 2017. This final report summarizes the progress of REDD+ readiness activities of Cambodia and contribution of JICA TA team in it in the past 6 years. Discussion on future activities is also included.

[1] The rectangle is "Promotion of Agriculture Sector" and one of the four sides of the rectangle is "Sustainable Management of Natural Resources".

1 Outline of the Project

1.1 Country Profile

Cambodia is located in lower Mekong river area and sharing border with Vietnam, Thailand and Laos. Country profile is as summarized below.

- Land area: 181,035 km^2
- Forest area[2]: Approximately 8.75 million hectare as of 2016
- Climate: Tropical monsoon climate with rain and dry seasons
- Population: 15,762,370 in 2016 (Source: World Bank statistics)[3]
- Annual GDP growth: 6.9% in 2016 (Source: World Bank)

According to "Cambodia Industrial Development Policy 2015-2025" of March 2015, historical and future change of contribution of each sector to GDP is as shown on Table 1. Agriculture is shrinking but according to the industrial development strategy agro-business such as rubber production will be promoted.

Table 1 Contribution of each sector of Cambodia to GDP

Sector	1962	1998	2008	2013	2015	2020	2025
Agriculture	49%	44.5%	32.8%	31.6%	29.0%	25%	23%
Industry	19%	16.7%	22.4%	24.1%	26.2%	28%	30%
(Manufacturing portion)	-	12.7%	15.3%	15.5%	16.0%	18%	20%
Service	32%	34.8%	38.8%	38.5%	39.4%	40%	40%
Taxes on products less subsidies	0%	4%	6%	5.8%	5.4%	7%	7%

(Source: "Cambodia Industrial Development Policy 2015-2025", March 2015)

1.2 Background of CAM-REDD

According to "Cambodia Forest Cover 2010" an official forest assessment report published by the Forestry Administration (FA) of Cambodia, deforestation rate of Cambodia was 0.51%/year[4] between 2002 and 2010. In October 2010, the Council of Ministers of the Cambodian

[2] Based on the forest definition of National Forest Programme.
[3] http://databank.worldbank.org/data/reports.aspx?source=2&country=KHM
[4] In this case, forest includes rubber and oil palm plantations and perennial crops.

government approved National Forestry Proramme (NFP) and announced the strategy for sustainable forest management. The Cambodia government also participated in REDD+ partnership, and with the support from UNDP, REDD+ Roadmap was prepared in 2010. However, capacity of the Cambodian government to implement activities listed in the roadmap was not enough. This led to the request from the Cambodia to Japan for technical assistance to implement activities identified in the roadmap. In response to this request, JICA agreed to implement "Project for Facilitating the Implementation of REDD+ Strategy and Policy" (CAM-REDD). Record of Discussion on the project was signed on May 27, 2011.

1.3 Cambodia's Forest Management

1.3.1 Relevant Laws, Strategies and Plans

Cambodia has various laws, plans and strategies related to the management of forest and natural resources as listed below.

Laws

- 1993 Royal Decree on Creation and Determination of Nature Reserves
- Environmental Protection and Natural Resources Management Law 1996
- Land Law 2001
- Forestry Law 2002
- Fisheries Law 2006
- Protected Areas Law 2008
- Sub-decree No.83 on Registration of Land of Indigenous Communities 2009

Plans and Strategies

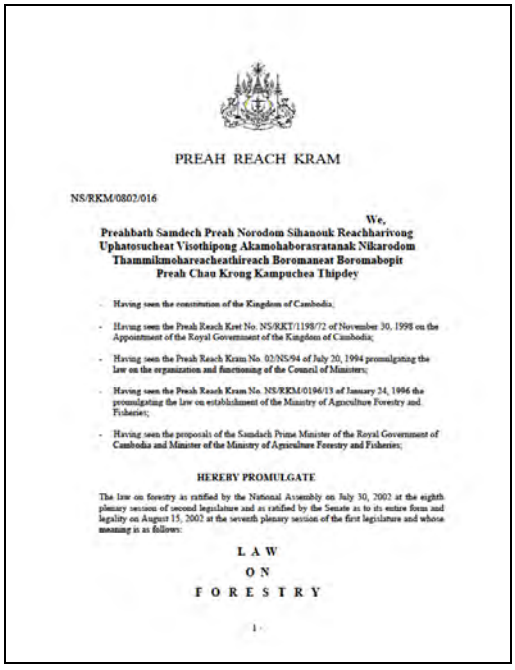
- First National Communication 2002
- National Forest Programme 2009-2029
- Strategic Planning Framework for Fisheries 2010-2019
- Rectangular Strategy Phase III 2013-2018
- National Strategy and Action Plan 2014-2016 Mangroves for the Future (2013)
- National Policy on Green Growth and Green Growth Strategic Plan 2013-2030
- Gender and Climate Change Action Plan 2014-2018
- National Strategic Development Plan 2014-2018
- Cambodia Climate Change Strategic Plan 2014-2023
- Second National Communication 2015
- National Environment Strategy and Action Plan (NESAP) covering 2015 - 2023

- National Protected Areas Strategic Management Plan 2016-2030
- National Biodiversity Strategy and Action Plan 2016-2020
- National Environmental Code (Draft)

Outline of major laws, plans and strategies is given below.

Forestry Law

The Forestry Law (2002) defines the framework for management, harvesting, use, development and conservation of the forests in Cambodia. The objective of this law is to ensure the sustainable management of forests for their social, economic and environmental benefits, including conservation of biological diversity and cultural heritage. The Forestry Law states that the management of forests is under the jurisdiction of the Ministry of Agriculture Forestry and Fisheries (MAFF) (except for management of flooded forests which is covered by a different law). Furthermore, it delegates the authority to manage Protected Areas to the Ministry of Environment.



PREAH REACH KRAM

NS/RKM/0802/016

We,

Preahbath Samdech Preah Norodom Sihanouk Reachharivong Uphatosucheat Visothipong Akamohaborasratanak Nikarodom Thammikmohareacheathireach Boromaneat Boromabopit Preah Chau Krong Kampuchea Thipdey

- Having seen the constitution of the Kingdom of Cambodia;
- Having seen the Preah Reach Kret No. NS/RKT/1198/72 of November 30, 1998 on the Appointment of the Royal Government of the Kingdom of Cambodia;
- Having seen the Preah Reach Kram No. 02/NS/94 of July 20, 1994 promulgating the law on the organization and functioning of the Council of Ministers;
- Having seen the Preah Reach Kram No. NS/RKM/0196/13 of January 24, 1996 the promulgating the law on establishment of the Ministry of Agriculture Forestry and Fisheries;
- Having seen the proposals of the Samdach Prime Minister of the Royal Government of Cambodia and Minister of the Ministry of Agriculture Forestry and Fisheries;

HEREBY PROMULGATE

The law on forestry as ratified by the National Assembly on July 30, 2002 at the eighth plenary session of second legislature and as ratified by the Senate as to its entire form and legality on August 15, 2002 at the seventh plenary session of the first legislature and whose meaning is as follows:

L A W
O N
F O R E S T R Y

1

Figure 1　Front Page of Law on Forestry

National Forest Programme（NFP）

NFP is a plan for the forestry sector covering the period between 2010 and 2029, and approved by the Council of Ministers in October 2010. NFP consists of six programmes that includes forest demarcation, classification and registration; conservation and development of forest

resources and biodiversity; forest law enforcement and governance; community forestry; capacity and research development; and sustainable forest financing. Current national policy commitments under the NFP include increasing the country's forest cover to 60%. One of the principal aims of the NFP is to support the establishment of community forests through the allocation of increased forestland to rural communities. Under the Forest Law, rights of local communities and the importance of decentralized management of natural resources are well recognized.

Figure 2 Front Page of NFP

Vision, Mission and Strategic objective of NFMS are cited below from the NFP document.

Vision

Ecologically, socio-economically, culturally and environmentally sound management and development of forest resources form a major pillar for public welfare.

Mission

To advance the sustainable management and development of Cambodian forests for their contribution to poverty alleviation, enhanced livelihoods, economic growth and environmental protection, including conservation of biological diversity and Cambodia's cultural heritage.

Strategic Objectives

1. *Maximize sustainable forest contribution to poverty alleviation, enhanced livelihoods and equitable economic growth*
2. *Adapt to climate change and mitigate its effects on forest based livelihoods*
3. *Macro land-use planning that allows for holistic planning across sectors, jurisdictions and local government borders*
4. *Forest governance, law and enforcement at all levels*
5. *Develop a conflict management system*
6. *Raise awareness, capacity of institutions and quality of education to enable sustainable implementation of the National Forest Programme*

7. *Ensure environmental protection and conservation of forest resources*
8. *Apply modern sustainable management models adaptive to changing context*
9. *Develop sustainable financing systems*

Concerning Strategy 9 "Develop sustainable financing systems" listed above, benefits from carbon markets is expected to be a part of the self- financing as quoted below:

> *"The NFP outlines methods of self-financing for the forestry sector, based initially on donor and government support whilst gradually introducing cautious low impact logging, certification and exports, and benefits from carbon markets."*

Also, NFP shows strategic indicators for the period between 2010 and 2029 as follows. Indicators which are considered relevant to REDD+ are highlighted by shading by the author.

- Current level of forest cover will be increased to 60% of the total land area.[5]
- Sustainable forest management with prescribed silviculture implemented on 2.4 million hectares of production forest.
- On average, 20 registered and vibrant small and medium scale direct and indirect forest based enterprises or cooperatives operating in each forestry cantonment, minimum of 50% of processed wood for export will be certified.
- Annual net revenue from the forest sector of 125 million USD.
- Annual average net income (excluding establishment and maintenance costs) from carbon sequestration of 25 million USD.
- Demarcation of a total 120,000 km of forest borders (primarily completed during the last ten years)
- Strategic forest decisions taken by the forest authorities in dialogue with other ministries and a vibrant civil society through a minimum of two cross-sectoral and public meetings per year.
- Forest monitoring and reporting system, showing the results and outcomes, updated monthly and available in the public domain.
- Larger scale forest based conflicts spiraling to destructive levels or hostilities limited to a maximum of two of national attention per year, through the application of conflict management.
- Civil servants in the forest sector able to initiate and implement activities with partners external to the FA as a natural part of their daily routines.

[5] In NFP, plantations and perennial crops are included in forest category.

- Protected Forest covers 3.0 million hectares.
- 500,000 hectares of high value commercial plantation established and 10 million tree seedlings distributed per year.
- Two million ha or forest land allocated for Community Forestry (approximately 1,000 CF) groups fully recognized with CF agreements.
- The forest sector will be fully self-financed.

Rectangular Strategy and National Strategic Development Plan 2014-2018

Rectangular Strategy for Growth, Employment, Equity and Efficiency, often abbreviated as the Rectangular Strategy, lays out the political commitment to a sustainable socioeconomic development of the country and sustainable management of natural resources is listed as one of four Rectangles. Current strategy is Phase III covering 2013-2018. The rectangle is "Promotion of Agriculture Sector" and one of the four sides of the rectangle is "Sustainable Management of Natural Resources".

National Strategic Development Plan (NSDP) 2014-2018 is the national development plan of Cambodia. NSDP at Phase III covers four years between 2014 and 2018. The NSDP Phase III carries forward the agenda laid out in the Rectangular Strategy for Growth, Employment, Equity and Efficiency Phase III.

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National Environment Strategy and Action Plan and Environmental Code

National Environment Strategy and Action Plan (NESAP) covers the period between 2015 and 2023. NESAP identifies priority policy tools and financing options for sustainable natural resource management and environmental protection. It will guide government ministries, private sector, civil society, and development organizations to mainstream environmental considerations into development policies, plans, and investments. The NESAP has been approved by NCSD recently and in the process of approval by the Council of Ministers.

Environmental Code focuses on the establishment of a stronger legal framework for environmental policy and strategy. A draft of the code has already been developed and now in the review process.

National Protected Area Strategic System Management Framework

The National Protected Area Strategic System Management Framework (NPASMF) is to put forward long-term overarching guidance on ways and means to address the obstacles to the establishment of new protected areas and conservation areas, the current and possible future

pressures from various threats on existing protected areas and conservation areas, and the constraints hindering the management of all these areas. (Cited from the NRS of Cambodia)

Cambodia Climate Change Strategic Plan 2014-2023

Cambodia Climate Change Strategic Plan (CCCSP) was publicized in October 2013 aligning to the planning cycle of NSDP. CCCSP is designed to ensure its strategic cohesion to address a wide range of climate change issues concerning adaptation, GHG mitigation, and low-carbon development. CCCSP states 8 strategic objectives and Strategic Objective No.3 is "Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas and cultural heritage sits". And as one of the four strategies to achieve this objective is "Promote payment for ecosystem services including REDD+". REDD+ is recognized as one of tools suitable for to deal with climate change issues.

1.3.2 Forest Land Management

When JICA TA Team started its activity in November 2011, land management of Cambodia was as shown in Figure 3.

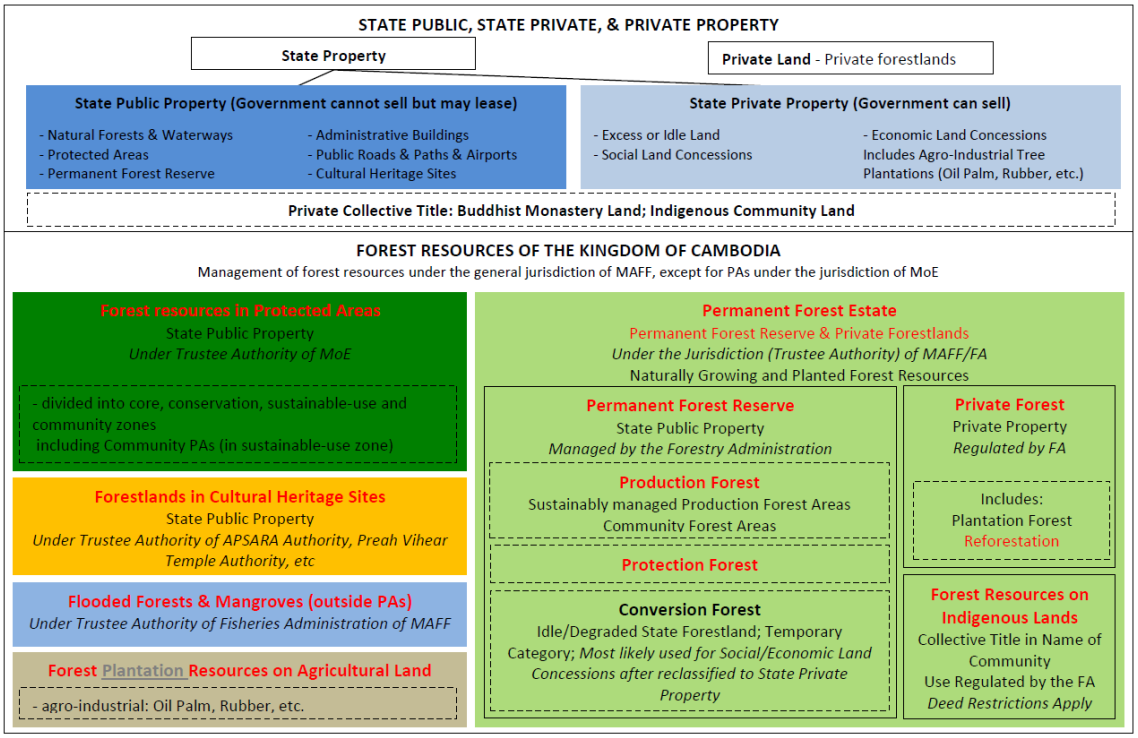


Figure 3 Forest Land Management in Cambodia before middle of 2016
(Source: Cambodia REDD+ Roadmap)

And forests in Cambodia were managed by three agencies - the Forestry Administration (FA) of MAFF, charged as the responsible Government Authority, the Ministry of Environment (MoE), responsible for Protected Areas, and the Fisheries Administration (FiA) of MAFF, responsible for flooded forest and mangrove areas.

This forest land management structure went through a drastic reform by two Sub-Decrees listed below.

- Sub-Decree No.34 dated March 4, 2016 on "Reformation the positions and duties of MoE and MAFF regarding management of ELCs and management of PA, and forest and fisheries conservation areas"
- Sub-Decree No.69 dated April 28, 2016 on "the Transfer of the Protected Forest, Forest Conservation and Production Forest Areas, and Economic Land Concessions between MAFF and MoE",

As of October 2017, Cambodia's forests are managed under the jurisdiction of the MoE and MAFF. FA within MAFF is responsible for the management of the permanent forest estate that includes forest reserves, and conversion forests. FiA in MAFF is responsible for the management of the country's flooded forests and mangrove areas. The General Directorate of Administration for Nature Conservation and Protection (GDANCP), MoE is responsible for the management of approximately 7.5 million ha protected areas network of Cambodia that includes the core areas of the Tonle Sap Biosphere Reserve and biodiversity conservation corridors.

1.3.3 Forest Cover

Forest of Cambodia is now divided into 11 classes for the purpose of land use/cover assessment. They are Evergreen Forest, Semi-Evergreen Forest, Deciduous Forest, Bamboo, Mangrove, Rear Mangrove, Flooded Forest, Forest Regrowth, Pine Tree, Pine plantation and Tree plantation. Size of forest land in 2006, 2010, 2014 and 2016 is as listed on Table 2

Figure 4 is a graph presented in "Cambodia Forest Cover 2010", a document issued by FA in October 2011. Forest in this graph includes oil and rubber plantations and perennial crops. According to the graph, forest covered more than 70% of the country in 1965 and the ratio dropped to 57.07% by 2010. It should be noted that a steep line between 1965 and 1992/93 is caused by uneven scale of time axis for 1965 -1992/93. Figure 5 is the graph after time axis is adjusted to the same scale.

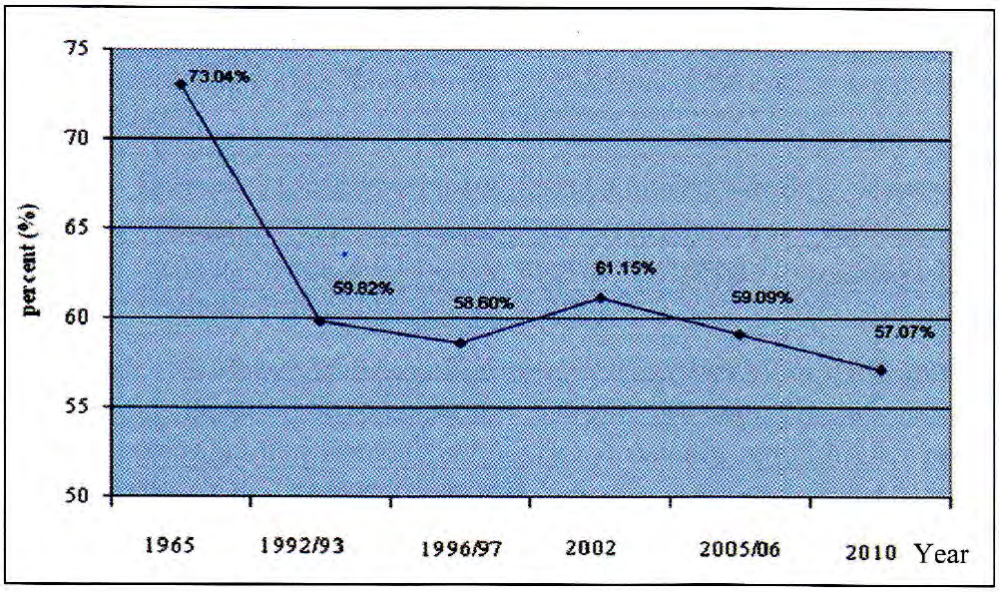


Figure 4 Historical forest cover change of Cambodia

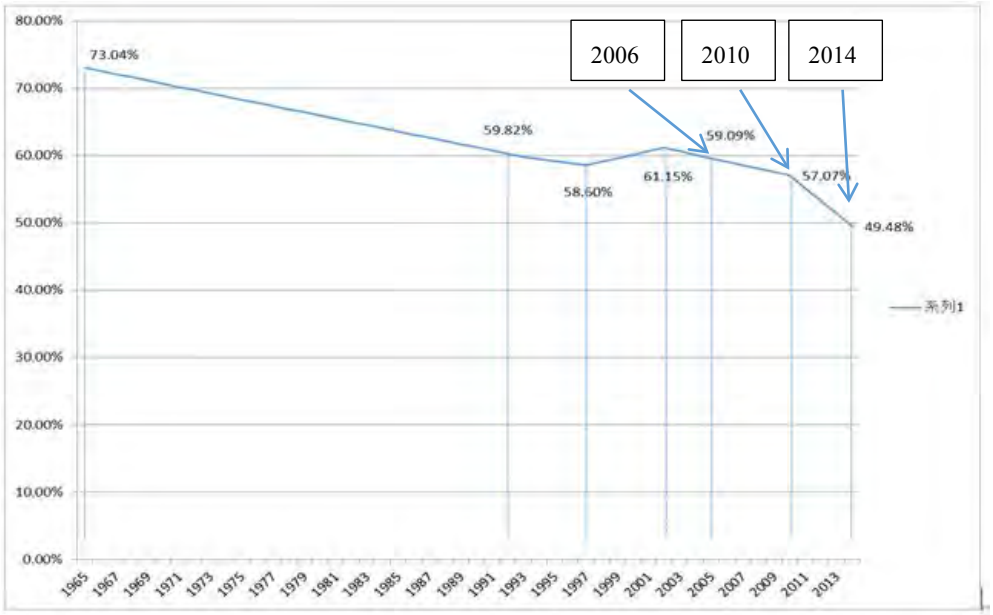


Figure 5 Historical forest cover change of Cambodia with evenly spaced timeline axis
Definition of forest is not for REDD+.

Table 2 Size of forests of Cambodia

Classification	2006		2010		2014		2016	
	Ha	%	Ha	%	Ha	%	Ha	%
Evergreen Forest	3,710,271	20.43%	3,573,925	19.68%	2,973,903	16.38%	2,861,233	15.76%
Semi-evergreen forest	1,453,441	8.00%	1,391,117	7.66%	1,108,320	6.10%	1,071,947	5.90%
Deciduous Forest	4,613,417	25.40%	4,498,397	24.77%	3,480,532	19.17%	3,336,349	18.37%
Flooded Forest	597,355	3.29%	524,005	2.89%	481,078	2.65%	477,813	2.63%
Forest Regrowth	216,123	1.19%	249,341	1.37%	228,560	1.26%	196,842	1.08%
Bamboo	129,837	0.71%	130,930	0.72%	130,678	0.72%	125,398	0.69%
Mangrove	32,060	0.18%	31,443	0.17%	33,002	0.18%	31,226	0.17%
Rear Mangrove	27,519	0.15%	27,371	0.15%	25,906	0.14%	25,906	0.14%
Pine Forest	8,157	0.04%	8,157	0.04%	8,196	0.05%	8,195	0.05%
Pine Plantation	0	0.00%	11	0.00%	3,709	0.02%	3,870	0.02%
Tree Plantation	43,547	0.24%	17,214	0.09%	44,289	0.24%	43,122	0.24%
Forest Area	**10,831,727**	**59.64%**	**10,451,911**	**57.55%**	**8,518,173**	**46.90%**	**8,181,901**	**45.05%**
Oil Palm Plantation	35	0.00%	5,055	0.03%	36,311	0.20%	51,276	0.28%
Rubber Plantation	78,148	0.43%	137,307	0.76%	484,316	2.67%	509,224	2.80%
Grassland	600,006	3.30%	473,281	2.61%	351,337	1.93%	341,132	1.88%
Agriculture	1,000,634	5.51%	1,275,444	7.02%	2,787,413	15.35%	3,017,435	16.62%
Paddy Filed	3,668,981	20.20%	3,859,452	21.25%	4,133,474	22.76%	4,221,407	23.24%
Rock	219	0.00%	668	0.00%	2,054	0.01%	1,100	0.01%
Sand	8,304	0.05%	10,459	0.06%	40,581	0.22%	41,245	0.23%
Built up area	37,435	0.21%	43,800	0.24%	328,820	1.81%	352,987	1.94%
Village	248,126	1.37%	296,513	1.63%	42,166	0.23%	42,930	0.24%
Water	438,410	2.41%	458,658	2.53%	813,839	4.48%	783,849	4.32%
Wood shrub	1,248,649	6.88%	1,148,126	6.32%	622,190	3.43%	616,177	3.39%
Non Forest	**7,328,947**	**40.36%**	**7,708,763**	**42.45%**	**9,642,501**	**53.10%**	**9,978,762**	**54.95%**
Total Area	**18,160,674**	**100.00%**	**18,160,674**	**100.00%**	**18,160,674**	**100.00%**	**18,160,674**	**100.00%**

According to Figure 5, rate of forest loss between 1965 and 1992 is nearly the same with the rate between 2002 and 2010. Cambodian government officials explain that the increase of forest area between 1997 and 2002 is caused by the improvement of satellite image interpretation technique – it became possible to detect smaller patches of forest by the introduction of screen digitizing technique which replaced interpretation of paper printed satellite image.

A graph in Figure 5 was created by FA before forest definition for REDD+ was made. Therefore, rubber and oil plantations and perennial crops were included in forest. Figure 6 is a graph made based on forest definition for REDD+ by excluding oil and rubber plantations and perennial crops from forest definition. Further, as for year 2006 and 2010 on Figure 6, upgraded maps were used to calculate forest cover ratio. On upgraded 2006 and 2010 maps, forest cover ratios are larger than the forest cover measured on original 2006 and 2010 maps even if oil and rubber plantations and perennial crops were not included. This reversal of figures is considered to be caused by the introduction of modern techniques in 2006 and 2010 map upgrading – forests, which were not captured on original 2006 and 2010 map, were identified during the upgrading process.

Figure 6 Change in forest cover ratio 2006 - 2016 (Based on forest definition for REDD+)

From Figure 6, annual rate of decrease in forest cover is calculated.

2006 - 2010: (59.64% - 57.55%)/4 = 0.52%

2010-2014: (57.55% - 46.90%)/4 = 2.66%

2014-2016: (46.90%-45.05%)/2 = 0.92%

These figures show that deforestation between 2010 and 2014 was large. The NRS

estimates the size of forest loss for each cause occurred before 2014 as follows.

Table 3 Cause and size of deforestation

Cause of Deforestation	Size	Remarks
Agribusiness development	2.02 million hectares	1.55 million hectares granted under the jurisdictional management of MAFF. 0.47 million hectares granted under the jurisdictional management of MoE.
Social land concessions to poor households, military households and for establishing new village	2.45 million hectares	2009-2013
De-gazetting forest land to issue and titles to landless communities.	1.2 million hectares	In 2014

According to the Forest Reference Level (FRL) document of Cambodia submitted to UNFCCC in November 2016, annual average emission between 2006 and 2014 was 78,953,951 t CO_2.[6] This figure is subject to change as the results of the assessment by UNFCCC.

In National REDD+ Strategy[7] (NRS), 9 drivers of deforestation and forest degradation in Cambodia are identified:

- Improvements in accessibility to remote forested areas, commercial logging, and infrastructure projects; and inadequate government capacity to manage forests in these areas
- Uncertain land tenure, land speculation, unauthorised encroachment of forest lands
- Rapid expansion of agriculture into forest lands, grant of large scale agro industrial economic land concessions, and distribution of land titles under social land concessions between 1996-2006
- Unauthorized logging and unsustainable harvesting of forest and non-timber products
- Weak forest governance, law enforcement, and monitoring of forest and land use sector
- Increasing regional and global demand for raw materials such as rubber and sugar

6 This figure is the latest one dated May 22, 2017.

7 As of writing this final report, the National REDD+ Strategy of Cambodia has not yet been approved by the Council of Ministers.

- Population increase and demand for agricultural land
- Rural poverty and lack of alternative livelihoods.
- Other drivers include migration into forest areas, weak implementation of land laws, inadequate implementation of environmental and social impact assessment regulations, and a lack of state land registration and forest estate demarcation.

1.4 Cambodia's Commitment to Action on Climate Change

The national policies of the Royal Government that include the Rectangular Strategy Phase III and the National Strategic Development Plan prioritize action on climate change.

Cambodia ratified the UNFCCC on December 18, 1995 and its membership became official on 17 March 1996. Cambodia also ratified Kyoto Protocol on August 22, 2002 which entered into force on February 16, 2005. Structure of government to deal with climate change issues and major documents and reports prepared are as described below.

1.4.1 National Organization in Charge of Climate Change Issues

In 2006, the Royal Government of Cambodia established the National Climate Change Committee (NCCC), a cross-sectoral and multi-disciplinary body with the mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and programmes related to climate change.

In May 2015, the function of NCCC was taken over by the National Council for Sustainable Development (NCSD). As shown in Figure 7, NCSD has four departments which are also related to REDD+.

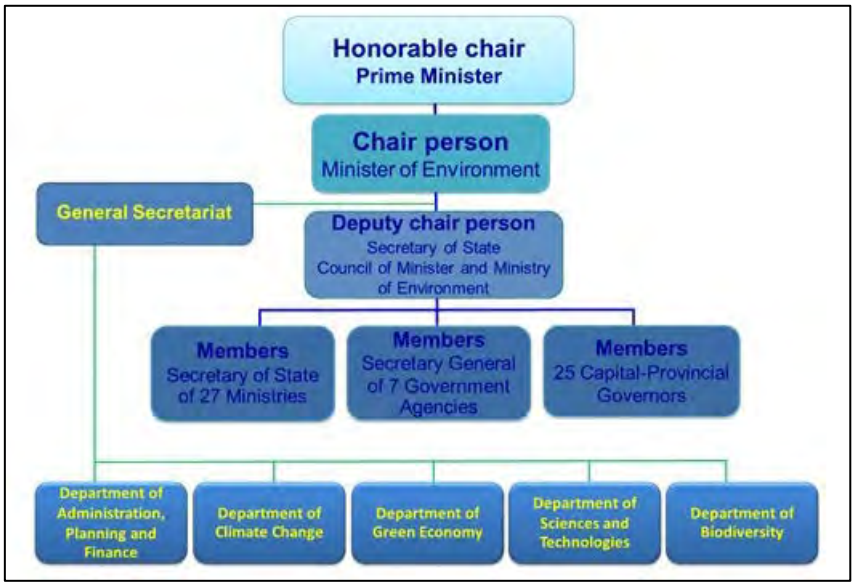


Figure 7 Structure of NCSD (Source: NCSD website)

GDANCP of MoE is actually responsible for the preparation of Cambodia Climate Change Strategic Plan (CCCSP) together with the Department of Climate Chang of NCSD.

1.4.2 National Communication and INDC

Cambodia has submitted important documents - National Communications (NC) and Intended Nationally Determined Contributions (INDC) - to UNFCCC to report Cambodia's action to climate change. Cambodia's first NC was issued in October 2002. INDC was submitted to UNFCCC in December 2015. And the second NC was submitted in January 2016. The GHG inventory of 2000 was presented in the second NC. And now, submission of the first Biennial Update Report (BUR) is being considered.

1.4.3 REDD+ Roadmap

According to "Forest change in the greater Mekong sub-region (GMS)" (FAO, 2017), deforestation rate of greater Mekong countries were as shown on Table 4.

This table shows that deforestation rate of Cambodia is second high among the five countries. Since forest cover of Cambodia on the table is larger than the official figure of Cambodia, reliability of forest cover of other four countries is considered not to be high. But this table would give some information on forest cover change in the region.

Table 4 Forest cover change of greater Mekong sub-region countries

Country	Forest cover	Annual change in forest area (%)

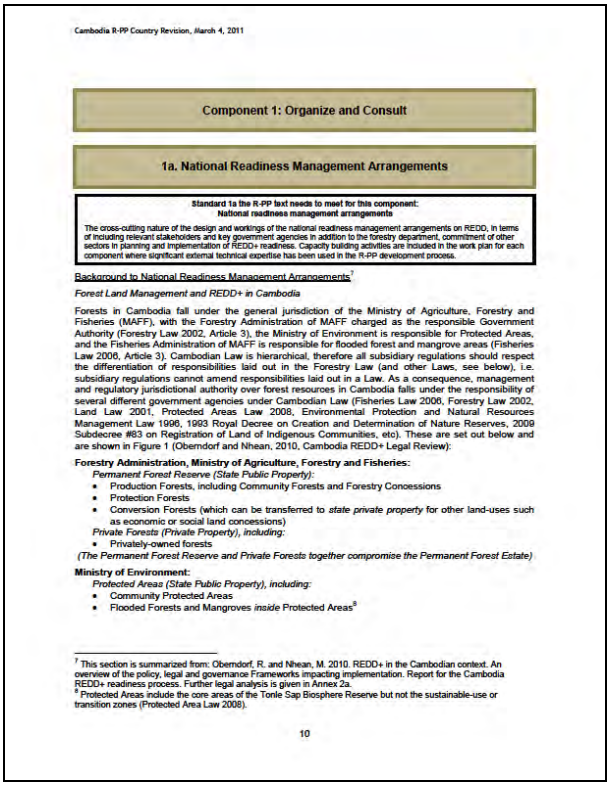
	2015 (%)	1990-2000	2000-2010	2010-2015
Cambodia	54	-1.1	-1.3	-1.3
Lao PDR	81	-0.7	0.8	1.0
Myanmar	44	-1.2	-0.9	-1.8
Thailand	32	2.0	-0.5	0.2
Vietnam	48	2.3	1.9	0.9

Deforestation is considered to be caused by the rapid pace of development in the country, including large scale agro-industrial development, and a lack of effective implementation of existing laws and policies for forest land and forest resource management.

Understanding that REDD+ is an effective mechanism for mitigating deforestation and forest degradation, Cambodia established its first REDD+ pilot project in 2008, became a partner country of the UN-REDD Programme in 2009, developed a national road map for REDD+ readiness in 2009-2010, submitted a Readiness Plan Proposal to the Forest Carbon Partnership Facility in 2009 and signed a UN-REDD National Programme in 2011.

Six main components of REDD+ readiness activities listed in the roadmap are:

- Management of national REDD+ readiness
- Consultation, stakeholder engagement and awareness raising plan
- Development and selection of REDD strategies
- Implementation framework (including benefit sharing and safeguards)
- Development of the reference scenario against which performance will be measured (Reference Levels or Reference Emissions Levels, RLs/RELs)
- Development of the monitoring system for national monitoring, reporting and verification(MRV)



Cambodia R-PP Country Revision, March 4, 2011

Component 1: Organize and Consult

1a. National Readiness Management Arrangements

Standard 1a the R-PP text needs to meet for this component:
National readiness management arrangements

The cross-cutting nature of the design and workings of the national readiness management arrangements on REDD, in terms of including relevant stakeholders and key government agencies in addition to the forestry department, commitment of other sectors in planning and implementation of REDD+ readiness. Capacity building activities are included in the work plan for each component where significant external technical expertise has been used in the R-PP development process.

Background to National Readiness Management Arrangements[7]

Forest Land Management and REDD+ in Cambodia

Forests in Cambodia fall under the general jurisdiction of the Ministry of Agriculture, Forestry and Fisheries (MAFF), with the Forestry Administration of MAFF charged as the responsible Government Authority (Forestry Law 2002, Article 3), the Ministry of Environment is responsible for Protected Areas, and the Fisheries Administration of MAFF is responsible for flooded forest and mangrove areas (Fisheries Law 2006, Article 3). Cambodian Law is hierarchical, therefore all subsidiary regulations should respect the differentiation of responsibilities laid out in the Forestry Law (and other Laws, see below), i.e. subsidiary regulations cannot amend responsibilities laid out in a Law. As a consequence, management and regulatory jurisdictional authority over forest resources in Cambodia falls under the responsibility of several different government agencies under Cambodian Law (Fisheries Law 2006, Forestry Law 2002, Land Law 2001, Protected Areas Law 2008, Environmental Protection and Natural Resources Management Law 1996, 1993 Royal Decree on Creation and Determination of Nature Reserves, 2009 Subdecree #83 on Registration of Land of Indigenous Communities, etc). These are set out below and are shown in Figure 1 (Oberndorf and Nhean, 2010, Cambodia REDD+ Legal Review):

Forestry Administration, Ministry of Agriculture, Forestry and Fisheries:

Permanent Forest Reserve (State Public Property):
- Production Forests, including Community Forests and Forestry Concessions
- Protection Forests
- Conversion Forests (which can be transferred to *state private property* for other land-uses such as economic or social land concessions)

Private Forests (Private Property), including:
- Privately-owned forests

(The Permanent Forest Reserve and Private Forests together compromise the Permanent Forest Estate)

Ministry of Environment:

Protected Areas (State Public Property), including:
- Community Protected Areas
- Flooded Forests and Mangroves *inside* Protected Areas[8]

[7] This section is summarized from: Oberndorf, R. and Nhean, M. 2010. REDD+ in the Cambodian context. An overview of the policy, legal and governance Frameworks impacting implementation. Report for the Cambodia REDD+ readiness process. Further legal analysis is given in Annex 2a.
[8] Protected Areas include the core areas of the Tonle Sap Biosphere Reserve but not the sustainable-use or transition zones (Protected Area Law 2008).

10

Figure 8 Front page of the REDD+ Roadmap

Cambodia has been implementing REDD+ readiness activities according to the plan laid out in the roadmap.

1.5 Outline of CAM-REDD

1.5.1 Goal and Objective of CAM-REDD

Overall Goal

Sustainable forest management as a mitigation measure against climate change is promoted based on the experiences of REDD+ implementation.

Project Purpose

Capacity of related stakeholders is strengthened for smooth implementation of REDD+ strategy and policy.

REDD+ activity can be divided into three phases:

Phase I	Readiness stage
Phase II	Implementation and demonstration stage

Phase III Full implementation for results-based payment

CAM-REDD basically aimed at supporting Phase I of Cambodian REDD+ although some parts of the Phase II were also supported.

The first PDM of CAM-REDD was made in March 2011 when details of REDD+ concept were still not clear even at UNFCCC and also activity plan of UN-REDD and other donors were not available. Therefore, the PDM had to be updated more than one time since the start of JICA TA Team's activities to align with the development of details of REDD+ by UNFCCC as well as the development of plans for support to Cambodian REDD+ by other donors.

Table 5 is the final version of PDM.

Table 5 PDM of CAM-REDD

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS (for CAM-REDD)	MEANS OF VERIFICATION	IMPORTANT ASSUMPTION
Overall Goal Sustainable forest management as a mitigation measure against climate change is promoted based on the experiences of REDD+ implementation.	Rate of deforestation and/or forest degradation is officially recognized and policies and measures are largely taken to reduce it.	Internationally submitted reports/ Other Reports/ Maps/Datasets	
Project Purpose Capacity of related stakeholders is strengthened for smooth implementation of REDD+ strategy and policy.	i) Necessary policies and measures in a national REDD+ strategy are drafted. ii) Policy level inter-ministerial coordination and stakeholder consultation for promoting a national REDD+ strategy is enhanced.	*Governmental Documents *Interviews from stakeholders	* Cambodian policies on REDD+ do not change greatly. * Financial sustainability is secured. * A national REDD+ strategy is endorsed and financed.
Outcomes 1. Effective National Management of the REDD+ Readiness process and stakeholder engagement	i) National taskforce, its secretariat, technical teams and consultation groups are established and become functional.	* Prakas[8] by Ministers / *Reports/Minutes of (Taskforce /advisory group/consultation events/trainings, etc.)	* International rules and modalities related to REDD+ procedure are established without delay. *Sufficient resources are allocated to draft national REDD+ strategy
2. Development of the National REDD+ Strategy	i) A national REDD+ strategy is drafted. ii) A relevant section on safeguards is compiled in a draft national REDD+ strategy. iii) Draft law on Wildlife and Biodiversity is submitted to the Council of Ministers iv) Sub-national NFP documents are endorsed for at least 7 provinces v)National/sub-national NFP programmes are implemented throughout 6 programmes and at least 4 provinces	* Prakas by Ministers / Reports/Documents/Minutes of (Taskforce /advisory group/consultation events/trainings, etc.)	
3. Improvement of capacity to manage REDD+ at the subnational/national levels.	i) Emission reduction is confirmed at least in one project ii) An initial pilot sub-national approach is	* Reports	

[8] "Praka" is defined as declaration by a minister.

	documented. iii) Experiences of all the demonstration sites supported by CAM-REDD are compiled and shared among stakeholders		
4. Design of a Monitoring System and RLs/RELs framework and capacity for implementation.	i) A relevant section on national forest monitoring system is compiled in a draft national REDD+ strategy and operationalized. ii) Initial REL(s)/RL(s) is developed. iii) Initial forest carbon measurement is completed above IPCC's Tier 1 level and its report is drafted for verification.	*Reports/Maps/ Datasets	

ACTIVITIES	**INPUTS**		
1.1 Establish National REDD+ Readiness Coordination Mechanism 1.2 Support National REDD+ Readiness Process 1.3 Engage Stakeholders in the REDD+ Readiness Process 1.4 Provide Stakeholders with Information on REDD+ and the National REDD+ Readiness Process 2.1 Develop National REDD+ Strategy 2.2 Evaluate Multiple Benefits 2.3 Establish REDD+ Fund Mechanisms and Revenue Sharing 2.4 Develop Policy and Legal Framework for the National REDD+ 2.5 Conceptualise Interim REDD+ Emission Reduction Registry and Accounting 2.6 Develop Safeguards and Monitoring of Multiple-Benefits 2.7 Conduct Research and Survey Related to REDD+ 3.1 Implement and Review Demonstration Activities 3.2 Develop Subnational/National Approach to REDD+ in the Field 4.1 Establish National MRV/REL 4.2 Develop National Forest Monitoring System Plan 4.3 Design the Satellite Land Monitoring System to provide Activity data for REDD+ related activities 4.4. Design a National Forest Inventory to Develop Emission and Removal Factors for REDD+ Related Activities 4.5 Develop Cambodia RLs/RELs Framework 4.6 Develop a REDD+ Related GHG Reporting System	Japanese Side 1) Allocation of Experts - Chief Advisor - Project Administrative Coordinator - Experts in the relevant fields *(decided based on mutual agreement and within budget limitations)* *(1) RS/GIS* *(2) Forest Monitoring* *(3) Others)* 2) Provision of equipment/facilities 3) Training in Japan/Third Country Training 4) Others	**Cambodian Side** **1) Stakeholders**[9] - **Project Director** (Chief of FA, MAFF) - **Project Manager** (Director of Dept. of Wildlife and Biodiversity, FA, MAFF) - **Project National Administrative Coordinator** (Acting Chief, Office of Carbon Credit and Climate Change, FA, MAFF) **- Project Administrative Personnel** - Administrative Staffs/ Secretaries /Typists/Clerks/Drivers/Security Guards/Other supporting Staffs if necessary **2) Buildings and Facilities** **- Office space for the Project** **- Space for related facilities** **- Buildings and rooms, facilities, equipment and materials** (Project Office in FA, MAFF and the Project Sites/Meeting rooms/Materials and Equipment provided through the Grand Aid by GOJ, Facilities and utilities, and other facilities if necessary on mutual agreement basis)	* Provision of the equipment by the grant aid does not get greatly delayed. * Stakeholders (FA/MoE/FiA) continue to work for the Project. **Preconditions** * Collaboration with other development partners (donors/NGOs) is secured.

For CAM-REDD, two types of experts were assigned - one type is long term experts and the other is JICA TA Team for MRV/REL.

1.5.2 Role of JICA TA Team for MRV/REL

Role of the JICA TA Team was to support the Cambodian stakeholders in the following technical fields.

- Establishment of NFMS
- Establishment of NRS
- Establishment of REL/RL
- Preparation of land use/cover maps required for REL/RL calculation
- Support FA in validation/verification of REDD+ projects.

More precisely, JICA TA Team was responsible for supporting the activities of the Cambodian REDD+ Taskforce members as listed on Table 6.

Table 6 PDM activities supported by JICA TA Team

PDF Number	Activity
<Outcome 2>	
2.1	Develop National REDD+ Strategy
<Outcome 3>	
3.1	Implement and review demonstration activities
<Outcome 4>	
4.1	Establish National MRV/REL
4.2	Develop National Forest Monitoring System Plan
4.3	Design the Satellite Land Monitoring System to provide Activity data for REDD+ related activities
4.4	Design a National Inventory to develop Emission and Removal Factors for REDD+ Related Activities
4.5	Develop Cambodia RLs/RELs Framework
4.6	Develop a REDD+ Related GHG Reporting System

1.5.3 Team Members

JICA TA Team worked for Cambodia from November 2011 until October 2017. The six year period was divided into three periods.

Period One: Nov 2011 – Mar 2013

Period Two: May 2013 – Mar 2015

Period Three: June 2015 – Oct 2017

Table 7 is a name of JICA experts participated in each period.

Table 7 List of members of JICA TA Team

1st period		2nd period		3rd period	
Field	Name	Field	Name	Field	Name
Leader/RS/GIS	Ono	Leader/Forest RS/GIS	Ono	Leader/REDD Strategy/NFMS	Ono
NFI 1	Yamase	NFI 1	Someya	NFMS 1	Sakai
NFI 2	Someya	NFI 2	Yamase/ Sakai	REL/NFMS 2	Inada
Forest Resources Database	Gomi	Forest Resources database	Gomi	Land use/cover assessment 1	Furuya
		Forest RS	Asai	Land use/cover assessment 2	Wachi
				Land use/cover assessment (Segmentation)	Asai

1.5.4 Policy of Support of CAM-REDD

JICA TA Team adopted policies listed below in carrying out its task.

- *Support* the Cambodian government agencies in their REDD+ readiness activities.
- Coordinate its activities with those of other development partners.
- Coordinate its activities with Japan Grant Aid Program

Role of JICA TA Team is not undertaking REDD+ readiness activities on behalf of the Cambodian government. The team's task is to support the Cambodian government agencies by providing necessary technical information and alternatives so that the agencies can make right choices.

Support the Cambodian government agencies in their REDD+ readiness activities

Three pillars of JICA TA Team's support to the Royal Government of Cambodia are:

- Lecture and training;
- Technical papers (Working papers and technical memos) and:
- Through the implementation of actual work such as mapping.

- Technical advice in MRV/REL Technical Team meetings, workshops and other meetings.

Table 8 is a list of Working Papers made by JICA TA Team. Working Papers were made in order to provide the MRV/REL Technical Team with necessary technical information when such information is mostly needed without waiting for final reports. For this reason, contents of the papers are not necessarily complete or comprehensive.

Table 8 List of working papers

Number	Title
WP#1	Simulation / Trial Calculation of RELs (Reference Emission Levels) of Cambodia with Different Scale Approach
WP#2	Trial Calculation of Historical Trend of Annual CO_2 Emissions/Removals in order to Understand Cambodian Nationwide RELs (Reference Emission Levels)
WP#3	Guide to calculate forest living biomass
WP#4	Review on existing forest carbon data and provisional design of national forest inventory in Cambodia
WP#5	Revision of provisional national forest inventory design (incorporating ITTO C&I[10] and NFMA[11] requirements)
WP#6	Available allometric equation for Cambodian REDD+ and possible works for tentative estimation of living biomass
WP#7	Trial calculation of above ground biomass in Cambodia
WP#8	Essence of the procedure for C stock estimation and reporting by IPCC guideline
WP#9	C stock change by method 1 with tentative activity data and default emission factors
WP#10	Literature review on forest biomass density of Cambodia Ver.1
WP#11	Data required for GHG inventory by two methods
WP#12	The number of survey points of NFI and the precision in estimating forest area and biomass
WP#13	Some remarks on the usage of GHG inventory software in AFOLU sector
WP#14	Identification of appropriate above ground biomass for emission factors in Cambodia REDD+ program
WP#15	Supplementary NFI design and field manual

[10] ITTO(2005) Revised ITTO criteria and indicators for the sustainable management of tropical forests including reporting format. http://www.itto.int/policypapers_guidelines/?pageID=2

[11] "Manual for integrated field data collection – National Forest Monitoring and Assessment" (NFMA Working Paper No.37/E Rome) published by FAO in 2012.

In addition to the working papers, JICA TA Team produced a number of technical papers and memos aiming to enhance the understanding of the Cambodian government officials on various technical subjects related to REDD+. Major technical papers are:

- Second revised provisional NFI design for carbon estimation in Cambodia (December 2013)
- Forest inventory training manual focusing on REDD-Plus for the Kingdom of Cambodia – Intermediate Class (March 2013)
- Understanding IPCC guidelines 2006 for forest inventory for REDD (March 2013)
- Basics of GPS, satellite remote sensing and GIS technology for forest resource survey (March 2013)
- Technical report on the use of eCognition for forest cover mapping (September 2013)
- Introduction of object base satellite image analysis method (Slide presentation, September 2013)
- Practical use of eCognition for forest cover mapping (February 2014)
- Methodology for logical check of forest cover map (2010) (March 2014)
- Concept paper for mapping for initial REL/RL establishment for Cambodian REDD+ (August 2014)
- Trail calculations of Carbon stock change by gain-loss method and lessons learned from the experiences (Sept 20, 2014)
- Methodology for compilation of forest cover map of 2010 (October 2014)
- Land cover type of Sihanouke Province (October 2014)
- Selection of emission factor for Cambodia (February 2015)
- GHG Inventory Method for Cambodia (February 2015)
- Forest Inventory Survey Method for Cambodia (February 2015)
- Land use and land use change assessment method for Cambodia (March 2015)
- Calculation of Initial Reference Emission Level for Cambodia (March 2015)

Further, JICA TA Team participated in most of the MRV/REL Technical Team meetings and also in other important meetings, workshops and seminars. List of major meetings attended by JICA TA Team members are attached as Appendix 1.

Coordination with Other Development Partners

Since multiple development partners were supporting the Cambodian in REDD+ activities, coordination among the partners is essential to maximize the efficiency of the support. JICA TA

Team maintained close communication with FAO and UNDP to avoid overlapping and to supplement each other.

In July 2013, FAO head office in Rome sent one expert to Cambodia in order to clarify the activity plan of both JICA and UN-REDD and to consolidate both plans. The result is a consolidated Plan of Operation. One page of the plan is shown in Figure 9. This plan was reviewed and updated along with the progress of the project.

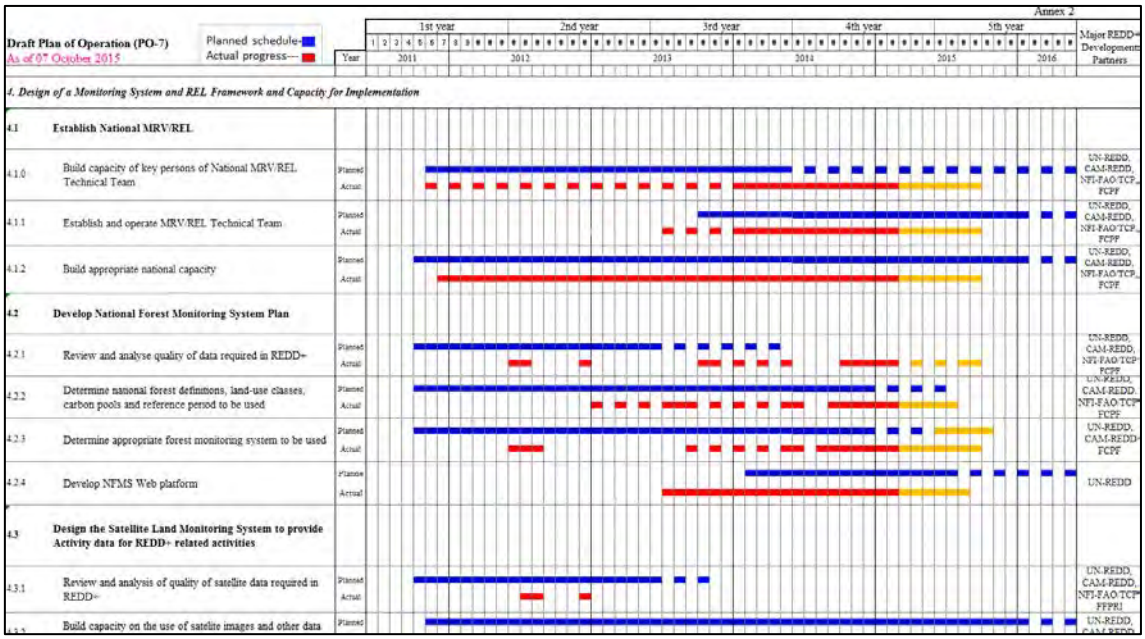


Figure 9 Part of the consolidated Plan of Operation

At the rightmost end of the consolidated Plan of Operation, relevant development partners for each activity are listed. Listing order does not mean the magnitude of contribution. For most of the activities, more than one development partners were involved. This does not mean that they did redundant work. Rather, experts from different development partner organizations worked almost as a one team under the command of REDD+ taskforce.

Coordination with Japan Grant Aid Program

In March 2010, Japanese government signed on the Exchange Note on a grant aid programme for Cambodian government with the aim to provide FA with equipment to increase FA's capacity for the implementation of the REDD+ Roadmap. Title of the grant aid was "Forest Preservation Programme".

Outline of major equipment procured under the grant aid programme is as follows.

Table 9 List of major equipment procured under Japan Grant Aid programme

Technical Field	Contents
Remote sensing/GIS	● Expand office space of FA ● Procurement of GIS software and satellite image data
Forest resource inventory	● Procurement of forest carbon measurement devices
REDD+ demonstration activities at 5 areas	● Ranger station, nursery ● Watering vehicle
Law enforcement on illegal logging	● Communication device ● Vehicles ● Technical support for database development

The Japan Grant Aid Programme not only provided FA with a large quantity of hardware, software and satellite image data but also conducted training on the use of procured hardware and software. Four types of training were conducted as follows under this programme between February 2013 and April of 2013.

- Forest Inventory at five locations in Cambodia including Phnom Penh.
- Operation of "ESRI ArcGIS"
- Satellite image processing using "ERDAS Imagine"
- Segmentation of satellite image using "eCognition"

JICA TA Team communicated with the Japanese team for the Grant Aid Programme to harmonize its capacity building activities.

1.6 Implementation Framework of REDD+ in Cambodia

1.6.1 REDD+ Taskforce

As an instrument to implement REDD+, Cambodia government established REDD+ Task Force in late 2013. The taskforce consists of wide range of government agencies as listed below.

Table 10 Members of Cambodian REDD+ Taskforce (As of October 2017)

Name	Title	Role in Taskforce
H.E Dr. Chea Sam Ang	Director General, General Directorate of Administration for Nature Conservation and Protection, Ministry of Environment	Chair
Mr Kim Nong	Deputy General Director, the General Department of Administration for Nature Protection and Conservation, the Ministry of Environment	Deputy Chair
H.E Cheam Pe A	Deputy General Director, the General Department of Local Administration, the Ministry of Interior	Member
Mr Net Mony	Director, the Department of State Property, the Ministry of Economic and Finance	Member
Ms Pov Voleak	Deputy General Director, the General Department of Energy, the Ministry of Industry Mine and Energy	Member
Mr Sao Vary	Chief of the office for State Property Conservation, the General Department of Cadastral and Geography, the Ministry of Land Management Urbanization and Construction	Member
Mr Dok Domar	Deputy Director, the Department of Water Supply for Rural Area, the Ministry of Rural Development	Member
Mr Ouk Vibol	Deputy Director, the Department of Fishery Conservation, the Ministry of Agriculture Forestry and Fishery	Member
Mr Sam Khandy	Member of the Secretariat for Economic Land Concession, the Ministry of Environment	Member

The Taskforce is responsible for the overall management of the REDD+ readiness process and is the primary coordination and decision making body within the Government of Cambodia.

It is also responsible for reviewing all key outputs and decisions to ensure they are appropriate in the Cambodia context and takes a lead in the development of the national REDD+ strategy and implementation framework.

Specific responsibilities of the taskforce are defined as follows:

- Developing the National REDD+ strategy and Implementation Framework
- Establishing standards and guidelines for REDD+ demonstration activities
- Compiling and approving REDD+ Readiness work plans and budgets from line agencies

- Establishing Technical Teams, reporting to the Taskforce, to review key technical issues as set out in the REDD+ Roadmap
- Reviewing and approving proposed consultants and advisors to work with the REDD+ Taskforce and REDD+ Readiness process
- Approving of all consultancy inputs
- Overseeing stakeholder consultation and awareness-raising processes
- Seeking financial support on REDD+ Readiness process
- Coordination with executive bodies of other programmes and partnerships (for example UN-REDD Programme Executive Board, relevant Technical Working groups)
- Providing information on ongoing REDD+ activities within their Ministries and agencies
- Participating in trainings, meetings on REDD+
- Coordinating and liaising with development partners and activities by NGOs
- Discussing and coordinating actions relating to FLEGT issues
- Reporting by line agency members to their respective line agency
- Addressing any conflicts that occur within the REDD+ development process

The Taskforce sends reports to the National Climate Change Committee (NCCC)[12], as the main coordination mechanism on climate change. NCCC adopts reports to the UNFCCC, as per Sub-decree No. 99 dated 18 August 2010. MoE is responsible for sending national reports to the UNFCCC.

Under the taskforce, four technical teams were organized.

- Benefit sharing
- Consultation and Safeguard
- MRV/REL
- REDD+ Projects (Demonstration activities)

Among the four, JICA TA Team supported MRV/REL Technical Team which was organized almost at the end of 2013 and started its activity in February, 2014. MRV/REL Technical Team consists of government officials of FA, FiA, GDANCP (MoE), Ministry of Land Management, Urban Planning and Construction, and Ministry of Industry, Mine and Energy plus five persons who have experience and knowledge useful for the establishment of MRV/REL of Cambodia. The number of the team member is expected to increase in order to deal with increasing volume of work in REDD+ Phase II.

[12] NCCC was replaced by National Council for Sustainable Development.

1.6.2 Support from Development Partners

For Cambodian REDD+, multiple development partners have provided technical and financial support. Major donors are JICA and UN-REDD (FAO, UNDP and UNEP)

As explained before, JICA started its activity under the framework of CAM-REDD in June 2011 while its Technical Assistant Team was assigned from November 2011 almost at the same time UN-REDD held its kick off meeting. Figure 10 below shows contribution of development partners to REDD+ readiness stage of Cambodia.

Outcome	Major REDD+ Development Partners (√√...Principle role/ √...Secondary role)				
	CAM-REDD (JICA Technical Cooperation)	UN-REDD Cambodia Programme	FCPF Readiness Project	Embassy of Japan	Potential REDD Projects in Community/Protected Forests
Outcome 1: Institutional Arrangements	√	√√	√√		
Outcome 2: Strategies/Policies	√√	√√	√√		
Outcome 3: Demonstration Activities	√√	√	√√	√√	√√
Outcome 4: MRV/REL/ GHG Inventory	√√	√√	√	√√	√

Figure 10 Role of major development partners for Cambodian REDD+

FAO also provided various type of technical support to the Cambodian government through its own program.

2 Project Activities

2.1 Work Schedule

In ordinary JICA project, work schedule is made and experts are assigned according to the schedule. However, this principle could not be applied to this project. One reason is that number of officials in the Cambodian government assigned to REDD+ was limited while multiple development partners carried out their own program almost at the same time. For this reason, Cambodian officials could not use enough time for each project and this made it difficult for them to follow pre-determined schedule. The other reason is that building NFMS, establishment of satellite land monitoring system, land use/cover mapping, establishment of REL/RL and

preparation a National REDD+ Strategy had to be carried out almost simultaneously because they are all inter-related.

In order to deal with the situation, JICA TA Team members had to be very flexible in determining timing of their visit to Cambodia.

2.2 Progress in REDD+ Readiness in Cambodia and JICA TA Team's Support

2.2.1 Overall Summary

Progress of REDD+ readiness stage of Cambodia over the last 6 years is summarized on Table 11.

Table 11 Progress of REDD+ Readiness Stage

Activities listed on PDM	Present Status (as of October 2017)
2.1 Develop National REDD+ Strategy	Completed. Now in the process of being approved by the Cambodian government.
3.1 Implement and Review Demonstration Activities	Oddar Meanchey and Seima REDD+ projects were verified by VCS and CCBA.
4.1 Establish National MRV/REL	MRV/REL Technical Team was established under the National REDD+ Taskforce and activated.
4.2 Develop National Forest Monitoring System Plan	Overall design of NFMS was completed and documented.
4.3 Design the Satellite Land Monitoring System to provide Activity data for REDD+ related activities	Satellite land monitoring system was designed as a part of NFMS. Also, by using improved methodology, 2006 and 2010 maps were upgraded and 2014 and 2016 maps were made.
4.4. Design a National Forest Inventory to Develop Emission and Removal Factors for REDD+ Related Activities	NFI was designed and Field Manual was completed and tested.
4.5 Develop Cambodia RLs/RELs Framework	Forest Reference Level (FRL) document was submitted to UNFCCC in November 2016. The FRL of Cambodia has gone through technical assessment by UNFCCC since March 2017 and the assessment will be completed by the end of 2017.
4.6 Develop a REDD+ Related GHG Reporting System	It was decided that IPCC Guideline 2006 would be used for the inventory.

It should be noted that most of the documents produced in the project are living documents and will be updated by incorporating changes such as listed below.

- Reform of structure of government agencies
- Policy on the use of third party data
- Policy on the Tier level of GHG inventory
- Available budget and human resource
- Improvement in technology
- Improvement of technical capacity of government officials

Actually, reform of forest and environment sector has not yet been completed. Local offices of FA are supposed to become one department of local governments. While local government and local offices of the central government should play important role in forest monitoring, particularly in forest inventory survey, and most importantly in the implementation of policies and measures to address drivers, it will take some more time before jurisdictional power of the central and local governments is redefined and legalized.

From the next paragraph, progress of Cambodia on major elements of REDD+ is described. Each paragraph consists of three sections – Activities, Support from JICA TA Team, and Future Development.

In Future Development section, margin or need for improvement or future development of each element of REDD+ are discussed.

2.2.2 Develop National REDD+ Strategy (PDM Activity 2.1)

2.2.2.1 Activities

Draft of National REDD+ Strategy was completed and as of writing this report, it is in the process of approval by the Royal Government of Cambodia. JICA TA team contributed to the preparation of the NRS, particularly NFMS and REL parts of the strategy.

In COP21 held in Warsaw, Poland, preparation of National REDD+ Strategy was listed as one of four conditions for the parties to become eligible to apply for the results-based payment. Cambodia started to draft the strategy in 2014. The drafting process was divided into three steps

as follows.

- Drafting by a little number of experts
- Consulting with wider stakeholders
- Editing the contents according to the Royal Government of Cambodia's document format for the council of ministers

In May 2015, the first consultation meeting was held to collect opinions of stakeholders on the draft strategy. Since then, many meetings were held to discuss the contents of the strategy, and by the end of November 2015, an improved draft was completed. Development of the strategy was implemented interactively with the development of NFMS and REL/RL. Review of the strategy continued from 2015 and as of the writing of this report the strategy is in the process of approval by the Cambodian government. Unauthorized English translation of current version of NRS is attached as Appendix 2.

Strategic framework of the NRS is summarized below.

Vision

The vision of Cambodia's National REDD+ Strategy is to contribute to national and global climate change mitigation through improving the management of its natural resources and forest lands, and biodiversity conservation and sustainable development.

Mission

The mission of the Strategy is to strengthen the functioning and capacity of national and sub-national institutions for effective implementation of policies, laws and regulations to enhance management of natural resources and forest lands, and biodiversity conservation.

Goal

The goal is to reduce deforestation and forest degradation while promoting sustainable management, conservation of natural resources and contribute to poverty alleviation.

Scope and Scale

The scope of the NRS prioritizes deforestation measured through land use change and conversion of forest land, and will build capacity alongside to address

degradation. Cambodia will implement REDD+ at the national level under the results-based payments mechanism of the UNFCCC. Cambodia will consider implementation of sub- national and voluntary market based REDD+ projects subject to specific criteria.

Milestones and Results

The Cambodia REDD+ strategy aims to achieve a key milestone by 2026.The objective is to reduce its annual deforestation by half compared to the rate during the FRL period of 2006-2014. Reduced emissions would be eligible for results based payments.

The NRS also states actions to be taken in a 10 year period between 2017 and 2026 which is divided into two phases. Key words are highlighted by the author of this report.

NRS Phase I (2017-2021)

- Development of **action plan**
- Finalization of **institutional arrangements** for the implementation of the NRS
- **Address of drivers** through improved implementation of existing forest management frameworks such as the NFP, NPASMP, SPFF and sub-decrees on ELCS and SLCs. These frameworks include policies and measures related to strengthening forest law enforcement, providing tenure security and implementing community based natural resource management.
- Prioritize mobilization of **upfront non-results based finance** that will address these challenges and alongside build **capacity for field based implementation and results**.
- **Improvement** of existing versions of the FRL and the NFMS
- **Establishment of SIS** to complete the requirements of the Warsaw Framework.
- **A mid-term assessment of the NRS** to identify lessons, challenges, and to address these during the next phase.

NRS Phase II (2022-2026)

- **Completion of the transition** from readiness to implementation
- Prioritization of the **achievement of measurable results**.
- **Review** of the findings of the assessment of Phase I
- **Assessment of the forest and land cover change results of 2016, 2018, and 2020** that would provide an indication of the effectiveness of the NRS.

- Establishment of a functioning **disclosure mechanism** of the information, data, and results of FRL, NFMS, studies and analytical work through a web-based platform and other communication media and tools.
- **Data improvement** that will lead to revised versions of the FRL and the NFMS.
- **Submission of the first report on emission reductions for results-based payments** during this phase.
- A key milestone during this phase would be **the establishment of a rigorous forest monitoring mechanism** that can review policies and measures to address drivers of deforestation and forest degradation for effectiveness and efficiency.
- In addition the **SIS will continue to be monitored and strengthened** as required to ensure compliance with UNFCCC requirements for safeguards.

2.2.2.2 Support from JICA TA Team

Initially, JICA TA Team contributed to the drafting of NFMS and REL/RL parts of NRS including the clarification of relation among AD, EF, FRL, NC and BUR. By the end of March 2015, provisional draft of the strategy was made by the REDD+ taskforce. JICA TA Team also participated in meetings organized by REDD+ Taskforce to discuss contents of the NRS.

2.2.2.3 Future Development

Because of the reform of forest and environment sector in the Royal Government of Cambodia, institutional arrangement for the implementation of REDD+ activities could not be well planned. In the future, REDD+ action plan including institutional arrangement should be prepared based on the strategy. Particularly, role of local governments needs to be carefully studied and determined because they are main players of actual implementation of policies and measures to address drivers of deforestation and forest degradation.

2.2.3 Implement and Review Demonstration Activities (PDM Activity 3.1)

2.2.3.1 Activities

REDD+ projects in Oddar Meanchey and Seima were verified and part of Carbon Credit of the project in Seima area was sold.

While Cambodia seeks to establish a REDD+ mechanism to cover entire country, it was necessary to implement small scale REDD+ projects so that Cambodia can get valuable

lessons which can be used in designing national scale mechanism. Small scale REDD+ projects, whose carbon credit can be sold in a voluntary carbon market, also contributes to secure financial sources for forest management activities even before results-based payment under UNFCCC becomes possible.

Cambodia is implementing two REDD+ projects[13] based on Verified Carbon Standard (VCS) and Climate Community Biodiversity Alliance (CCBA) standard. They are "Reduced Emissions from Deforestation and Degradation in Community Forests Oddar Meanchey" and "Reduced Emissions from Deforestation and Degradation in Seima Protected Forest".

Oddar Meanchey Project

Project Proponent: Forestry Administration
Supporting organization: Terra Global Capital and PACT
Province: Oddar Meanchey (Northern Cambodia)
Project area: 56,050 hectare
Standard: VCS VM0006 and CCBA
Validation: by TUV SUD Industrie Service GmbH
Verification: by SCS Global Services

Seima Project

Project Proponent: Forestry Administration
Supporting organization: Wildlife Conservation Society (WCS)
Province: Mondulkiri
Project Area: 292,690 hectare
Standard: VCS VM0015 and CCBA
Validation: by SCS Global Services
Verification: by SCS Global Services

Oddar Meanchey project verification was completed in November 2013. Seima project validation was completed in November 2015. The Seima project validation took long time because of the sudden change in CCBA standard in the midst of the validation work. Verification of the Seima project was contracted out by FA.

[13] In Cambodia three more REDD+ projects are being implemented or planned.They are: Prey Long project supported by Conservation International (Kratie, Kompong Thom, Stung Treng and Preah Vihear provinces), Tumring project supported under Korea-Cambodia REDD+ Joint Project (Kompong Thom Province), and Southern Cardamom Mountains REDD+ project supported by Wildlife Alliance (Southern Cardamom Landscape).

Figure 11 is a copy of VCS web site showing verified carbon units of both projects.

VCU Search Results

Issuance Date	Vintage Start	Vintage End	ID	Name	Country	Sectoral Scope	Methodology	Total Vintage Quantity	VCU Quantity Issued	Additional Certifications	Retirement / Cancellation Date
03/07/2017	01/01/2015	31/12/2015	1650	Reduced Emissions from Deforestation and Degradation in Keo Seima Wildlife Sanctuary	Cambodia	14. Agriculture, Forestry, Land Use	VM0015	2,168,042	23,116	CCBS Third Edition - Gold Level	05/07/2017
27/05/2015	28/02/2008	28/02/2012	904	Reduced Emissions from Deforestation and Degradation in Community Forests – Oddar Meanchey, Cambodia	Cambodia	14. Agriculture, Forestry, Land Use	VM0006	597,210	1	CCBS Second Edition - Gold Level	05/06/2015
27/05/2015	28/02/2008	28/02/2012	904	Reduced Emissions from Deforestation and Degradation in Community Forests – Oddar Meanchey, Cambodia	Cambodia	14. Agriculture, Forestry, Land Use	VM0006	597,210	1	CCBS Second Edition - Gold Level	05/06/2015

Figure 11 Verified carbon unit of Oddar Meanchey and Seima projects.

As for the Seima project, a document titled "Lessons learned from REDD+ VCS/CCBA Validation: Seima Protection Forest REDD+ demonstration site Mondulkiri and Kratie Provinces, Cambodia" was made in June 2015 by WCS which supported FA in this project. Full sentence of WCS's observation on the validation work is as quoted below:

> ***Validation requires detailed information available to cover all steps***
>
> Documentary evidence is required for every stage of the validation process. Every single meeting, decision, event, issue, reference or piece of information referred to in the Project Design document must have comprehensive and believable documentary evidence to demonstrate compliance. An essential investment is a detailed and well-organized filing system, both for electronic and physical files.
>
> ***The process is costly***
>
> The very level of technical capacity required to review a complex document against the standards, as well as the fact that validation remains a niche industry, means that the costs of the validation are very high. Additional costs beyond the basic contract are also not uncommon. Projects should budget at least $60,000 for the contracts, along with additional costs for preparatory and remedial work if needed.

The process can be very lengthy

The time required to do the validation is lengthy. Many of the corrective actions, in particular those which require extensive fieldwork, are very challenging, and reliant on seasonal factors. Promptly responding to finds, as well as leaving plenty of time for multiple iterations of findings is highly recommended. Depending on the scale of the project, in our experience, as part of an ongoing conservation program the process takes at least one year.

Clarify is required on plans, response and timing

The audit process is very complex, with multiple simultaneous and subsequent steps; the process requires regular and very clear communication between the auditor and the proponent or their representatives. A key high-level coordinating technical expert, with a very clear understanding of the project document, the standards, and the project as a whole is an essential requirement for commencing such an audit.

While WCS's observation is on the validation for VCS/CCBA standard, it is assumed that the observation will also apply to the verification of GHG inventory to be submitted to UNFCCC as a technical annex to NC and BUR.

2.2.3.2 Support from JICA TA Team

JICA supported FA in the administrative work of the verification of Oddar Meanchy project and the validation of Seima project. The administrative work included the selection of a validation and verification body (VVB), the preparation of contract documents, the inspection of the progress of work, and the payments.

2.2.4 Establish National MRV/REL (PDM Activity 4.1)

2.2.4.1 Activities

MRV/REL Technical Team was established under Cambodia's National REDD+ Taskforce and activated in 2014.

When JICA and UN-REDD started to work in Cambodia, REDD+ Taskforce had not been fully

established yet nor the technical teams to support the taskforce. A series of discussion within the Cambodian government was necessary to determine TOR of the taskforce and technical teams. And it took about two years before MRV/REL technical team of the taskforce started its activity in February 2014. The MRV/REL team was one of the four technical teams organized under the Cambodian REDD+ Taskforce.

MRV/REL Technical Team members are:

- Ministry of Environment
- Ministry of Agriculture, Forestry, and Fisheries
- Ministry of Land Management, Urban Planning and Construction
- National Council of Sustainable Development
- Ministry of Industry, Mine and Energy (General Department of Energy)
- 5 Consultation Group (CG) members with skills and experience within relevant technical areas nominated by the CG.
- Up to two members of the REDD+ Taskforce Secretariat to be nominated by the Head of the REDD+ Taskforce Secretariat.
- Additional representatives from experienced NGOs may be invited to meetings as temporary participants as required.

The MRV/REL Technical Team is responsible for working with the REDD+ Taskforce to support the development of national MRV/REL framework for the REDD+ Taskforce to make decisions, including the following tasks:

- Develop the national forest classification
- Develop a functional design of the Cambodia REDD+ Monitoring and Measurement Reporting and Verification system
- Design the satellite forest monitoring system to support the generation of forest activity data
- Design the National Forest Inventory to support the development of emission and removal factors for REDD+ related activities
- Establish the reference period
- Establish National reference levels (REL/RL) including submission of Forest Reference Level (FRL) to UNFCCC and corresponding to their technical assessment.
- Develop the REL/RL national and subnational carbon accounting framework(if required)
- Development of the technical infrastructure to prepare for the implementation of Forest Monitoring and MRV systems

- Determine institutional roles in the REDD+ monitoring and MRV systems
- Establish and maintain the national Forest monitoring and MRV database
- Facilitate data access and data sharing among relevant key actors for Quality Control /Quality Assurance and verification
- Prepare GHG inventory data of the LULUCF sector and contribute for submission to UNFCCC reports such as Biennial Update Report
- Prepare annual implementation plans, and also improvement plan for database management
- Coordinate technical supports on MRV/REL with relevant institutions

Each team member of the Team is expected to:

- Attend the Team meeting, training, workshop, and conferences
- Review relevant documents and presentations, and provide inputs
- Assist consultants and REDD+ Taskforce Secretariat Personnel to carry out their assignments

The MRV/REL Technical Team had nearly 20 meetings to study, discuss and determine matters related to MRV and REL part of REDD+ of Cambodia. The list of the meetings is as follows.

Table 12 List of MRV/REL Technical Team meetings

#	Date	Agenda
1	2014/2/3	● Components of MRV/REL ● Schedule of REDD+ taskforce ● Activity plan of MRV/REL Technical Team and responsibility of team members ● Forest definition for Cambodian REDD+ ● Base map and reference year for GHG reporting
2	2014/2/6	● Activity plan of MRV/RELTT ● Issuance of certificate to MRV/REL TT members for their contribution
3	2014/2/24	● Guidelines for the development of MRV/REL ● Components of MRV/REL ● Development of national GHG inventory
4	2014/3/4	● Updating of activity plan ● National or sub-national REDD ● Comments on NFI draft design ● Plot design ● Necessity of revising forest definition ● Plan for land use/cover mapping
5	2014/3/20	● Forest definition ● Contents of base map
6	2014/3/26	● Activity plan of MRV/RELTT
7	2014/4/9	● Activity plan of MRV/RELTT ● Forest definition to be presented to REDD+ taskforce

		● Assessment of current capacity ● Reference period ● Test of WEB site of NFMS
8	2014/4/24	● Review of activity plan of MRV/REL TT ● Preparation of WEB site
9	2014/5/6	● Activity plan of MRV/RELTT
10	2014/5/20	● Responsibility of each member of MRV/RELTT and capacity assessment ● Contents of MRV/REL TT activity report to be presented in the taskforce meeting of June.
11	2014/6/3	● Comparison of IPCC guidelines 1996 and 2006
12	2014/7/21-23	● Land Cover Classification System（LCCS） Lecture and training
13	2014/7/25-26	● LCCS training ● Forest definition and map specifications to be presented to the REDD+ taskforce ● Role of each government agencies in NFMS ● Draft NFMS design
14	2014/8/5	● Management of activities of MRV/REL TT and improvement of communication
15	2014/10/2	● Forest definition ● Land use/cover classification class ● REL/RL development ● Contents of database ● Situation of non-cost extension of UN-REDD program
16	2014/12/9	● Review of contents of database ● Preparation of agreement for data collection ● Data collection strategy ● Additional support from UN-REDD on REL establishment
17	2015/1/21	● Contents of national REDD+ strategy ● Confirmation of schedule up to COP21
18	2017/8/24, 25	● Review of TOR of MRV/REL Technical Team

On August 24 and 25, 2017, MRV/REL Technical Team held a meeting in order to review TOR and membership of the team. The meeting was necessary because of the reform of forest and environment sector in the government and also to make the team suitable for REDD+ Phase II and the implementation of a national forest monitoring system. It was proposed that number of team member from some government offices should be increased. TOR is in the process of revision.

2.2.4.2 Support from JICA TA Team

First, JICA TA Team participated in the discussion to determine TOR of the MRV/REL Technical Team. And after the MRV/REL Technical Team was activated, JICA TA Team assisted the preparation of activity schedule of the MRV/REL Technical Team and JICA TA team members attended most of the meetings to provide technical comments and suggestions.

2.2.4.3 Future Development

MRV/REL Technical Team needs to align themselves from REDD+ readiness stage to REDD+ implementation stage. This means more involvement of local government is necessary for the sub-national implementation of monitoring part of NFMS.

2.2.5 Develop National Forest Monitoring System Plan (PDM Activity 4.2)

2.2.5.1 Activities

Overall design of a National Forest Monitoring System (NFMS) was completed.

Selecting effective policies and measure to address deforestation and forest degradation depends on reliable information on forest and socio-economic conditions of REDD+ target areas and the country. And establishing NFMS is one of four conditions for parties to become eligible to receive results-based payment for REDD+ activities.

Cambodia has been practicing forest monitoring since long time. From 2002, forest assessment has been implemented every four years. Forest inventory surveys were carried out in various places in the country although the surveys did not cover the entire forest of Cambodia in a systematic manner. As for collecting information on local forest management, FA, FiA and MoE have a similar mechanism to send periodical report from local offices to the central offices although the contents of reports are not comprehensive.

Considering the situation described above, Cambodia decided to build its NFMS in a phased approach based on existing mechanism and current capacity. Target is the GHG inventory covering five carbon pools at the level higher than Tier 2.

Design of a NFMS of Cambodia started in 2011 even before the formal establishment of MRV/REL Technical Team. Existing map and forest inventory survey data were analyzed and ideas for their improvement were examined by the support from UN-REDD and JICA.

NFMS designing work became active from February 2014 by the establishment of MRV/REL Technical Team. Proposal for National Forest Inventory (NFI) design and field manual were

made in parallel with the review of exiting land use/cover classes and also the introduction of new mapping technologies. At the same time, construction of a database management system and a WEB interface started.

In December 2014, the first workshop on NFMS of Cambodia was held to share intermediate results of the NFMS designing work with relevant stakeholders and also to show them a roadmap to the completion of the NFMS design.

Version 1 document of NFMS of Cambodia was completed by the end of March 2016. In the Version 1, overall structure of Cambodian NFMS is proposed as shown in Figure 12.

NFMS is divided into two functions – MRV function and monitoring function. MRV function is to measure GHG emission/removal which is used as the base for GHG inventory and reporting to UNFCCC. Monitoring part is for checking the effect of measures taken to address deforestation and forest degradation. Satellite land monitoring system is useful for both functions.

Included in Monitoring Function is Data Management function consisting of 1) Database and database management system and 2) Data dissemination system (WEB site and WEB database). By October 2017, a prototype data management system was designed including WEB design by the support from UN-REDD. For the moment, database is not connected to internet because of security reasons. A rule for data disclosure is now being examined to decide types of data to be uploaded to WEB site.

Current version of NFMS document is attached as Appendix 3.

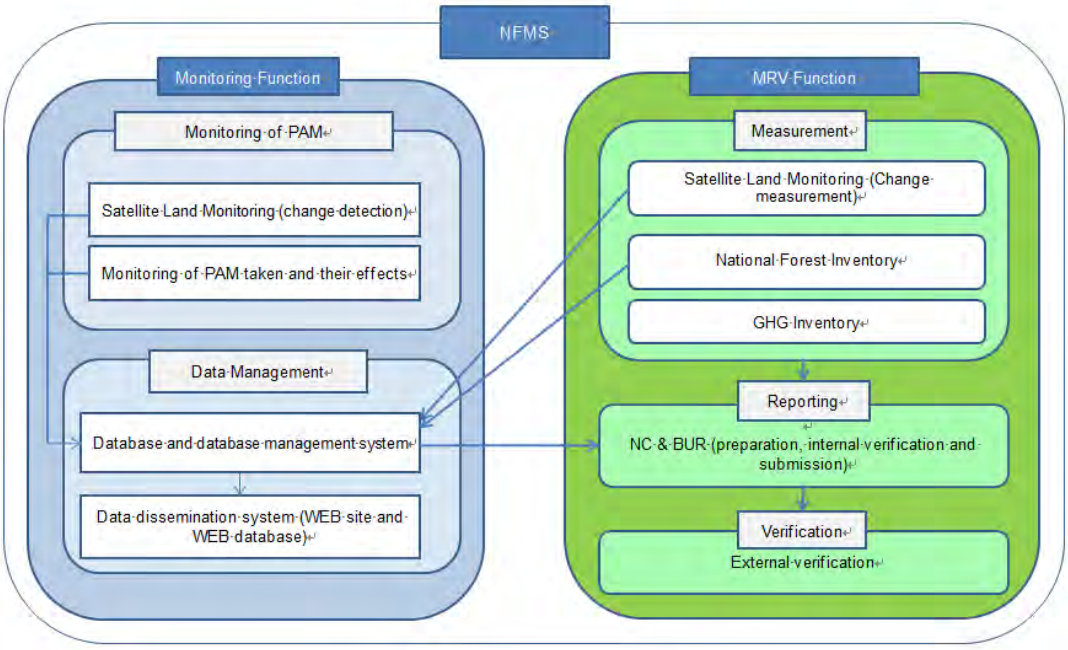


Figure 12 Structure of NFMS of Cambodia

Chapters in this report which describe the three components of MRV function are as shown below.

NFMS components	Chapter in this report
Satellite Land Monitoring System	2.2.6 Design of Satellite Land Monitoring System (PDM Activity 4.3) 2.2.7 Land Use and Land Use Change Assessment by Remote Sensing (PDM Activity 4.3)
National Forest Inventory System	2.2.8 Design of National Forest Inventory (PDM Activity 4.4)
GHG inventory	2.2.10 Develop a REDD+ Related GHG Reporting System (PDM Activity 4.6)

2.2.5.2 Support from JICA TA Team

JICA TA Team prepared initial draft of NFMS and various technical materials to be used in MRV/REL Technical Team meetings. Technical advice of JICA TA team was also provided to core members of the MRV/REL Technical Team during the entire process of designing NFMS.

2.2.5.3 Future Development

In the current version of NFMS, general schedule for future development is laid out as follows.

Phase I is a preparatory stage between 2011 and 2015.
Phase II is a development stage between 2016 and 2020
Phase III is an operational stage starting from 2021.

NFMS is designed based on the technologies currently available. For this reason, measurement and monitoring of forest degradation was not included in the NFMS design.

Further, methodology to monitor REDD+ interventions have not yet been fully planned. This is because monitoring technique needs to be determined according to the type of the drivers of deforestation and forest degradation and type of intervention to address them

Now, Cambodia is in the process of selecting sub-national area(s) to implement activities to reduce emissions from deforestation and forest degradation. Drivers of deforestation and forest degradation differ from area to area. After selecting priority area(s) for REDD+ implementation, more detailed driver analysis will be done and based on the results of the analysis, policy and measures to address the drivers will be determined. Ultimate indicator for assessing the effect of policy and measures is land use/cover change assessment. However, for some policies and measures, other indicators can be used for monitoring their performance such as the number of community forest project registered.

Lastly, main part of the Version 1 document was made before major reform of forestry and environment sector started. Therefore, description of institutional structure needs to be updated after the reform is completed.

2.2.6 Design of Satellite Land Monitoring System to provide activity data for REDD+ related activities (PDM Activity 4.3)

2.2.6.1 Activities

Cambodia has been using satellite images for forest assessment even before the start of REDD+ readiness activities. Based on the basic capacity of Cambodian government officials, usage of satellite image for land use/cover mapping was upgraded. As a tool for accuracy assessment of forest maps and also for quick assessment of forest area, Collect Earth tool of FAO was introduced. Further, MoE staff in charge of mapping will learn the use of Google Earth Engine.

For MRV purpose, land use/cover change needs to be measured. Satellite images are essential source of land use/cover information and useful to detect the effect of interventions to address deforestation and forest degradation.

Cambodia has monitored its forest cover using satellite images for a long time and from 2002 at nearly four year interval. By using forest cover information of different epochs, severe deforestation areas – or hotspots – have been identified by FA. This means, Cambodia has already been operating a satellite land monitoring system.

FA also introduced Collect Earth tool developed by FAO. Collect Earth can collect and store land use/cover information obtained by visual interpretation of satellite images at small patches of land located at a certain interval. This sampling tool is useful for quickly assessing forest cover and also for collecting land use/cover information for accuracy assessment of land use/cover maps. FA and MoE officers are already using this tool for accuracy assessment purpose.

In December 2010 Google started to operate a satellite data platform to assist land use/cover assessment. This is called Google Earth Engine. Google Earth Engine “combines a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities and makes it available for scientists, researchers, and developers to detect changes, map trends, and quantify differences on the Earth's surface.” (Source: WEB site of Google Earth Engine https://earthengine.google.com/)

International researchers are developing tools to use satellite data stored in the Google Earth Engine. Google Earth Engine web site also provides a tool for satellite image data analysis. And MoE and FA officials in charge of land use/cover mapping received trainings to use Google Earth Engine and/or tools developed by researchers such as of Silva Carbon and other NGOs.

Exact method of national forest monitoring will be determined after policies and measures for mitigating deforestation and forest degradation are selected. But Cambodian officials already have acquired basic capacity to use any tool or method of satellite land monitoring.

2.2.6.2 Support of JICA TA Team

JICA offered lectures on basic remote sensing and training on satellite image analysis. And for selected officials, lectures and training of more advanced level of satellite image analysis method were given.

2.2.6.3 Future Development

Capturing Forest Degradation

Capturing forest degradation is a subject of future technical development. Technology to detect forest degradation already exists but it is costly and therefore impractical. If high resolution satellite images, for example images with 1 meter resolution, becomes available free of charge or at very low cost, then, automatic or semi-automatic image classification will be a useful technique for detecting forest degradation.

It should be noted, however, that non-detection of forest degradation would be an option if the cost of the detection is considered to be very high comparing to the benefit gained by the measurement of forest degradation.

Use of 3rd Party Data

Preparation of reliable land use/cover maps requires a sizable budget. One alternative for saving cost for mapping is the use of third party data such as Global Forest Change data of the University of Maryland (Figure 13) and Forest-Non-Forest map made by JICA-JAXA Forest Early Warning System in the Tropics (JJ-FAST) (Figure 14). Forest definition of third party data is different from that of Cambodia, so, they cannot be directly used in land use/cover mapping or monitoring. However, they can be a convenient tool if they are provided in much shorter cycle than land use/cover assessment maps of Cambodia and if they can show a trend of forest cover change similar to that derived from the maps.

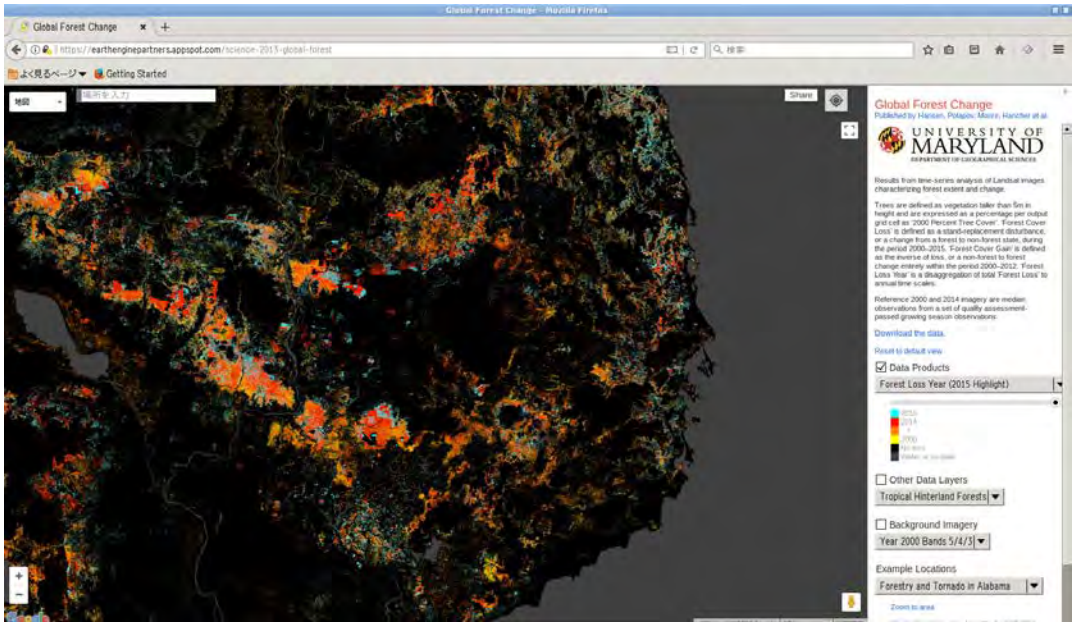


Figure 13　WEB site of Global Forest Change

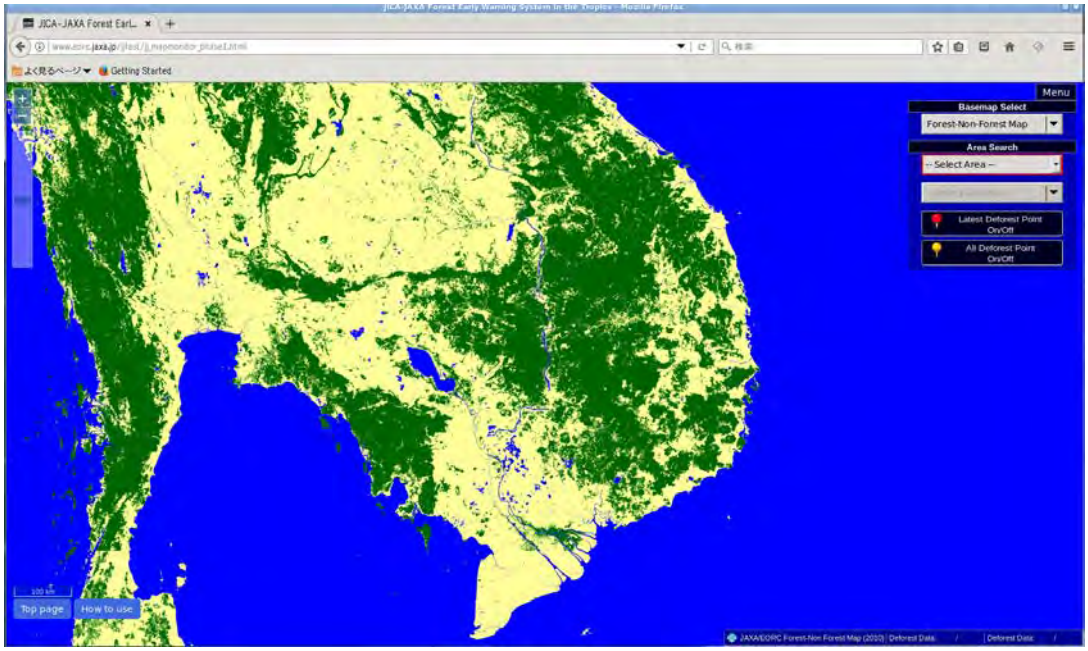


Figure 14　Forest-Non-Forest Map of JJ-FAST

Further Capacity Building

Through the 2014 and 2016 mapping, government officials in charge of land use/cover mapping could improve their knowledge and skill in using satellite images. However, in order to use free of charge services provided by Google Earth Engine or FAO's SEPAL, more solid knowledge

on satellite remote sensing is useful. It is advised that they will read reading materials and guidelines they received in various trainings related to mapping and remote sensing.

2.2.7 Land Use and Land Use Change Assessment by Remote Sensing (PDM Activity 4.3.3)

In PDM of the project, land use and land use change assessment or mapping is a part of satellite land monitoring system. But since land use/cover mapping is very important part of the support from JICA TA Team, it is described here separately.

2.2.7.1 Activities

Advanced techniques of satellite image analysis were introduced and Cambodian officials are using them in land use/cover assessment and land use/cover change analysis.

Review of existing maps and mapping methodology

First of all history of land use/cover mapping of Cambodia was reviewed and contents of existing maps were analyzed to check to see if they can be used for the measurement of emission and REL/RL calculation. UN-REDD contributed to this analysis by compiling a report titled "Land cover and forest classification system of Cambodia" published in 2013. Also, reports made by DHI-GRAS, a Danish consultant contracted by FA for accuracy assessment of 2006 and 2010 maps, were studied to understand the characteristics of historical forest cover or assessment maps of Cambodia. The result of this review was as follows:

(1) Mapping method

FA had been using satellite images for long time to make forest cover or assessment maps. In late 1990s, satellite images printed on paper were interpreted and polygons of each land use/cover class were hand drawn on the image.

For the preparation of 2002 forest assessment map, GIS was introduced and satellite images displayed on computer screen were interpreted and digitized by using digitizer functions of GIS. Introduction of this technique contributed to detect geographic features which were not clearly visible on images printed on paper. The same methodology was used by FA in the production of 2006 and 2010 forest cover assessment maps. Minimum

Mapping Unit for the existing 2006 and 2010 maps was 25 hectares.

(2) Land use/cover classes

By comparing legends of historical maps and their definition, it was recognized that land use/cover classes of the maps produced before 2002 were inconsistent with 2002, 2006 and 2010 maps. On 2002, 2006 and 2010 maps, forests were divided into 5 classes, namely, evergreen forest, semi-evergreen forest, deciduous forest, bamboo and other forest. Other Forest class includes rubber plantations, oil palm plantations, tree of perennial crops such as cashew which are not considered as forest for the purpose of REDD+ in many countries. Other Forest class and Non-Forest class had not been stratified.

Scope of Improvement of Land Use/Cover Assessment

Based on the review of existing maps and studying the requirement of REDD+ the scope of new land use/cover assessment was determined.

(1) Land use/cover class

It was decided to stratify both Other Forest areas and Non-Forest areas. For this purpose, UN-REDD introduced Land Cover Classification System (LCCS) to objectively define each land use/cover class. As the results of a series of discussion land use/cover classes to be used for REDD+ purpose were determined as shown on Table 13. Other Forest class was sub-divided into 9 sub-classes and Non-Forest class into 8 sub-classes.

It was pointed out by both JICA TA Team and an UN-REDD expert that separation of some classes would be difficult. Also pointed out was the ambiguity of the definition of Forest Regrowth. Forest Regrowth is a land use category and separating them from other treeless or small tree areas is quite difficult on satellite image and even in the field unless clear boundary information is available.

Despite these arguments, FA decided that Forest Regrowth class would be still important and made the Forest Regrowth as an independent class.

Table 13 Comparison of land use/cover classes

	Old class (original 2006 and 2010 maps)		Newly defined classes	LULUCF categories from IPCC guidelines
1	Evergreen forest	1	Evergreen forest	Forest land
2	Semi-evergreen forest	2	Semi-evergreen forest	
3	Deciduous forest	3	Deciduous forest	
4	Bamboo	4	Bamboo	
5	Wood shrub dry	5	Wood shrub	Other land
6	Wood shrub evergreen			
7	Other forest	6	Mangrove forest	Forest land
		7	Rear mangrove	
		8	Rubber plantation	Cropland
		9	Flooded forest	Forest land
		10	Forest regrowth	
		11	Pine tree	
		12	Pine plantation	
		13	Oil palm	Crop land
		14	Tree plantation	Forest land
8	Non-forest	15	Paddy field	Cropland
		16	Crop Land	
		17	Grassland	Grassland
		18	Built-up area	Settlement
		19	Village	
		20	Rock	Other land
		21	Sand	
		22	Water	Wetland

(2) Map to be used for GHG inventory and REL/RL calculation

In order to calculate REL/RL, minimum two sets emission/removal data of forest carbon are required. And this means at least three sets of land use/cover map are required. 2006 and 2010 maps can be used if *Other Forest* and *Non-Forest* classes are stratified. Then it became necessary to produce one more map. Since FA used to produce forest map at four year interval, it was decided to make a new map of 2014.

This makes reference period for the initial REL/RL and GHG inventory 8 years between 2006 and 2014. And in 2015, it was decided that 2016 map also should be made to improve FRL.

(3) Improvement in mapping methodology

In order to reduce subjective decisions by humans in determining land cover class boundaries and also to assist young generation staff who do not have experience in drawing polygons, FA decided to introduce an object oriented image processing tool - or, segmentation tool. The segmentation software named eCognition was procured by Japan Grant Aid for Forest Preservation Programme.

This software (eCognition) was used in the production of new 2014 and 2016 land use/cover map and as well as for stratifying Other Forest Class and Non-Forest Class of existing 2006 and 2010 forest cover maps. Also introduced was the technique of logical checking for QA/QC purpose. If land use/class of an area changes from Forest (2006) – Non Forest (2020) – Forest (2014) for example, then, land use/cover class of such an area is double checked because its change pattern is unlikely.

Table 14 is the summary of the scope of the production of the four maps.

Table 14 Scope of the four maps

	2016	2014	Upgraded 2010	Upgraded 2006
Land use/cover class	New class specified in Table 13			
Forest definition	Minimum area: 0.5ha Minimum height at maturity: 5 meters Minimum crown cover rate: 10%			
Mapping methodology	● Segmentation and visual interpretation of satellite images. ● Extracted potential area of change using Principal Component Analysis ● MMU is 5ha	● Segmentation and visual interpretation of satellite images ● MMU is 5ha	● Combined manual drawing (digitization) of polygons (for forest classes) and segmentation (for sub-classes of other forest and non-forest), and visual interpretation of satellite images ● MMU of Other Forest and Non Forest is 5ha ● On original 2006 map, MMU of Forest classes other than Other Forest class was 25ha. However, they were reviewed and edited based on 5ha MMU.	
Satellite image	LANDSAT 8		LANDSAT 5	LANDSAT 7 gap-filled

Production of 2006, 2010, 2014 and 2016 maps

In order to keep consistency among maps prepared for different epoch, it is better to produce the base map first and then maps of other epochs are made by referring to the base map. However, Cambodia was trying to submit FRL to UNFCCC by the end of 2015 and there was no time to produce maps by referring to the map of previous epoch. For this reason, preparation of the maps of the three epochs was carried out simultaneously.

Mapping methodology was designed by JICA TA Team and determined through the

discussion with FA officials in charge of land use/cover mapping as well as with experts of FAO.

Upgrading of 2006 and 2010 maps and creation of new 2014 map started in the 2013. UN-REDD expert mainly supported the upgrading of 2006 map while JICA TA Team supported the upgrading of 2010 map. After the completion of the draft of the 2006, 2010 and 2014 maps, consistency check was conducted by FA and JICA TA Team. FA, particularly, made detailed inspection of the three maps and made additional editing on all of them.

Production of 2016 map started in 2015. In the 2016 mapping, a digital image processing method, Principal Component Analysis, was used to efficiently identify potential areas of land use/cover change. Figure 15 is a workflow and methodology used for the 2016 mapping. The 2016 mapping was completed in October 2017. In the process of making the 2016 map, consistency with previous maps were also checked.

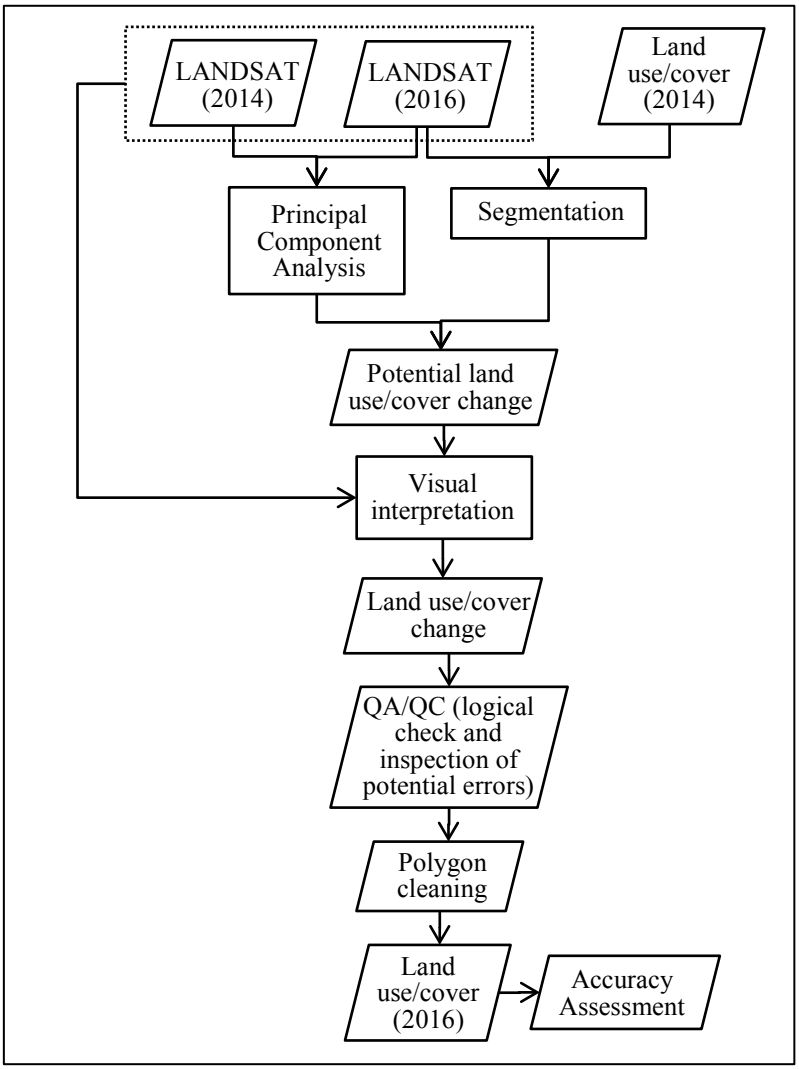


Figure 15 Methodology for 2016 mapping

Figure 16, Figure 17, Figure 18 and Figure 19 are the images of the four maps.

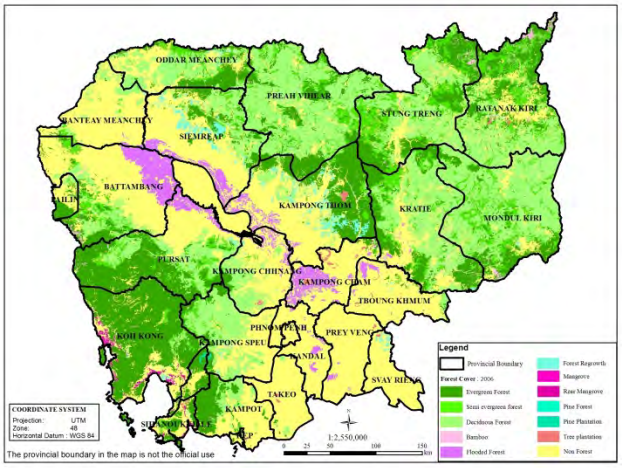


Figure 16 Land use/cover map of 2006

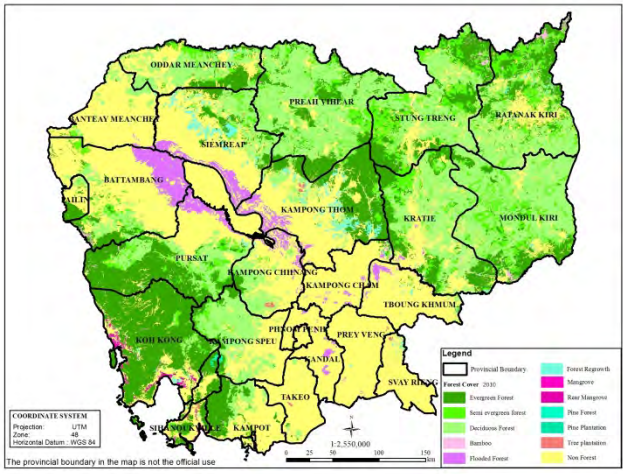


Figure 17 Land Use/Cover map of 2010

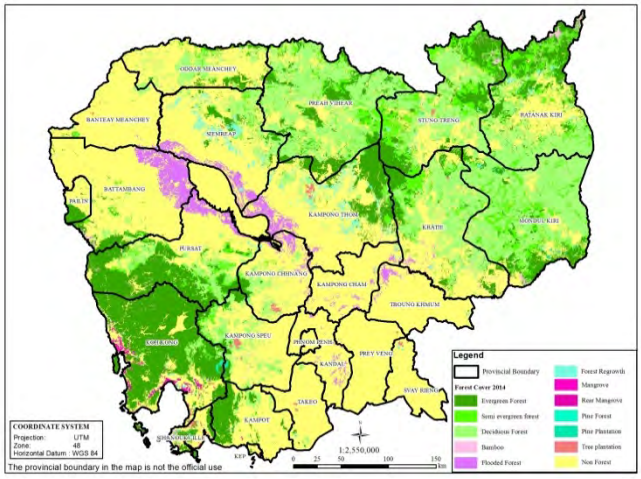


Figure 18 Land Use/Cover map of 2014

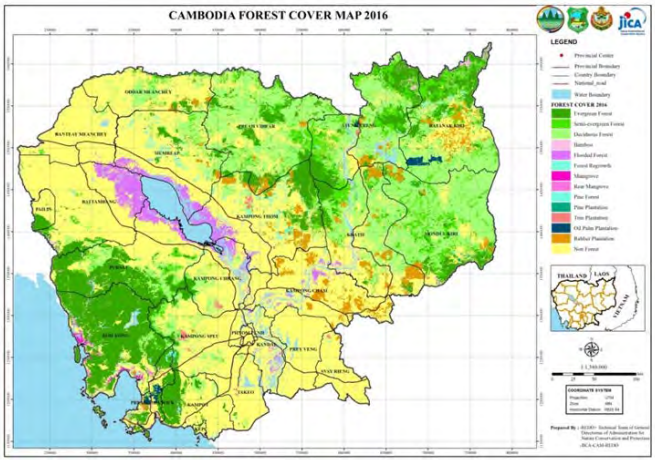


Figure 19 Land Use/Cover map of 2016

Accuracy of 2010, 2014 and 2016 maps was verified. As for the 2006 map, accuracy assessment was not done because GRAS did it when the original 2006 map was produced.

Overall accuracy of 2006, 2010, 2014 and 2016 maps were as follows.

2006 map: 71%

2010 map: 73.97%

2014 map: 82.17%

2016 map: 87.48%

While JICA TA Team taught Cambodian officials methods for accuracy assessment of individual maps, UN-REDD introduced the methodology for the accuracy assessment of land

use/cover change.

Historically, FA produced forest maps at four year interval. But with the introduction of JICA TA Team's new methodology, mapping time was reduced substantially and technically it is possible now for the Cambodian government to produce land use/cover map at two years cycle.

2.2.7.2 Support from JICA TA Team

First of all, JICA TA Team drafted procedure and scope for all the maps to be produced. The draft was examined by core members of MRV/REL Technical Team and FAO experts. JICA TA Team also assisted FA in 2010, 2014 and 2016 mapping and their accuracy assessment. Method of accuracy assessment of individual map was designed by JICA TA Team. For the accuracy assessment of 2010 map, AVNIR2 images of ALOS satellite procured by the Japan Grant Aid programme were used.

The Japan Grant Aid for Forest Preservation Programme procured object oriented image processing software named eCognition. Basic training on the use of the software was done under the Japan Grant Aid program. In 2013, 2014, 2015 and 2016, JICA TA Team also provided staff of FA with technical training for practical use of the software. Further, Forestry and Forest Products Research Institute (FFPRI) Japan also trained FA officials on the use of the software. JICA TA Team coordinated the three types of training to maximize the training results.

In summary, JICA TA Team assisted Cambodia to upgrade its mapping work by introducing the following new techniques.

- Satellite image segmentation
- Logical check of draft map
- Principal component analysis for identifying potential area of land cover change

2.2.7.3 Future Development

As for the detection of forest degradation, it is planned that a research is conducted under FCPF program. Also, grouping of difficult to separate land use/cover classes should be considered. For example, separation of Mangrove and Rear Mangrove and separation of shrub from grass was found to be difficult. Also difficult to identify was Forest Regrowth because this is a land use class and not land cover class. If Forest Regrowth class is really important from forest management point of view, then, they should be identified by overlaying some kind of boundary information of forest areas.

2.2.8 Design a National Forest Inventory to Develop Emission and Removal Factors for REDD+ Related Activities (PDM Activity 4.4)

2.2.8.1 Activities

Draft of NFI design and field operation manual were completed and are waiting for the final approval of FA and MoE.

NFI is a component of NFMS. Design of NFI of Cambodia started with the analysis of the situation of forest surveys in the country. In Cambodia, forest inventory surveys were carried out mainly for estimating timber volume or for research purposes. Therefore, existing surveys do not cover entire forest in the country. Locations of the forest survey carried out in Cambodia were analyzed from various perspective as shown in Figure 20, Figure 21and Figure 22. Hardly any data exists for mountainous areas over 800 meters above sea level. And only very limited number of surveys or researches was conducted in flooded forest and mangrove forest.

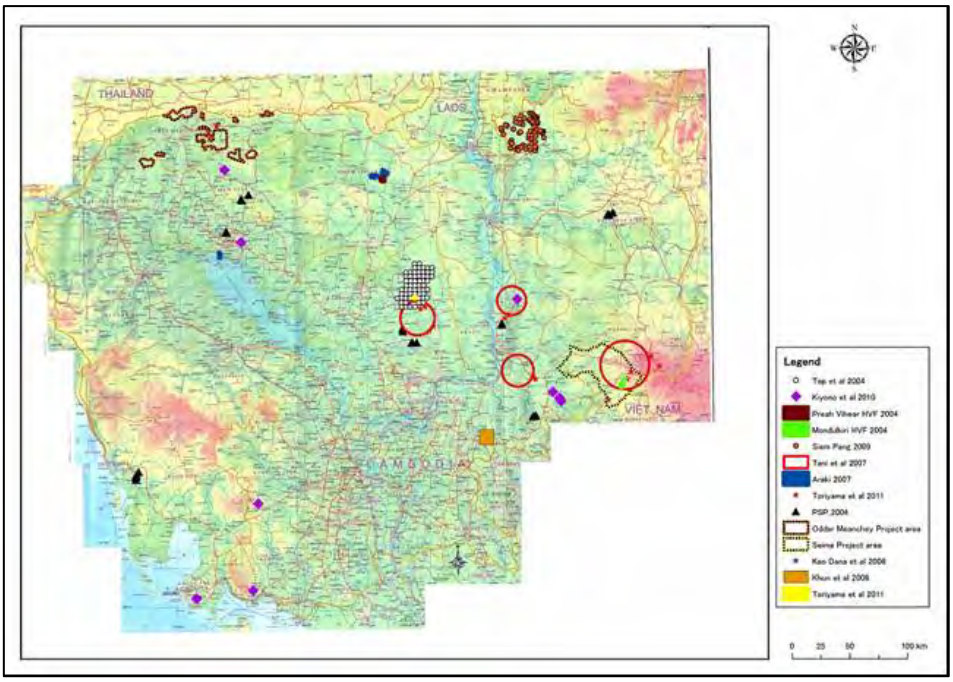


Figure 20 Location map of existing forest survey plots

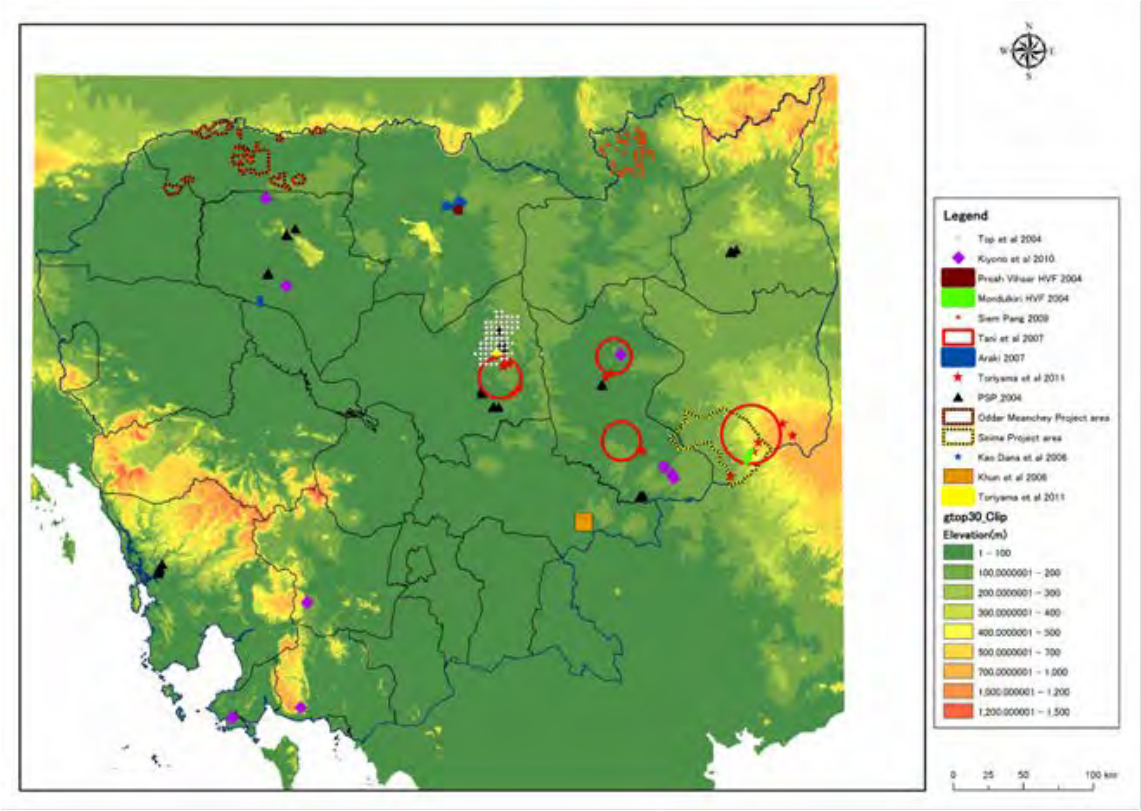


Figure 21 Location of existing forest survey plots overlaid on elevation map

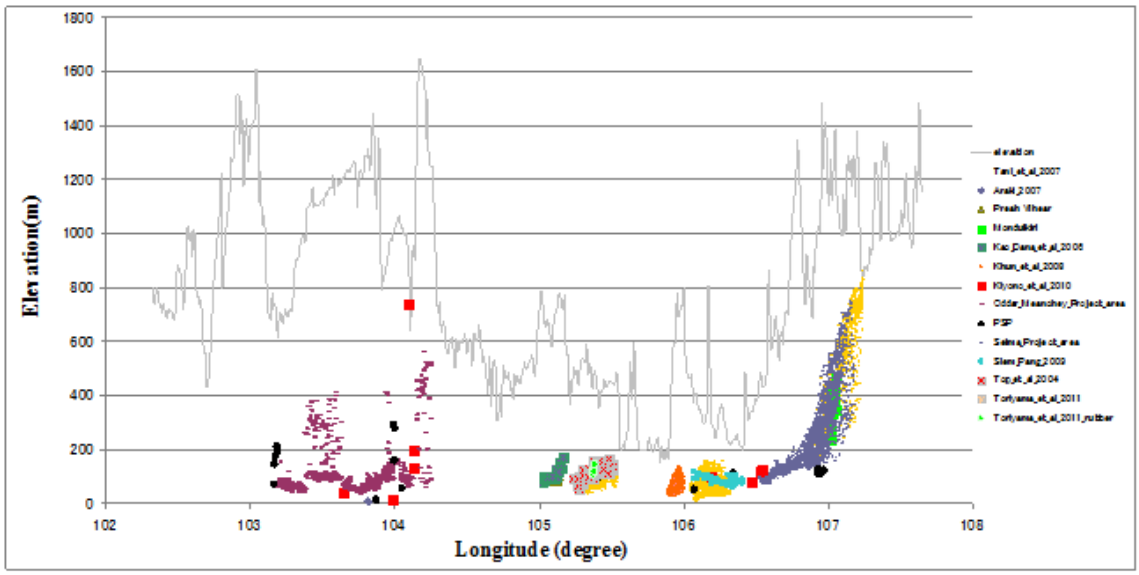


Figure 22 Vertical distribution of existing forest survey plots

As early as in 2012, JICA TA Team compiled a provisional design of NFI and provided it to FA as a material for technical discussion and education. In 2013 FAO also started NFI design work under its Technical Cooperation Programme (TCP). By TCP fund, FAO assigned one

international expert in 2013. By using JICA TA Team's provisional NFI design as one of reference materials, the FAO expert started the design. His work was succeeded by the second FAO expert. During the design process, JICA TA Team had a series of technical discussion with the FAO experts particularly on the number of sample plots.

Figure 23 is a schematic of the relation of the works of JICA TA team and FAO.

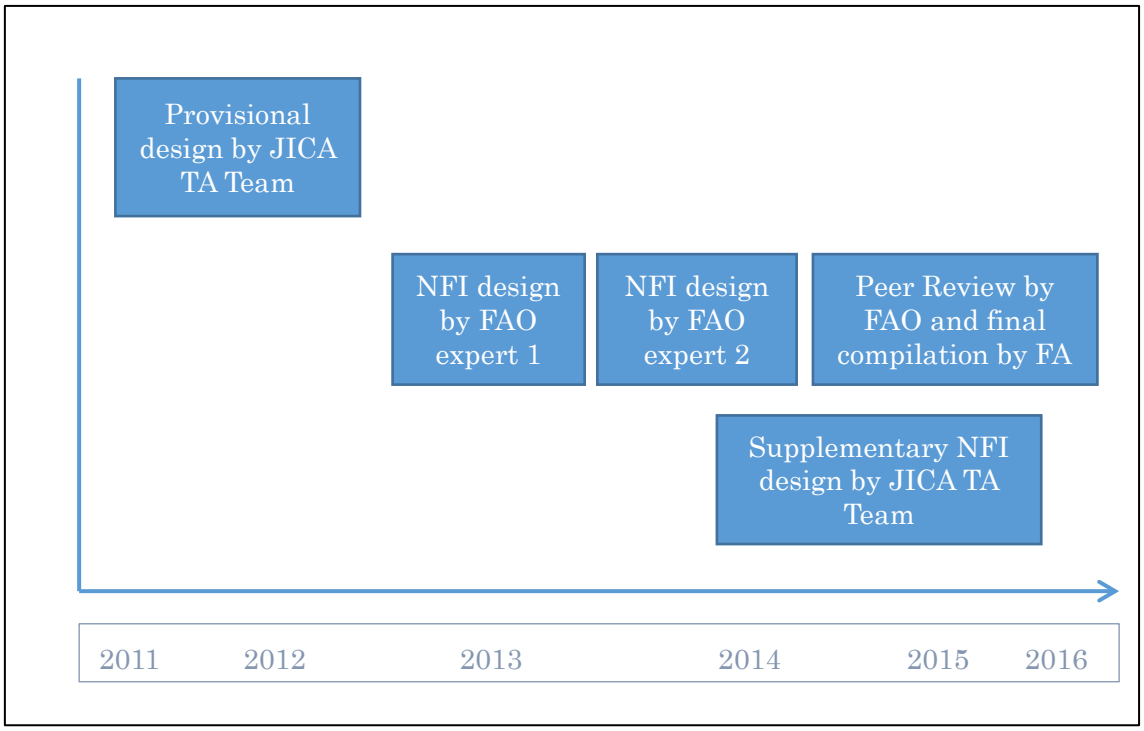


Figure 23 NFI design work for Cambodia

In the middle of 2014, after the completion of the first draft of a NFI design and a field manual by the second FAO expert, FAO sent the draft to some foreign universities for peer review. JICA TA Team also provided technical comments on the drafts.

In relation to the estimation of forest carbon stock, JICA TA team studied existing allometric equations which enable the conversion of forest inventory survey data into biomass, and examined the limitation for application. The result was compiled as Working Paper titled "Available allometric equation for Cambodian REDD+ and possible works for tentative estimation of living biomass" in September 2013.

While NFI design and field manual were carefully examined by FAO headquarters in Rome and

by FA, JICA TA team did its own study on the contents of the design and manual as described below.

(1) Compiling supplementary NFI design and Field Manual

In the draft NFI design and field manual, JICA TA Team found some deficiencies. Table 15 summarizes elements of NFI not covered or not fully explained in FAO's draft.

Table 15 Key procedures of NFI covered in the draft NFI Design and draft Field Manual

Carbon pools	Sampling Design	Field Survey	Laboratory analysis	Allometric equation	Data processing
AGB	Yes	Yes		No	No
BGB				No	
Dead wood	Yes	Yes	No		
Litter	Yes	No	No		
Soil	Yes	No	No		

On a basis of this analysis, the team compiled supplementary NFI design and Field manual which explain elements of NFI which were not covered or fully explained in the FAO's drafts as Working Paper No.15 titled, "Supplementary NFI Design and Field Manual". The table of contents of the Supplementary NFI Design and Field Manual is shown below.

Table of contents of Supplementary NFI Design and Field Manual

(2) The number of NFI survey points and design accuracy

UNFCCC recommends the usage of a combination of remote sensing and ground-based forest carbon inventory approaches for GHG inventory. However, the methodology proposed in the draft NFI design uses remote sensing for subsidiary purposes in the pre-selection of survey points only. As a result, the proposed number of the survey points in forest area is 3,170 in total (Mangrove 97, Wetland 322 and Uplands 2,751). JICA TA Team proposed the modification of the design for decreasing survey point because the number of survey points would influence the feasibility of NFI. And in order to assist Cambodian government in understanding the relation between number of survey point and expected accuracy, JICA TA Team made Working Paper No.12, "The Number of Survey Points of NFI and the Precision in Estimating Forest Area and Biomass" in August 2015.

Table 16 is an example of analysis presented in the Working Paper No.12. This table shows that the relative standard error of ±2.3 % will be earned for evergreen forest in 90% confidence interval if survey points are positioned with 6km interval as designed in a draft NFI Design, standard error will be 4.6 % in case the number of survey points is decreased to one fourth or to 1,357 points from 3,170 points.

Table 16 Design accuracy of estimating biomass density

SE = $S/\sqrt{n}$								
SE = 68.27% confidence interval								
SE*1.65 = 90% confidence interval								
A								
	Area (ha) (FA 2010)	# of sample (n)	Mean biomass (t dry matter/ha)	S (t dry matter/ha)	SE (+−t dry matter/ha)	SE*1.65 (+−t dry matter/ha)	Relative SE (+−%)	Relative SE*1.65 (+−%)
Evergreen ("6km*6km" interval)	3,499,185	972	327.6	143.8	4.6	7.6	1.4	2.3
Semi evergreen ("6km*6km" interval)	1,274,789	354	327.6	143.8	7.6	12.6	2.3	3.8
Deciduous ("6km*6km" interval)	4,481,214	1,245	112.4	51.9	1.5	2.4	1.3	2.2
Other forest ("4km*4km" interval)	1,108,600	693	112.4	51.9	2.0	3.3	1.8	2.9
Forest sub total	10,363,788	3,264						
Non forest ("6km*6km" interval)	7,796,885	2,166						
Total	18,160,674	5,430						
B								
	Area (ha) (FA 2010)	# of sample (n)	Mean biomass (t dry matter/ha)	S (t dry matter/ha)	SE (+−t dry matter/ha)	SE*1.65 (+−t dry matter/ha)	Relative SE (+−%)	Relative SE*1.65 (+−%)
Evergreen ("12km*12km" interval)	3,499,185	243	327.6	143.8	9.2	15.2	2.8	4.6
Semi evergreen ("12km*12km" interval)	1,274,789	89	327.6	143.8	15.3	25.2	4.7	7.7
Deciduous ("12km*12km" interval)	4,481,214	311	112.4	51.9	2.9	4.9	2.6	4.3
Other forest ("8km*8km" interval)	1,108,600	173	112.4	51.9	3.9	6.5	3.5	5.8
Forest sub total	10,363,788	816						
Non forest ("12km*12km" interval)	7,796,885	541						
Total	18,160,674	1,357						

It can be a useful reference for examining feasibility and accuracy of result when a detailed plan of NFI is designed or reviewed.

Scope of NFI as a component of NFMS is as outlined in a box below.

Scope of NFI design in NFMS of Cambodia

- Purpose: acquisition of EF for GHG inventory, and acquisition of basic data necessary for forest policies and measures.
- Scale: National level.
- Survey method: Sample plot survey.
- Plot shape: Square for upland and wetland forests and circle for mangrove
- Number of clusters: about 3,170 clusters. Each cluster consists of three sample plots.
- Main survey items: forest type, name/DBH/height of each tree, condition of under growth, quantity of dead trees/litter, quantity of carbon in soils.
- Cycle: 4 - 5 years

2.2.8.2 Support from JICA TA Team

As explained in 8.8.2 above, draft of NFI design was made by FAO and JICA. In 2012 the team made a prototype design of NFI of Cambodia. Since MRV/REL Technical Team was not organized yet, NFI design document was provided to FA officials as a material for internal discussion on NFI design.

From 2013 UN-REDD assigned a NFI expert and he used the prototype design as a reference. After UN-REDD completed its draft NFI, JICA TA Team provided various technical comments and papers to MRV/REL Technical Team particularly on the number of plots as explained in Paragraph 8.8.2. Further JICA team made design of the method of collection of soil organic matter data which was later incorporated in NFI draft by MRV/REL Technical Team.

2.2.8.3 Future Development

Future development will be as follows:

- Implementation plan of NFI is prepared. The most important element is the institutional arrangement to define roles of participating parties such as local governments. Considering the fact that reform of forestry sector seems to include transfer of local FA officials to a department of provincial government in charge of forest management, establishing a new mechanism to mobilize local officers for NFI is required.
- Additional NFI training is conducted based on the NFI design and field manual approved by the government

- Implement NFI in a limited area
- Review NFI design and field manual based on the result of the limited implementation
- NFI is implemented for entire forest of Cambodia
- Further review of NFI method and field manual and also plan for next NFI

2.2.9 Develop Cambodia RELs/RLs Framework (PDM Activity 4.5)

2.2.9.1 Activities

Forest Reference Level (FRL[1]) of Cambodia was submitted to UNFCCC in November 2016. In March 2017 technical assessment of the submitted FRL started. As of October 2017, the assessment process is nearly completed.

Current version of FRL is attached as Appendix 4.

FRL establishment is the most crucial condition for parties to become eligible to apply for results-based payment for REDD+ activities. At first, Cambodia planned to submit its initial FRL to UNFCCC secretariat in January 2016 so that the FRL can be assessed by UNFCCC in 2016. And this decision determined the scope of first FRL of Cambodia including the selection of AD and EF.

Soon after the start of its activity in Cambodia, JICA TA Team produced two Working Papers on FRL as follows.

Working Paper No.1	Simulation / Trial Calculation of RELs (Reference Emission Levels) of Cambodia with Different Scale Approach
Working Paper No.2	Trial Calculation of Historical Trend of Annual CO_2 Emissions/Removals in order to Understand Cambodian Nationwide RELs (Reference Emission Levels)

These working papers were submitted to FA by March 2012. Then, background paper for initial FRL calculation for Cambodia was drafted in late December 2014.

In March, 2015, JICA TA Team prepared a document titled “Calculation of Initial Reference Emission Level for Cambodia (Draft)” as a base document for an official FRL document of

Cambodia and to promote discussion on the design of FRL. In addition to FAO experts, FAO head quarter joined the discussion.

A series of MRV/REL Technical Team meetings and workshops were held and a draft of initial FRL document was completed before the start of COP21 in November 2015. However, approval of the result of the new 2014 map by the Royal Government of Cambodia took time. The FRL document was finally submitted to UNFCCC in November 2016 during COP22 in Paris.

Key elements of FRL of Cambodia are as summarized below.

(1) Scope

Category	Scope
Scale	National
Activity	Deforestation. Forest degradation in terms of change of forest class from one to another is captured. Change in biomass within a forest remained in the same forest class was not captured.
Carbon Pool	Above Ground Biomass, Below Ground Biomass
Greenhouse Gas	CO_2

In five carbon pools recognized by IPCC guidelines (IPCC, 1997; 2003; 2006), only Above Ground and Below Ground biomass were selected for Initial FRL of Cambodia. Other three pools, i.e. litter, dead wood and soil organic matter, were not included in emission and removal calculation because data were scarce and also their stock change was considered to be not significant in Cambodia.

As for Greenhouse Gases, only CO_2 was included. Because, in Cambodia, emission of other gases from land use and land use change was considered to be not significant.

(2) Definition of forest and forest types used for FRL

For forest management FA was using forest definition specified in its National Forest Programme (NFP). Under the NFP definition, forest includes rubber and oil palm plantations and also perennial crops. For the purpose of REDD+, a new definition was

established by the Royal Government of Cambodia as follows.

- *Forest under the REDD+ programme refers to a unit of an ecosystem in the form of wetland and dry land covered by natural or planted vegetation with a height from 5 meters on an area of at least 0.5 hectares, and canopy crown cover of more than 10%.*
- *Rubber plantations, oil palm plantations and perennial crops are excluded from forest category.*

(3) Reference period

The UNFCCC requires historical data to be taken into account for the construction of a FRL but does not specify the length of reference periods. As Figure 4 shows, Cambodia has record of forest cover since 1965. However, it was judged that map made before 2002 would not be used for FRL calculation because their land cover classes are different from that of the map made after 2006. 2002 map was also not used because MMU was 50ha, two times larger than MMU of existing 2006 and 201 maps, and the result of accuracy assessment of the map was not available.

(4) Methodology

Cambodia chose to use historical average of net emission and removal for eight years between 2006 and 2014. This methodology was chosen because with only two sets of emission/removal data it is impossible to use any other sophisticated method such as a regression method or modeling.

Annual CO_2 Emissions and Removals (t CO_2 / year) were calculated by the following equation

$$\Delta C_B = \frac{(Ct_2 - Ct_1)}{(t_2 - t_1)}$$

$$\Delta CO_2 = \Delta C_B \times 44/12$$

ΔC_B = annual change in carbon stocks in biomass (the sum of above-ground and below-ground biomass) in land remaining in the same category (e.g., Forest Land Remaining Forest Land), tonnes C yr-1

C t_2 = total carbon in biomass for each land sub-category at time t_2, tonnes C

C t_1 = total carbon in biomass for each land sub-category at time t_1, tonnes C

Ct (Total Emission) = Activity Data (AD)×Emission Factor (EF)

44/12: Molecular weight ratio of carbon dioxide to carbon

(IPCC, 2006)

(5) Activity data

As explained before in this report, upgraded 2006 and 2010 maps and new 2014 map were used in FRL calculation. Forest cover ratios in Figure 6 in Section 3.4 of this report are those calculated by using upgraded 2006 and 2010 maps and new 2014 map and also based on the new forest definition of Cambodia for REDD+ purpose.

(6) Average CO_2 stock per unit of area

Emissions are estimated by calculating the change of carbon stock for each land use/cover class between two points in time. In Initial FRL calculation, carbon stock of non-forest areas was assumed to be zero because there was no reliable data existed.

Since NFI has not yet been conducted in Cambodia average CO_2 stock or AGB per unit of area was estimated based on several existing data. Table 17 shows the selected AGB values and calculated C and CO_2 values.

Table 17 Estimation of above ground biomass (ton ha-1) by forest types in Cambodia

Forest type	AGB ton ha-1	C ton ha-1*	CO_2 ton ha-1**
Evergreen forest	163	76.61	280.90
Semi-evergreen	243	114.21	418.77
Deciduous	85	39.95	146.48
Pine forest	100	47.00	172.33
Bamboo	0	0.00	0
Mangrove	150	70.50	258.50
Rear Mangrove	165	77.55	284.35
Inundated	70	32.90	120.63
Forest regrowth	75	35.25	129.25
Pine plantation	100	47.00	172.33

*0.47 was used as Carbon fraction (ton C /ton d.m.) from the default value in IPCC (2006).

**One carbon equals 44/12 carbon dioxide.

References: MOE UNDP (2003), CFI (2008), IPCC (2006), JICA TAT (2015), Sasaki *et.al*. (2013), Sola *et al*. (2014), Tran (2015)

The process of the selection of AGB values on Table 17 is described in Section 8.10.3 of this report.

2.2.9.2 Support from JICA TA Team

First of all JICA TA Team made technical papers and held lecture in order to make Cambodian officials understand the concept of REL/RL. Then, JICA TA Team made the first draft of the FRL document and calculated emission/removals. And through the preparation of official FRL document and technical assessment by UNFCCC, JICA TA Team supported Cambodian officials.

2.2.9.3 Future Development

The FRL still needs to be improved. In summary, following activities should be conducted to improve FRL of Cambodia:

- Make land use change maps for coming years to increase the number of AD and to reduce uncertainty of FRL;
- Implement NFI to improve average carbon stock data for each forest type;
- Develop and improve wood density estimates to improve carbon stock data;
- Develop allometric equations for major tree species to improve carbon stock data; and
- Determine validity period of FRL.

(1) Make land use change maps for coming years to reduce uncertainty level

Maps of only three epochs were used for Cambodia's FRL. In order to know more precise trend in land use/cover change, more activity data are required. In the National REDD+ Strategy and NFMS document, two year map updating cycle is proposed.

(2) Implement NFI to improve average carbon stock for each forest type.

The data in Sola *et al*. (2014)[14] were based on forest inventory surveys conducted in Cambodia independently by various researchers. Survey plots of past forest inventory survey do not cover Cambodian forest in a systematic manner and also forests located in areas higher than 800 meters above sea level were not covered. Further, for some types of the forest, such as Mangrove, no biomass data based on field survey in Cambodia are available. Therefore, implementation of NFI is necessary.

14 "Forest biomass in Cambodia: from field plot to national estimates", Sola G., Vannha S., Vesa L., Van Rijn M., Henry M., 2014

(3) Develop and improve wood density estimates to improve carbon stock data

When trunk diameter, tree height and wood density are included in the aboveground biomass model, a single model was found to hold across tropical vegetation types without effect of regional or environmental factors. Wood density is an important predictor of tree biomass especially when including a much broader range of vegetation types (Chave *et al*., 2014)[15]. Available methodologies and associated cost for measuring the density in forest inventories are huge constraints but average wood density at species level can be used to produce accurate estimate of biomass with the available equation. (Fayolle *et al*., 2013)[16]. Therefore, developing a table of wood density values at species level would be very useful to improve biomass estimates.

(4) Develop allometric equations for major tree species to improve carbon stock data

An allometric equation is used to calculate dry weight of above ground biomass of a tree from easier-to-measure characteristics such as tree diameter or height. For the initial FRL development, default allometric equations were used. However, tree forms are different one species to another, so are tree biomass and allometric equations. When wood density is analyzed based on the field survey data, allometric equations should also be made, especially for major tree species in Cambodia.

(5) Determine validity period of FRL

FRL has a validity period. Length of validity period affects total emission reduction a party can make. More discussion and simulation is required to determine appropriate validity period for the first FRL of Cambodia.

15 "Improved allometric models to estimate the aboveground biomass of tropical trees" Global Change Biology (2014) 20, 3177-3190

16 Fayolle AD, Doucet JL, Gillet JF, Nils Bourland, Philippe Lejeune, 2013. Tree allometry in Central Africa: testing the validity of pantropical multi-species allometric equations for estimating biomass and carbon stocks. Forest Ecology and Management:305:29-37

2.2.10 Develop a REDD+ Related GHG Reporting System (PDM Activity 4.6)

2.2.10.1 Activities

Cambodian officials acquired knowledge on the principles of GHG inventory and reporting system and operation of GHG inventory tools.

IPCC published revised 1996 Guideline on GHG inventory (IPCC, 1997), then published a Good Practice Guidance (GPG) in 2003 and a new guideline in 2006 (IPCC, 2003 and IPCC, 2006). According to the decision in COP8 (2002), all non-Annex I Parties including Cambodia are required to submit a national inventory of GHGs as a part of their NC following IPCC Guideline 1996. Non-Annex I Parties are encouraged to use IPCC 2003 (Good Practice Guidance). The usage of IPCC 2006 depends on the decision of each party.

Cambodia made its initial NC including GHG inventory (reporting year: 1994) in the year of 2000, then submitted it to UNFCCC in 2002. (The second NC was submitted to UNFCCC in 2016 but base year was 2000). However, when JICA TA Team started to work, the knowledge on GHG inventory was not sufficiently possessed by Cambodian officials because long time had passed since the preparation of the 2nd NC were carried out.

For this reason, Cambodian officials had to learn the basics of GHG inventory and reporting. In order to acquire capacity to make GHG inventory and reporting, following steps were followed.

- Study of basic principles of GHG inventory and reporting
- Training of the use of GHG inventory tool
- Selection of emission factors
- Training on trial calculation

(1) Study of basic principles of GHG inventory and reporting

Cambodian officials received a series of lectures from JICA TA Team and UN-REDD experts.

(2) Training of GHG inventory tool

UN-REDD expert provided training on the use of GHG inventory tool made by FAO.

(3) Selection of emission factors

Emission factors for GHG inventory were selected by JICA TA Team and examined in

MRV/REL Technical Team meetings.

(4) Trial calculation

MRV/REL Technical Team members experienced actual calculation of GHG inventory following the methods of IPCC Guidelines.

2.2.10.2 Support from JICA TA Team

JICA prepared various materials to enhance understanding of Cambodian officials on GHG inventory and reporting. Major materials are as listed below:

- Working Paper No.7 "Trial Calculation of Above Ground Biomass in Cambodia" (January 2014)
- Working Paper No.8 "Essence of the Procedures for C Stock Estimation and Reporting by IPCC Guidelines" (March 2014)
- Working Paper No.9 "Trial Calculation of Carbon Stock Change by Method 1 with Tentative Activity Data and Default Emission Factor" (May 2014)
- "Essence of the procedure for Carbon stock estimation by IPCC Guideline 2006 and trial calculation of Carbon Stock Change (August 2014)"
- "Trial Calculations of Carbon Stock Change by Gain-Loss Method and lessons learned from the experience (September 2014)"
- "Material for discussion on the choice of GHG inventory method for forest sector and availability of data in time series (June 2015)"
- Working Paper No.11 "Data required for GHG Inventory by two methods" (September 2015)
- Working Paper No.13 "Some remarks on the usage of GHG Inventory Software in AFOLU sector"(September 2015),

In "Material for discussion on the choice of GHG inventory method for forest sector and availability of data in time series" possible schedule of NC and BUR submission, and availability of Activity Data and Emission Factors are examined (Figure 24), and possible choices of method in each phase are presented (Table 18).

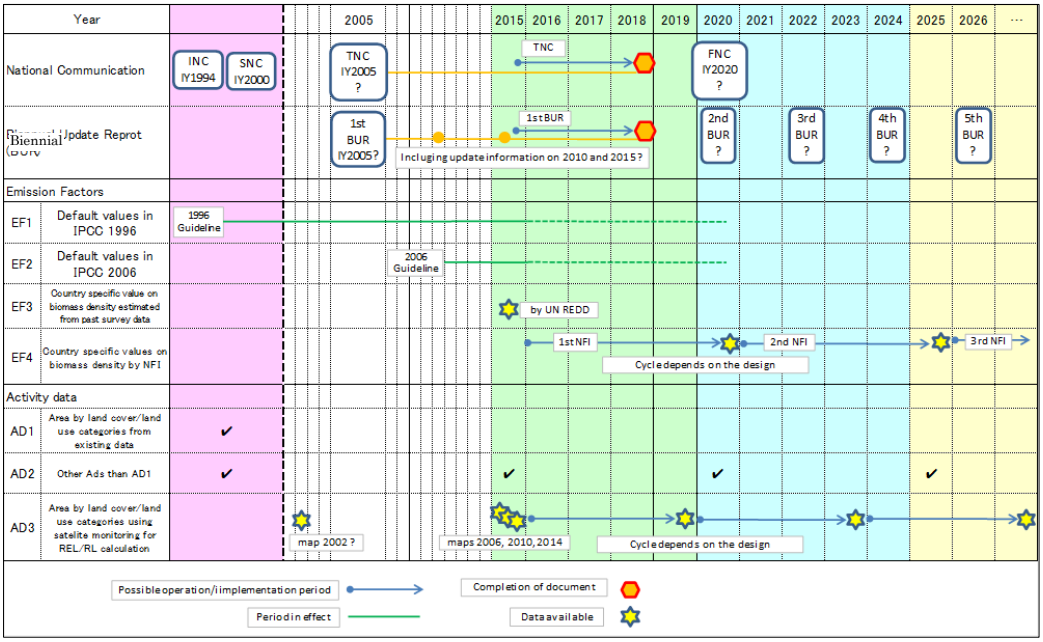


Figure 24 Possible schedule of NC and BUR and availability of EF and AD in AFOLU Sector

Table 18 Possible choice of the method and data in each phase of the GHG inventory

	Method	EF	AD	Target activity	Possible Tier	Target C Pools					Target GHGs				
						AGB	BGB	DW	Litter	SOM	CO_2	CH_4	CO	N_2O	NOx
1. INC (and SNC)															
1.1	Gain-loss	EF1	AD1+ AD2	Df, Dg	Tier 1	✔	✔	✔	✔		✔	✔	✔	✔	✔
2. Initial phase before 1st NFI (for TNC and/or First BUR)															
2.1	Gain-loss	EF1 (+EF3)	AD2 + AD3	Df, Dg	Tier 1.2?	✔	✔	✔	✔	?	✔	✔	✔	✔	✔
2.2	Gain-loss	EF2 (+EF3)	AD2 + AD3	Df, Dg	Tier 1.2?	✔	✔	✔	✔	?	✔	✔	✔	✔	✔
2.3	Stock difference	EF3 (single)	AD3	Df	Tier 1.4?	✔	✔				✔				
3. Developing phase between 1st and 2nd NFIs (for NC and/or BUR of base year 2020?-)															
3.1	~~Gain-loss~~	~~EF1 (+EF3)~~	~~AD2 + AD3~~	~~Df, Dg~~	~~Tier 1.2?~~	✔	✔	✔	✔	?	✔	✔	✔	✔	✔
3.2	Gain-loss	EF2 (+EF3)	AD2 + AD3	Df, Dg	Tier 1.2?	✔	✔	✔	✔	?	✔	✔	✔	✔	✔
3.3	Stock difference	EF4 (single)	AD3	Df	Tier 1.6?	✔	✔	?	?	?	✔	?	?	?	?
3.4	Stock difference	EF3 + EF4	AD3	Df, Dg?	Tier 1.8?	✔	✔	?	?	?	✔	?	?	?	?
4. Fully implemented phase after the completion of 2nd NFI (for NC and/or BUR of base year 2025?-)															
4.1	Stock difference	EF4 (plural)	AD3	Df, Dg	Tier 2	✔	✔	?	?	?	✔	?	?	?	?

Df: deforestation
Dg: forest degradation

Working Paper No.11 “Data required for GHG Inventory by two methods” was made based on the review of the necessary data for both Gain-loss Method and Stock difference Method.

As for the selection of Emission Factors, JICA TA Team searched and reviewed existing research papers and documents on the values of forest biomass density of Cambodia and Asian countries with an aim of selecting EF used for GHG inventory and FRL calculation. As a result, relevant data were found from 38 literatures and the result was compiled as Working Paper

No.10 “Literature review on forest biomass density of Cambodia Ver.1” (July 2015).

The author believes that almost all published literatures on the values of forest biomass density of Cambodia were reviewed. Based on this work, the range of AGB value for each forest type was estimated. Table 19 shows the values of above ground biomass density of evergreen forest in Cambodia compiled in Working Paper No.10.

Table 19　Biomass density of evergreen forest cited from existing studies

Forest type	AGB		References
	Biomass (Mg/ha)	C stock (Mg/ha)	
Evergreen forest	380.9	179.0	Kiyono et.al. (2010)
Semi-dense (moist)	370	173.9	Rollet (1962) cited in Brown (1997)
Evergreeen (less degraded)	367.5	172.7	Halperin et.al. (2013)
Evergreen forest	351.7	165.3	IGES (2012)
Evergreen seasonal forest	345.24	162.3	Hozumi et.al. (1969)
Evergreen forest	298.59	140.3	Sar (2010)
Evergreen seasonal forest	297.20	139.7	Hozumi et.al. (1969)
Dense (moist)	295	138.7	Rollet (1962) cited in Brown (1997)
Evergreen forest	291	136.8	Top et.al. (2006)
Evergreen forest (including Semi-evergreen forest)	290.4	136.5	Samreth et.al. (2010)
Evergreen forest	272.3	128	CFI, C.F. (2008) cited in Sar (2010)
Evergreen forest	257.9	121.2	Sasaki et.al. (2009) using data of DFW & FAO (1996).
Evergreen forest	256	120.3	Top et.al. (2004)
Evergreeen (more degraded)	246.4		Halperin et.al. (2013)
Evergreen/Semi-evergreen forest	243	114.2	WINROCK (2008)
Evergreen forest (rich)	219.8	103.3	Kim-Phat et.al. (2000)
Evergreen forest	204.7	96.2	Sasaki et.al. (2013)
Evergreen forest (medium)	178.0	83.7	Kim-Phat et.al. (2000)
Evergreen forest	135.7	63.8	Kao.et.al. (2010)
Evergreen forest	135.0	63.5	Kao et.al. (2010)
Unlogged evergreen forest	130.2	61.2	Kao et.al. (2006)
Logged evergreen forest	106.2	49.9	Kao et.al. (2006)
Well to poorly stocked evergreen	100-155	47-73	FAO (1971) cited in Brown (1997)
Evergreen forest (poor)	96.0	45.1	Kim-Phat et.al. (2000)

Remarks: 0.47 was used for Carbon fraction. The names of forest types follow those shown in each literature.

On the other hand, FAO calculated and analyzed forest biomass density using inventory data of Cambodia offered by FA and others including NGOs.

After those two types of work by JICA TA Team and FAO, JICA TA Team examined the values of biomass density for each forest class, and tentatively selected a value which was thought to be the most suitable for each class. Then, the Team discussed these tentatively selected values were presented to MRV/REL Technical Team also in a workshop held by UN-REDD (September 2015) to reach a consensus on the values. The result was compiled as Working Paper No.14 (November 2015, “Identification of Appropriate Unit Above Ground Biomass for Emission Factors in Cambodia REDD+ Program”). AGB for each forest type were selected as shown in Table 20.

Table 20 Values of forest biomass density

Land use/cover			Recommended AGB (t/ha)	Data source
Category		Sub-category		
Forest land	Natural forest	Evergreen	163	Country specific
		Semi-evergreen	243	Country specific
		Deciduous	85	Country specific
		Pine forest	100	IPCC Default
		Bamboo	0	-
		Mangrove	150	Regional
		Rear mangrove	165	Regional
		Flooded forest	70	IPCC Default
		Forest regrowth	75	Country specific
	Planted Forest	Pine plantation	100	IPCC Default
		Tree plantation	100	IPCC Default
Cropland		Rubber plantation	43	Country specific
		Oil palm plantation	42	Regional

UN-REDD and USAID carried out some works for developing allometric equations adaptable for flooded forest and mangrove forest. The result has not yet been published.

While the method for GHG inventory for next NC has not yet been determined, the scope of Cambodia GHG inventory is considered to be not much different from what is shown in a box below.

Outline of next GHG Inventory

- Target activities: “Deforestation” including “conservation”, “sustainable management of forests” and “enhancement of forest carbon stocks”. “Forest degradation” is not included.
- Tier level: Tier 2.
- Target GHG: CO_2 only. (CH_4, CO, N_2O, NOx are not included.)
- Target carbon pools: AGB and BGB.
- AD: Obtained by satellite data analysis (forest: 11 categories, non-forest: 11 categories).
- EF: For AGB, country specific data for each land cover class cited from existing

studies (including some regionally specific data). BGB is converted from AGB by using ratio of below-ground biomass to above-ground biomass.

2.2.10.3 Future Development

Cambodia has not yet officially decided the method of GHG Inventory – Gain Loss method or Stock Difference method. Submission of BUR is one of the conditions to apply for a pilot programme of Green Climate Fund. If Cambodia seeks to get Green Climate Fund, method for GHG inventory needs to be selected first.

And the scope of GHG inventory also needs to be expanded in the future to incorporate all the five carbon pools and Green House Gases other than CO_2.

2.2.11 Capacity Building related to MRV/FRL

2.2.11.1 Activities

Capacity building of FA, MoE and FiA officials in charge of REDD+ or member of MRV/REL Technical Team was carried out throughout Cambodia's REDD+ readiness phase in forms of lecture, training or provision of technical papers. Equipment for MRV/REL work necessary for training was also procured by JICA TA Team. Procurement of equipment is described in 8.12.

REDD+ is a complex and developing mechanism. For this reason, JICA TA team explained concept and mechanism of REDD+ and its components to Cambodian stakeholder in various ways and occasions such as workshops, lectures, technical documents and most importantly through daily communication.

In 2011, 2012 and 2013, capacity building was the major activity of JICA TA Team and UN-REDD. Concept and mechanism of MRV for REDD+ including satellite land monitoring system, NFI and GHG inventory as well as of forest reference emission level were explained. Training on the use of satellite images for forest monitoring and mapping was also conducted for FA and FiA staff.

Concerning forest inventory, JICA TA Team gave lecture on GIS database and training on field

survey in 2012. JICA also sent several people of FA to Japan for training on NFMS.

During 2013 – 2015, lecture and technical discussion at MRV/REL Technical Team meetings was the major method of capacity building. Also, On-the-Job training was conducted for land use/cover mapping.

Between 2015 and 2017, two remote sensing and GIS training sessions were held for MoE staff, the first session from July 27 until July 31 and the second session from August 31 until September 4. In the training, use of satellite image and GIS for zoning of protected area was also explained. On the job training for land use/cover mapping was also conducted.

In addition to working papers, JICA TA Team also made documents for training and lecture as listed below.

Table 21 JICA TA Team documents for training and lecture

Document Title	Month/year	Remarks
Toward forest cover data preparation for establishment of historical REL (Sharing information and Experience)	November 2012	English
Understanding IPCC Guidelines 2006 for forest inventory for REDD+ Ver.1.0	March 2013	English and Khmer
Forest Inventory Training Material focusing on REDD Plus for the Kingdom of Cambodia	March, 2013	English and Khmer
Basics of GPS, Satellite Remote Sensing and GIS Technology for Forest Resource Survey Ver.1.0	March 2013	English and Khmer
Technical report on the use of eCognition for forest cover mapping	September, 2013	English
Second revised provisional NFI design for carbon estimation in Cambodia	December 2013	English
Comments on the draft of "Manual of NFI in Cambodia"	February 2014	English
Practical use of eCognition for forest cover mapping	February, 2014	English and Khmer
Essence of the procedure for carbon stock estimation by IPCC guideline 2006 and trail calculation of carbon stock change	August 2014	English. Slide presentation material
Concept Paper for Mapping for Initial REL/RL	August 2014	English

Establishment for Cambodian REDD+		
Trial calculations of Carbon stock change by gain-loss method and lessons learned from the experience	September 2014	English. Slide presentation material
Methodology for Compilation of Forest Cover Map of 2010	October 2014	English
Comments on NFI design proposal of FAO	December 2014	English
Forest inventory training material for REDD-Plus and Sustainable Forest Management	January 2015	English and Khmer
Selection of Emission Factor for Cambodia	February 2015	English
GHG Inventory Method for Cambodia	February 2015	English
Forest inventory survey methods for Cambodia	February 2015	English
Understanding IPCC guidelines 2006 for forest inventory for REDD+ Ver.2.0	February 2015	English and Khmer
Basics of GPS, Satellite Remote Sensing and GIS Technology for Forest Resource Survey Ver.2.0	February 2015	English and Khmer
Calculation of Initial Reference Emission Level for Cambodia	March 2015	English
Land Use and Land Use Change Assessment Method for Cambodia	March 2015	English

JICA TA Team also held three workshops on NFMS in collaboration with UN-REDD to enhance understanding of Cambodian officials on NFMS and related subjects and to present items to be determined or selected by Cambodian government. (Table 22)

Table 22 List of workshops and a seminar held by JICA TA Team

Date	Title
2014/12/12	1st Workshop on NFMS
2015/10/9	2nd Workshop on NFMS
2015/11/16-17	3rd Workshop on NFMS

And on October 17, 2017, JICA held a final seminar to summarize Cambodia's REDD+ readiness activities, role of JICA TA Team and clarify things that Cambodia needs to do to move from REDD+ Phase I to Phase II. A brochure distributed in the seminar is attached as Appendix 5.

2.2.11.2 Future Capacity Building

Cambodian officials in charge of MRV/REL part of REDD+ have acquired nearly all the necessary skills and knowledge to monitor forest area and conditions, make land use/cover maps, calculate FRL, make GHG inventory, and carry out forest inventory surveys.

However, staff of GDANCP of MoE who are in charge of land use/cover mapping and change assessment need more knowledge and skill of advanced remote sensing to fully use the information contained in satellite images. Further, young generation staff needs more experience in land use/cover mapping work.

2.3 Procurement of Equipment

Japan Grant Aid program procured a large number of hardware and software for FA. However, some of the hardware and software for GIS/Remote Sensing work and forest inventory surveys needed to be procured by JICA TA team earlier than Japan Aid Program in order to start training. Table 23 shows the outline of procured hardware and software

Table 23 Hardware and software procured by JICA TA Team

Period	User	Outline
Period 1 (Nov 2001 – Mar 2013)	FA	● PCs and peripherals ● GIS and remote sensing software ● GPS ● Forest inventory survey equipment
	FiA	● PCs and peripherals ● GIS software ● GPS
Period 2 (May 2013 – Mar 2015)	MoE	● PCs ● GIS software ● GPS ● Forest inventory survey equipment
Period 3 (Jun 2015 – Oct 2017)	MoE	● PC and peripherals ● GIS software
	FA	● PC

Detailed list of procured hardware and software is attached as Appendix 6.

In 2016, JICA procured total 44 files of Rapid Eye satellite data covering total 66,705 km^2 for

the purpose of supporting accuracy assessment of the 2016 land use/cover map produced by FA and MoE.

3 Assessment of Technical Capacity for MRV/REL for REDD+

3.1 Situation as of November 2011

Overall Situation

In November 2011, when JICA TA Team and UN-REDD started its work in Cambodia, only a limited number of officials of FA, FiA and MoE had knowledge on REDD+. Even though Cambodia made and submitted its first NC to UNFCCC in 2002, most of knowhow of NC preparation was lost.

As far as NFMS is concerned, FA had experience on the production of forest maps for general forest management purpose but definition of forest was not directly applicable to REDD+ purpose. GIS had been widely used in various government offices but at very limited level. Remote sensing technique was only partially used by FA to make color composite satellite image for mapping.

FA

- As the key government agency responsible for the management of forests, FA had been conducting forest assessment since long time including the preparation of forest map using satellite images.
- FA also carried out forest inventory surveys in order to estimate timber volume for sustainable forest management.
- This means FA already had fundamental knowledge and skill on field forest surveys and land use/cover mapping – key components of a NFMS.

FiA

- FiA had limited experience in using GIS software and almost no experience in satellite remote sensing.

MoE

- As a key agency supporting NCCC, MoE had fundamental knowledge on climate change and REDD+. But number of officials who had solid understanding on REDD+ was limited.
- A few members who belonged to Department of Natural Resources Assessment and Environmental Data Management had some experience in using GIS for the production of maps such as zoning map of protected areas. Except two persons, no experience in satellite image interpretation or analysis.

- Department of National Park (former GDANCP) at that time did not have capacity in GIS and land use mapping.

3.2 Situation as of October 2017

Overall Situation

- Core members of MRV/REL Technical Team, who regularly attended MRV/REL Technical Team meetings and various training, seminar and workshops, have gained comprehensive knowledge on REDD+ mechanism and components of REDD+ such as NFMS, FRL and GHG inventory.
- Understanding on REDD+ of Cambodian officials was deepened by making a national REDD+ strategy and NFMS design and more importantly by actually submitting FRL to UNFCCC and receiving technical assessment by UNFCCC.
- Satellite land monitoring technique was improved by experiencing the production of 2014 and 2016 maps and upgrading of 2006 and 2010 maps.
- Based on the 2014 map, Cambodian government technical officers are now able to produce 2016 and future maps.
- Now, all members of MRV/REL technical team are eligible to use all the equipment procured and provided by JICA and Japan Grant Aid program.

FA

- Core members of FA who experienced 2006 and 2010 map upgrading and the production of new 2014 and 2016 maps moved to GDANCP of MoE.
- Two senior officials who have good experience and capacity in satellite image interpretation remained in FA. These senior officials are still indispensable persons for land use/cover mapping which is now implemented mainly by officials who moved to MoE from FA.
- Members of FA who participated in the preparation of a national REDD+ strategy also had much better understanding on overall picture of REDD+.

FiA

- FiA manages Flooded Forest and Mangrove area outside protected areas and they are mapped by FiA. Remote sensing techniques are not much used compared to GDANCP and FA. FiA staff participated in training of inventory survey of flooded forest and mangrove area under the support of UN-REDD and other research activities.

MoE

- Staff of the Department of Inspectorate and Law Enforcement of GDANCP, who moved from FA to MoE, now have enough technical capacity to produce land use/cover maps. They also have better knowledge and skill in satellite land monitoring. However, more training and experience are required for some specific technique of digital image processing.
- The same staff was also core members of making FRL and NFMS documents. Through this work, they could have much better understanding on REDD+.
- Training for fundamental skill of remote sensing and GIS for land use cover mapping is still needed for junior officials.
- Some staff of Department of Geographic Information Services, General Directorate of Environment Knowledge and Information, has capacity for land use planning and zoning – essential skill required in the management of protected areas.

4 Next Step of Cambodia's REDD+

4.1 Next Step and the NRS

Cambodia is in a transition stage from REDD+ Phase I (Readiness stage) to REDD+ Phase II (Demonstration/Implementation Stage). And some parts of Phase II activities, such as land use/cover assessment and FRL calculation, have already been implemented.

Cambodia will follow the NRS in moving into the Phase II. As explained in Paragraph 8.2 of this report, the NRS states actions to be taken in a 10 year period between 2017 and 2026 which is divided in two phases.

In the following paragraphs, points to be considered in implementing important actions listed in the NRS are discussed. Margin or need for improvement or development of each element of NRS, NFMS, MRV and FRL has already been identified in Future Development sections of Chapter 8 of this final report. Their contents are also taken into account in the following discussion.

4.2 Points to be considered

4.2.1 Development of action plan

- Scale of Cambodia's REDD+ is national. However, due to the limit of budget and human

resources, it is unrealistic to implement actions to address drivers at every corner of the country at the same time. For this reason, in making REDD+ action plan target areas need to be selected first.

- Criteria for the selection of the target areas will be:
    - Historically high emission
    - Historically not high emission but risk of deforestation and degradation is high
    - Driver of deforestation and forest degradation can be addressed
    - Local government understands the value of sustainable natural resource management

- Selection of target area includes the determination of the boundary of target area – whether it should be jurisdictional or landscape? If forest extends beyond a jurisdictional boundary, landscape boundary is better. However, if more than one local government needs to be involved in REDD+ activities, transaction cost for the coordination of local governments is assumed to be high. One solution will be starting REDD+ activities in one local government and expansion to neighboring areas will be tested along with the progress of the activities.

- Drivers could be criteria for the selection of target area. And after the target area is determined, more detailed driver analysis will become necessary to make realistic action plan.

- One more important thing for the selection of sub-national area for REDD+ implementation is the consultation with the Ministry of Interior and the Ministry of Land Management, Urban Planning and Construction. Often review or change in land use plan or policy becomes necessary to solve the deforestation and forest degradation problem. Ministry of Land Management, Urban Planning and Construction is responsible for governing land use, urban planning and construction projects. According to "Law on Land Use Planning, Urbanization and Construction_940524", land use master plan shall be established for each province. Provincial master plan needs to be approved by the National Committee for Country Planning, Urbanization and Construction.

- Ministry of Interior is responsible for guiding and controlling local governments of all levels and if strengthening of law enforcement is considered as the important measure, the ministry's role is big. The two ministries are members of REDD+ taskforce. But from now

on, closer communication with them is required than ever.

4.2.2 Finalization of institutional arrangements for the implementation of the NRS

- When the NRS was being drafted, administration system of Cambodia's forest went through a drastic reform. This is one of the reasons that the role of each stakeholder is not described in details in the NRS and NFMS design.

- In order to make action plan for REDD+ it is imperative that role of stakeholders is clearly defined. It is about time to design institutional arrangement together with the preparation of action plan for REDD+ implementation.

4.2.3 Implement policies and measure to address drivers

- NRS states that drivers of deforestation and forest degradation should be addressed through improved implementation of existing forest management frameworks such as the NFP, NPASMP, SPFF and sub-decrees on ELCS and SLCs. NRS further states that these frameworks include policies and measures related to strengthening forest law enforcement, providing tenure security and implementing community based nature resource management.

- This statement indicates that Cambodia already has tools to address the drivers and if fully implemented those tools will be able to control the drivers.

4.2.4 Prioritize mobilization of upfront non-results based finance

Mobilizing upfront non-results based finance means support from development partners. But, in principle, development partners have provided financial support for REDD+ readiness activities. So, it is not sure if non-results based finance is possible in the Phase II stage of REDD+ of Cambodia. It is necessary to keep watching the decisions to be made for GCF and JCM.

4.2.5 Improvement of existing versions of the FRL and the NFMS

- Current version of FRL and NFMS of Cambodia is not perfect and can be improved in a phased approach as mentioned in the Future Development part of this report. The NRS states that the improvement is necessary and FCPF Phase II also includes activities contributing to the improvement of FRL and NFMS.

- Improvement of FRL and NFMS has two purposes. One is to obtain reliable information to select effective measures to address the drivers. The other is to get as much results-based

payment as possible by submitting reliable GHG inventory and emission reduction calculation.

- However, improvement means more budget and human resources. If too much resource are used in the improvement of FRL and NFMS, then, budget for the REDD+ implementation will be suppressed. FRL and NFMS are important tools but not the most important part of REDD+. The most important part is the implementation of actual measures to reduce emissions.

- So, the improvement should be planned carefully to make it well balanced with available financial and human resources. One of the most costly parts of NFMS is accuracy assessment of new land use/cover map. In case of 2016 land use/cover map, mapping team consisting of nearly 10 persons spent about 3 weeks in the field to verify the result of satellite interpretation. And for the assessment points impossible to reach, satellite images whose resolution was higher than LANDAT8 images had to be used as substitutes. To save budget, higher resolution images freely available were used as much as possible. But still, approximately US$100,000 worth of Rapid Eye data had to be procured.

- Year by year, type of satellite images which are made freely available to general public is increasing. So, the cost for the procurement may drop in the future. However, it is difficult to assume that all the higher resolution image necessary for the accuracy assessment become free of charge.

- Two alternatives to save the cost of satellite image are available. One is increasing volume of field work and the other is abandoning the idea of making map updating cycle shorter. Increasing the volume of field work depends upon the time officials in charge of the mapping can spare. Those officials in charge of land use/cover mapping at MoE and FA are also responsible for a large variety of work and mapping is just a part of their task. So, they cannot spend as much time as they wish for field work for the accuracy assessment.

- The other alternative is giving up an idea to map updating cycle shorter. Historically Cambodia used update forest cover maps every four years. And now, Cambodia has capacity to update land use/cover map at much shorter cycle such as two years. It is unquestionable that shorter cycle is better. However, if it is difficult to find budget, keeping the map updating cycle longer and filling the gap by using simpler and less costly method, including the use of 3rd party data, could be worth studying.

4.2.6 Establishment of SIS to complete the requirements of the Warsaw Framework

- Draft design of a safeguard information system has been worked out by the Technical Team for a Safeguard Information System of REDD+ Taskforce. However, type of information to be collected and managed still needs examination.

- MRV/REL Technical Team also examined type of data which could be collected by satellite monitoring and during forest inventory survey in the field and which could be useful to monitor safeguard situation. However, it was realized that not much reliable information on safeguard can be collected during forest inventory survey or satellite monitoring. Most of the information on safeguards is related to socio-economic conditions of local communities or biodiversity. Collection of reliable and meaningful information on them requires professional skill and experience. Therefore, survey for safeguard should be carried out separately from other forest monitoring activities.

4.2.7 Role of government and capacity building

It is a matter of course that government officials have a solid understanding on REDD+ concept and mechanism as well as on elements of REDD+ such as NRS, NFMS, GHG inventory and FRL. However, it will be worth questioning if government officials really should carry out all of the work by themselves.

If government has sufficient number of staff, it is possible to form a special team exclusively in charge of REDD+. This, however, cannot be expected in many countries. So, officials had to increase their capacity while carrying out ordinary administrative tasks. If government officials cannot spend enough time for capacity building, then, outsourcing will be an option worth studying. If outsourcing is selected, preparation of technical specifications and supervision of the contract work are the major skills government officials need to acquire.

Appendix 1

List of Meetings attended by JICA TA team

List of Meetings attended by JICA TA team

(including major MRV/REL Technical Team Meetings)

1st period (Nov 2011 – Mar 2013)

Date	Agenda
2011/11/17	Inception workshop of UN-REDD
2011/11/19	Meeting with FAO to discuss work plan of UN-REDD program
2011/11/29	Skype conference with FAO Rome to exchange information on the method to be employed in MRV/REL of Cambodia
2012/1/30	TV conference with FAO Rome to discuss the implementation of UN-REDD program
2012/2/6	Meeting with FAO to discuss activity plan of UN-REDD
2012/2/8-9	REDD+ Negotiator Dialogue
2012/9/28	Inception workshop of NFI/FAO-TCP
2012/10/25	Cambodian REDD+ Task Force Meeting
2012/10/3	FA's climate change and REDD+ committee (FA-CCC) (2nd JCC)
2012/10/3	UNREDD 2nd program executive board meeting
2012/10/23,25	CI Japan Consultation Meeting for REDD+ Project in Prey Lang Area
2012/11/5-7	GHG Inventory Workshop at Siem Reap
2012/11/22	TWG task group on NFI meeting
2012/12/10	Workshop by FFPRI Japan
2013/1/15	Seminar by FFPRI Japan

2nd period (May 2013 – Mar 2015)

Date	Agenda
2013/5/22	REDD Seminar by UNDP
2013/7/29	APFNET workshop
2013/9/11	FACCC
2013/10/7	International workshop on social and environmental safeguard by FFPRI Japan and Forest Research Institute of FA
2014/1/13	FACCC
2014/2/20	FACCC (Reporting from mid-term evaluation mission of JICA)
2014/6/6	REDD+ Taskforce meeting
2014/7/21	Land Cover Classification System workshop by FAO
2014/8/7	First meeting on REDD+ strategy of Cambodia
2014/12/12	Workshop on NFMS by JICA TA Team

3rd period (May 2015 – Nov 2017)

Date	Agenda
2015/5/4-5	Discussion on forest reference emission level
2015/5/18	The 20th meeting of MRV/REL Technical Team (Main topic: REL and NFMS)
2015/5/20-21	Consultation meeting on National REDD+ Strategy
2015/6/3	Kick off meeting of REL/MRV Technical Team (Establishment of a special working unit to establish REL/RL)
2015/7/2	Meeting on National REDD+ Strategy (Discussion on the contents of the strategy)

2015/6-7	Consultation meeting on National REDD+ Strategy
2015/7/10	Meeting of MRV/REL Technical Team (Discussion on the contents of REL/RL)
2015/7/27	Meeting on National REDD+ Strategy (by core members)
2015/8/4	Meeting on National REDD+ Strategy (by core members)
2015/8/10	Meeting on National REDD+ Strategy (by core members)
2015/9/23	Meeting on REL/RL (Discussion on REL/RL strategy)
2015/10/9	The 2nd Workshop on NFMS
2015/10/30	Meeting on REL/RL (Determination on REL/RL contents)
2015/11/3/-4	The 9 month meeting of FA (presented REL/RL design)
2015/11/16-17	The 3rd Workshop on NFMS (collected comments on NFMS draft from stakeholders)
2015/11/9	Meeting on National REDD+ Strategy and NFMS (Examination of the contents of the drafts
2016/3/2	FACCC meeting
2016/6/29	Workshop on Progress of Technical Development of Cambodia's Forest Reference Level and National Forest Monitoring System
2017/8/24-25	MRV/REL Technical Meeting

Appendix 2

National REDD+ Strategy

(Unauthorized English translation of current version)

The Kingdom of Cambodia

Nation Religion King

Royal Government of Cambodia

National REDD+ Strategy 2017-2026

May 2017

Samdech Akka Moha Sena Padei Techo HUN SEN
Prime Minister of the Kingdom of Cambodia

Message

Cambodia has ratified The Paris Agreement of the United Nations Framework Convention on Climate Change and has joined the international community to address the challenge of global climate change. The national policies of the Royal Government that include the Rectangular Strategy Phase III and the National Strategic Development Plan, prioritize action on climate change.

The Royal Government of Cambodia considers REDD+ an effective global initiative that will contribute to mitigating impacts of climate change in agriculture, forestry and related sectors. Cambodia REDD+ provides an opportunity to support the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Environment, and relevant stakeholders, including local communities and indigenous peoples in their efforts to sustainably manage forest resources in the country.

The vision of Cambodia's National REDD+ Strategy is to contribute to national and global climate change mitigation by improving the management of its natural resources and forest lands.

Therefore, on behalf of the Royal Government of Cambodia, I am pleased to announce the promulgation of the Cambodia National REDD+ Strategy 2017-2026. This strategy is an expression of our continued commitment to sustainable forest resource management in an era of climate change.

Finally, successful implementation of the Strategy will depend on effective collaboration and participation from the Government, private sector, national and international non-governmental organizations, development partners and local communities. I invite all stakeholders to strengthen cooperation with relevant Government agencies, particularly Ministry of Agriculture, Forestry and Fisheries and Ministry of Environment to successfully implement the National REDD+ Strategy in order to contribute to the Royal Government's commitment to move Cambodia's society towards green economy development, low carbon pathway and climate resilient Cambodia.

Phnom Penh, ……. 2017

HUN SEN

Preface

On behalf of the Ministry of Agriculture, Forestry and Fisheries, I would like to express my profound respect and sincere gratitude to **Samdech Akka Moha Sena Padei Techo HUN SEN**, Prime Minister of the Kingdom of Cambodia. My Ministry honours the Prime Minister's support and commitment to addressing climate change issues in Cambodia, and his active engagement with the international community in responding to climate change challenges through reducing deforestation and forest degradation.

The impacts of climate change and the consequences of deforestation and forest degradation pose major challenges to Cambodia's key development sectors, including agriculture, forestry and fisheries, biodiversity and environmental management. Responding to this, the Ministry of Agriculture, Forestry and Fisheries has coordinated the development of the Cambodia National REDD+ Strategy that provides a framework and action plan to reduce deforestation, and forest degradation in Cambodia.

The mission of the REDD+ Strategy is to strengthen the capacity of national and sub national institutions for effective implementation of policies, laws and regulations that will contribute to improved management of natural resources, forest lands, and biodiversity conservation. The goal of the strategy is to reduce deforestation and forest degradation, promote sustainable management and conservation, and contribute to poverty alleviation of local communities. The National REDD+ Strategy also provides guidance for implementation of actions that will enhance forest productivity, increase supply of forest and non-forest products, and contribute to conservation and protection of forest ecological systems.

This Strategy has been developed with the collaboration, commitment and effort of key stakeholders, including local communities, indigenous peoples, national and sub-national government institutions, and with support from national and international non-governmental organizations and development partners.

On behalf of the Ministry of Agriculture, Forestry and Fisheries, I would like to acknowledge the contribution of all stakeholders, for their support in developing this Strategy in an effective and timely manner, and look forward to continued cooperation in its implementation.

Phnom Penh,……..2017
Minister
Ministry of Agriculture, Forestry and Fisheries

Veng Sakhon

Preface

On behalf of the Ministry of Environment, I would like to express my profound respect and sincere gratitude to **Samdech Akka Moha Sena Padei Techo HUN SEN**, Prime Minister of the Kingdom of Cambodia. My Ministry honours the Prime Minister's support and commitment to addressing climate change issues in Cambodia, and his active engagement with the international community in responding to climate change challenges through reducing deforestation and forest degradation.

The Royal Government of Cambodia has taken significant policy measures that aim to address deforestation and forest degradation. These include the consolidation of Cambodia's protected areas under the Ministry of Environment and the establishment of biodiversity conservation corridors. The Ministry has also drafted an Environment and Natural Resources Code that aims to establish principles for the sustainable and equitable management of Cambodia's rich endowment of forest and biodiversity resources.

The protected area system of Cambodia cover about 41 per cent of the country's total area that is one of the highest percentages of national territory within protected areas in the world. In order to improve the management of protected areas the Ministry of Environment has prepared a National Protected Area Strategic Management Plan (NPASMP) that will complement the promulgation of the National REDD+ Strategy. Effective implementation of the NPASMP and the NRS will together contribute to reducing deforestation and forest degradation in Cambodia.

The mission of the REDD+ Strategy is to strengthen the capacity of national and sub national institutions for effective implementation of policies, laws and regulations that will contribute to improved management of natural resources, forest lands, and biodiversity conservation. This Strategy has been developed with the collaboration, commitment and effort of key stakeholders, including local communities, indigenous peoples, national and sub-national government institutions, and with support from national and international non-governmental organizations and development partners.

On behalf of the Ministry of Environment, I would like to acknowledge the contribution of all stakeholders, for their support in developing the National REDD+ Strategy in an effective and timely manner, and look forward to continued cooperation in its implementation.

Phnom Penh,……...2017
Minister
Ministry of Environment

Say Samal

Acknowledgements

The Royal Government of Cambodia expresses its gratitude to national ministries and agencies, development partners, international and national non-governmental organizations, the private sector, academia and all stakeholders for their contribution to the development of the Cambodia National REDD+ Strategy.

The Strategy was developed under the overall coordination of the Ministry of Agriculture, Forestry and Fisheries with the active participation of the Ministry of Environment. The Cambodia REDD+ Taskforce, technical teams, consultation group and gender group participated actively and provided invaluable guidance to the development of the REDD+ Strategy. Stakeholders at the local, sub-national and national level provided important inputs in developing the Strategy. National and international experts were generous in providing technical support to the document.

The development of the REDD+ Strategy was made possible with financial support from development partners, namely the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD Programme); Food and Agriculture Organization (FAO); Japan International Cooperation Agency (JICA); and the World Bank's Forest Carbon Partnership Facility (FCPF).

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Abbreviations

BUR	Biennial Update Report
COP	Conference of the Parties
ELCs	Economic Land Concessions
ENRC	Environment and Natural Resources Code
FA	Forestry Administration
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FiA	Fisheries Administration
FRL	Forest Reference Level
GDANCP	General Department of Administration for Nature Conservation and Protection
GHG	Greenhouse Gas
GRM	Grievance Redress Mechanism
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEF	Ministry of Economy and Finance
MME	Ministry of Mines and Energy
MoE	Ministry of Environment
MoI	Ministry of Interior
MLMUPC	Ministry of Land Management, Urban Planning and Construction
MOWA	Ministry of Women's Affairs
MRD	Ministry of Rural Development
MRV	Measurement, Reporting and Verification
M&E	Monitoring and Evaluation
NCSD	National Council for Sustainable Development
NFDF	National Forestry Development Fund
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NFP	National Forest Programme
NGO	Non-Governmental Organization
NPASMP	National Protected Areas Strategic Management Plan
NRS	National REDD+ Strategy
NSDP	National Strategic Development Plan
REDD+	Reducing Emissions from Deforestation and forest Degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks
RGC	Royal Government of Cambodia
RTF	REDD+ Taskforce
RTS	REDD+ Taskforce Secretariat
SIS	Safeguards Information System
SLC	Social Land Concession
SLMS	Satellite Land Monitoring System
SPFF	Strategic Planning Framework for Fisheries
LULUCF	Land Use, Land Use Change and Forestry
UNFCCC	United Nations Framework Convention on Climate Change
tCO_2	Tonnes of carbon dioxide

Executive Summary

The Royal Government of Cambodia (RGC) provides strong support to the development and implementation of REDD+ as an option to mitigate impacts of climate change, and reduce greenhouse gas emissions from the forestry sector. The outcomes of effective implementation of REDD+ policies and measures would contribute to socio-economic development and promote the shift towards sustainable development. Cambodia has incorporated REDD+ into several of its key climate change development policies, strategies and programmes.

Cambodia's REDD+ programme is consistent with decisions adopted by the United Nations Framework Convention on Climate Change (UNFCCC) that recommends three phases of readiness, implementation, and results based payments for greenhouse gas (GHG) emission reductions from the forestry and land use sector. Cambodia initiated its REDD+ readiness in 2012 and has made significant progress in meeting UNFCCC requirements related to achievement of key milestones for readiness. The National REDD+ Strategy (NRS) has been developed; a Forest Reference Level (FRL) completed and submitted to the UNFCCC in late 2016; the design of a National Forest Monitoring System (NFMS) has been completed; and significant policy analysis and consultation undertaken to design and establish a Safeguards Information System (SIS).

VISION: The vision of Cambodia's National REDD+ Strategy is to contribute to national and global climate change mitigation through improving the management of its natural resources and forest lands, and biodiversity conservation and sustainable development.

MISSION: The mission of the Strategy is to strengthen the functioning and capacity of national and sub-national institutions for effective implementation of policies, laws and regulations to enhance management of natural resources and forest lands, and biodiversity conservation.

GOAL: The goal is to reduce deforestation and forest degradation while promoting sustainable management, conservation of natural resources and contribute to poverty alleviation.

The scope of Cambodia's REDD+ Strategy will prioritize addressing deforestation, and build capacity alongside to later address forest degradation. Cambodia will implement REDD+ at the national level under the results-based payment mechanism of the UNFCCC. Cambodia will consider implementation of sub- national and voluntary market based REDD+ projects subject to specific criteria.

The three strategic objectives that have been identified to achieve the vision, mission and goal

of the Strategy are to: (1) Improve management and monitoring of forest resources and forest land use; (2) Strengthen implementation of sustainable forest management; and (3) Mainstream approaches to reduce deforestation, build capacity, and engage stakeholders.

The National REDD+ Strategy will be implemented in two phases:

Phase I 2017-2021 An action plan will be developed and institutional arrangements for the implementation of the NRS will be finalized. Drivers will be addressed through improved implementation of existing forest management frameworks such as the NFP, NPASMP, SPFF and sub-decrees on ELCS and SLCs. These frameworks include policies and measures related to strengthening forest law enforcement, providing tenure security and implementing community based nature resource management. Implementation is however hindered by adequate financial and technical resources. The NRS will prioritize mobilisation of upfront non-results based finance that will address these challenges and alongside build capacity for field based implementation and results. Steps will be taken to improve existing versions of the FRL and the NFMS and a SIS will be established to complete the requirements of the Warsaw Framework. A mid-term assessment of the NRS will be undertaken to identify lessons, challenges, and to address these during the next phase.

Phase II 2022-2026 The NRS focus during this phase will be to complete the transition from readiness to implementation and prioritize the achievement of measurable results. The findings of the assessment of Phase I would be reviewed and appropriate steps would be taken. An assessment would also be made of the forest and land cover change results of 2016, 2018, and 2020 that would provide an indication of the effectiveness of the NRS. A key milestone during this phase would be the establishment of a rigorous forest monitoring mechanism that can review policies and measures to address drivers of deforestation and forest degradation for effectiveness and efficiency. In addition the SIS will continue to monitored and strengthened as required to ensure compliance with UNFCCC requirements for safeguards. This phase will also establish a functioning disclosure mechanism of the information, data, and results of FRL, NFMS, studies and analytical work through a web-based platform and other communication media and tools. This phase will also see improved and accurate data and results that will lead to revised versions of the FRL and the NFMS.Cambodia will submit its first report on emission reductions for results-based payments during this phase.

The Cambodia National REDD+ Strategy provides a roadmap for the implementation of policies and measures to address the drivers of deforestation and forest degradation. Successful

implementation of the NRS will depend on the transformative actions related to the management and governance of natural resources and forest lands in Cambodia. This will further depend on the strengthening of institutions, regulations, mechanisms and inter-ministerial coordination.

To achieve these transformative actions adequate and appropriate capacity will need to be created; procedures and regulations would need to become efficient and transparent; and national mechanisms and inter-ministerial coordination would need better integration.

The NRS will create awareness and strengthen engagement of stakeholders and the public to participate actively in effective implementation of policies and regulations that will lead to improved management of natural resources, forest lands, biodiversity conservation, and sustainable development. This will make a significant contribution to Cambodia's shift towards low carbon pathways and a green economy, and contribute to national and global climate mitigation that will help realise the vision of Cambodia's REDD+ Strategy.

1. INTRODUCTION

The Royal Government of Cambodia is committed to reducing greenhouse gas emissions to contribute to global efforts on climate change. Cambodia with its high forest cover in Southeast Asia has long recognized that deforestation and forest degradation are significant sources of emissions. As an active Party to the UNFCCC Cambodia has provided consistent support to decisions and actions related to climate change mitigation, through improving the sustainable management of its natural resources, forest land and biodiversity conservation.

In 2007, at the UNFCCC Conference of the Parties (COP) in Bali, Cambodia provided strong support to the adoption of REDD+, a global policy initiative to reduce emissions from deforestation and forest degradation; and the role of sustainable management of forests, conservation and enhancement of forest carbon stocks in developing countries.

In 2008, two REDD+ pilot projects were established in Cambodia, and in 2010, the national REDD+ roadmap was finalised for implementation. Cambodia's REDD+ Readiness started in 2012 with the establishment of the Cambodia National REDD+ Programme and institutional arrangements that include an inter-ministerial national REDD+ taskforce and a secretariat. Stakeholder engagement, capacity building and awareness raising have remained strong elements of REDD+ in Cambodia.

1.1 REDD+ at the International Level

Since 2005, Parties to the UNFCCC have been actively negotiating a policy initiative for the development and implementation of policies and measures that would contribute to climate change mitigation through REDD+. Under the Cancun Agreement of the UNFCCC, developing countries are encouraged to contribute to climate change mitigation actions in the forestry sector by undertaking REDD+ activities.

The UNFCCC also established the process, rules and modalities for developing countries to access **results based payments** for REDD+ activities. The Warsaw Framework for REDD+ recalls that developing countries are eligible to receive **results-based payments** for actions that are fully measured, reported and verified. The Cancun Agreement and the Warsaw Framework state that before receiving such payments, developing countries are required to establish an institutional framework as presented in Figure 1.

Figure 1: Warsaw Framework for REDD+

The Warsaw Agreement also provides guidance on reporting requirements that have to be met prior to receiving results-based payments. These include submission of a FRL for technical assessment to the UNFCCC and the establishment of a NFMS. These steps are designed to ensure measurement, reporting, and verification of anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest-area changes resulting from the implementation of REDD+ policies and measures. Mitigation results are to be reported through a technical annexure to the Biennial Update Report (BUR) that will be done through submission of the national GHG inventory. In addition, countries are required to submit a summary of information on how REDD+ safeguards have been addressed and respected.

1.2 Cambodia REDD+ Readiness 2008-2016

Cambodia announced at the 2007 UNFCCC COP in Bali, Indonesia that, "*The Royal Government of Cambodia strongly supports the inclusion of GHG emission reduction from forest conservation and avoided deforestation in post-Kyoto regimes*".

Cambodia began to plan its REDD+ readiness process from 2008 onwards. During 2008-2016, the Cambodia REDD+ Programme achieved important milestones and learned important lessons, including the understanding that REDD+ must be mainstreamed within existing and planned national government policies, frameworks and plans related to sustainable

development, resilient agriculture, conservation and low carbon development pathways.

The RGC has taken significant measures to address climate change in the context of sustainable development, and to improve national coordination mechanisms that will have positive impacts on the sustainable management of forest resources. A Climate Change Strategic Plan (2014-2023) has been approved and is mainstreaming climate change into national and sub-national planning processes. The **National Council for Sustainable Development** (NCSD) has been established to promote sustainable development by ensuring a balance between economic, social, environmental, and cultural development in Cambodia. The Government recognizes that the sustainable management of forest resources will make an important contribution to local livelihoods, generate co-benefits and build resilience against extreme climate-change-induced events.

REDD+ has been recognized by the RGC as one of the means for Cambodia to contribute to addressing global climate change, and to fulfil its commitments under the UNFCCC. REDD+ has been acknowledged as one of the mechanisms to generate financial support for Cambodia to develop and strengthen implementation of its policies and measures related to sustainable forest management and poverty alleviation.

1.3 National REDD+ Strategy 2017-2026

The National REDD+ Strategy for the period 2017-2026 takes note of the Cancun Agreement, the Warsaw Framework for REDD+, the Paris Agreement and RGC policies. Cambodia has developed and submitted its FRL to the UNFCCC; developed its national forest monitoring system; and undertaken significant analytical and awareness work on establishing a safeguards information system that will include a grievance mechanism. The institutional framework for REDD+ will enable Cambodia to report its GHG emissions from the land use, land use change, and forestry (LULUCF) sector and provide a technical annex to the BUR to be submitted to the UNFCCC as part of the process to request **results based payments**.

The preparation of the National REDD+ Strategy followed an inclusive consultation process. A consultation roadmap was prepared and multiple national and sub-national consultations were held to ensure all key stakeholders from local communities, women, forest users, civil society organizations, sub-national government administration, and relevant national government ministries were given adequate opportunities to provide comments and contribute inputs to the strategy. The consultation group that represents nine constituencies and is an

intrinsic part of Cambodia's REDD+ institutional framework was actively engaged with the consultation process. In addition a gender group was established to provide comments and inputs to the strategy.

The strategy articulates a vision, mission and goal; identifies deforestation trends and causes; and proposes a set of strategic objectives and actions. With effective inter-ministerial coordination, and adequate technical, human and financial resources Cambodia is well positioned to transition from readiness to implementation of its national REDD+ strategy.

2. STRATEGIC FRAMEWORK

Cambodia's National REDD+ Strategy 2017-2026 strategic framework builds on the strategic analysis and identifies strategies and actions to address drivers of deforestation and forest degradation.

2.1 Vision

The vision of Cambodia's National REDD+ Strategy is to contribute to national and global climate change mitigation through improving the management of its natural resources and forest lands, and biodiversity conservation and sustainable development.

2.2 Mission

The mission of the Strategy is to strengthen the functioning and capacity of national and sub-national institutions for effective implementation of policies, laws and regulations to enhance management of natural resources and forest lands, and biodiversity conservation.

2.3 Goal

The goal is to reduce deforestation and forest degradation while promoting sustainable management, conservation of natural resources and contribute to poverty alleviation.

2.4 Scope and Scale

The scope of the NRS prioritizes deforestation measured through land use change and conversion of forest land, and will build capacity alongside to address degradation. Cambodia will implement REDD+ at the national level under the results-based payments mechanism of the UNFCCC. Cambodia will consider implementation of sub- national and voluntary market based REDD+ projects subject to specific criteria.

2.5 Milestones and Results

The Cambodia REDD+ strategy aims to achieve a key milestone by 2026.The objective is to reduce its annual deforestation by half compared to the rate during the FRL period of 2006-2014. Reduced emissions would be eligible for results based payments.

The target will be achieved by implementing the REDD+ strategy through two phases. The first phase over 2017-2021 will finalize an action plan, consolidate the readiness process,

finalize the institutional framework, and mobilize non-results based investments as upfront finance for implementation. The second phase over 2022-2026 will operationalize a results-based mechanism with a measured, reported and verifiable target of GHG emissions by 2026.

2.6 Guiding Principles

The REDD+ strategy will be guided by the following principles:

- Fulfil Cambodia's contribution to the achievement of the Objectives, as set out in Article 2, and Commitments, as set out in Article 4, Paragraph 3, of the UNFCCC
- Build on the RGC's existing coordination mechanisms and support the implementation of national policies, laws and regulations related to climate change and sustainable development
- Promote cross-sectoral engagement and coordination for the implementation of REDD+ policies and measures
- Ensure full and effective participation of relevant stakeholders, including those most vulnerable, such as local communities, indigenous peoples and women
- Build capacity within government institutions and non-government stakeholders
- Maintain consistency with methodologies and guidance as set out by the Intergovernmental Panel on Climate Change (IPCC).

3. STRATEGIC ANALYSIS

The strategic analysis provides an overview of the national policy framework and the evolving role of forest resources; an overview of forestry sector institutions and challenges; the current status of forest cover change and its causes; and potential carbon credit and benefits of reducing emissions in Cambodia's forests.

3.1 Alignment with National Development Goals and Priorities

The Cambodia REDD+ Readiness Roadmap and achievements from activities conducted during the implementation of the Roadmap were the basis for developing the NRS. The Roadmap was a product of extensive consultations with multiple diverse stakeholders from the local to international level. While contributing to current national forest management strategies and programmes, the NRS is linked to current policies, strategic plans, socio-economic development programmes and the environment.

The NRS supports and complements the implementation of Cambodia's broader development plans in particular, the development of the NRS has taken into account the following national policies, strategies and programmes:

- Rectangular Strategy Phase III 2013-2018
- National Strategic Development Plan 2014-2018
- National Policy on Green Growth and Green Growth Strategic Plan 2013-2030
- Cambodia Climate Change Strategic Plan 2014-2023
- National Protected Areas Strategic Management Plan 2016-2030
- National Biodiversity Strategy and Action Plan 2016-2020
- Strategic Planning Framework for Fisheries 2010-2019
- National Forest Programme 2009-2029
- Gender and Climate Change Action Plan 2014-2018
- Cambodia's First 2002, and Second 2015 National Communication to the UNFCCC.

The Royal Government of Cambodia has taken several transformative steps and made the sustainable management of natural resources, including its forest resources, its primary policy priority. The Rectangular Strategy Phase III and the National Strategic Development Plan (NSDP) 2014-2018 reinforce as well as broaden the management of the country's natural resources to achieve an optimal "balance between development and conservation". That

balance is intended to enhance the contributions of natural resources to the Cambodia's development by ensuring the conservation of the country's forests and wildlife, sustaining its fisheries resources, and maintaining the integrity of its forest ecosystems.

At the institutional level the RGC has completed the reorganization of its Ministry of Environment (MoE) and has established the National Council for Sustainable Development chaired by the Prime Minister to coordinate and integrate sustainable development principles. The RGC has also taken a decision to integrate Cambodia's national REDD+ institutional arrangements with the NCSD and the MoE. This will enable mainstreaming of approaches and measures that will strengthen sustainable management of natural resources and forest lands. The MoE is also developing an Environment and Natural Resources Code (ENRC) to review its existing environmental laws with the objective of rationalizing the legal framework. The ENRC will strengthen the policy framework and lead to improved management of social and environmental impact assessment regulations. During 2016 significant policy measures have been finalized. These include the consolidation of conservation areas in the MoE and declaration of additional conservation areas. MoE now manages a protected area network of 49 landscapes and biodiversity conservation corridors that cover an area of approximately 7.5 million hectares that is almost 41 percent of Cambodia's land area. A National Protected Area Strategic Management Plan 2016-2030 has been prepared with implementation to begin in 2017.

3.2 Overview of Forest Land Management in Cambodia

Cambodia's 9 million ha of forests are managed under the jurisdiction of the MoE and the Ministry of Agriculture, Forestry and Fisheries (MAFF). The Forestry Administration (FA) within MAFF is responsible for the management of the permanent forest estate that includes forest reserves, and conversion forests. The Fisheries Administration (FiA) in MAFF is responsible for the management of the country's flooded forests and mangrove areas. The General Department of Administration for Nature Conservation and Protection (GDANCP), MoE is responsible for management of approximately 7.5 million ha protected areas network of Cambodia that includes the core areas of the Tonle Sap Biosphere Reserve and biodiversity conservation corridors.

The forestry sector policy framework is guided by the National Protected Area Strategic Management Plan 2016-2030; the National Forest Programme 2010-2029; and the Strategic Planning Framework for Fisheries 2010-2019.

The NPASMP is designed around four strategic objectives that aim to strengthen conservation, enhance sustainable management, expand community livelihood opportunities, and strengthen infrastructure and institutional capacity. The MoE, that is also the country's focal point for the UNFCCC, is responsible for implementing the Climate Change Strategic Plan 2014-2023, promoting green growth, and low emissions development approaches.

The NFP consists of six programmes that includes forest demarcation, classification and registration; conservation and development of forest resources and biodiversity; forest law enforcement and governance; community forestry; capacity and research development; and sustainable forest financing. Current national policy commitments under the NFP include increasing the country's forest cover to 60 per cent. One of the principal aims of the NFP is to support the establishment of community forests through the allocation of increased forestland to rural communities. Under the Forest Law, rights of local communities and the importance of decentralized management of natural resources are well recognized.

The principal challenges for forestry sector institutions are capacity constraints for management of forest resources, land use planning, forest resource assessment and forest monitoring. In addition law enforcement capacity and implementation requires strengthening. Forestry staff also need new skills and methodologies to apply innovative approaches for land and forest resource management, enhance community based natural resource management, green value chains, and contribute to rural livelihoods. Capacity constraints are especially important at the sub national level to strengthen field operations for forest management and law enforcement. The NFP, NPASMP, and SPFF will provide impetus to address these challenges and will also be able to absorb additional funds to effectively operationalize its programmes and objectives.

3.3 Forest Cover Change

Cambodia's forest cover has undergone significant change first, in earlier years as the result of civil war and social dislocations, and, more recently as a result of the evolving role of forest resources with respect to the country's development priorities, levels of poverty and dependence on forest resources. During the period 1965-2014 Cambodia's forest cover has declined from 73.04 per cent to 49.48 per cent as illustrated by Figure 2.

Forest cover assessment data used for the Cambodia FRL covers the eight year period 2006-2014 and excludes rubber and palm oil plantations. As per the national definition forest cover

in 2006 was 59.09 per cent and in 2010 it was 57.07 per cent, and in 2014 it was 49.48 per cent. In 2006 and 2010 there were no rubber or palm oil plantations and the period 2010-2014 forest cover change to 46.90 per cent has been due to agro-industrial plantations of mainly rubber and palm oil, and grant of social land concessions.

Figure 2: Forest cover change in Cambodia 1965-2014

3.4 Drivers of Deforestation and Forest Degradation in Cambodia

Drivers of deforestation and forest degradation are unique to Cambodia's national circumstances, capacities and capabilities. Deforestation and forest degradation result from a complex set of processes. Historically in Cambodia these include:

- Improvements in accessibility to remote forested areas, commercial logging, and infrastructure projects; and inadequate government capacity to manage forests in these areas
- Uncertain land tenure, land speculation, unauthorised encroachment of forest lands
- Rapid expansion of agriculture into forest lands, grant of large scale agro industrial

economic land concessions, and distribution of land titles under social land concessions between 1996-2006

- Unauthorized logging and unsustainable harvesting of forest and non-timber products
- Weak forest governance, law enforcement, and monitoring of forest and land use sector
- Increasing regional and global demand for raw materials such as rubber and sugar
- Population increase and demand for agricultural land
- Rural poverty and lack of alternative livelihoods.

Other drivers include migration into forest areas, weak implementation of land laws, inadequate implementation of environmental and social impact assessment regulations, and a lack of state land registration and forest estate demarcation.

By 2014, the RGC granted total forest land area of approximately 2.02 million hectares for agribusiness development of which 1.55 million hectares was granted under the jurisdictional management of MAFF and 470,000 hectares under the jurisdictional management of MoE. In addition, forest land area was granted in the form of concessions for natural gas and mining exploration. During the period 2009 to 2013, a total forest area of 2.45 million hectares was allocated as social land concessions to poor households, military households and for establishing new villages. In 2014, the government de-gazetted forest land area of 1.2 million hectares to issue land titles to landless communities. Development of infrastructure also contributes to forest cover change.

3.5 Potential for Emissions Reduction and Co-benefits in Cambodia

Assessments in Cambodia indicate that from 2006 to 2010, annual GHG emissions from deforestation account for 34,148,629 tCO_2, while from 2010 to 2014 they account for 151,267,528 tCO_2, a four-fold increase. Cambodia's remaining forested area serves as a carbon sink. Cambodia's forest-removed GHG accounts for an annual average of -6,626,046 tCO_2 from 2006 to 2010 and -20,298,825 tCO_2 from 2010 to 2014. Therefore, the total GHG sources resulting from deforestation and removal by sink is 158,491, 286 tCO_2. This is an annual average of 79,245,643 tCO_2.

Despite its deforestation rate, Cambodia has high potential to reduce emissions from deforestation and forest degradation, and enhance forest carbon stocks. Assessments based on the 2014 forest cover map indicate that a total of 2.41 Gt of carbon dioxide are stored in the country's forests, down from the 2.93 Gt of carbon dioxide in 2006.

Period tCO_2 Per Year	2006-2010	2010-2014
Annual CO_2 Removals	-6,626,046	-20,298,825
Average Annual CO_2 Removals	-13,462,436	
Annual CO_2 Emissions	34,148,629	151,267,528
Average Annual CO_2 Emission	92,708,079	
Net Total Annual CO_2 Emissions and Removals	27,522,583	130,968,703
Average Net Total Annual CO_2 Emissions and Removals	79,245,643	

Table 1: Emissions and removals 2006-2014

The largest areas of very high carbon density are found in the wet evergreen forests of the Cardamom Mountains Rainforest Eco region in the southwest of the country. The highest carbon density class that holds 20 percent of the country's carbon covers 12 percent of the country's land area; approximately 40 percent of Cambodia's carbon stock is held in less than 23 percent of its area.

Deforestation and forest degradation accounts for around 17 percent of global GHG emissions. In Cambodia, however, loss of forest cover and associated land use change are the main factors for the country becoming a net emitter of GHGs. Forests serve as the single most important sink of GHGs in Cambodia. According to the MoE's GHG inventory, while Cambodia emitted a total of 47,000 Gg of GHG for the year 2000, its forest cover helped absorb more than half that amount – 24,500 Gg. Degradation of forest and loss of cover means the potential for absorbing GHGs will also be compromised.

Scientific predictions of climate change for Cambodia suggest that forests will be affected by changes in temperature, precipitation and shifts in seasons. The Second National Communication 2015 to the UNFCCC by MoE indicated that exposing forests to a longer dry period might reduce forest productivity and increase the risk of fire. If forests are being logged, there is a risk that it will take longer for them to regenerate. The impacts of climate change could have multiple consequences. Given the importance of forests to rural livelihoods, any loss of productive forests, as well as of biodiversity, will lead to loss of income or livelihood options for forest-dependent and adjacent communities. Exposing forests to longer dry periods might reduce forest productivity and biodiversity. This could also lead to atypical insect growth cycles that can further affect agriculture and forests. The integrity of forest cover is linked to

maintenance of fresh water supply and soil cover and quality, and this link could be negatively affected. The loss of forests may lead to consequences such as storms, soil erosion and landslides.

Nearly four million people live within five kilometres of a forest, with forest resources accounting for an average of 10 percent to 20 percent of household consumption. The vast majority of rural households – about 84 percent – rely on fuel wood and charcoal. Traditionally, forest resources – in particular, non-timber forest products – have provided important safety nets for rural people in times of crisis.

Much of Cambodia's terrestrial carbon stock occurs in areas that have the potential to generate co-benefits and are also important for biodiversity conservation. Many of these areas also have some form of protection status. Actions to secure more of these areas and their carbon, as well as to improve management, are likely to achieve substantial biodiversity-related co-benefits.

Cambodia is a country with high potential to reduce GHG emissions from deforestation and forest degradation and expand the area that can absorb carbon. Protecting forests, and thereby watersheds and land, can contribute to ecological protection, water resource management, sustainable land use and agriculture, and human health. Conservation of biodiversity and enhancement of other environmental services are additional co-benefits.

The rich forest resources of Cambodia play critical roles in rural livelihoods as well as providing valuable ecological and economic resources for the country's overall development. Managing forests sustainably and equitably will be essential for maintaining ecological integrity, maintaining freshwater supplies and protecting biodiversity. It is through forest management that much of the potential new climate change finance could be realized with significant potential benefits for economic, social, environmental and cultural development in Cambodia.

4. STRATEGIC OBJECTIVES

4.1 Strategic Objective 1: Improve management and monitoring of forest resources and forest land use

Strategies

- Strengthen management of forest conservation areas, such as protected areas and flooded and mangrove conservation areas
- Promote forest land tenure security through forest land classification, zoning, demarcation, and registration
- Strengthen law enforcement activities to address unauthorized logging, and encroachment
- Monitor the status of ELCs and SLCs for compliance with regulations
- Support harmonization of legal frameworks for effective management of forest resources
- Strengthen regulatory framework and capacity for social and environmental impact assessment and compliance
- Strengthen capacity for data management and establish decision support systems for forest and land use sector

4.2 Strategic Objective 2: Strengthen implementation of sustainable forest management

Strategies

- Strengthen and scale up community-based forest management
- Engage and encourage the private sector to implement alternative and sustainable supply chains from agro industrial plantations, and to reduce emissions
- Expand afforestation, reforestation and restoration activities
- Enhance timber supply and wood-based energy sourced from community-based forest management areas and private plantations to reduce pressure on forest areas
- Promote effective, equitable, sustainable management and use of forests, forest lands and non-timber forest products
- Identify and implement alternative and sustainable livelihood development programmes for local communities most dependent on forest resources

4.3 Strategic Objective 3: Mainstream approaches to reduce deforestation, build capacity and engage stakeholders

Strategies

- Support mechanisms to mainstream policies and measures that reduce deforestation in relevant government ministries and agencies
- Strengthen national and sub national capacity for improved coordination mechanisms for national land use policy and planning
- Strengthen capacity, knowledge and awareness of stakeholders to enhance their contribution to reducing deforestation and forest degradation
- Encourage public engagement, participation and consultations in forestry and land use planning, and promote the involvement of multiple stakeholders
- Strengthen capacity of academic and research institutions in training, research and technology development associated with forestry and land use
- Establish partnerships with development partners in building knowledge and human resources related to forestry, land use and climate change.

5. IMPLEMENTATION APPROACH

The NRS provides a strategic framework for the ten year period 2017-2026 during which Cambodia REDD+ will consolidate and complete its readiness, develop the institutional framework, access adequate finance, and implement measures that will reduce emissions and make Cambodia eligible for results-based payments. The implementation approach has been divided into two five-year phases that will ensure planned actions are completed effectively and efficiently.

5.1 Phase I 2017-2021

An action plan will be developed and institutional arrangements for the implementation of the NRS will be finalized. Drivers will be addressed through improved implementation of existing forest management frameworks such as the NFP, NPASMP, SPFF and sub-decrees on ELCS and SLCs. These frameworks include policies and measures related to strengthening forest law enforcement, providing tenure security and implementing community based nature resource management. Implementation is however hindered by adequate financial and technical resources. The NRS will prioritize mobilisation of upfront non-results based finance that will address these challenges and alongside build capacity for field based implementation and results. Steps will be taken to improve existing versions of the FRL and the NFMS and a SIS will be established to complete the requirements of the Warsaw Framework. A mid-term assessment of the NRS will be undertaken to identify lessons, challenges, and to address these during the next phase.

5.2 Phase II 2022-2026

The NRS focus during this phase will be to complete the transition from readiness to implementation and prioritize the achievement of measurable results. The findings of the assessment of Phase I would be reviewed and appropriate steps would be taken. An assessment would also be made of the forest and land cover change results of 2016, 2018, and 2020 that would provide an indication of the effectiveness of the NRS. A key milestone during this phase would be the establishment of a rigorous forest monitoring mechanism that can review policies and measures to address drivers of deforestation and forest degradation for effectiveness and efficiency. In addition the SIS will continue to monitored and strengthened as required to ensure compliance with UNFCCC requirements for safeguards. This phase will also establish a functioning disclosure mechanism of the information, data, and results of FRL, NFMS,

studies and analytical work through a web-based platform and other communication media and tools. This phase will also see improved and accurate data and results that will lead to revised versions of the FRL and the NFMS. Cambodia will submit its first report on emission reductions for results-based payments during this phase.

5.3 Development of Warsaw Framework

To be eligible to request results-based finance for reduced emissions Cambodia is required to develop elements under the Warsaw Framework that include a FRL, NFMS, and SIS. Cambodia REDD+ readiness is in an advanced stage of developing this institutional framework and will continue to further strengthen the framework during the implementation of the NRS.

5.3.1 Forest Reference Level

Cambodia's FRL is a benchmark that will be used to assess the country's performance in implementing REDD+ policies in verifiable results for receiving payments for emission reductions.

Cambodia has finalized and submitted its FRL and a team of the UNFCCC REDD+ technical experts has already completed the technical assessment in 2017. The priority for Phase I is to address the findings of the UNFCCC technical assessment and to revise and improve the FRL. This phase will also see accuracy assessment of forest cover/land use changes that will contribute to improved results for the 2016 and future assessments that will undertake on the basis of a two-year cycle.

The development of Cambodia's FRL is based on guidance from the IPCCC and follows best-practice guidelines of using existing data, and adopting a conservative and incremental approach. Cambodia's FRL has given due consideration to availability and accuracy of data and has been developed with a limited scope of policies and measures, and carbon pools. Improved estimates are planned to be incorporated into future revised versions of FRL as new data and methods become available.

The scale of Cambodia's FRL is national, and its scope covers deforestation and afforestation. UNFCCC guidelines recommend inclusion of five carbon pools that include above ground biomass, below ground biomass, dead wood, litter, and soil organic matter. The inclusion of these pools by a REDD+ country is subject to technical parameters and availability of accurate, and reliable data. Based on Cambodia's context the FRL aims to initially assess GHG emissions

and above and below ground carbon pools. Other carbon pools such as dead wood, litter, and soil organic matter will be added at a later stage. The FRL reference period is 2006-2014 with an eight-year rolling average approach. Activity data is based on spatially explicit observations of land use categories and conversions between the years 2006, 2010 and 2014; and the update cycle is two years to ensure rapid results that can inform policy and measures. Country-specific emission factors for key categories (Tier 2) based on existing forest inventory data, aided by default emission factors for other categories have been used to develop the FRL.

Future plans include periodic review to incorporate emerging data and methods. In addition, subject to technical considerations, future revisions to the FRL could include other carbon pools of dead wood, litter and soil organic matter; and improved emission factors for accuracy. The FRL would be updated once the first National Forest Inventory (NFI) is complete and activity data for the period 2016 onwards is available.

5.3.2 National Forest Monitoring System

Cambodia's NFMS will monitor information relevant to measurement, reporting and verification (MRV) of REDD+ activities, and support broader forest sector policies and programmes, including the NFP, NPASMP and SPFF. The design of Cambodia's NFMS uses a phased approach that incorporates inclusion of improved methods, data, and opportunities from strengthened capacity and evolving technology. This will ensure that the NFMS continues to provide timely, reliable, and accurate information that informs policy and practice to address deforestation and forest degradation drivers in Cambodia.

Cambodia's NFMS has been developed in keeping with its national circumstances, capabilities, and priorities and relies on existing institutional arrangements, with provision for capacity building. The NFMS is also compatible with IPCC guidelines and with relevant UNFCCC COP decisions. Cambodia aims to obtain Tier 2 or higher level standards associated with GHG inventories that includes assessment of five carbon pools.

The conceptual design of Cambodia's NFMS aims to perform two broad functions of MRV and monitoring. The MRV function is divided into the three elements of measurement, reporting and verification. The measurement activity will focus on GHG inventories, the Satellite Land Monitoring System (SLMS), and the NFI. The monitoring function will focus on REDD+ activities, policies and measures and consists of a monitoring component and a data management component.

Cambodia SLMS has been producing national forest cover maps every four years from 2002 onwards. National forest cover maps of 2006 and 2010 have been upgraded to be consistent with the six land use classes defined by the IPCC, and a 2014 map has been produced as per IPCC classes. Further accuracy assessments of 2006 and 2010 maps will be undertaken. The NFMS will focus on forest land cover changes between six land use/cover classes particularly land use/cover change between forest and non-forest areas, and to monitor effectiveness and outcomes of REDD+ policies and measures. To ensure improved monitoring of forest cover change Cambodia has decided to undertake land use assessment every two years and production of the 2016 map has already been started, with plans to produce maps in 2018 and 2020. An assessment of the land use assessment cycle will be undertaken in 2020 and significant capacity building is planned for upgrading skills in satellite image interpretation, and associated technologies.

The NFI will generate accurate data on biomass volumes of forests of different types, age, density, and location that will be used to calculate emissions and removals of forest carbon. Existing data on tree biomass has already been analysed and emissions factors determined for evergreen forest, semi-evergreen forest, deciduous forest, forest regrowth, inundated forest, forest plantation, mangrove, and bamboo. The NFI will target all the five carbon pools in a phased manner with an implementation cycle of four to five years. Development of the NFI has already started with completion of the design, and ongoing capacity building and training. The first cycle of the NFI will be conducted during the period 2018-2021 once assurance of adequate quality control has been achieved. The second cycle of the NFI will be started after 2022 after a detailed review of the design and methodology of the first NFI.

The purpose of the national GHG inventory in the forestry sector is to estimate and report on climate change mitigation impacts from implementation of REDD+ actions. Cambodia prepared and submitted its second national communication to the UNFCCC in 2016. GHG data will be updated for the third national communication and the first BUR. The first BUR is planned to be submitted to the UNFCCC in 2018 along with a technical annexure for results-based payments. The gain-loss method was used in preparing the national communication and due considerations will be given to the stock difference method in order to raise the tier level. A decision on the selection of the method will be made along with the results and progress of NFI cycles.

5.3.3 Safeguards Information System

REDD+ participating countries are required to establish a SIS that provides information on how the UNFCCC Cancun safeguards have been addressed and respected. This requirement is essential for countries who are seeking to become eligible for results-based payments. Cambodia has undertaken significant analytical work for the design of its SIS that includes development of a set of safeguards, principles and criteria, and a gap analysis of policies, laws and regulations. The results of the gap analysis indicate that the RGC has in existence an adequate framework to address social safeguards, but would need to address the environmental risk of reversals and displacement. The process of design of the SIS is embedded in a participatory and consultative process that ensured and provided adequate opportunity for all stakeholders to provide inputs through a series of sub national, and national consultations.

The anticipated ENRC has several elements that will make a direct and positive contribution to several elements of the national policy framework and on Cambodia's REDD+ activities, especially safeguards. This includes a priority to social and environmental safeguards, remedial action through grievance redress mechanisms, and creation of multiple institutional mechanisms to address non-compliance.

The Cambodia SIS will take guidance from the ENRC and build on existing and new institutional mechanisms and arrangements. In addition national standards of social and environmental safeguards will be strengthened and procedural documentation, guidelines and manuals for effective management of safeguards will be produced. A strong impetus will be provided to orientation and capacity building programmes for staff from forestry sector agencies and institutional arrangements for safeguards management will be established. These measures will ensure that Cambodia is well positioned to manage an effectively functioning SIS that provides timely and transparent information on how Cambodia addresses and respects the Cancun safeguards.

6. INSTITUTIONAL ARRANGEMENTS

Implementation of the NRS will be undertaken by forestry sector ministries and agencies as per the forest resources and lands managed by them. Implementation of the NRS will be guided by the principles of good governance; inclusiveness, by ensuring full and effective stakeholder participation; cost efficiency; and accountability.

Existing national mechanisms such as the REDD+ Taskforce (RTF), Technical Teams, Consultation Group and Gender Group will continue to have a role in the Cambodia REDD+ transition from readiness to implementation during the period 2017-2021.

REDD+ Taskforce: The national REDD+ Taskforce is composed of representatives from the NCSD and seven ministries with a mandate to oversee the development of Cambodia REDD+ readiness process. The government agencies represented in the Taskforce are: (1) NCSD (2) MoE, (3) MAFF, (4) Ministry of Economy and Finance (MEF), (5) Ministry of Land Management, Urban Planning and Construction (MLMUPC), (6) Ministry of Interior (MoI), (7) Ministry of Rural Development (MRD), and (8) Ministry of Mines and Energy (MME). The Taskforce will be responsible for the overall management of the REDD+ readiness process and will remain the primary coordination and decision making body within the Government of Cambodia. The RTF will also have responsibility for reviewing key outputs and decisions to ensure they are appropriate to Cambodia's context and will take the lead in the implementation of the national REDD+ strategy and developing the implementation framework.

The RTF will be supported by its Secretariat and report to the RGC through the NCSD. RTF will also update and report on the progress of NRS implementation to their respective ministries. The role and mandate of the RTS will be reviewed as required and its terms of reference revised to ensure it continues to provide effective management and oversight to achieving the goal of the NRS.

REDD+ Technical Teams: Four technical teams on (1) Safeguards, (2) Benefit Sharing, (3) Demonstration, and (4) MRV were established by the RTF. These teams are responsible for developing technical recommendations on their subject matter. Members of these teams include technical staff from different government agencies. Representatives from civil society, indigenous peoples and non-governmental organizations also have representation on these technical teams.

Consultation Group: The consultation group is represented by two elected representatives from

nine constituencies in Cambodia. Those constituencies include representatives from community forests, community protected areas, fisheries conservation areas; indigenous peoples; local NGOs; national NGOs; international NGOs, the private sector, and academic institutions. The consultation group provides a forum to represent the views of local stakeholders, especially civil society and NGOs in Cambodia's REDD+ readiness process, including the preparation of the NRS.

Gender Group: The gender group was established by the RTF to build awareness on gender issues among members of the RTF, consultation group and technical teams and to review and provide gender-specific inputs to the NRS. The four members of the gender group are affiliated with FA and FiA of MAFF, MoE, and the Ministry of Women's Affairs (MoWA).

REDD+ Taskforce Secretariat: The mission of the REDD+ Taskforce Secretariat (RTS) is to support the effective and efficient development of measures for REDD+ in Cambodia through providing support to the REDD+ Taskforce. The RTS is responsible for implementation and execution of the work plan of the RTF. The RTS has to operationalize the vision of the RTF for development of a national REDD+ programme through mobilizing and coordinating technical and financial activities and support from government agencies, development partners, NGOs and other stakeholders. The RTS is the primary contact point and coordination mechanism at operational level for REDD+ in Cambodia.

7. FINANCING APPROACH

During Phase I of NRS implementation 2017-2021, the RGC will prioritize access to upfront non-results-based finance from bilateral and multilateral development partners, and supplement allocations from its national budget. This approach will enable the RGC to consolidate its REDD+ readiness process and to transition to implementation. The RGC will also consider market-based finance opportunities subject to specific criteria. A specific timeline for results-based payments for Phase II will be determined in 2021.

The RGC has already established several national funds and is considering additional funds to establish mechanisms for sustainable financing of its conservation areas, forest and biodiversity resources. These include the National Forestry Development Fund (NFDF) that will be managed by MAFF; and multiple funds being proposed by the MoE in the ENRC that include environmental trust funds, an environment and social fund, and a collaborative management fund.

Environmental trust funds may include conservation trust funds, wildlife trusts, climate and forest funds, rehabilitation and restoration funds, or other forms of delivery of environmental, social and economic benefits. The MoE shall duly establish by legal instrument funding categories, guidelines and priorities for the establishment and operation of environmental trust funds.

The NRS will take due guidance from RGC's existing and evolving finance management mechanisms and support these mechanisms as promising channels for effective management and utilization of REDD+ finance and the implementation of the NRS. Emerging lessons on the implementation of these funds will guide the choice and option of a funds-based approach for REDD+. As and when established, the REDD+ fund would adhere to internationally accepted principles of transparency, accountability, effectiveness, equity and efficiency. In addition modalities and requirements of development partners who provide up front non-results based finance would be negotiated on a case by case basis.

8. MONITORING AND EVALUATION

An Action Plan that will have a results framework, and a monitoring and evaluation (M & E) plan will be developed to fast-track implementation of the NRS. The results framework will be nested within the national climate change M&E framework that includes reporting requirements to the UNFCCC and will be developed by the MoE.

Developing a results framework and M & E plan for the NRS will create an enabling environment of accountability and learning. These instruments will contribute to effective and timely implementation, strengthen accountability and transparency, and promote participatory and open learning. The framework will also have indicators that allow for sustained focus to track delivery of results and benefits to vulnerable communities, indigenous peoples, and women. Collection of gender disaggregated data would be prioritized.

9. CONCLUSION

The Cambodia National REDD+ Strategy provides a roadmap for the implementation of policies and measures to address drivers of deforestation and forest degradation. Successful implementation of the NRS will depend on transformative actions related to the management and governance of natural resources and forest lands in Cambodia. This will further depend on the strengthening of institutions, regulations, mechanisms and inter-ministerial coordination.

To achieve these transformative actions adequate and appropriate capacity will need to be created; procedures and regulations would need to become efficient and transparent; and national mechanisms and inter-ministerial coordination would require better integration.

The NRS will create awareness and strengthen engagement of stakeholders and the public to participate actively in effective implementation of policies and regulations that will lead to improved management of natural resources, forest lands, biodiversity conservation, and sustainable development. This will make a significant contribution to Cambodia's shift towards low carbon pathways, a green economy and contribute to national and global climate mitigation that will help realise the vision of Cambodia's REDD+ strategy.

10. APPENDIX

10.1 Appendix 1: NRS Strategic Framework

Cambodia National REDD+ Strategy

Strategic Framework

VISION

Contribute to national and global climate change mitigation through improving the management of its natural resources and forest lands, and biodiversity conservation and sustainable development.

MISSION

Strengthen the functioning and capacity of national and sub-national institutions for effective implementation of policies, laws and regulations to enhance management of natural resources and forest lands, and biodiversity conservation.

<table>
<tr><th colspan="3">STRATEGIC OBJECTIVES</th></tr>
<tr>
<td>GOAL
Reduce deforestation and forest degradation while promoting sustainable management, conservation of natural resources and contribute to poverty alleviation</td>
<td>Improve management and monitoring of forest resources and forest land use

- Strengthen management of forest conservation areas, such as protected areas and flooded and mangrove conservation areas
- Promote forest land tenure security through forest land classification, zoning, demarcation, and registration
- Strengthen law enforcement activities to address unauthorized logging, and encroachment
- Monitor the status of ELCs and SLCs for compliance with regulations
- Support harmonization of legal frameworks for effective management of forest resources
- Strengthen regulatory framework and capacity for social and environmental impact assessment and compliance
- Strengthen capacity for data management and establish decision support systems for forest and land use sector.</td>
<td>SCOPE
Prioritize deforestation and address degradation later

SCALE
Prioritize national approach under UNFCCC mechanism

POOLS
Prioritize above and below ground biomass; address dead wood, litter and soil carbon later</td>
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	Strengthen implementation of sustainable forest management - Strengthen and scale up community-based forest management - Engage and encourage the private sector to implement alternative and sustainable supply chains from agro industrial plantations, and to reduce emissions - Expand afforestation, reforestation and restoration activities - Enhance timber supply and wood-based energy sourced from community-based forest management areas and private plantations to reduce pressure on forest areas - Promote effective, equitable, sustainable management and use of forests, forest lands and non-timber forest products - Identify and implement alternative and sustainable livelihood development programmes for local communities most dependent on forest resources. **Mainstream approaches to reduce deforestation, build capacity and engage stakeholders** - Support mechanisms to mainstream policies and measures that reduce deforestation in relevant government ministries and agencies - Strengthen national and sub national capacity for improved coordination mechanisms for national land use policy and planning - Strengthen capacity, knowledge and awareness of stakeholders to enhance their contribution to reducing deforestation and forest degradation - Encourage public engagement, participation and consultations in forestry and land use planning, and promote the involvement of multiple stakeholders - Strengthen capacity of academic and research institutions in training, research and technology development associated with forestry and land use - Establish partnerships with development partners in building knowledge and human resources related to forestry, land use and climate change.	
PHASES <u>2017-2021</u> Consolidation; mobilize upfront financial resources; transition to implementation <u>2022-2026</u> Results-based phase operational		**RESULTS** By 2026 reduce annual deforestation by half compared to the rate during FRL period of 2006-2014

10.2 Appendix 2: List of Protected Area in Cambodia

No.	PROTECTED AREA	Area (Ha)
	National Park 12	**1,720,269.35**
1	Preah Soramarith Kosamak "Kirirom"	35,232
2	Preah Munivong "Bokor"	154,458
3	Kep	1,152
4	Pheah Sihanouk "Ream"	15,000
5	Botum Sakor	171,250
6	Preah Cheyvarama "Phnom Kulen"	37,500
7	Virachey	332,500
8	Vensai Siempang	57,469
9	Central Cardamom	401,313
10	O'Yadao	101,348
11	Southern Cardamom	410,392
12	Koh Rong	2,655.35
	Wildlife Sanctuary 18	**3,684,328**
13	Phnom Aural	253,750
14	Peam Krasop	23,750
15	Phnom Somkos	333,750
16	Ronien Daun Sam	178,750
17	Kulen Promtep	402,500
18	Beng Per	242,500
19	Lomphat	250,000
20	Phnom Prich	222,500
21	Phnom NamLyr	47,500
22	Snoul	75,000
23	Prey Lang	431,683
24	Preah Roka	90,361
25	Western Siempang	65,389
26	Chhaeb	190,027
27	Tatai	144,275
28	Koe Seima	292,690
29	Sre Pok	372,971
30	Siem Pang	66,932
	Protected Landscape 8	**149,347.30**
31	Angkor	10,800
32	Banteay Chhmar	81,200

33	Preah Vihear	5,000
34	An Long Pring	217
35	North TonleSap	31,159
36	Boeung Prek Lpov	8,305
37	Ang Trapeng Thmor	12,650
38	Boeng Prektub	16.30
Multiple Use Area 5		**409,669**
39	Dong Peng	27,700
40	Samlaut	60,000
41	Tonle Sap	316,250
	Boeng Chhmar Core Area (Ramsar Site)	(14,560)
	Prek Toal Core Area (Ramsar Site)	(21,342)
	Stung Sen Core Area	(6,355)
42	Punchearkrek	199
43	Kbal Chay	5,520
Ramsar 4		**14,600**
44	Stung Treng	14,600
	Koh Kapi	(1,200)
	Boeng Chhmar	(14,560)
	Prek Toal	(21,342)
	Natural Heritage Park 1	**24,654**
45	Phnom Tberng	24,654
46	**Biodiversity Corridor of Protected Area 3**	**1,427,940**
	North East Corridor	757,661
	North West Corridor	500,810
	Cardamom Corridor	169,469
	Total	**7,430,807.65**

Note:

1. Multiple Use Area of the Tonle Sap Lake Biosphere Reserve divided into three core areas: Boeng Chhmar, Prek Toal and Stung Sen
2. Protected Area Biodiversity Corridor divided into three corridors: Northeast, Northwest and Cardamom
3. Koh Kapi Ramsar site located in Peam Krasop Sanctuary and Botum Sakor National Park.

10.3 Appendix 3: Glossary

Carbon Dioxide – CO_2
A naturally occurring gas, also a by-product of burning fossil fuels from fossil carbon deposits, such as oil, gas and coal, of burning biomass and of land use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance.

Carbon Emission
The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (tCO_2e).

Carbon Removal
Any process, activity or mechanism that results in the net removal of greenhouse gases from the atmosphere.

Displacement
The effort of arresting deforestation and forest degradation in one area may also result in the pressures of deforestation and forest degradation being shifted to other ecosystems of importance for the conservation of biodiversity.

Forest Reference Level – FRL
One of the elements to be developed by developing country Parties implementing REDD+ activities (according to paragraph 71 of decision 1/CP.16) in order to be eligible for results-based finance under the UNFCCC. Reference levels are expressed as tonnes of CO_2 (tCO_2e) equivalent per year for a reference period against which the emissions and removals from a results period will be compared. Thus, reference levels serve as benchmarks for assessing each country's performance in implementing REDD+ activities. Reference levels need to maintain consistency with the country's greenhouse gas inventory estimates.

Greenhouse Gas – GHG
The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Less prevalent - but very powerful - greenhouse gases are hydro fluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

Market Based Mechanism
Carbon market mechanism within the carbon legal framework bound by national, regional or international agreements. This mechanism is driven by the obligation of institutions and individuals.

National Forest Monitoring System – NFMS
This system will allow countries to monitor the performance of REDD+ policies and measures in mitigating climate change, deforestation in protected areas and logging concessions, as well as national policies and measures in the forestry sector. NFMS for REDD+ vary in structure and function from country to country. Most are designed in a way that can also be used for other monitoring purposes in addition to monitoring and reporting for REDD+.

Reducing Emissions from Deforestation and Forest Degradation - REDD+
The five activities listed in the Cancun Agreements that developing countries are encouraged to implement to reduce emissions and enhance removals from the forest sector: (1) reducing emissions from deforestation, (2) reducing emissions from forest degradation, (3) conservation of forest carbon stocks, (4) sustainable management of forests, and (5) enhancement of forest carbon stocks. Developing countries stand to receive results-based finance from the effective implementation of these activities if they lead to measurable mitigation of GHG emissions.

Results Based Payment - RBP
RBP is the payments that a country receives for the successful implementation of actual reductions of forest carbon emissions or enhanced removals of atmospheric carbon by forests that have been verified according to the UNFCCC process against an established FREL, and achieved through the implementation of PAMs in the context of respecting and addressing relevant social and environmental safeguards.

Reversal
Re-emission of carbon stored in terrestrial sinks, such as forests and soils, when disturbed by natural phenomena or human intervention.

Safeguards
Safeguards are procedures and approaches that can help to ensure that REDD+ activities "do no harm" to people or the environment, but rather enhance social and environmental benefits.

Voluntary Carbon Market - VCM
Carbon market mechanism outside the carbon legal framework not bound by any international agreement. This mechanism is driven by voluntary commitments from institutions (i.e. Energy Company, Aviation Company) and individuals.

Appendix 3

National Forest Monitoring System Ver.1

NATIONAL FOREST MONITORING SYSTEM OF CAMBODIA

(Draft)

Ver.1_10

May 2016

Acknowledgements

The Royal Government of Cambodia expresses its sincere gratitude to national ministries and agencies, development partners, non-governmental organizations, academia, the private sector and all stakeholders for their contribution to the development of the draft National Forest Monitoring System (NFMS) of Cambodia.

The draft NFMS was developed under the overall coordination of the Ministry of Agriculture, Forestry and Fisheries (MAFF), including Forestry Administration and Fisheries Administration, with the active participation of the Ministry of Environment (MoE) and invaluable guidance from the Cambodia REDD+ Taskforce, Technical Teams, Consultation Group and Gender Group. Their participation made the NFMS more coherent and aligned to other existing sectoral plans of the line ministries and agencies. The suggestions and comments received from stakeholders a series of consultative meetings offered strategic guidance for development of the NFMS. A wide range of technical support was generously given by several national and international experts for the development of the NFMS.

The development of the NFMS was made possible with the financial and technical support from development partners, namely the United Nations *Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD Programme), the World Bank's Forest Carbon Partnership Facility (FCPF), United Nations Development Programme (UNDP) and Japan International Cooperation Agency (JICA).*

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List of Abbreviations and Acronyms

AD	Activity Data
BUR	Biennial Update Report
CAM-REDD	Cambodian REDD+ program
COP	Conference of the Parties
DFC	Department of Forestry and Community Forest
EF	Emission Factor
FAO	Food and Agriculture Organization of the United Nations
FA	Forestry Administration, MAFF
FiA	Fisheries Administration, MAFF
FREL	Forest Reference Emission Level
GDANCP	General Department of Administration for Nature Conservation and Protection (Cambodia)
GIS	Geographic Information System
GHG	Greenhouse Gas
GSSD	General Secretariat for Sustainable Development
ICA	International Consultation and Analysis
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoE	Ministry of Environment
MRV	Measurement, Reporting and Verification
NC	National Communication
NFI	National Forest Inventory
NFP	National Forest Programme
NFMS	National Forest Monitoring System
NPASMP	National Protected Areas Strategic Management Plan
PAM	Policies and Measures
PFE	Permanent Forest Estate
QA/QC	Quality Assurance/Quality Control
REDD+	Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RGC	The Royal Government of Cambodia
RS	Remote Sensing

RUA	Royal University of Agriculture
RUPP	Royal University of Phnom Penh
SIS	Safeguard Information System
SLMS	Satellite Land Monitoring System
SPFF	Strategic Planning Framework for Fisheries
UNFCCC	United National Framework Convention on Climate Change
UN-REDD	The United Nations Collaborative Programme on REDD
WFA	Watershed Management and Forest Cover Assessment Office of FA

Executive Summary

Effective policies and measure to address deforestation and forest degradation depend on reliable information on forest and socio-economic conditions of the target area. The assessments of the outputs of implemented policies and measures also depend on the tinformation that is collected during and after implementation.

There are three government agencies responsible for the management of forests in Cambodia, including the Forestry Administration (FA), the Fisheries Administration (FiA) in the Ministry of Agriculture, Forestry a/nd Fisheries, and the General Department of Administration of Nature Conservation and Protection (GDANCP) in the Ministry of Environment.

The FA has assessed forest conditions every four years since 2002 by producing national forest cover maps using satellite images. While not covering the entire country in a systematic manner, forest inventory surveys have been implemented in various parts of the country and at various times for a variety of purposes. There are also reporting mechanisms that have been established to transfer information from local offices of the Forestry Administration (FA), Fisheries Administration (FiA) and the Ministry of Environment (MoE) to their respective central offices.

In an effort to implement more efficient policies and measures to address deforestation and forest degradation and to become eligible to receive results-based payments for the implementation of REDD+ activities, the parties are obliged to establish a national forest monitoring system. Cambodia will establish such a system based on prevailing mechanisms and modalities by 2020 in a phased approach. The target of GHG inventories will be to assess five carbon pools to achieve the Tier 2 level.

Chapter 1. Background and Purpose

Monitoring forest condition is the basis of effective forest management and forest assessments in Cambodia have been conducted every four years since 2002. Forest inventory surveys have been implemented in various parts of the country and at various times, as well, although they do not cover the entire country in a systematic manner. There are also reporting mechanisms that are used to transfer information from local offices of the Forestry Administration (FA), Fisheries Administration (FiA) and the Ministry of Environment (MoE) to their respective central offices.

The development of a National Forest Monitoring System (NFMS) was listed under a COP 19 decision as one of four conditions required for parties to become eligible to apply for results-based payments under REDD+. In its effort to ensure compliance with that requirement, Cambodia is in the process of developing a National Forest Monitoring System (NFMS) that will be useful for not only monitoring REDD+ activities, but also for monitoring the performance of other forest management activities, as well.

The effort to establish a National Forest Monitoring System in Cambodia was initiated in 2011 prior to the formal establishment of the REDD+ Taskforce and the MRV/REL Technical Team under the REDD+ Taskforce. Available maps and forest inventory survey data were analyzed at that time and a provisional conceptual framework for developing the NFMS was established. The process to develop the NFMS accelerated with advances made by the MRV/REL Technical Team subsequent to its establishment. Proposals for the design of the interrelated National Forest Inventory (NFI) and the production of the NFI Field Manual were developed in parallel with the review of existing land use/cover classes, as well as with the introduction of new mapping technologies and the construction of a database management system and companion WEB interface site.

This draft document describes the phased approach planned to be used to design the NFMS in Cambodia.

Chapter 2. UNFCCC Requirements

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

The Conference of the Parties requests developing country Parties to develop the following elements:

(c) A robust and transparent national forest monitoring system for the monitoring and reporting of the five activities: (1) Reducing emissions from deforestation, (2) reducing emissions from forest degradation, (3) conservation of forest carbon stocks, (4) sustainable management of forests and (5) enhancement of forest carbon stocks, with the provisions contained in decision 4 of COP15.

Decision 11 of COP 19 in 2013 in Warsaw, Poland

The conference of the Parties decides that national forest monitoring systems should

(a) Build upon existing systems, as appropriate;

(b) Enable the assessment of different types of forest in the country, including;

natural forest, as defined by the Party;

(c) Be flexible and allow for improvement;

(d) Reflect, as appropriate, the phased approach as referred to in Decision 1 of COP 16.

Chapter 3. Current Forest Monitoring in Cambodia

3.1. General situation

The current state and distribution of the four major classifications of forests in Cambodia that include Evergreen, Semi-evergreen, Deciduous and Other forest types have been monitored every four years since 2002 in forest cover assessments conducted by the FA.

The FA and the other two government agencies responsible for forest management in the country, the FiA and the MoE, have similar monthly, quarterly, semi-annual and annual reporting processes that are used to collect and transmit information from local offices. Reports regarding illegal activities are reported to the central offices of each of these organizations to support appropriate government deterrent actions. There is a mechanism to collect information on community forestry practices that is currently under design, as well.

3.2. Institutional structure

There are three government agencies responsible for forest resources management in Cambodia, the FA, FiA and the MoE. The FA is responsible for reporting the assessment of forest cover conditions throughout the country, as well as for producing nationwide wall-to-wall land use/cover maps. Field forest inventory assessments are implemented separately by each of the three agencies, as well.

3.3. General status of forest condition in Cambodia

Cambodia established its National Forest Programme (NFP) in 2010 to support its forest reform program to ensure sustainable forest resources management. The NFP is based on the vision outlined and well-embedded in the Statement of the Royal Government of Cambodia on National Forest Sector Policy. That vision states that"The Royal Government of Cambodia considers the ecologically, socially and economically viable conservation and management of forest resources as a major pillar of public welfare directly contributing to environmental protection, poverty reduction and socio-economic development."

National forest definition for sustainable forest management

Under the NFP, the term 'forest' is defined in the following manner:

> *Forest is the unit of natural ecosystem or plantation in the form of wetland, low land and dry land which covers by natural stands of plantation trees with a height from 5 meters on an area at least 0.5 hectares with a canopy of more than 10 percent The plantations such as rubber, oil palm, teak, acacia and eucalyptus and other kinds of trees which fall under the above criteria will also be classified as forests.*

The FA adheres to this definition in implementing its national sustainable forest management programs. Prior to 1970, forests covered about 73 % of the country's land area. Those forests have since been subjected to an irregular recurring pattern of deforestation and degradation as the result of civil war and social unrest, illegal logging, shifting agriculture, forestland encroachment and the conversion of forestland to other land uses.

The assessment that was conducted in 2002 indicated that forest cover had declined to 61.15%. Forest cover continued to decline, first to 59.09% in 2006 and then to 57.07% in 2010. Figure 1 depict the most recent assessment conducted in 2014, indicates that forest cover declined to 49.48%. Table 1 summarizes these changes in forest cover between 2006 and 2014.

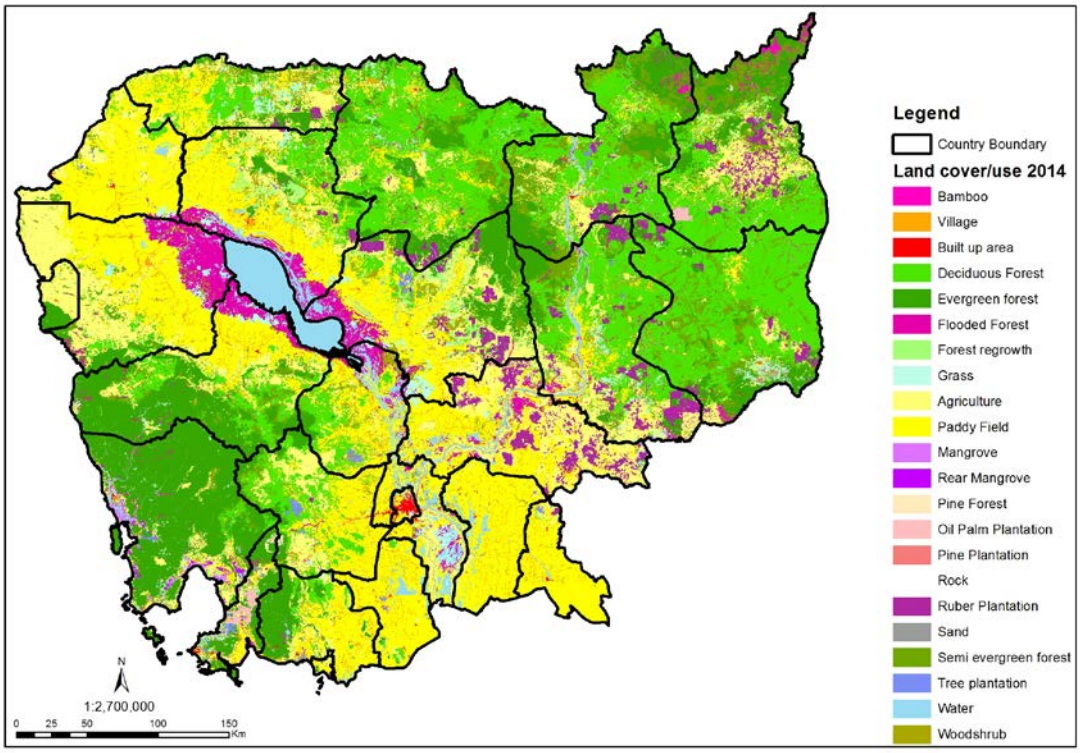

Figure 1. Land use/cover map in Cambodia in 2014.

Forest Type	2006	2010	2014
Evergreen	20.20%	19.27%	16.38%
Semi-evergreen	7.50%	7.02%	6.10%
Deciduous	25.84%	24.68%	19.17%
Other forest	5.55%	6.10%	7.83%
Total forest	59.09%	57.07%	49.48%

Table 1. Forest cover change in Cambodia from 2006-2014.

Forests in Cambodia are under the general jurisdiction of the Ministry of Agriculture, Forestry and Fisheries (MAFF), with the FA charged as the responsible Government Authority (2002 Forestry Law, Article 3), the MoE responsible for the management of Protected Areas, and the FiA responsible for the management of flooded forests and mangrove areas (2006 Fisheries Law, Article 3). Cambodian Law is hierarchical and subsidiary regulations are subject to the differentiation of responsibilities stipulated in the Forestry Law, as well as in other related laws. Since subsidiary regulations cannot amend responsibilities stipulated in a law, management and regulatory jurisdictional authority over forest resources in Cambodia is under the responsibility of several

different government agencies as defined in Cambodian Law (e.g., 2006 Fisheries Law, 2002 Forestry Law, 2001 Land Law, 2008 Protected Areas Law, 1996 Environmental Protection and Natural Resources Management Law, 1993 Royal Decree on Creation and Determination of Nature Reserves, and 2009 Sub-decree # 83 on Registration of Land of Indigenous Communities).

Forest definition for the REDD+ program

In implementing the Cambodia REDD+ program, forests are defined in the following manner:

> *"Forest" under the REDD+ program refers to the unit of the ecosystem in the form of wetland and dry land covered by natural or planted vegetation with area coverage of at least 0.5ha, height more than 5 meters, and canopy crown cover more than 10%.*
>
> *Other areas included in the REDD+ program are forest regrowth and areas under afforestation or reforestation. Rubber, oil palm plantations and perennial crops are excluded from this definition.*

3.4. Land use/cover mapping

Methodology

Since the 2002 Forestry Law, the Forestry Administration has been responsible for assessing forest cover every four years. On-screen digitizing techniques were introduced to produce the 2002 forest map and LANDSAT images were the primary sources of the satellite data that were used in producing the 2002, 2006, and 2010 assessments.

In 2014, image segmentation software was introduced through a series of trainings on the use of those techniques. Image segmentation was subsequently used to stratify Non-Forest and Other Forest areas of the 2006 and 2010 cover maps, as well as to produce the land use/cover map for the 2014 epoch.

Land Cover classifications

Forest cover assessments have been prepared for the 1965, 1992/93, 1996/97, 2002, 2006 and 2010 epochs. Evaluations of the accuracy of those assessments have only been

performed on the 2006 and 2010 forest cover maps, however. As a result, although those two epochs would have been considered to be suitable for calculating FRELs, rubber and oil palm plantations, which are excluded from the definition of forest used for REDD+ activities, were not separated from the classification of forests on the map. Moreover, the non-forest area was also not stratified.

It is for this reason that details of land use/cover classes were reviewed to define a new series of classes suitable for REDD+ that would also be compatible with IPCC's six land use/cover classes. Table 2 compares the relationships between the 'old' classes and the 'new' classes, which are defined in Annex III. The revised set of land use/cover classes was used to upgrade the 2006 and 2010 maps and to produce the 2014 map.

	Old categories		New categories
1	Evergreen forest	1	Evergreen forest
2	Semi-evergreen forest	2	Semi-evergreen forest
3	Deciduous forest	3	Deciduous forest
4	Bamboo	4	Bamboo
5	Wood shrub Dry	5	Wood shrub
6	Wood shrub evergreen		
7	Other forest	6	Mangrove forest
		7	Rear mangrove
		8	Rubber plantation
		9	Flooded forest
		10	Forest regrow
		11	Pine tree
		12	Pine plantation
		13	Oil palm
		14	Tree plantation
8	Non-forest	15	Paddy field
		16	Crop Land
		17	Grassland
		18	Built-up area
		19	Village
		20	Rock
		21	Sand

		22	Water

Table 2. Comparison of 'old' and 'new land use/cover classes¥.

3.5. Forest inventory survey

Current situation

The FA has conducted forest inventory surveys for various purposes, including the collection of timber volume data in forest concessions and for developing assessments of forest resources in Economic Land Concessions (ELCs), community forests, REDD+ project areas, and forest plantations, as well as for project research. Forest inventory data covering the entire country do not exist, however, and are not publicly available. The FA and the MoE have not conducted comprehensive surveys of the country's forest biomass.

Data availability

There are some of the results of the forest inventory surveys that have been undertaken that are available, while some of that data are still in the process of compilation and validation and are not readily accessible. The forest inventory survey results which are available were compiled by FAO (2015 unpublished). Annex II presents a part of the results of that compilation.

3.6. Information collected from local offices and communities

The FA is organized into 4 inspectorates, 21 cantonments, 55 divisions and 170 triages. Information from local offices is transmitted to the central office by means of one of the following three routes.

- Monthly reports from Inspectorates ➔ Department of Administration, Planning, and Finance.
- Monthly reports from Protection Forests ➔ Department of Wildlife and Biodiversity Conservation.
- Reports on illegal activities ➔ Department of Legislation and Law Enforcement.

The comprehensive list of subjects that is reported on in the monthly reports is enumerated in Annex V. The primary subject matter covered in these reports includes:

- Forest demarcation, classification and registration.
- Forest community development.

- Timber and non-timber product management.
- Tree plantation development and silviculture.
- Wildlife and biodiversity conservation.
- Forest industry, commercial development and management.
- Capacity building.
- Forest law enforcement.

The FiA and GDANCP in the MoE have similar reporting mechanisms.

A "Preliminary Investigation Report", the reporting format used for a Case Tracking System in the FA, is presented in Annex IV. That report is designed to collect information on illegal forest activities through the disposition of cases on forest crime that are stored in a national database. While this system is not currently operative, the report format might be used effectively as one of the bases to develop an even more comprehensive reporting format.

3.7. Data management

The FA has a mandate to manage and store the map data in the FA database. There is no office or department that has yet been mandated to manage the forest inventory survey data.

Database system

A database management system was developed to improve data management. Land use/cover maps produced by the FA are now stored in the digital database operated by the REDD+ Taskforce Secretariat. A Windows-based computer server was selected for the management of data collected from REDD+. The system was developed to be compatible with both commercial GIS software such as ArcGIS, which is familiar to most of the MRV team members, and open-source GIS software, especially QGIS, which is increasingly used in Cambodia.

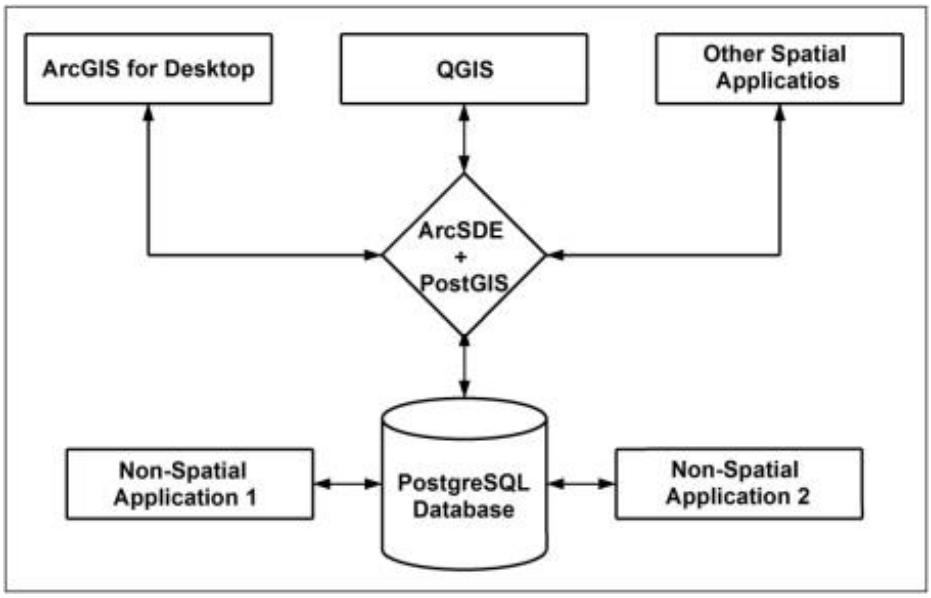

Figure 2. Conceptual design of the NFMS database management system.

The information collected from monitoring illegal forest activities that is incorporated into reports from local offices to the central office and used to initiate appropriate deterrent actions is not yet stored in a systematic manner in the FA, FiA or GDANCP. There are also reporting mechanisms to monitor conditions in community forests that are currently in the process of design.

List of collected data

The MRV team has identified and created a list of potential data to be used for REDD+ and collected some datasets from various government agencies and relevant NGOs.

The design of the WEB platform that will provide information on REDD+ activities that is currently under development is provided in Figure . Initial training on the management of the WEB site and database has been provided to officials of the FA, FiA and GDANCP.

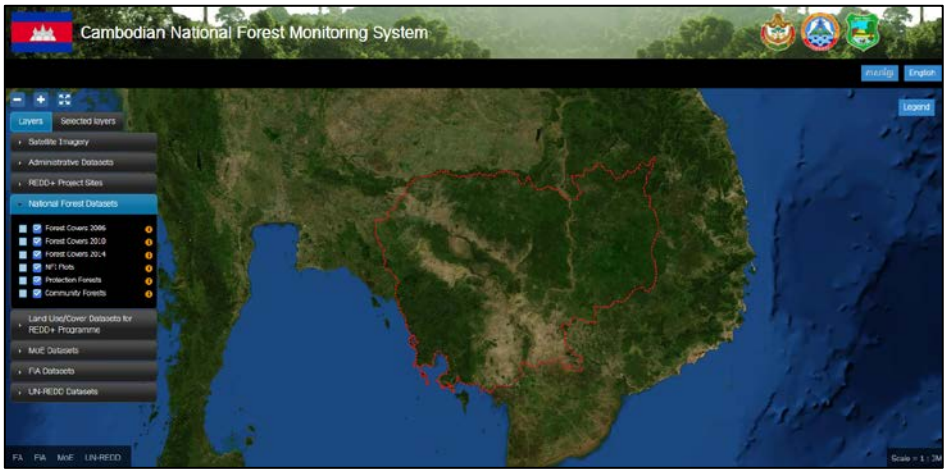

Figure 3. Design of the WEB site of the Cambodia NFMS.

Chapter 4. Principles of NFMS Development in Cambodia

Cambodia has adopted the following set of principles to guide the development of its NFMS.

Multiple benefits:

The NFMS must extend beyond carbon and become a multi-functional instrument used to serve sustainable forest management, as well as programs and activities of the NFP, the National Protected Areas Strategic Management Plan (NPASMP) and the SPFF.

National ownership:

Cambodia must retain control of every NFMS-related process and be solely responsible for the implementation of the NFMS.

International organizations or foreign institutions may support the NFMS program through the strengthening of technical capacity and the development of institutional capacity.

Autonomy:

The NFMS must be developed according to national circumstances, capabilities and priorities. Institutional arrangements must be based, whenever possible, on existing institutions, with the creation of new institutions arising only as the result of necessity.

Operations:

The NFMS should be funded through the state budget and the managers of activities should seek out the most cost-effective solutions at all stages and structural levels.

Centrally coordinated, standardized and scalable top-down system:

Institutions responsible for the implementation of the NFMS should define standardized methodology protocols and agree supply plans with data suppliers.

Compliance with IPCC

The NFMS must be compatible with the most recently adopted or recommended IPCC Guidance and Guidelines, as well as with relevant COP decisions.

Phased approach:

Cambodia intends to obtain the Tier 2 or higher level associated with greenhouse gas (GHG) inventories that includes assessments of 5 carbon pools and to develop its NFMS using a phased approach that will be synchronized with the three phases of the REDD+ program presented in Figure 44.

Chapter 5. Conceptual design of the NFMS in Cambodia

5.1. Composition of the NFMS

Figure 3 depicts the planned composition of the NFMS. It will have two interrelated functions – the MRV Function and the Monitoring Function.

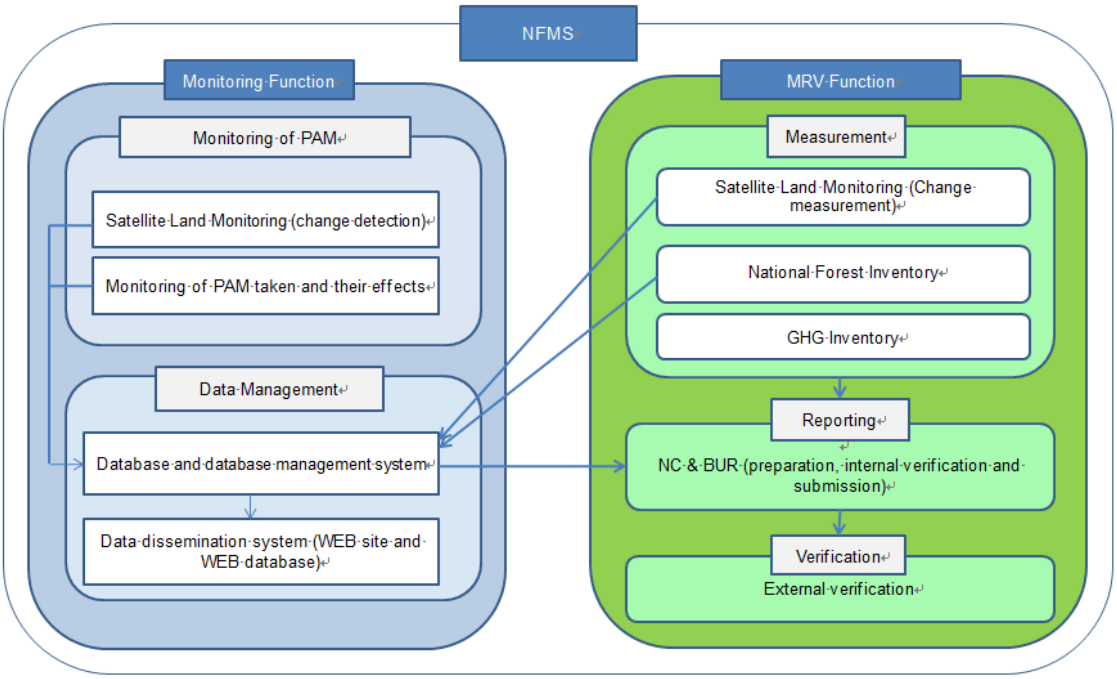

Figure 3. Planned composition of the NFMS in Cambodia.

MRV Function

The MRV Function is divided into three elements, Measurement, Reporting and Verification.

Measurement involves obtaining reliable data from Satellite Monitoring, the NFI and the GHG Inventory. Satellite monitoring will measure land use/cover changes used to obtain Activity Data (AD), while the NFI, which is designed to obtain forest biomass information, will be used to determine the Emission Factor (EF). It is on the basis of the determination of the AD and the EF that the GHG inventory will be conducted.

The data and outputs of the measurements will be used to inform the development of policies and measures (PAMs) to strengthen sustainable forest resources management.

Reporting and Verification provides the means for compiling the results of the measurements to report to the UNFCCC. Verification is comprised of two interconnected steps, internal verification of results by Cambodia followed by international verification of those results by the UNFCCC.

Monitoring Function

The Monitoring Function is concerned with monitoring REDD+ activities and policies and measures to address drivers of deforestation and forest degradation. It consists of a monitoring component and a data management component, the latter of which is further divided into database management and dissemination (publication) parts. Monitoring information will be obtained from external, as well as internal, sources.

5.2. 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 4. 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.

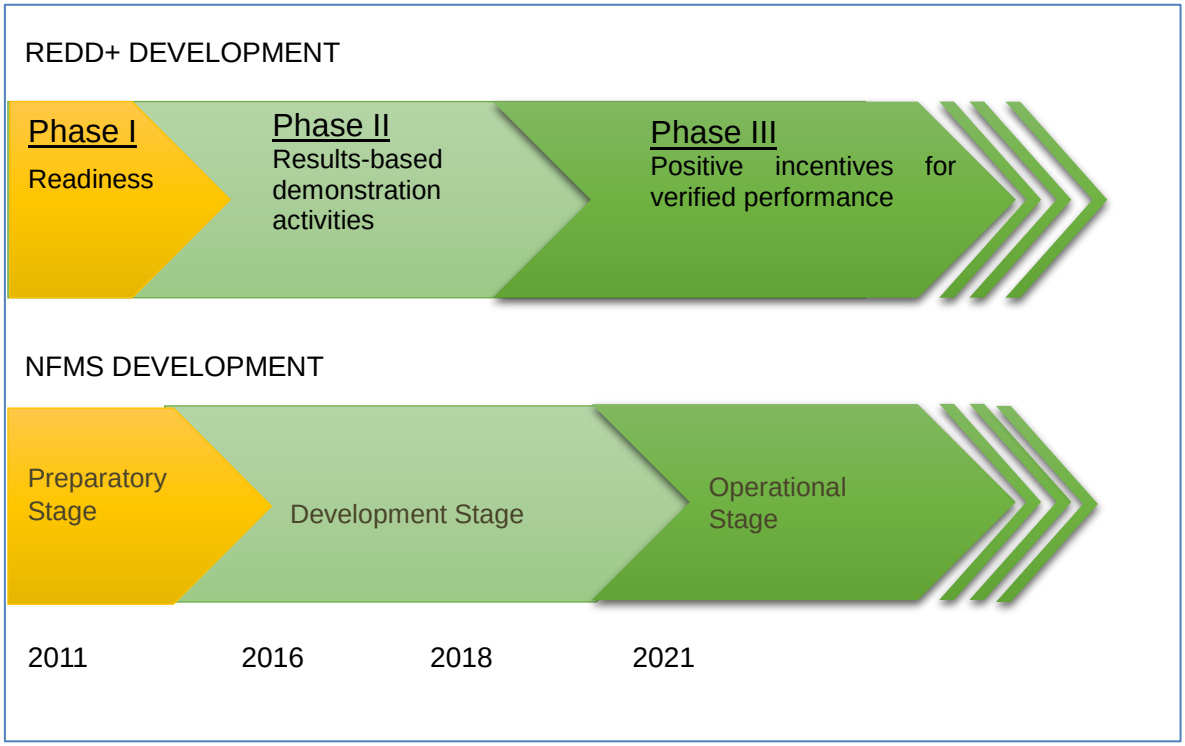

Figure 4. Phased approaches of the development of the Cambodia REDD+ program and the NFMS in Cambodia.

The conceptual basis and primary activities of each of the development phases of the NFMS are presented below. The detailed descriptions of each of those activities are provided in Chapter 6.

Phase I (Preparatory Stage) - (2011-2015)

Cambodia initiated its REDD+ readiness activities in 2011. The primary activities during this phase have been associated with the design of the NFMS and the strengthening of the capacities of government officials.

The primary accomplishments during this phase as of the end of November 2015 include:

- Development of a new satellite monitoring system by introducing an improved methodology for land use/cover mapping to detect land use/cover changes between different land/use cover classes.

- The updating of 2006 and 2010 maps and the production of a new 2014 map by using the developed mapping methodology, which involves the *implementation of the Satellite Land Monitoring System (SLMS)*
- Development of the design of the national forest inventory. (In progress).
- Assessments of GHG inventory methods to guide the selection of either the Gain-Loss or the Stock Difference methods. (*The selection has not yet been made.*)
- Establishment of a database management system and a WEB interface supporting REDD+ in Cambodia. (The construction of the *WEB site is in progress.*)

<u>Phase II Development Stage - (2016-2020)</u>

Phase II will involve further development of the NFMS, including, especially, the design and testing of methodologies and mechanisms of the NFMS established in Phase I. Some components of the NFMS will be implemented during this phase, as well.

(1) 2016-2017

The next cycle of land use/cover mapping using satellite images will begin in 2016. The development of the NFI, starting from the completion of its design and the preparation of a field manual, will continue in 2016 with the preparation of an action plan and the provision of practical training for officials of local offices. In 2017, the implementation of the NFI will be initiated on a relatively small scale and the GHG Inventory for the reporting year of 2014, representing the third National Communication (NC) or the first Biennial Update Report (BUR), will be implemented, using the AD acquired from past satellite monitoring and the EF calculated on the basis of the results of past studies.

There will be an action plan developed for monitoring PAMs, as well, that address drivers of deforestation and forest degradation. Most of the PAMs listed in the National REDD+ Strategy (NRS) of Cambodia will be monitored with reference to documentation that will include relevant laws and decrees, while those PAMs with numerical targets, and the progress of REDD+ activities, will be monitored on the basis of quantitative measures.

In parallel with the identification of monitoring indicators for PAMs, an improved mechanism for collecting monitoring information from local offices and the central office will be evaluated.

Data entry into the database will also be initiated during this phase and the design of the WEB interface will be completed and be made operational.

(2) 2018-2020
During the transition from the second phase to the third phase, activities will be developed in accordance with current conditions and capacities, as well as the state of development and implementation of the NFI.

The succeeding cycle of land use/cover mapping will be conducted while the first cycle of the NFI continues. The GHG Inventory for the fourth NC or the second BUR will be conducted until completion. A revised AD obtained through Satellite Monitoring and a revised EF obtained from the first NFI will be used.

Phase III (Operational Stage) - (2021 -):
In this phase, the data management system will be operational and all of the designed items will be monitored and reported. Information required for the development of the PAMs and the Safeguard Information System (SIS) will be provided, as well, and the PAMs will be monitored.

Satellite Monitoring will be periodically conducted on a two-year cycle. The NFI will enter into its second cycle, reflecting the experience accumulated in the first cycle. The GHG Inventory will utilize the data from the two NFI cycles as EFs to detect forest degradation. The revised AD from Satellite Monitoring will also be available. Monitoring will be conducted with full specification and data management functions.

5.3. Relation with other activities

Although the NFMS of Cambodia will be developed as an independent system, it will be related to other activities, as well, and linked to those activities such as the SIS. The

information that will be required by the SIS and provided through the NFMS – particularly through its Monitoring Function - will be determined in concert with the development of the SIS to avoid duplication in the functions and nature of the information that will be managed.

Chapter 6. Development of NFMS Components

As it was previously explained, Cambodia has monitored the distribution of forest areas using satellite-based forest cover maps. Furthermore, various types of forest inventory surveys have been conducted. The initial National Communication was submitted to the UNFCCC in 2002. Therefore, Cambodia has the foundation for the development of a national forest monitoring system.

The required modifications of the current forest monitoring mechanism in Cambodia include:

- Expanding in a systematic manner the targets of forest inventory surveys to encompass all of the forest types in the country.
- Developing a mechanism to collect information other than that directly related to the measurement of carbon and the area of forests.
- Establishing procedures to improve the management and dissemination of data.

6.1. MRV function

6.1.1. Satellite Land Monitoring System (SLMS)

6.1.1.1. Purpose

The SLMS has two purposes, one of which is to provide Activity Data for the MRV function and the second which is to provide information for land use/cover classes change detection between class categories.

6.1.1.2. Scope

Target activity

In recognition of current technological limitations, the detection of land use change, including deforestation, will be the initial target. The detection of changes occurring in a land use/cover class, or forest degradation, will be subject to continued technological advances.

Measurement cycle

The FA will update land use/cover maps (data) every two years. The upgrading of the map content will also be considered.

Methodology:

The FA has used land use/cover maps in vector format to monitor land use and cover over an extended period of time. Land use/cover maps in vector format were produced because the boundary line of each land use/cover class was required for forest management purposes. In 2014 and 2015, however, segmentation was used to produce the 2014 land use/cover map. Technical details of the mapping process are summarized in Annex IV.

Freely available LANDSAT 8 images will be used to produce land use/cover maps since high resolution satellite images are currently prohibitively expensive. Changes occurring inside forests are difficult to detect on medium resolution images such as LANDSAT 8, however, and, as a result, only land use change, including deforestation, will be the initial target of detection.

6.1.1.3. QA/QC measures

For quality control, QC, manuals providing detailed explanations of the operation of software and procedures have been prepared. For quality assurance, QA, accuracy assessment of a map of one epoch has been established. The methodology to use to assess the accuracy of land use/cover change will be developed.

6.1.1.4. Development Plan of SLMS (2016-2018)

(1) Revision of current mapping techniques.

Preparation for the next cycle of mapping will be initiated, including review of the mapping technique introduced for the 2014 mapping.

(2) Exploration of techniques to detect different carbon stock levels.

The exploration of cost effective methodologies to detect forest degradation other than that caused by land use change will be conducted, as will assessments of the techniques to stratify forests according to different carbon stock levels.

(3) Exploration of techniques to assess the accuracy of land use/cover change.

(4) The further strengthening of the capacities of FA officials in satellite image interpretation and analysis.

6.1.2. National Forest Inventory

6.1.2.1. Purpose

The National Forest Inventory will be implemented to obtain precise information on biomass volumes of forests of different types, ages, densities and locations. The data collected will be used to calculate emissions and removals of forest carbon. Prior to the completion of one cycle of NFI, the EF will be obtained from existing studies.

6.1.2.2. Scope

Target carbon pool:

Each of the 5 carbon pools, including 'above ground biomass' (AGB), 'below ground biomass' (BGB), 'dead wood', 'litter' and 'soil organic matter,' will be targeted.

Implementation Cycle:

The implementation cycle will be four to five years.

Methodology

Permanent Sample Plots (PSPs) will be distributed in forested areas using stratified systematic sampling methods. Different point densities will be applied for upland forest stratum, inundated forest stratum, and mangrove stratum, as presented in .

Stratum	Area (km^2)	Number of sampling plots (clusters) expected in forest or other woodland
Upland	152,751.3	2,751
Wetland	27,742.0	322
Mangrove	1,207.6	97
Total	181,701.0	3,170

Source* FAO (2014).

Table 3. Number of Permanent Sample Plots in each stratum.

Data to be collected

Biomass data, including diameter and height, are principal targets. Conditions of forest in and around the plots will also be described to improve understanding of

ecological and socio-economic conditions.

6.1.2.3. QA/QC measures

A documented field manual was developed for the standardization of survey methods. The manual increases the understanding of survey methods for survey personnel and contributes to the reduction of survey errors. Sampling surveys will be conducted in 5% of the surveyed plots. There will be an independent QA/QC team comprised of specialists, who are responsible for re-measuring the plots to ensure the quality of the measurements of the field team and to provide appropriate feedback to improve data quality.

6.1.2.4. Development plan of NFI

(1) 2016-17

It is expected that detailed design and practical training will be organized in 2016 and that implementation will start in 2017 on a small scale. Reflection on the experience gained and subsequent adjustments will facilitate the full-scale operation of the NFI in succeeding phases.

(2) 2018-21

The first cycle of the NFI will be conducted until it has attained sufficient Quality Control because it will be the first large scale forest inventory survey organized in Cambodia.

(3) 2022 -

The second cycle of the NFI will start after the design and methodology of the initial NFI have been reviewed.

6.1.3. GHG Inventory for Land use and Land Use Change and Forestry Sector

6.1.3.1. Purpose

The purpose of the national GHG inventory is to estimate and report on the climate change mitigation impacts resulting from the implementation of REDD+ activities.

The national GHG inventory will utilize standard international templates and be developed using the Good Practice Guidance of the Intergovernmental Panel on Climate Change (IPCC). It will be reported to the UNFCCC Secretariat on a

regular basis.

The mitigation results reported through the GHG inventory will form the basis for results-based payments for REDD+ once the results have undergone a process of verification through International Consultation and Analysis (ICA).

6.1.3.2. Scope

Target carbon pool:

Of the five carbon pools, AGB and BGB will be targeted because of the state of current data availability of Tier 2 level data. Dead wood, litter and soil organic matter will be included after the initial NFI has been completed.

Target activities:

Deforestation," plus "conservation", "sustainable management of forests" and "enhancement of forest carbon stocks," will be targeted. "Forest degradation" will not be included until the fully-operational phase in which efficient EFs over two periods have been obtained.

Target GHG:

CO_2 will be targeted while CH_4, CO, N_2O, NOx will not be included. "Biomass burning," which is the principal source of non-CO^2 GHG in the LULUCF sector will not be included in the inventory until required data (e.g., area burned, amount burned, etc.) become available. Since organic soil, which is the other sink/source of non-CO2 GHGs, has very limited distribution in Cambodia and is not a significant sink/source, it will not be considered.

Tier level:

The tier level will be Tier 2 with country-specific ADs and EFs.

GHG Inventory Cycle:

GHG inventory will be repeated in the same cycle of the NC and BUR submission.

Methodology:

The Gain-Loss method was used in preparing the first and second National Communications of Cambodia. Since the aim is to raise the tier level from 1 to 2,

however, the continued use of the Gain-Loss method would be constrained because of the difficulties of collecting the number of country- or regional-specific data required to use that method. There is also an important consideration regarding the use of the Stock Difference method because in order to use it, the EF could only be obtained after two cycles of the NFI would have been completed. The selection of the method will be determined in the process of preparing the first BUR, which is planned to be submitted in 2018. Subsequent to completion of two cycles of the NFI, the use of the Stock Difference method may be considered.

6.1.3.3. Development plan of GHG Inventory

(1) Initial Phase: (2016-2017)

The GHG Inventory will be conducted for the third NC or the first BUR which will be submitted in 2018. The reporting year will be 2014. There will be a series of data sets provided through Satellite Monitoring conducted in 2015 that will be used to determine the AD. The EF will be obtained from existing studies on Cambodian forests.

(2) Transition Phase: (2018-2019)

The GHG Inventory will be conducted for the fourth NC or the second BUR which will be submitted in 2020. There will be a revised AD provided as the result of the new mapping. The EF obtained from existing studies may also be replaced as a result of the new EF that was obtained in the first NFI, although that will depend on the progress of the NFI and the schedule of the GHG inventory.

(3) Fully-operational Phase (2020 -)

The GHG Inventory will be conducted on a regular basis. The ADs determined from Satellite Monitoring will also be periodically accumulating. Two sets or more of EFs obtained from the NFI will be available after the completion of the second cycle of the NFI.

6.1.4. Reporting and Verification

Reporting and review requirements for non-Annex I Parties under the UNFCCC include:

Biennial Update Reports (BUR): These reports, which are submitted biennially, contain information on national circumstances, national GHG inventories, mitigation actions and their effects, constraints and gaps, and related financial, technical and capacity requirements. The reports are subject to International Consultations and Analysis.

National Communications (NC) :

These reports contain information on national circumstances, national GHG inventories, mitigation measures, adaptation measures, vulnerability assessments, constraints and gaps, and related financial, technical and capacity requirements. There is no review process

The reporting and review requirements for non-Annex I Parties under the UNFCCC when implementing and seeking results-based payments include:

Forest Reference (Emission) Levels (FREL/FRL):

These are voluntary submissions used as benchmarks for assessing each country's performance in implementing REDD+ activities. These reports contain information on forest definitions, scope (activities, pools, gases), historical data, ADs and EFs, construction approach, scale, etc. The reports are subject to technical assessments.

Technical annex to BUR (REDD+):

Supplemental information: Non-Annex I Parties may supply a technical annex that includes sector-specific information (e.g., information on REDD+) seeking to obtain and receive payments for results-based actions. The reports contain information on assessed forest reference emission levels, results of REDD+ activities, consistency with assessed forest reference emission levels, etc. These reports are subject to International Consultations and Analysis.

The relationships among map/activity data, national forest inventories, forest reference level establishment and NCs and BURs are summarized in Table 4.

Table 4. Provisional schedule of NC and BUR submissions.

Year	Map/Activty Data		National Forest Inventory		Forest Reference Emission Level			National Communications (NC)			Biennal Update Report (BUR)			
	Data	Production	Data collection	Comple-tion	Baseline	Submissio n	Technical assess-ment	Inventory Year	Prepara-tion	Submi-ssion	Inventory Year	Prepara-tion	Submi-ssion	ICA
2014	•				•			•			•			
2015		•				•				•				
2016	•		•				•		•			•		
2017		•	•						•			•		
2018	•		•		•			•	•	•	•	•	•	
2019		•	•			•						•		•
2020	•		•	•			•		•		•	•	•	
2021		•	•						•			•		•
2022	•		•		•			•	•	•	•	•	•	
2023		•	•			•						•		•
2024	•		•	•			•		•		•	•	•	
2025		•	•						•			•		•
2026	•		•					•	•	•	•	•	•	

6.2. Monitoring Function

6.2.1. Purpose

The Monitoring Function of the NFMS focuses on the effects of policies and measures to address drivers of deforestation and forest degradation. The flow of information between the NFMS and PAMs is interactive. The NFMS provides required information for executing the PAMs and subsequent to the implementation of the PAMs, the NFMS monitors their progress and outcomes. The items to be monitored are determined on the basis of necessity and feasibility.

6.2.2. Scope: The primary activities under REDD+ are deforestation and forest degradation, plus the enhancement of carbon stocks.

Methodology and Monitoring Items

PAMs will be monitored by means of:

(1) Assessments of implemented plans.

Documents describing the contents of policies and measures and budget allocations will be used as evidence supporting the implementation of PAMs. Performance will be monitored by other documented reports, including audit reports.

The current government auditing system will be used to monitor planned REDD+ activities, as well as provide comparisons between allocated budgets and actual amounts spent.

(2) Assessments of outcomes.
The assessments of land use/cover changes will also be used to monitor PAMs. This process will entail the use of satellite images, as well as information provided by local governments, local offices of central government, and local communities. Since the purpose of these assessments is not measurement, the satellite image analyses will be implemented in a shorter cycle than that applied for measurement.

1) Satellite monitoring:
Land use/cover maps will be produced every two years. Considering recent changes in land use/cover, however, it will be useful to supplement that coverage by monitoring land use/cover change on a more restricted schedule.

The SLMS will also be used to provide regular updates on land use/cover conditions to support the Monitoring Function. The information provided from local offices and local government will be merged with that derived from satellite images to increase the reliability of monitoring.

2) Monitoring using information collected from local areas:
In principle, details of the targets to be monitored will be determined according to the PAMs that have been selected.

If a PAM is measurable, such as the demarcation of a forest boundary or the establishment of community forestry projects, it will be monitored by measuring the length of demarcated boundary or the number of new community forest projects, respectively, that are recorded on documents or reports.

Information from local areas is a critical consideration with regards to monitoring situations affecting REDD+ activities. The maintenance of open lines of communication between central and provincial governments is essential to ensure the successful outcomes of REDD+ activities and the NFMS. There will be a mechanism established to collect information on forest conditions from provincial

governments in each province. The effectiveness of that process will depend on the central government's commitment to providing provinces with the information required to support improved forest management in the provinces.

There will be regular reporting from local offices of the FA, FiA and MoE. The current procedures of reporting will be revised as might be required and the establishment of an exclusive reporting process for MRV will be under consideration.

The impacts of PAMs on local communities and biodiversity will also be monitored by means of the establishment of a well-coordinated group of government officers, members of academia, and representatives of NGOs and local governments and communities.

Scale of Monitoring

Monitoring will be implemented at two different scales, that of the entire country and that of REDD+ activity areas that require more intensive monitoring.

Monitoring the entire country will require:

- Early detection of nation-wide land use/cover changes.
- The use of low to medium resolution satellite images that may be acquired without cost.
- The use of software to obtain image analyses combined with information collected from local offices to identify significant land use/cover changes.
- The periodic updating of land use/cover maps.

Monitoring of REDD+ activity areas will require:

- Intensive monitoring of the effects of PAMs in specified areas.
- The use of medium to high resolution satellite images depending upon the available budget.
- The use of the results of image analyses combined with information collected from local offices to confirm the findings.

6.2.3. Development Plan

(1) Development phase: (2016 –2020)

While detailed elements of monitoring cannot be determined until the action plan of the NRS has been developed, the following preparatory actions are able to still be implemented:

- The revision of the current procedures for reporting from local offices to the central offices of the FA, FiA and MoE to ensure the full utilization of the information contained in reports.
- The design of an effective system of information transmission between local governments and the central offices of the FA, FiA and MoE related to REDD+ activities.
- The strengthening of the capacities of local offices on the use of satellite images for monitoring and the subsequent initiation of satellite monitoring activities.
- The selection of appropriate indicators for monitoring those PAMs that have been determined and the initiation of the monitoring of those PAMs.

(2) Full implementation phase (2021-)
Full scale monitoring will be initiated in this phase.

6.3. Data Management System

6.3.1. Functions of the data management system

The data management system has two functions, data storage and data dissemination. The data required for monitoring and for conducting GHG inventories and preparing reports will be stored in the database management system. The database management system will be dedicated to the use of government officials responsible for managing NFMS activities.

6.3.2 Dissemination of data

The dissemination of data will ensure that stakeholders have access to relevant data and information associated with REDD+ activities. That will be accomplished by means of a website that has been developed for sharing information and that will include land use/cover changes and accompanying statistics. The specific sorts of data that will be provided through the website are currently under discussion. The FA will be responsible for uploading data into the data management system.

6.3.2. Phased development

By the end of 2015, the database management system will have been designed. It will be populated in its initial stages with the data that is most easily obtainable.

The WEB site for data dissemination is expected to be completed in 2017.

6.4. Institutional arrangements

6.4.1. Institutional arrangements for MRV

The institutional arrangements for the MRV component of the national forest monitoring system are illustrated in Figure 5. The principal institutions that will be involved in the coordination and management of the monitoring system include the FA, FiA and GDANCP.

The FA will lead the effort associated with wall-to-wall map production while the three organizations cooperate in the mapping of the country's mangrove and flooded forest areas.

The NFI, including data processing activities and required laboratory analyses, will be implemented collaboratively by the FA, FiA and MoE for forested areas under their respective jurisdictions. The accumulated biomass data of all of the forest areas of the country will be reviewed by the MRV/REL Technical Team to ensure consistency and revisions will be made by each of the respective organizations.

The involvement of domestic research institutes will be encouraged, depending on the sorts of information to be collected.

The tasks of each party involved in the MRV component of the NFMS, and the procedures for implementing MRV activities, will be formalised through institutional arrangements to ensure the long-term sustainability and accountability of the system.

6.4.2. Institutional arrangements for monitoring

The central government will use the same mechanism presented in Figure 5 for monitoring. Each of the agencies will be responsible for monitoring activities implemented in their respective area of jurisdiction.

There will be amechanism developed to exchange information between the central government, local governments, local offices of relevant government agencies and local communities. The tasks of each party involved in the monitoring component of the NFMS, and the procedures for monitoring, will be formalised through institutional arrangements to ensure the long-term sustainability and accountability of the system.

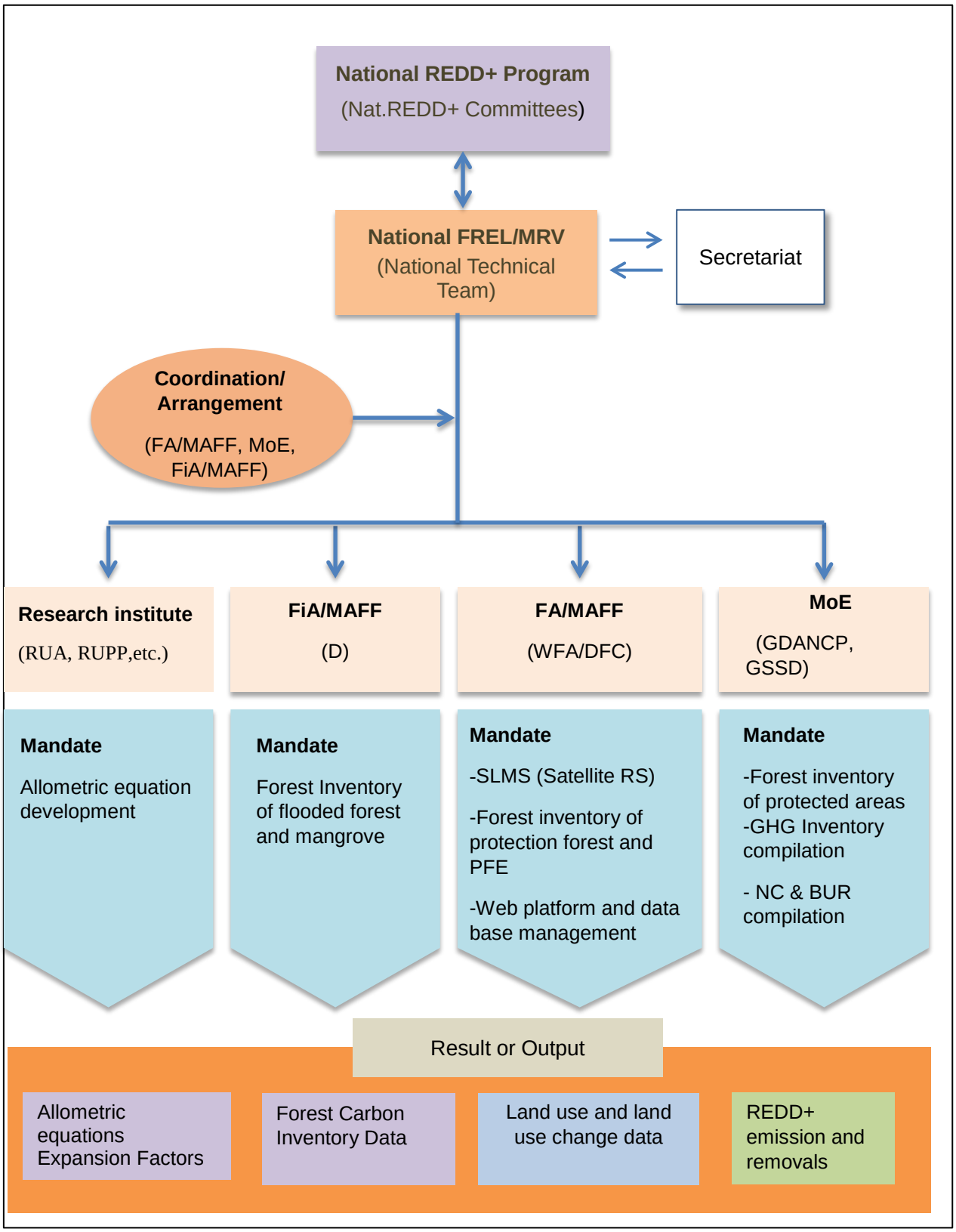

Figure 5. Institutional arrangement for the implementation of MRV.

Chapter 7. Capacity Building

The series of lectures, workshops and on-the-job training programs that have been provided during this initial phase of NFMS development have increased the capacities of officials on forest monitoring to a significant extent. There are still some areas in which further training is required, however. Those areas include:

- Accuracy assessments of land use/cover change.
- Forest inventory surveys.
- Monitoring PAMs.
- Management of the database system and WEB site.
- Overall management of the NFMS.
- GHG Inventories for the LULUCF sector.

It is expected that this additional capacity building will be organized in 2016 and 2017. The capacity building with regard to “accuracy assessments of land use/cover change” and “monitoring PAMs” will be conducted only after the methodologies have been completely developed, with the exception of the detection of land use/cover change using satellite images.

Chapter 8. Cost Considerations

The costs of the major elements associated with developing and implementing the NFMS are estimated in Table.

	Activity and Cost Items	Unit cost	Quantity	Cost
1	Satellite Land use/cover mapping			
1.1	Pre-processing			
1.1.1	Personnel cost			
2	Accuracy verification survey			
2.1	Personnel cost			
2.2	High resolution satellite image			
2.3	Travel cost			
2.3	Field survey cost			
3	National Forest Inventory			
3.1	Field work			
3.1.1	Personnel cost			
3.1.2	Travel cost			
3.1.3	Field survey cost			
3.1.4	Equipment cost			
3.2	Indoor work			
3.2.1	Personnel cost			
3.2.2	Laboratory test – litter			
3.2.3	Laboratory test - soil			

SLMS

Activity	Cost	Remarks
1. Image Interpretation	$350,000-$400,000/each cycle	
2. Accuracy assessment of map and land use/cover change	$250,000/each cycle	
3. Capacity to improve the effective of tasks	$40,000	
4. Workshop and publication	$20,000/each publication	
5. Capacity Building		
5.1 Long term such as studying for master's degree	$65,000/person × 3-4 persons	
5.2 Short course trainings	$60,000/course	
5.3 Training workshop at different levels	30,000/workshop /year × 2 years	

NFI except litter and soil survey

Activity	Cost	Remarks
Field survey (One cycle	US$6,500,000 (4-5 years)	
Field survey (Future)	US$1,000,000/year	

Litter and soil survey and analysis

Activity	Cost	Remarks
1 For Personnel for soil and litter sampling in the field	0	
2 For procuring equipment for soil and litter sampling	US$4,104	
3 For laboratory work for litter analysis	US$2,000	
4 For laboratory work for soil analysis	US$4,718	

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Ministry of Environment, Cambodia (2015) National Protected Areas Strategic Management Plan (Initial Working Draft)

UNFCCC (2009) Decision 4 COP15

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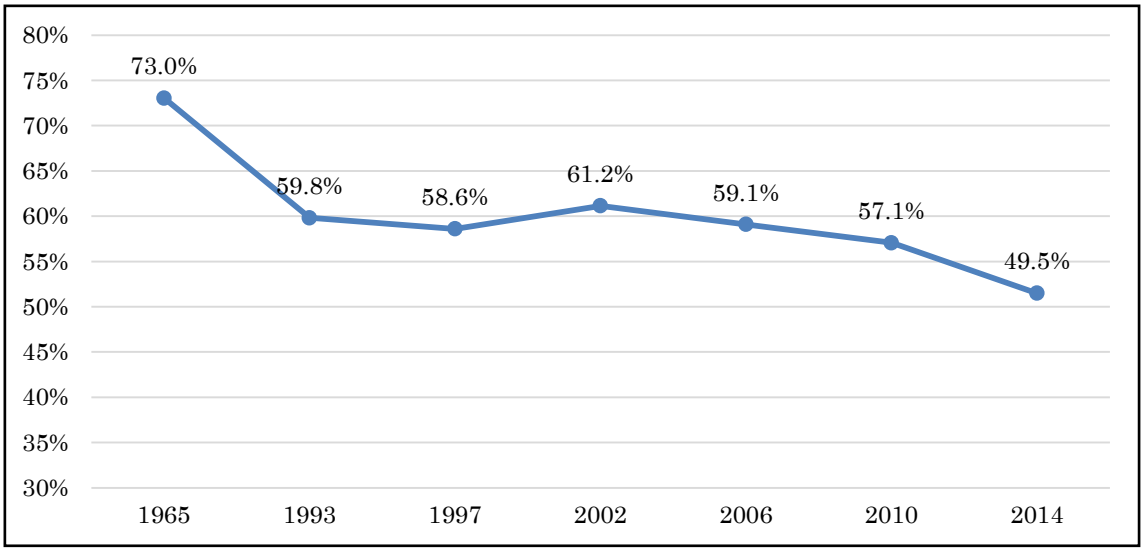
Annex I

Historical change in forest cover of Cambodia.

(1965, 1992/93, 1996.97, 2002, 2006, 2010, and 2014)



Annex II

Plot characteristics of various forest inventories in Cambodia.

Institution	Project	Plot shape	Nested	Level 1 Condition	Level 1 shape	Level 1 area (ha)	Level 2 condition	Level 2 shape	Level 2 area (ha)	Level 3 condition	Level 3 shape	Level 3 area (ha)	# of plots	# of trees	Min DBH (cm)	Max DBH (cm)	Tree height
WA	Cardamom	rectangle	Yes	DBH >= 30 cm	25x200m (twice)	1	DBH: 5 - 29 cm	10x25m (twice)	0.05	DBH <= 5 cm	10x6m (twice)	0.012	105	20124	1	462	Sample
CFMP-FAO	All	rectangle	yes	DBH >= 30 cm	50x100m	0.5	DBH: 10 - 29 cm	50x50m	0.25	DBH <= 10 cm	50x25m	0.125	218	16485	2	209	No
CFMP-RECOFTC	Kampong Thom CF	rectangle	yes	DBH >= 30 cm	50x100m	0.5	DBH: 10 - 29 cm	50x50m	0.25	DBH <= 10 cm	50x25m	0.125	79	4904	10	150	Sample
CFMP-RECOFTC	Anh Chanh CF	rectangle	yes	DBH >= 30 cm	50x100m	0.5	DBH: 10 - 29 cm	50x50m	0.25	DBH <= 10 cm	50x25m	0.125	7	753	10	131	No
WCS	Cherndar PV	rectangle	No	No	250x20m	0.5	No	No	No	No	No	No	15	1465	20	150	No
CFMP-FA	All	rectangle	Yes	DBH >= 30 cm	50x50m	0.25	DBH: 10 - 29 cm	25x50m	0.125	DBH <= 10 cm	25x25m	0.0625	40	2717	10	166	Yes
CFMP-RECOFTC	Okrasang CF	rectangle	yes	DBH >= 30 cm	50x50m	0.25	DBH: 10 - 29 cm	25x50m	0.125	DBH <= 10 cm	25x25m	0.0625	57	1419	10	75	No
CFMP-RECOFTC	Okrieng CF	rectangle	yes	DBH >= 30 cm	50x50m	0.25	DBH: 10 - 29 cm	25x50m	0.125	DBH <= 10 cm	25x25m	0.0625	106	3488	10	100	No
FA-PSP	Koh Kong and Siem Reap	rectangle	yes	DBH >= 30 cm	50x50m	0.25	DBH: 15 - 29 cm	20x20m	0.04	DBH < 15 cm	10x10m	0.01	40	1570	7.1	133.4	No
PACT	Oddar Meanchey	rectangle	no	No	50x50m	0.25	No	No	No	No	No	No	151	12063	2.5	200	No
PACT	Siem Reap	rectangle	yes	DBH >= 20 cm	25x25m	0.0625	DBH: 5 - 19 cm	15x15m	0.0225	DBH <= 5 cm	10x10m	0.01	51	1949	1	124	No
CFMP-GERES	All	rectangle	Yes	DBH >= 30 cm	20x30m	0.06	DBH: 10 - 29 cm	10x10m	0.001	DBH <= 10 cm	2x2m	0.0004	350	3648	5	216	No
WCS	Kulen Promtep WS	circles	Yes	DBH >= 30 cm	20m radius (3 times)	0.377	DBH: 15 - 29 cm	15m radius (3 times)	0.212	DBH < 15 cm	5m radius (3 times)	0.024	57	3573	5	190	No
WCS	Preah Vihear PF	circles	Yes	DBH >= 30 cm	20m radius (3 times)	0.377	DBH: 15 - 29 cm	15m radius (3 times)	0.212	DBH < 15 cm	5m radius (3 times)	0.024	61	3523	5	161	No
CI	Prey Long	circles	yes	DBH >= 30 cm	20m radius	0.126	DBH: 15 - 29 cm	15m radius	0.071	DBH < 15 cm	5m radius	0.0079	51	1056	5	143.6	No
WCS	Seima PF	circles	Yes	DBH >= 30 cm	20m radius	0.126	DBH: 15 - 29 cm	15m radius	0.071	DBH < 15 cm	5m radius	0.0079	308	7819	5	217	No
FFI	CCPF	circles	Yes	DBH >= 10 cm	15m radius	0.071	DBH < 10 cm	5m radius	0.0079	-	-	-	71	1476	5	104	No

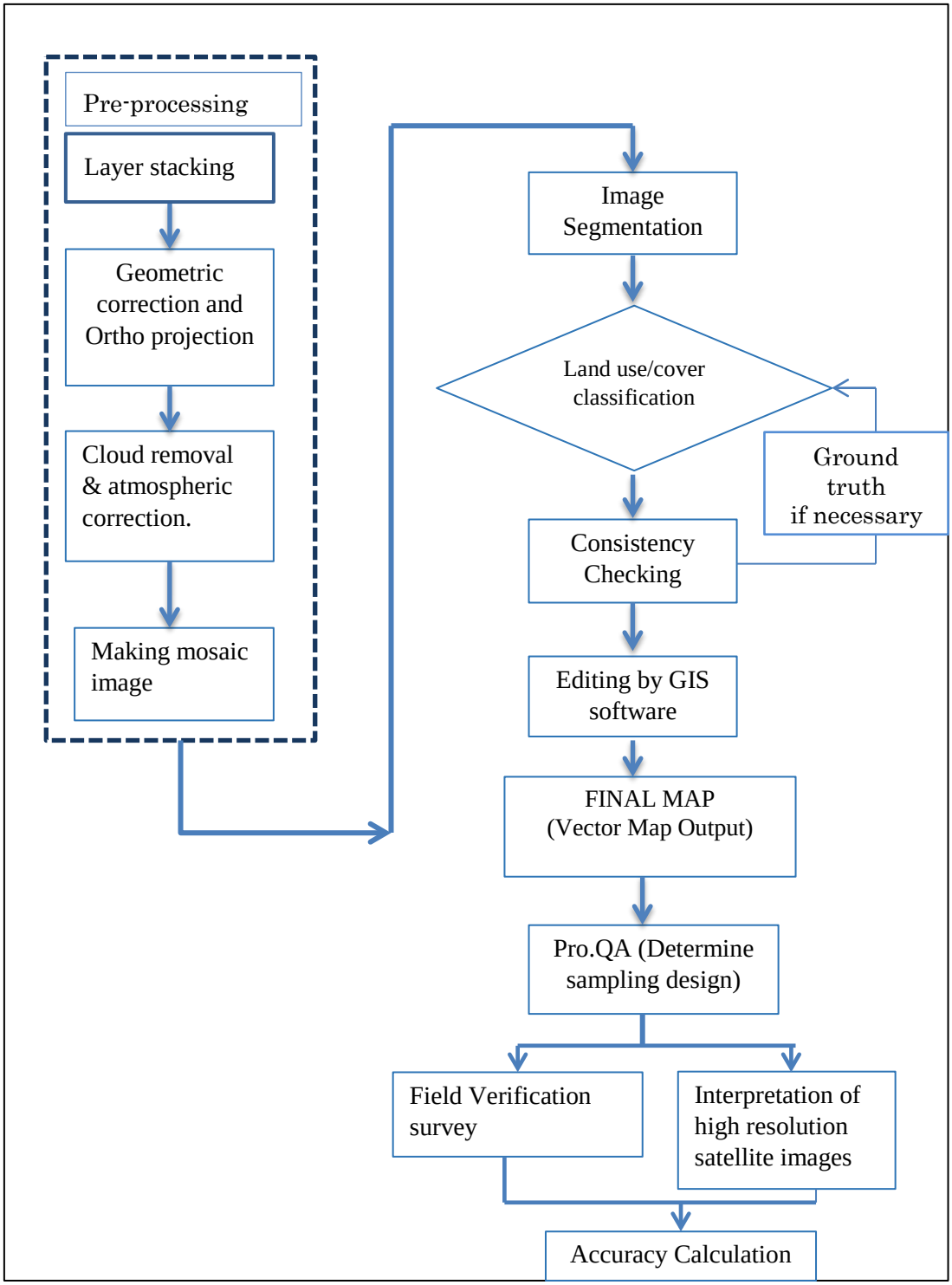
Annex III

Land use/cover classes.

	Land cover class	Description
1	Evergreen forest	Areas covered by trees maintaining their leaves during the whole year.
2	Semi-evergreen forest	Contain variable percentages of evergreen and deciduous trees.
3	Deciduous forest	Comprised of dry mixed deciduous forest and dry Dipterocarp forests
4	Bamboo	Areas dominated by bamboo
5	Wood shrub	Areas dominated by evergreen and deciduous woodland with a height less than 5 meters
6	Mangrove forest	Areas dominated by Mangroves i.e. coastal salt tolerant species
7	Rear Mangrove	Mostly growing in coastal zone after mangrove spp. however, this species also seen growing in some other places which containing soil type of "Podzol"
8	Rubber plantation	Areas currently supporting, and areas reserved for, rubber plantation
9	Flooded Forest	This forest type is found in Tonle Sap Lake. Most of the forests are low and disturbed. In many cases, there is only a mosaic remaining
10	Forest Regrowth	Areas of naturally regenerated forest where there are clearly visible indication of human activities such as selective logging, areas regenerating following agricultural land use, areas recovering from human induced fire, etc. – Include forest where it is not possible to distinguish whether planted or naturally regeneration. – Include forests with mix of naturally regenerated trees and planted/seeded trees, and where the naturally regenerated trees are expected to constitute more than 50 percent of the growing stock at stand maturity. – Include abandoned forest land and bare land which will regrow into forest within ten years
11	Pine Tree	The area dominated by pine tree
12	Pine plantation	The area domunated by pine tree plantation
13	Oil palm	The area dominated by oil palm tree.
14	Tree plantation	This class includes the following type: teak, eucalyptus, acacia, jatropha and others.
15	Paddy Field	Paddy field is a flooded parcel of arable land used for growing semiaquatic rice.
16	Crop Land	This category includes arable and tillage land, and agro-forestry systems where vegetation falls below the thresholds used for the forest land category
17	Grassland	Grasslands are characterized as lands dominated by grasses rather than large shrubs or trees. It is crucial that the rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur.
18	Built-up area	The patch of land with building and construction
19	Village	The patch of land with houses and garden surrounding house.
20	Rock	Land of naturally exposed rocks or strip mines, quarries and gravel pits.
21	Sand	In general, land of sand having thin soil or sand including deserts, dry salt flats, beaches, sand dunes.
22	Water	Area of fresh and sea water

Annex IV

Scope and Method of Land Use/Cover Mapping.



Minimum mapping unit (MMU):

MMU for existing maps is 25ha. For new mapping, 5ha MMU was used.

Land use/cover classes:

Table 4 shows land use/cover classes that will be monitored, while table 4 shows the relation with IPCC's six classes.

Land Use/Cover Classes for forest monitoring in Cambodia

Class defined in IPCC guideline	Newly defined classes of Cambodia
Forest Land	Evergreen forest
	Semi-evergreen forest
	Deciduous forest
	Forest regrowth
	Pine
	Pine plantation
	Tree plantation
	Mangrove
	Rear mangrove
	Flooded forest
	Bamboo
Cropland	Rubber plantation
	Oil palm plantation
	Agriculture
	Paddy field
Grassland	Grass
Settlement	Built-up area
	Village
Other land	Wood Shrub
	Rock outcrop
	Sandy beach
Wetland	Water

(Page 1.9 of 2006 IPCC Guidelines for National Greenhouse Gas Inventory)

QA/QC measures

Necessary measures, such as logical check of mapping results, have been introduced for

quality control (QC). For quality assurance (QA), map accuracy is verified through an accuracy assessment process. Accuracy assessment points are selected among from planned PSP of NFI. Systematic stratified random method will be used for the selection.

Annex V

ITEMS IN MONTHLY REPORT OF FA.

1. Forest and Forest Community management and development
   - 1.1 Forest Demarcation, Classification and Registration
   - 1.2 Forest Community
   - 1.3 Timber and Non timber Product management
   - 1.4 Practice other work beside

2. Tree Plantation development and Silviculture
   - 2.1 New Plantation and Old Plantation Protection from year 1 to year 5
   - 2.2 Seedling Transplant for providing to local People
   - 2.3 Nursery Preparation and Creation
   - 2.4 Genetic resource development
   - 2.5 Tree Transplant inventory (verify and making map for tree plantation)
   - 2.6 Other work related to development of tree plantation development and private forest
3. Wildlife and Biodiversity Conservation
   - 3.1 Protected Forest and Wildlife Conservation area
   - 3.2 Wildlife Research
   - 3.3 Wildlife Conservation
   - 3.4 Monkey Feeding and Breeding
4. Rescuing, Rehabilitation biological animal breeding and release into natural forest
   - 4.1 Repair and Protect
   - 4.2 Rescue, Take Care, and Protected
   - 4.3 Wildlife improving
   - 4.4 Others
5. Forest Industry, Commercial development and management and International Operation
   - 5.1 International Operation
   - 5.2 Forest Carbon Credit and Climate Change
6. Forest Factor ability improving and researching
   - 6.1 Training
   - 6.2 Researching by using national budget
   - 6.3 Operation with Partner development
7. Forest Law enforcement to contribute to sustainable forest
   - 7.1 Advertising and training of law related to Forest

7.2 Improving Forest law to against Forest crime

7.3 Follow, Check, Verify on Deforestation

7.4 Abstract forest information from news, do research, verify information and take legal action

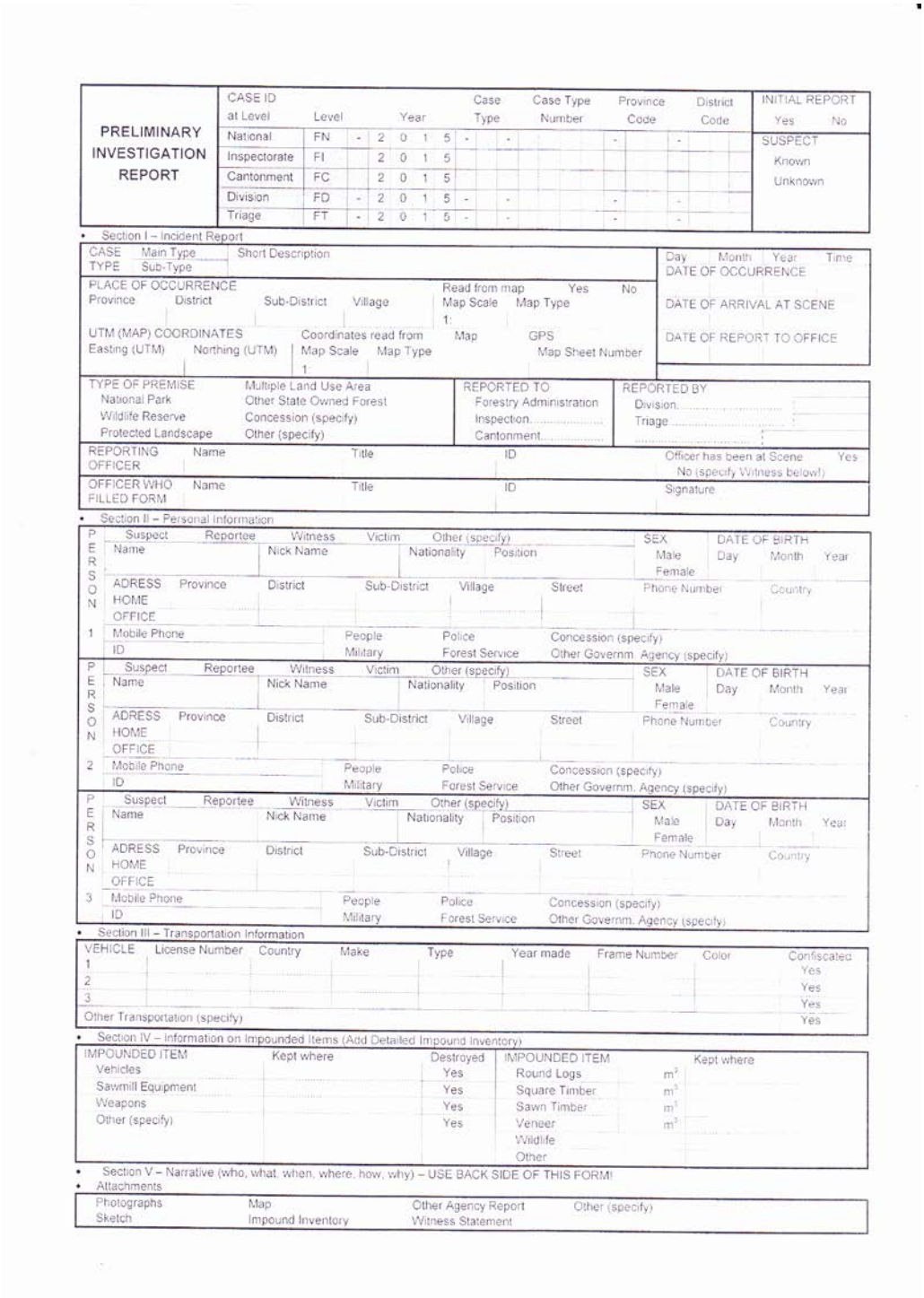
7.5 Examine and Verify forest crime, Wildlife crime, deforestation and Proof the forest crime

7.6 Administer and Encourage forest crime to court

7.7 Prevent and Repress forest Crime, Wildlife Crime and deforestation by forestry

Annex VI

Preliminary Investigation Report for tracking illegal cases.



PRELIMINARY INVESTIGATION REPORT

CASE ID at Level	Level	Year	Case Type	Case Type Number	Province Code	District Code
National	FN	2015	-	-	-	-
Inspectorate	FI	2015				
Cantonment	FC	2015				
Division	FD	2015	-	-	-	-
Triage	FT	2015	-	-	-	-

INITIAL REPORT: Yes / No

SUSPECT: Known / Unknown

- Section I – Incident Report

CASE TYPE: Main Type / Sub-Type; Short Description

DATE OF OCCURRENCE: Day / Month / Year / Time

PLACE OF OCCURRENCE: Province / District / Sub-District / Village; Read from map: Yes / No; Map Scale 1: ; Map Type

DATE OF ARRIVAL AT SCENE

UTM (MAP) COORDINATES: Easting (UTM) / Northing (UTM); Coordinates read from: Map / GPS; Map Scale 1: ; Map Type; Map Sheet Number

DATE OF REPORT TO OFFICE

TYPE OF PREMISE: National Park; Wildlife Reserve; Protected Landscape; Multiple Land Use Area; Other State Owned Forest; Concession (specify); Other (specify)

REPORTED TO: Forestry Administration; Inspection; Cantonment

REPORTED BY: Division; Triage

REPORTING OFFICER: Name / Title / ID; Officer has been at Scene: Yes / No (specify Witness below!)

OFFICER WHO FILLED FORM: Name / Title / ID / Signature

- Section II – Personal Information

PERSON 1: Suspect / Reportee / Witness / Victim / Other (specify); Name; Nick Name; Nationality; Position; SEX: Male / Female; DATE OF BIRTH: Day / Month / Year

ADRESS: Province / District / Sub-District / Village / Street / Phone Number / Country

HOME

OFFICE

Mobile Phone; People; Police; Concession (specify)

ID; Military; Forest Service; Other Governm. Agency (specify)

PERSON 2: Suspect / Reportee / Witness / Victim / Other (specify); Name; Nick Name; Nationality; Position; SEX: Male / Female; DATE OF BIRTH: Day / Month / Year

ADRESS: Province / District / Sub-District / Village / Street / Phone Number / Country

HOME

OFFICE

Mobile Phone; People; Police; Concession (specify)

ID; Military; Forest Service; Other Governm. Agency (specify)

PERSON 3: Suspect / Reportee / Witness / Victim / Other (specify); Name; Nick Name; Nationality; Position; SEX: Male / Female; DATE OF BIRTH: Day / Month / Year

ADRESS: Province / District / Sub-District / Village / Street / Phone Number / Country

HOME

OFFICE

Mobile Phone; People; Police; Concession (specify)

ID; Military; Forest Service; Other Governm. Agency (specify)

- Section III – Transportation Information

VEHICLE	License Number	Country	Make	Type	Year made	Frame Number	Color	Confiscated
1								Yes
2								Yes
3								Yes

Other Transportation (specify) Yes

- Section IV – Information on Impounded Items (Add Detailed Impound Inventory)

IMPOUNDED ITEM	Kept where	Destroyed
Vehicles		Yes
Sawmill Equipment		Yes
Weapons		Yes
Other (specify)		Yes

IMPOUNDED ITEM		Kept where
Round Logs	m^3	
Square Timber	m^3	
Sawn Timber	m^3	
Veneer	m^3	
Wildlife		
Other		

- Section V – Narrative (who, what, when, where, how, why) – USE BACK SIDE OF THIS FORM!
- Attachments

Photographs; Map; Other Agency Report; Other (specify)

Sketch; Impound Inventory; Witness Statement

Appendix 4

Forest Reference Level Document

(as of May 2017)

Initial Forest Reference Level for Cambodia under the UNFCCC Framework

May 22, 2017

Table of Content

Annex

Figure

Table

Reference Data

ABBREVIATIONS

ACRONYM	FULL WORD
AGB	Aboveground Biomass
BGB	Belowground Biomass
EF	Emission Factor
ELCs	Economic Land Concessions
FA	Forestry Administration
FAO	Food and Agriculture Organization of the United Nations
FiA	Fisheries Administration
FREL	Forest Reference Emission levels
FRL	Forest Reference Level
GDANCP	General Department of Administration for Nature Conservation and Protection
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change and Forestry
MAFF	Ministry of Agriculture Forestry and Fisheries
MMU	Minimum Mapping Unit
MoE	Ministry of Environment
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NPASMP	National Protected Areas Strategic Management Plan
NRS	National REDD+ Strategy
NSDP	National Strategic Development Plan
ODA	Official Development Assistance
PA	Protected Area
PFE	Permanent Forest Estate
PFR	Permanent Forest Reserve
PSP	Permanent Sample Plots
REDD	Reducing Emission from Deforestation and Forest Degradation
RGC	Royal Government of Cambodia
SIS	Safeguard Information System
SLCs	Social Land Concessions
SOM	Soil Organic Matter

1. Introduction

1.1. FRL submission

In accordance with decisions 4/CP.15, 1/CP.16, 12/CP.17, 13/CP.19, Cambodia is submitting on a voluntary basis for consideration by the UNFCCC its initial Forest Reference Level (FRL).

In this report, we provide an overview of the data and methodologies used to develop Cambodia's initial FRL. The information presented is intended to be transparent, complete, consistent, and accurate, and is guided by the most recent IPCC guidance and guidelines (IPCC, 2003a, 2003b, 2006a, 2006b). The submission of a FRL is exclusively for the purpose of obtaining and receiving payments for results from Cambodia's REDD+ program implementation.

Cambodia has high levels of deforestation and forest degradation but limited capacity and finance and expects to face continuing challenges to reduce emissions. The Cambodia REDD+ strategy outlines the policies and measures intended to reduce emission from deforestation and forest degradation. As these policies and measures are shaped they are expected to introduce long-term effects.

1.2. Cambodia's forest sector

Cambodia covers a total area of 181,035 km2. Cambodia is categorized as a least developed, low-income country. Relative peace and stability over the past decade has brought steady economic growth, averaging between 7 and 10 percent since 1998, leading to substantial reductions in poverty, but also increased pressure on Cambodia's natural resources. Cambodia was able to maintain a relatively high forest cover, with one of the highest levels of forest cover in Southeast Asia. While the current forest cover is still relatively high, Cambodia lost a considerable amount of forest over the last two decades, and the pace of land use and forest conversion has seen acceleration.

Cambodia's forest area is governed by three institutions: Forestry Administration (FA) of the Ministry of Agriculture, Forestry and Fisheries, Fisheries Administration (FiA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF), General Department of Administration for Nature Conservation and Protection (GDANCP) of the Ministry of Environment (MoE).

FA is the government authority under MAFF, in managing forest and forest resources of the Permanent Forest Estate (PFE), which comprises naturally growing and planted state forest resources, and is subdivided into the Permanent Forest Reserve (PFR) and Private Forest. The PFR is composed of Production Forest, Protection Forest, and Conversion Forestland. Private

Forests shall be maintained by owners with interesting right to manage, develop and harvest, use, sell, and distribute the product by themselves (Source: Forestry Law 2002).

The policy objectives of the forestry sector under Permanent Forest Estate (PFE) are synthesized into an overarching strategic framework set out in the National Forest Programme 2010-2029, which defines the policy and implementation strategies for the sustainable management of the nation's forestry sector under a series of programmes, including (a) forest demarcation, classification and registration; (b) Conservation and Development of Forest Resource and biodiversity; (c) forest law enforcement and governance; (d) community forestry programme; (e) capacity and research development; and (f) sustainable forest financing.

Forest resources within Protected Areas (PA) are under the jurisdictional management and regulatory authority of the General Department of Administration for Nature Conservation and Protection (GDANCP) of the Ministry of Environment (MoE) under the 2008 Protected Areas Law. Cambodia's 23 PAs covering about 3.2 million ha, or 18% of total land area. The National Protected Areas Strategic Management Plan (NPASMP) 2016-2030 outlines the implementation framework for achieving its vision of effective, efficient and equitable management of the national protected area system in Cambodia.

Under the 2006 Fisheries Law, inundated forests and mangrove areas outside of PAs are managed and regulated by the Fisheries Administration (FiA),[1] set out in the Strategic Planning Framework for Fisheries 2010-2019.

More general government policies related to climate change adaptation and mitigation include the National Climate Change Strategic Plan 2014-2023, National Strategic Plan on Green Growth Development 2013-2030, and the White Paper on Land Policy, enacted in 2015, which seeks to harmonize cross-sectoral land-use policy to ensure sustainability. In addition, a law on Environmental Impact Assessment and an Environmental Code are being developed. The National Council for Sustainable Development was recently formed to spearhead the harmonization of Cambodia's sustainable development efforts. These various efforts by RGC are expected to support to mitigate emissions from the forestry sector by improving governance, inter-ministerial coordination and coherence of land use policy.

Specifically for REDD+ a number of institutions and mechanisms have been established to streamline REDD+ in government policy and pave the way for implementation of activities. The REDD+ Taskforce and Taskforce Secretariat have been established. A number of Technical Teams have been created to oversee day-to-day operations, and key components, including the NRS, SIS, and NFMS are being developed. Participation by all major stakeholders, including

local communities, indigenous groups, donors and civil society groups has been ensured.

2. Application of UNFCCC Modalities

2.1. UNFCCC modalities

The presented Initial Forest Reference Level (FRL) is consistent with the following UNFCCC decisions, among others:

1. Decision 4/CP.15: recognizing that developing country Parties in establishing forest reference emission levels and forest reference levels should do so transparently taking into account historic data, and adjust for national circumstances, in accordance with relevant decisions of the Conference of the Parties,
2. Decision 1/CP.16, paragraph 71: include forest reference emission levels as one of the four key elements to be developed for REDD+ in accordance with national circumstances and respective capabilities[1]
3. Decision 12/CP.17: modalities relating to forest reference emission levels and forest:
    - expressed in tonnes of carbon dioxide equivalent per year and serve as benchmarks for assessing the country's performance in implementing the activities referred to in decision 1/CP.16, paragraph 70
    - maintaining consistency with anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks as contained in the country's greenhouse gas inventories
    - a step-wise approach to national forest reference emission level and/or forest reference level development, enabling Parties to improve the forest reference emission level and/or forest reference level by incorporating better data, improved methodologies and, where appropriate, additional pools
    - allowing updates periodically as appropriate, taking into account new knowledge, new trends and any modification of scope and methodologies
4. Decision 13/CP.19: Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels FREL/FRL:
    - submission shall be subject to a technical assessment

[1] According to Decision 12/CP.17, countries can submit rational on the development of FRL including details of national circumstances and if adjusted include details on How the national circumstances were considered, in accordance with the guidelines.

- developing countries may, on a voluntary basis and when deemed appropriate, submit a proposed forest reference emission level and/or forest reference level
- proposed forest reference emission levels and/or forest reference levels might be technically assessed in the context of results-based payments

2.2 Consistency with National GHG reporting

Cambodia's initial FRL uses the most recent Intergovernmental Panel on Climate Change guidance and guidelines (IPCC 2003 GPG and 2006 guidelines) to estimate emissions. The period covered does not overlap with the earlier GHG inventories. Planned GHG inventories are set to use IPCC GPG 2003/2006 guidelines consistent with the FRL and the updated data used for the development of the FRL, reflecting improvements in methodologies and capacities to assess activity data, emission factors and emission/removal estimates.

3. Proposed Forest Reference Level

The Initial Forest Reference Level is assessed at 78,953,951 tCO2/year in Cambodia based on the historical average net emission levels from 2006 to 2014.

The average (AVG) net total annual CO2 emissions and removals (tCO2/year) are calculated following this equation;

$$\text{Average} = \frac{C_{def_{y1}} + C_{def_{y2}}}{n_{y1+y2}}$$

Where:

$\boldsymbol{C_{defy}}$: The sum of emissions from deforestation over the "y" years of emissions over the time of observation. In case of removal, the sum of removal over the "y" years of removal over the time of observation.

Table 3-1: Total Annual CO2 Emissions and Removals (t CO2 / year) FRL reference period

Period (year to year)	2006-2010	2010-2014
Annual CO_2 Removals (t CO_2 / year)	-7,109,077	-20,138,797
Annual CO_2 Emissions (t CO_2 / year)	34,111,931	151,043,845
Net Total Annual CO_2 Emissions and Removals (t CO_2 / year)	27,002,854	130,905,048
AVG Net Total Annual CO_2 Emissions and Removals (t CO_2 / year)	78,953,951	

Notice:

Cambodia defined Tree Plantation and Pine Plantation as forest. For the FRL, consistent with Safeguards, Cambodia excludes Emissions and Removals related to the two classes, in the case of conversion of natural forest classes, from the calculation of total Emissions and Removals.

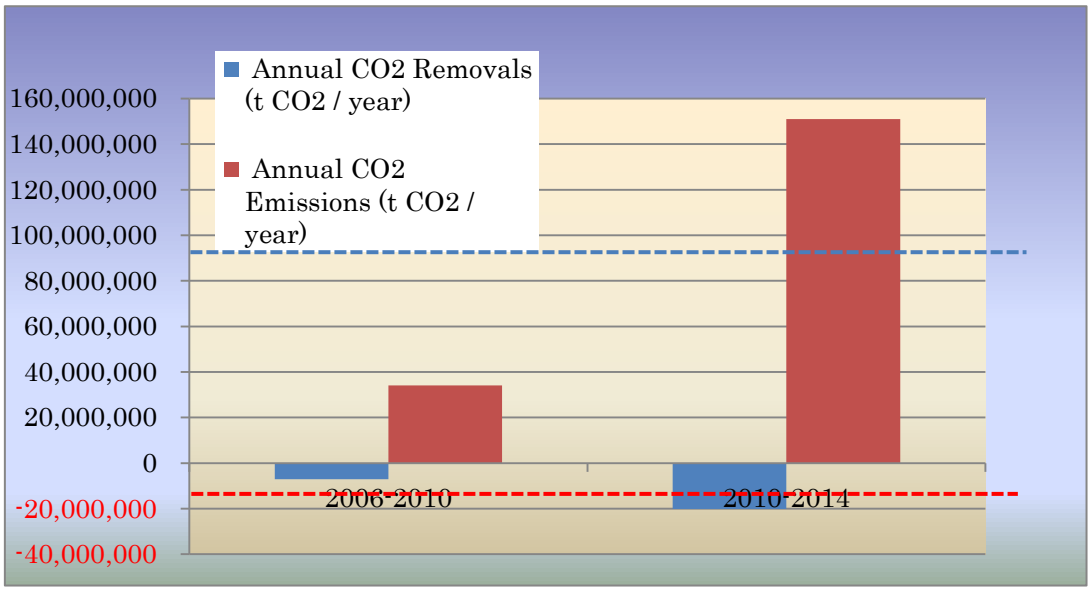


Figure 3-1: Histrical Trend of Annual CO_2 Emissions / Removals

Red dotted line is the Average annual CO_2 removal

Blue dotted line is the Average annual CO_2 emission

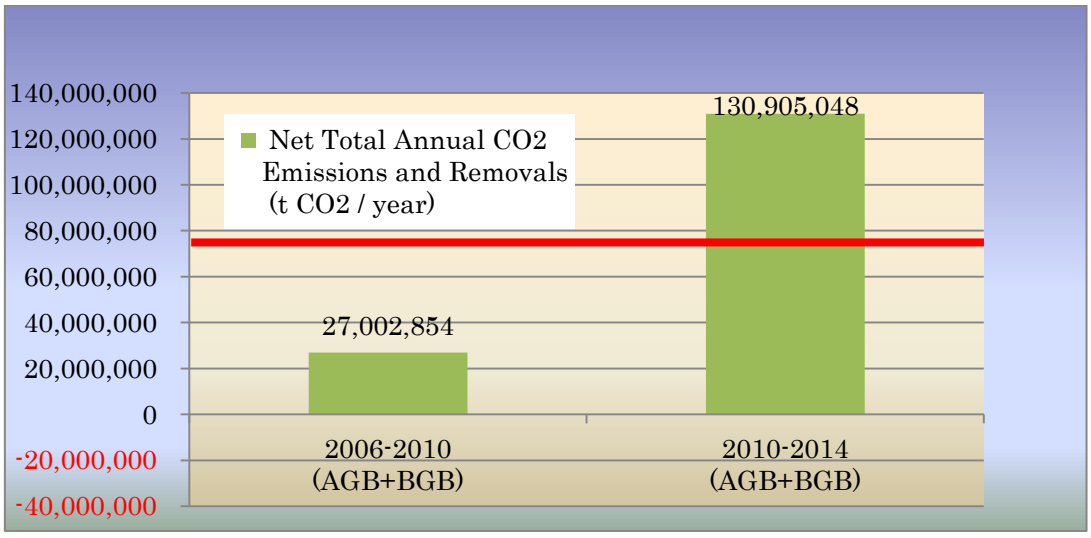


Figure 3-2: Historical Trend of Net Total Annual CO_2 Emissions

4. Information used for development of forest reference level

4.1. Scale

The FRL area encompasses Cambodia's Nation. The national scale is chosen to include considerations such as inter-institutional collaborations, with the responsibility of the forest estate under three institutions and linkages to national policies to implement REDD+. The national scale was possible due to the establishment of the National Forest Monitoring System (NFMS), availability of data and capacities.

It is however noted that REDD+ implementation could focus on specific areas before reaching the maturity of implementation at the national scale.

4.2. Scope

4.2.1. Scope of activity

Deforestation (forest land converted to other land types), degradation and enhancements (forest land remaining forest land with changes in forest sub-categories), and removal of CO_2 from the atmosphere through afforestation (other land uses converted to forest land) are included in the initial FRL.

Degradation and enhancement (through biomass stock changes within forest land without changes in forest sub-categories) are believed to be a significant contribution to emission or removals, however the information to monitor these type of degradation and enhancement (though biomass stock changes within forest land without changes in forest sub-categories) is for the moment not robust and reliable enough to be included in this FRL submission.

4.2.2. Scope of pools

Out of five carbon pools as described per IPCC guidelines, two pools, above ground biomass and below ground biomass, are included for the initial FRL establishment in Cambodia, which is consistent with LULUCF section in the national GHG inventory, and believed to be conservative while limited information exist on the litter, deadwood, and SOM pools. Information of these pools is expected after implementation of Cambodia's first National Forest Inventory (NFI).

Table 4-1: Carbon pools included in Initial FRL

Carbon Pool	Included/Excluded	Justification/ Explanation of Choice
Above Ground Biomass	Included	Major carbon pool affected by selected activity
Below Ground Biomass	Included	Major carbon pool affected by selected activity
Litter	Excluded	Stock change expected to be minor by selected activity and no data available.
Deadwood	Excluded	Stock change expected to be minor by selected activity and no data available.
Soil Organic Matter	Excluded	Stock change expected to be minor by selected activity and no data available.

4.2.3. Scope of Gas

Only CO_2 is included because in Cambodia emissions of other gases from land use and land use change are considered to be minor, and considered conservative while limited information exist on other gases. The Global Forest Resources Assessment (FAO, 2015) has recently released tables on forest fires; these figures are not used in the initial FRL to be conservative. Cambodia intends to monitor and explore inclusion of other gasses in its future submissions.

4.3. Definition of forest and land use classes

The forest definition adopted by Cambodia for REDD+ follows the National Forest Programme definition for forest and is consistent with the FAO FRA definition, but differs in the fact that rubber plantations Oil Palm plantations and Perennial crops are not reported as forests. In order to implement the Cambodia REDD+ programme, forests have been re-defined as follows:

Forest under the REDD+ programme refers to a unit of an ecosystem in the form of wetland and dry land covered by natural or planted vegetation with a height from 5 metres on an area of at least 0.5 hectares, and canopy crown cover of more than 10%.

Areas also included in the REDD+ programme are forest regrowth and areas under afforestation or reforestation (1). Rubber, oil palm plantations and perennial crops are excluded from this definition (2).

Notices:

(1). Afforestation or reforestation is an area of natural degraded forest land, forest fire, under natural forest regrowth/local planted trees where regenerated tree are expect to reach more than 50 percent of growing stock at stand maturity.

(2). Rubber plantation and oil palm plantation land are considered as crop land. Future removals from trees within crops land remaining crop land are not covered by FRL or result base payments for REDD+.

The forest definition adopted by Cambodia for REDD+ has been formed taking into consideration Decision 1/CP.16 Appendix 1E (safeguard natural forest), for countries seeking result based payments, the conversion of natural forest to plantations is not eligible for result based payments.

The following Table highlights the hierarchical structure of IPCC land use categories and National Land use/cover classes adapted for REDD+ purpose in Cambodia. Detailed description of the national land use/cover classes is provided in annex 2.

Table 4-2: land use types hierarchy:

No	Forest/Non-Forest	IPCC land use Category	No	National Land Use/Cover Categories	FRL Classes (Initial FRL)
1	Forest	Forest	1	Evergreen forest	Evergreen forest
			2	Semi-evergreen forest	Semi-evergreen forest
			3	Deciduous forest	Deciduous forest
			4	Pine forest	Pine forest
			5	Pine plantation	Pine plantation
			6	Tree plantation	Tree plantation
			7	Mangrove forest	Mangrove
			8	Rear mangrove	Rear mangrove
			9	Forest regrowth	Forest regrowth
			10	Flooded forest	Flooded forest
			11	Bamboo	Bamboo
2	Non-Forest	Crop land	12	Rubber plantation	Non-forest
			13	Oil palm	

			14	Paddy field	
			15	Crop Land	
3		Grassland	16	Grassland	
			17	Wood shrub	
4		Wetlands	18	Water	
5		Settlements	19	Built-up area	
			20	Village	
6		Other	21	Rock	
			22	Sand	

4.4. Historical period

The UNFCCC requires historical data to be taken into account for the construction of a FRL but does not specify the length of reference periods. In Cambodia, there is a continuing trend of rapid deforestation in recent years. Therefore the emissions from a recent period are expected to better reflect future emissions from deforestation in absence of REDD+. For this moment reliable and consistent historical activity data is only available from 2006 to 2014. Cambodia chose the years from 2006 to 2014 as historical period for initial FRL construction because of data availability and because Cambodia believes the recent data form a better approximation of deforestation rates in the near future in the absence of REDD+ implementation.

The choice of the reference period and use of historical average is based on a review of national circumstances. The average of historical emissions from the data available is conservative choice for approaching FRL construction, as explained in Section 4.5. However, there is a high degree of uncertainty regarding the impact of current circumstances in socioeconomic development, including policies and growth patterns, on the level of future emissions arising from forestland conversion.

4.5. National circumstances during historical period under review for FRL development

As part of the development of the FRL the national circumstances have been thoroughly reviewed. This section begins by describing an outline of the development of the legal and policy context for environmental conservation between 2006 and 2014. A qualitative analysis of the drivers of deforestation and forest degradation is then presented, as is an overview of the expected implications of Cambodia's for future emissions based on consideration of the national circumstances.

4.5.1. Legend and policy context during the reference period

The 2001 Land Law, 2002 Forestry Law, 2006 Law on Fisheries and the 2008 Protected Areas Law established the legal framework governing forest use in Cambodia. A series of sub-decrees elaborated on forestland management prescriptions, including a 2003 Sub-Decree (SD) on Community Forestry Management, 2003 SD on Social Land Concessions (SLCs), 2005 SD on Economic Land concessions (ELCs), and 2009 SD on Registration of Land of Indigenous Communities.

The National Strategic Development Plan (NSDP) contains the overarching goals and action plans for harmonizing and maximizing effectiveness of development efforts. It seeks to implement RGC's "Rectangular Strategy", focusing on growth, employment, equity and efficiency. Starting in 2006, the NSDP has emphasized natural resource management throughout its existence. Currently in its third phase, NSDP 2014-2018 aims to balance the demands for economic development and needs for conservation via a series of land and forestry reforms. Forest management is strengthened through the National Forest Programme (NFP) 2010-2029 for improved management forests in the PFR, while the National Strategic Plan on Green Growth and Development 2013-2030 seeks to develop regulatory frameworks and mechanisms for carbon trading and strengthening the capability, preparation and implementation of climate change adaptation measures, among other things. The NFP 2010-2029 defines the policy and implementation strategies for the sustainable management of the nation's forestry sector under a series of programmes, including forest demarcation, classification and registration; Conservation and development of forest resource and biodiversity; forest law enforcement and governance; community forestry programme; capacity and research development; and sustainable forest financing.

4.5.2. Drivers of forest cover change

The drivers of deforestation and forest degradation in Cambodia are the result of a complex set of interrelated factors related to a pattern of economic development and resulting land-use change in a context where state institutions still have limited capacity to enforce the existing regulatory frameworks, exacerbated by incomplete land management systems and lack of inter-ministerial coordination (Broadhead & Izquierdo, 2010). The REDD+ Roadmap identified a series of direct drivers, including clearance for agriculture, settlement expansion, infrastructure development, illegal logging, and unsustainable harvesting wood fuel, alongside a large set of indirect factors related to the socioeconomic environment and governance conditions both within and outside the forestry sector (Forestry Administration, 2010). Since then, a number of reports have sought to quantify these drivers, and have pointed to the relevance of SLCs, mining, large-scale infrastructure development, and unsustainable fuelwood collection and charcoal production, and an incomplete and often overlapping land management system (see Aruna Technology ltd, 2015; Delux & Van Rijn, 2015; GERES, 2015). Lack of up to date and reliable primary data is a common concern across all studies, limiting the ability to accurately assess the identified drivers. While rates of deforestation can relatively accurately be measured using Remote Sensing (RS) attributing observations support to specific agents and underlying causes requires information that is often absent. Nonetheless, findings from the

various studies indicate that the dominant driver of deforestation has been the conversion of forestland to large-scale agro-industrial plantations by private investors under Economic Land Concessions (ELCs) (Banks, Sloth, Garcia, & Ra, 2014; Forests Trends, 2015; Lawson et al., 2014). The dramatic increase in emissions resulting from deforestation since 2010 is likely a consequence of an increase in forestland conversion and timber harvesting within sites allocated for ELCs and agricultural expansion for cash crops. Forest disturbance resulting from the expansion of monoculture plantations for rubber has been statistically linked to international market price fluctuations, with the past few years seeing higher market prices , and exceptionally high disturbance rates (Grogan, Pflugmacher, Hostert, Kennedy, & Fensholt, 2015).

Both MoE and MAFF have the authority to issue ELCs.[2] [Between 1996 and 2012, MAFF and MoE allocated ELCs covering 1,55 mill. ha (Source: MAFF on 21 Jul 2016) and 470,000 ha of Cambodia's approximately (Source: MoE reported on 15 Sept 2015). The allocation of land to ELCs halted with the implementation of Directive01 in 2012, although some forests within existing ELCs are still largely intact, and conversion to inside these ELCs is expected to remain for the coming years.

SLCs are a legal mechanism for redistributing land to for socioeconomic development. There are two categories of beneficiaries of SLCs: (a) poor and landless families or families of former military personnel, (b) communities requiring land for local development projects such as physical infrastructure, for future population increase, and (c) issued land title to local people (RGC, directive01). Although the procedural requirements for the granting and distribution of SLCs have been in place since the 2003[3], the mechanism was not fully utilized until 2010. [Between 2009 and 2013, government land allocated for SLCs 2,450,000 ha (Source: MLMUPC declaration dated on 25 Jan, 2016)]. Due to an increasing scarcity of available land, combined with an incomplete forest demarcation, SLCs often encroach on forestland and have been linked to deforestation and forest degradation, although the aggregate impact is unknown. Nevertheless, monitoring of both ELCs and SLCs are being conducted by RGC to ensure alignment with laws and regulations. The National REDD+ strategy is envisioned to strengthen this monitoring.

Under Directive01, RGC has accelerated land titling through the sporadic and systematic land registration systems, in addition to implementing an "old policy, new action" initiative. A

[2] Under the 2008 Protected Area Law and 2001 Land Law, respectively

[3] 2003 Sub-decree on Social Land Concessions

total of around 1.2 mill.ha of land titles have been distributed so far. The land registration system and SLC programmes are embedded with incentives for land clearance. Claimants must prove occupation of land parcel for a minimum of five years, and SLC holders must abide by conditions that include development of the land through agricultural cultivation.

4.5.3. Future

A number of trends in the national context point to continued high emission levels arising from the land use and forestry sectors in the future. Strong economic growth is expected to continue, and is likely to continue relying on extractive economic institutions in the land-use sectors for the immediate future. Expansion of monoculture cropping is expected to grow as the Cambodian government invests in strengthening commercialization for small-scale farmers and enhancing linkages between large-scale agro-industrial plantations and surrounding smallholders. Examples of relevant policies include the policy on "Promotion of Paddy Rice Production and Milled Rice Export" and the "National Rubber Development Strategy 2011-2020."

Although the sector is currently underdeveloped, mining is expected to grow extensively in the future with increased foreign investment and improved technology, with uncertain implications for forests. An unknown area has been granted by MME for mining and mineral exploration. Moreover, Investment in the construction of hydropower dams to supply the population's growing energy needs is growing, with numerous projects at varying stages of development. These large-scale projects are regulated by the 2007 Concessions Law, without effective mechanisms for ensuring of environmental and social safeguards, there is a risk that logging and other illegitimate extractive practices will occur.

Many of the issues illustrated above illustrate the need for a well-functioning and effective governance of the forestry sectors and coherent approach to policies within the land-use sectors. Today, government reforms to align development priorities with conservation efforts and inculcate coherence in land use are well underway. RGC's submission of its Intended Nationally Determined Contribution (INDC) in 2015 outlines Cambodia's efforts at reducing greenhouse gas emissions by sector. There is thus a growing recognition of the need for enhanced efforts at climate change mitigation and adaptation.

As Cambodia graduates to Lower-Middle Income Country status in the near future (RGC, 2014), donor funding will dissipate and RGC will have to seek funding from other sources.

Already by 2013, a larger share of Overseas Development Assistance took the form of concessional loans compared to ODA grants (CDC, 2014). In 2012, of a total of USD 1.50 billion around USD 14 million and USD 7 million of a total of 1.5 billion USD for ODA were committed to environment and conservation, and climate change, respectively.

Cambodia will continue to integrate into regional and global markets, with uncertain implications for environmental conservation. As the ASEAN Economic Community is consolidated, Cambodia's forests could become increasingly threatened as economic hubs become increasingly connected. On the other hand, further integration might be accompanied by pressures for strengthened state regulations of the flow of goods across borders.

For these reasons and acknowledging the uncertainty of future impacts on emissions within these sectors, averaging historical emissions over 2006-2014 represents a conservative approach to FRL development.

4.6. Approach for FRL establishment

Cambodia takes an approach based on historical average of net emission from deforestation[4] for eight years from 2006 to 2014. The reason for the choice of this methodology is due to the national circumstances outlined above and the fact that there are only three points in time for activity data. Three data points (for two change assessments) are considered insufficient to create a regression line for the predication of future trends.

4.7. Methodology

Historical emission estimates are developed based on the activity data from 2006 to 2014. Annual CO^2 Emissions and Removals (tCO_2 / year) are calculated by the following equation;

$$\Delta C_B = \frac{(Ct_2 - Ct_1)}{(t_2 - t_1)}$$

$$\Delta CO_2 = \Delta C_B \times 44/12$$

ΔC_B = annual change in carbon stocks in biomass (the sum of above-ground and below-ground biomass) in land remaining in the same category (e.g., Forest Land Remaining Forest Land), tonnes C yr-1

C t_2 = total carbon in biomass for each land sub-category at time t_2, tonnes C

C t_1 = total carbon in biomass for each land sub-category at time t_1, tonnes C

Ct (Total Emission) = Activity Data (A) × Emission Factor (EF)

44/12: Molecular weight ratio of carbon dioxide to carbon

(IPCC, 2006b)

4.8. Activity Data

Activity data explains the extent of human activities, in this case expressed in land use and land use change maps. There are several historical forest cover maps in Cambodia; made in 1989, 1993, 1997, 2002, 2006, 2010 and 2014. However, there are inconsistencies in the definition of forests and the forest classification before the 2006 data. Therefore, Cambodia development of FRL, only the maps in 2006, 2010 and 2014 were used.

"Forest" and "Non Forest" classes were stratified according to newly defined land use/cover classes by using the same LANDSAT images used in the original mapping. Land use/cover class of each segment (polygon) was identified by visual interpretation of LANDSAT images. Information such as maps made by FAO and Mekong River Commission and images of

[4] Net emissions from deforestation in this context includes degradation and enhancements in areas of forest land remaining forest land but with changes in forest sub-categories, and removal of CO2 from the atmosphere through afforestation where other land uses are converted to forest land

Google Earth were also used as reference. The minimum mapping unit (MMU) of the Land use/cover classes was 5ha.

For consistency of the mapping procedure, LANDSAT 8 images were used to develop 2014 map. The segmentation technique was used in automatic polygon generation and then land use/cover class of each segment (polygon) was identified by visual interpretation of LANDSAT images. Google Earth images were also used as a reference.

Note: The detailed methodology to develop the activity data is described in Annex 3.

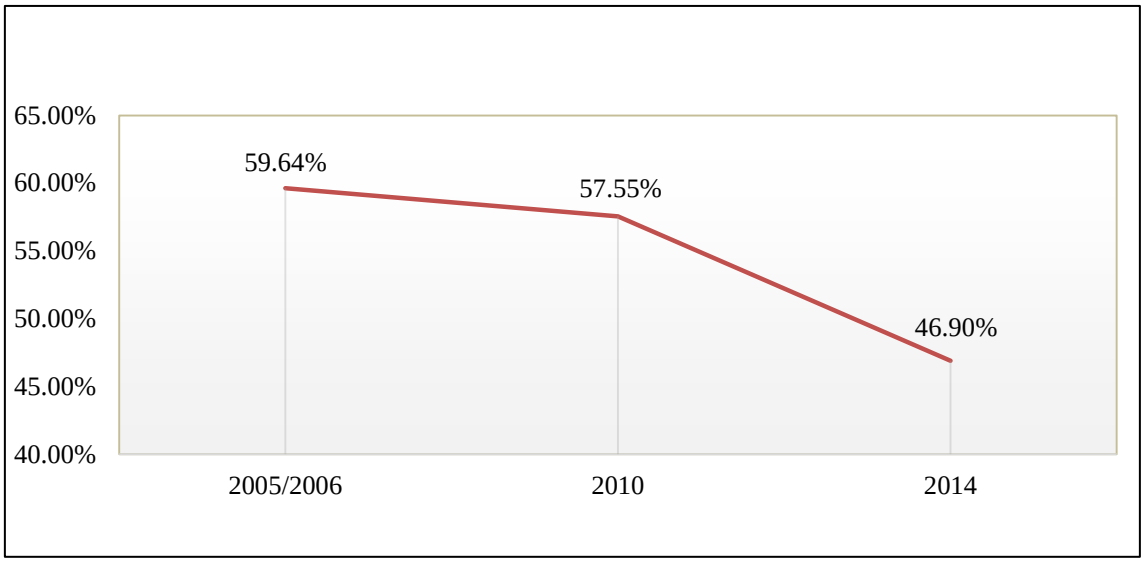


Figure 4-1: Change of forest cover from 2006 to 2014 excluding rubber and oil palm plantation as in the definition for REDD+

Table 4-3: Forest Cover and land use statistics in 2006, 2010 and 2014

Classification	2006		2010		2014	
	Ha	**%**	**Ha**	**%**	**Ha**	**%**
Evergreen forest	3,710,271	20.43%	3,573,925	19.68%	2,973,903	16.38%
Semi-evergreen forest	1,453,441	8.00%	1,391,117	7.66%	1,108,320	6.10%
Deciduous forest	4,613,417	25.40%	4,498,397	24.77%	3,480,532	19.17%
Flooded forest	597,355	3.29%	524,005	2.89%	481,078	2.65%
Forest regrowth	216,123	1.19%	249,341	1.37%	228,560	1.26%
Bamboo	129,837	0.71%	130,930	0.72%	130,678	0.72%
Mangrove	32,060	0.18%	31,443	0.17%	33,002	0.18%
Rear mangrove	27,519	0.15%	27,371	0.15%	25,906	0.14%
Pine forest	8,157	0.04%	8,157	0.04%	8,196	0.05%
Pine plantation	0	0.00%	11	0.00%	3,709	0.02%
Tree plantation	43,547	0.24%	17,214	0.09%	44,289	0.24%
Forest Area	**10,837,260**	**59.64%**	**10,451,911**	**57.55%**	**8,518,173**	**46.90%**
Oil palm plantation	35	0.00%	5,055	0.03%	36,311	0.20%
Rubber plantation	78,148	0.43%	137,307	0.76%	484,316	2.67%
Grassland	600,006	3.30%	473,281	2.61%	351,337	1.93%
Agriculture	1,000,634	5.51%	1,275,444	7.02%	2,787,413	15.35%
Paddy filed	3,668,981	20.20%	3,859,452	21.25%	4,133,474	22.76%
Rock	219	0.00%	668	0.00%	2,054	0.01%
Sand	8,304	0.05%	10,459	0.06%	40,581	0.22%
Built up area	37,435	0.21%	43,800	0.24%	328,820	1.81%
Village	248,126	1.37%	296,513	1.63%	42,166	0.23%
Water	438,410	2.41%	458,658	2.53%	813,839	4.48%
Wood shrub	1,248,649	6.88%	1,148,126	6.32%	622,190	3.43%
Non Forest	**7,328,947**	**40.36%**	**7,708,763**	**42.45%**	**9,642,501**	**53.10%**
Total Area	**18,160,674**	**100.00%**	**18,160,674**	**100.00%**	**18,160,674**	**100.00%**

4.9. Emission Factor

Emission factors (EF) are defined as CO2 emission per unit area induced by human activities. Emissions are estimated by calculating the change of carbon stock per unit area between two points in time. In FRL calculation, post-deforestation carbon stock is assumed to be zero. Emission factors for Aboveground Biomass (AGB) changes between forest types and changes between land use types are derived from the table below. Whereas Belowground Biomass (BGB) is estimated following application of a ratio recommended for tropical forests (IPCC 2003b).

Cambodia has never conducted a National Forest Inventory (NFI). Cambodia has recently designed a NFI. When implemented, the NFI is expected to improve the national emission factors. The post-deforestation carbon stock per unit of area is assumed zero because there is no reliable data on the replacing land-use and regrowth at the moment.

Based on existing references, Cambodia selected following AGB for FRL establishment. Detailed methodology is described in Annex 4.

Table 4-4: Estimation of above ground biomass (ton ha-1) by forest types in Cambodia

Forest type	AGB ton ha-1	C ton ha-1*	CO^2 ton ha-1**
Evergreen forest	163	76.6	280.90
Semi-evergreen	243	114.21	418.77
Deciduous	85	39.95	146.48
Forest regrowth	75	35.25	129.25
Flooded	70	32.90	120.6
Tree plantation	100	47.00	172.33
Pine plantation	100	47.00	172.33
Mangrove	150	70.50	258.50
Rear mangrove	165	77.55	284.35
Bamboo***	0	0.0	0

*0.47 was used as Carbon fraction (ton C /ton d.m.) from the default value in IPCC (2006b).

**One carbon equals 44/12 carbon dioxide.

References: CCEAP (2003), CFI (2008), IPCC (2006b), JICA TAT (2015), Sasaki *et.al*. (2013), Sola *et al*. (2014), Tran (2015)

***Bamboo=0, mean that area land cover represented bamboo class are very small

Above ground biomass values for Evergreen, Semi-evergreen and Deciduous forests were

estimated based on the estimation by Sola *et al*. (2014). Chave *et al*. (2005) equations were used for the calculation.

-Dry zone (Annual rain < 1500 mm):

$AGB=WD\times(-2.187+0.916\times\ln(WD\times DBH^2\times H)$

- Moist zone (1500 mm ≤ Annual rain ≤ 3500 mm):

$AGB=WD\times(-(DB0$ mm):$\times DBH^2\times H)$

- Wet zone (Annual rain > 3500 mm):

$AGB=WD\times(-2.557+0.940\times\ln(WD\times DBH^2\times H)$

Where

AGB: Above ground biomass of trees

DBH: Diameter at breast height

WD: Wood density

H: Tree height

- Tree height was estimated with the local H-DBH model for trees (Sola *et al*., 2014)

$$H=1.3+9.303525\times DBH^{0.24991}$$

-BGB was calculated from AGB using the following equation.

UBGB (ton/ha of dry matter) = exp[-1.0587 + 0.8836 • ln (UAGB)]

Variable: UAGB (Unit Above Ground biomass) (ton / ha of dry matter)

Application: tropical forests

(Reference: IPCC (2003b))

5. Transparency, completeness, consistency and uncertainty of information

Per decision 12/CP17 Guidelines for submissions of information on reference levels, information provided in the FRL submission should include information that is Transparent, Complete, Consistent and Accurate, for the purpose of allowing a technical assessment of the data. The following information supports this.

5.1. Transparency

Decision 12/CP.17 requires transparent and consistent information should be provided, that is, information should be accessible by all relevant stakeholders and updated on a regular basis. The data used for calculation of emission factors of the FRL will be published after completion of the technical assessment. Also, the results of FRL are accessible by all relevant stakeholders through developed web interface which will be updated when FRL is updated. This report will also be open for public access. Key information is publically accessible on *www.cambodia-redd.org.*

5.2. Completeness

Completeness in Decision 12/CP.17 means whether the provision of information allows for the reconstruction of the FRL. Methods used are clearly described in the previous section and in the annexes. Therefore, the FRL can be reconstructed. The data provided in the FRL is complete to the extent possible and intentions to improvements are outlined in the separate section and in chapter 7 Plan for FRL improvement. Raw data for emission factors and activity data are available upon request from the REDD+ secretariat, Cambodia.

5.3. Consistency

Decision 12/CP.17 requires that the forest reference levels shall maintain consistency with anthropogenic forest related greenhouse gas emissions by sources and removals by sinks as contained in the country's national greenhouse gas inventory (GHG inventory). As described in chapter 1.2 Cambodia's initial FRL development reflecting improvements in methodologies and capacities to assess activity data, emission factors and emission/removal estimates. The FRL historical period covered does not overlap with the earlier GHG inventories, future planned GHG inventories are set to be consistent with the improvements reflected in the FRL.

5.4. Accuracy

5.4.1. Accuracy of Emission factors

In Cambodia, no nationwide forest inventory has been conducted. Although localities were limited, 39 PSP and above 474 REDD+ related project and 528 community forest survey data were collected for calculation of emission factors for main forest types, Evergreen,

Semi-evergreen and Deciduous forest. Coefficient of variation (CV) for those forest inventory data ranges from 0.99 % to 1.47%. These relatively high values of CV are expected to decrease by conducting the National Forest Inventory (NFI) in the future. For other forest types, emission factors will also be improved through the NFI.

5.4.2. Accuracy of Activity Data

Accuracy assessment of the original 2006 and 2010 forest assessment map was performed by Geographic Resource Analysis & Science A/S (GRAS). The report was compiled as Accuracy Assessment Report (draft final). Overall accuracy of the five classes – Evergreen Forest, Semi-evergreen forest, Deciduous Forest, Other Forest and Non-Forest, was 74% of 2006 map and 85% of 2010 map.

New accuracy assessment of the upgraded 2006 map and 2010 map was performed after the completion of the initial classification edit. The accuracy assessment of 2014 map, total number of accuracy assessment points was calculated by using the same Congalton & Green formula and distributed for each class in proportion to the area of each class. Overall accuracy of the 22 classes was 81.23% with kappa 79.49% (Annex 3).

Furthermore, Cambodia is currently undertaking an accuracy assessment of change of land use change data between 2006 and 2010, and between 2010 and 2014. The results are expected to be made available to the technical assessment team and part of future FRL submissions once available.

6. Plan of FRL improvement

The FRL submission presented in this report is thought to best reflect current methodologies, data and capacities to assess activity data, emission factors and emission/removal estimates, with an intention to improve future FRL submission.

The initial FRL is based on activity data between 2006 and 2014; it is envisioned that future FRL submissions include updates of the land use/cover data. It is planned to produce land use/cover map every two years from 2016.

Accuracy of data in the initial FRL based on activity assessment performed for individual maps it is envisioned that an assessment of the accuracy of land use changes will be performed in the future.

Improvements in both emission factors and activity data are expected through implementation of Cambodia's first NFI. The data in Sola *et al*. (2014) used assessing the AGB of Evergreen, Semi-evergreen and Deciduous forest are based on a collection of data from several locations, but do not represent a systematical assessment of forest in Cambodia.

An allometric equation is used to calculate dry weight, above ground biomass of a tree from easier-to-measure characteristics such as tree diameter or height. For the initial FRL development, general allometric equations were used. However, tree forms differ from one species to another, and therefore so would tree biomass and allometric equations. Country specific allometric equations will be developed to increase reliability

Recent studies show that wood density is an important predictor of tree biomass (Chave *et al*., 2014). Available methodologies and associated cost for measuring it in forest inventories are huge constraints but average wood density at tree species level can be used without creating bias (Fayolle *et al*., 2013). Therefore, developing a table of wood density values at species level would improve biomass estimates (Sola *et al*., 2014).

Overall consistency between FRL submissions and National GHG reporting is strengthened by the establishment of a REDD+ database. All information and subsequent updates in information are stored in the database, allowing for improvement of consistency between various submission reports.

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Annex 1 Emission/Removal Calculation Tables

Table 1: Forest Area Change Matrix between 2006 and 2010(ha)

Forest Type		Year 2010(Ha)												Total (Ha)	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2006	E	3,560,063.5				20.2				4,610.3	1,055.9		144,521.1	3,710,271	20.4%
	Se	171.6	1,384,195.9		12.6					3,285.3	42.1		65,733.4	1,453,441	8.0%
	P			8,156.6									0.0	8,157	0.0%
	D				4,477,380.9	9.7		8.4		1,114.6	2,275.6		132,627.8	4,613,417	25.4%
	B					128,795.8				11.4			1,029.8	129,837	0.7%
	M	143.5	55.2				31,031.2	40.2					789.5	32,060	0.2%
	Mr		77.7				90.8	26,482.7		43.2			824.5	27,519	0.2%
	Ff								471,842.1	592.2			124,920.9	597,355	3.3%
	Fr	174.9	5.9		83.2			10.9	20.4	190,385.9	277.4		25,164.5	216,123	1.2%
	Tp		16.7		26.1				7.5	161.5	8,013.9		35,321.3	43,547	0.2%
	Pp												0.0	0	0.0%
	NF	13,371.6	6,765.9	0.0	20,894.0	2,104.8	320.7	828.5	52,135.3	49,137.1	5,549.2	10.9	7,177,829.2	7,328,947	40.4%
Total		3,573,925	1,391,117	8,157	4,498,397	130,931	31,443	27,371	524,005	249,342	17,214	11	7,708,762	18,160,674	100.0%
		19.7%	7.7%	0.0%	24.8%	0.7%	0.2%	0.2%	2.9%	1.4%	0.1%	0.0%	42.4%	100.0%	

Table 2: Forest Living Aboveground Biomass Carbon Stock of 2006

Forest Type		Year 2010												Total (t C)	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2006	E	272,736,465	0	0	0	1,548	0	0	0	353,195	80,892	0	11,071,761	284,243,861	42.5%
	Se	19,598	158,089,014	0	1,439	0	0	0	0	375,214	4,808	0	7,507,412	165,997,485	24.8%
	P	0	0	383,360	0	0	0	0	0	0	0	0	0	383,360	0.1%
	D	0	0	0	178,871,367	388	0	336	0	44,528	90,910	0	5,298,481	184,306,009	27.6%
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	M	10,117	3,892	0	0	0	2,187,700	2,834	0	0	0	0	55,660	2,260,202	0.3%
	Mr	0	6,026	0	0	0	7,042	2,053,733	0	3,350	0	0	63,940	2,134,091	0.3%
	Ff	0	0	0	0	0	0	0	15,523,605	19,483	0	0	4,109,898	19,652,986	2.9%
	Fr	6,165	208	0	2,933	0	0	384	719	6,711,103	9,778	0	887,049	7,618,339	1.1%
	Tp	0	785	0	1,227	0	0	0	353	7,591	376,653	0	1,660,101	2,046,709	0.3%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Total														668,643,043	100.0%

Density	
t AGB/ha	t C/ha
163	76.61
243	114.21
100	47.00
85	39.95
0	0.00
150	70.50
165	77.55
70	32.90
75	35.25
100	47.00
100	47.00
-	0.00
-	#REF!

AGB value is integar.

t AGB/ha= 0.47 t C/ha

Table 3:Forest Living Aboveground Biomass Carbon Stock of 2010

Forest Type		Year 2010												Total
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF	
Year 2006	E	272,736,465	0	0	0	0	0	0	0	162,513	49,627	0	0	
	Se	13,146	158,089,014	0	503	0	0	0	0	115,807	1,979	0	0	
	P	0	0	383,360	0	0	0	0	0	0	0	0	0	
	D	0	0	0	178,871,367	0	0	651	0	39,290	106,953	0	0	
	B	0	0	0	0	0	0	0	0	402	0	0	0	
	M	10,994	6,304	0	0	0	2,187,700	3,118	0	0	0	0	0	
	Mr	0	8,874	0	0	0	6,401	2,053,733	0	1,523	0	0	0	
	Ff	0	0	0	0	0	0	0	15,523,605	20,875	0	0	0	
	Fr	13,399	674	0	3,324	0	0	845	671	6,711,103	13,038	0	0	
	Tp	0	1,907	0	1,043	0	0	0	247	5,693	376,653	0	0	
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	
	NF	1,024,398	772,733	0	834,715	0	22,609	64,250	1,715,251	1,732,083	260,812	512	0	
Total		273,798,402	158,879,507	383,360	179,710,952	0	2,216,710	2,122,598	17,239,774	8,789,288	809,063	512	0	643,950,166
		42.5%	24.7%	0.1%	27.9%	0.0%	0.3%	0.3%	2.7%	1.4%	0.1%	0.0%	0.0%	100.0%

Carbon Density t C/ha	76.61	114.21	47.00	39.95	0.00	70.50	77.55	32.90	35.25	47.00	47.00	0.00	35.46

Table 4: Forest Living Aboveground Biomass Carbon Stock Change Matrix between 2006 and 2010

Forest Type		Year 2010												Total (t C)	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2006	E	0	0	0	0	1,548	0	0	0	190,682	31,265	0	11,071,761	11,295,256	45.7%
	Se	6,452	0	0	936	0	0	0	0	259,407	2,830	0	7,507,412	7,777,036	31.5%
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	D	0	0	0	0	388	0	-316	0	5,239	-16,043	0	5,298,481	5,287,748	21.4%
	B	0	0	0	0	0	0	0	0	-402	0	0	0	-402	0.0%
	M	-877	-2,413	0	0	0	0	-283	0	0	0	0	55,660	52,087	0.2%
	Mr	0	-2,848	0	0	0	640	0	0	1,827	0	0	63,940	63,559	0.3%
	Ff	0	0	0	0	0	0	0	0	-1,392	0	0	4,109,898	4,108,506	16.6%
	Fr	-7,234	-466	0	-391	0	0	-461	48	0	-3,259	0	887,049	875,285	3.5%
	Tp	0	-1,122	0	184	0	0	0	106	1,898	0	0	1,660,101	1,661,166	6.7%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	-1,024,398	-772,733	0	-834,715	0	-22,609	-64,250	-1,715,251	-1,732,083	-260,812	-512	0	-6,427,365	-26.0%
Total		-1,026,057	-779,583	0	-833,987	1,935	-21,969	-65,310	-1,715,098	-1,274,823	-246,020	-512	30,654,301	24,692,876	100.0%
		-4.2%	-3.2%	0.0%	-3.4%	0.0%	-0.1%	-0.3%	-6.9%	-5.2%	-1.0%	0.0%	124.1%	100.0%	

Table 5: Forest Living Aboveground Biomass CO2 Emission / Removal Matrix between 2006 and 2010

Forest Type		Year 2010												Total	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2006	E	0	0	0	0	5,674	0	0	0	699,167	114,639	0	40,596,459	41,415,939	45.7%
	Se	23,658	0	0	3,431	0	0	0	0	951,160	10,375	0	27,527,176	28,515,800	31.5%
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	D	0	0	0	0	1,421	0	-1,158	0	19,208	-58,824	0	19,427,762	19,388,409	21.4%
	B	0	0	0	0	0	0	0	0	-1,473	0	0	0	-1,473	0.0%
	M	-3,215	-8,847	0	0	0	0	-1,039	0	0	0	0	204,086	190,985	0.2%
	Mr	0	-10,444	0	0	0	2,347	0	0	6,700	0	0	234,447	233,050	0.3%
	Ff	0	0	0	0	0	0	0	0	-5,103	0	0	15,069,625	15,064,522	16.6%
	Fr	-26,524	-1,708	0	-1,434	0	0	-1,691	176	0	-11,951	0	3,252,512	3,209,379	3.5%
	Tp	0	-4,115	0	675	0	0	0	388	6,958	0	0	6,087,037	6,090,942	6.7%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	-3,756,127	-2,833,356	0	-3,060,623	0	-82,901	-235,584	-6,289,255	-6,350,970	-956,312	-1,878	0	-23,567,006	-26.0%
Total		-3,762,208	-2,858,471	0	-3,057,951	7,095	-80,554	-239,472	-6,288,691	-4,674,352	-902,074	-1,878	112,399,103	90,540,546	100.0%
		-4.2%	-3.2%	0.0%	-3.4%	0.0%	-0.1%	-0.3%	-6.9%	-5.2%	-1.0%	0.0%	124.1%	100.0%	

CO_2 Emission for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	114,120,066	t CO_2
CO_2 Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	-23,633,758	t CO_2
CO_2 Emission / Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	90,486,308	t CO_2
Annual CO_2 Emission from 2006 to 2010 without emissions from forest conversion to forest plantation	28,530,017	t CO_2/yr
Annual CO_2 Removal from 2006 to 2010 without emissions from forest conversion to forest plantation	-5,908,440	t CO_2/yr
Annual CO_2 Emission / Removal from 2006 to 2010 without emissions from forest conversion to forest plantation	22,621,577	t CO_2/yr

Table 6: Forest Living Belowground Biomass Carbon Stock of 2006

Forest Type		Year 2010												Total (t C)	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2006	E	52,297,333	0	0	0	297	0	0	0	67,725	15,511	0	2,123,015	54,503,881	41.9%
	Se	3,586	28,929,694	0	263	0	0	0	0	68,663	880	0	1,373,828	30,376,915	23.4%
	P	0	0	77,814	0	0	0	0	0	0	0	0	0	77,814	0.1%
	D	0	0	0	36,983,166	80	0	69	0	9,207	18,796	0	1,095,506	38,106,824	29.3%
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	M	1,959	753	0	0	0	423,576	549	0	0	0	0	10,777	437,614	0.3%
	Mr	0	1,154	0	0	0	1,348	393,268	0	642	0	0	12,244	408,656	0.3%
	Ff	0	0	0	0	0	0	0	3,284,021	4,122	0	0	869,449	4,157,592	3.2%
	Fr	1,294	44	0	616	0	0	81	151	1,408,856	2,053	0	186,217	1,599,311	1.2%
	Tp	0	159	0	249	0	0	0	72	1,541	76,453	0	336,965	415,438	0.3%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Total														130,084,045	100.0%

Density	
t BGB/ha	t C/ha
31.25	14.69
44.48	20.90
20.30	9.54
17.58	8.26
0.00	0.00
29.04	13.65
31.59	14.85
14.81	6.96
15.74	7.40
20.30	9.54
20.30	9.54
0.00	0.00
-	7.2

BGB is estimated from AGB based on Carins et al (1997) in IPCC (2003).

t BGB/ha= 0.47 t C/ha
C value is round off to two decimal places.

Table 7: Forest Living Belowground Biomass Carbon Stock of 2006

Forest Type		Year 2010												Total
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF	
Year 2006	E	52,297,333	0	0	0	0	0	0	0	34,116	10,073	0	0	
	Se	2,521	28,929,694	0	104	0	0	0	0	24,311	402	0	0	
	P	0	0	77,814	0	0	0	0	0	0	0	0	0	
	D	0	0	0	36,983,166	0	0	125	0	8,248	21,709	0	0	
	B	0	0	0	0	0	0	0	0	84	0	0	0	
	M	2,108	1,154	0	0	0	423,576	597	0	0	0	0	0	
	Mr	0	1,624	0	0	0	1,239	393,268	0	320	0	0	0	
	Ff	0	0	0	0	0	0	0	3,284,021	4,382	0	0	0	
	Fr	2,569	123	0	687	0	0	162	142	1,408,856	2,646	0	0	
	Tp	0	349	0	216	0	0	0	52	1,195	76,453	0	0	
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	
	NF	196,429	141,407	0	172,584	0	4,378	12,303	362,862	363,615	52,939	104	0	
Total		52,500,960	29,074,352	77,814	37,156,758	0	429,193	406,455	3,647,077	1,845,127	164,223	104	0	125,302,061
		41.9%	23.2%	0.1%	29.7%	0.0%	0.3%	0.3%	2.9%	1.5%	0.1%	0.0%	0.0%	100.0%

Carbon Density t C/ha	14.69	20.90	9.54	8.26	0.00	13.65	14.85	6.96	7.40	9.54	9.54	0.00	6.90

Table 8: Forest Living Belowground Biomass Carbon Stock Change Matrix between 2006 and 2010

Forest Type		Year 2010												Total (t C)	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2006	E	0	0	0	0	297	0	0	0	33,609	5,438	0	2,123,015	2,162,359	45.2%
	Se	1,066	0	0	159	0	0	0	0	44,352	478	0	1,373,828	1,419,883	29.7%
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	D	0	0	0	0	80	0	-55	0	959	-2,913	0	1,095,506	1,093,576	22.9%
	B	0	0	0	0	0	0	0	0	-84	0	0	0	-84	0.0%
	M	-149	-400	0	0	0	0	-48	0	0	0	0	10,777	10,179	0.2%
	Mr	0	-470	0	0	0	109	0	0	322	0	0	12,244	12,205	0.3%
	Ff	0	0	0	0	0	0	0	0	-261	0	0	869,449	869,189	18.2%
	Fr	-1,275	-80	0	-72	0	0	-81	9	0	-594	0	186,217	184,125	3.9%
	Tp	0	-190	0	33	0	0	0	19	346	0	0	336,965	337,174	7.1%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	-196,429	-141,407	0	-172,584	0	-4,378	-12,303	-362,862	-363,615	-52,939	-104	0	-1,306,621	-27.3%
Total		-196,787	-142,547	0	-172,463	377	-4,269	-12,488	-362,833	-284,373	-50,530	-104	6,008,001	4,781,984	100.0%
		-4.1%	-3.0%	0.0%	-3.6%	0.0%	-0.1%	-0.3%	-7.6%	-5.9%	-1.1%	0.0%	125.6%	100.0%	

Table 9: Forest Living Belowground Biomass CO2 Emission / Removal Matrix between 2006 and 2010

Forest Type		Year 2010												Total	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2006	E	0	0	0	0	1,088	0	0	0	123,233	19,939	0	7,784,388	7,928,648	45.2%
	Se	3,907	0	0	584	0	0	0	0	162,622	1,754	0	5,037,370	5,206,237	29.7%
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	D	0	0	0	0	294	0	-203	0	3,515	-10,680	0	4,016,854	4,009,779	22.9%
	B	0	0	0	0	0	0	0	0	-309	0	0	0	-309	0.0%
	M	-547	-1,467	0	0	0	0	-177	0	0	0	0	39,514	37,323	0.2%
	Mr	0	-1,724	0	0	0	400	0	0	1,180	0	0	44,894	44,750	0.3%
	Ff	0	0	0	0	0	0	0	0	-955	0	0	3,187,981	3,187,026	18.2%
	Fr	-4,675	-292	0	-262	0	0	-298	33	0	-2,177	0	682,797	675,126	3.9%
	Tp	0	-696	0	122	0	0	0	71	1,267	0	0	1,235,539	1,236,304	7.1%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	-720,239	-518,493	0	-632,810	0	-16,051	-45,112	-1,330,493	-1,333,253	-194,111	-381	0	-4,790,943	-27.3%
Total		-721,554	-522,672	0	-632,366	1,382	-15,652	-45,789	-1,330,389	-1,042,700	-185,275	-381	22,029,337	17,533,941	100.0%
		-4.1%	-3.0%	0.0%	-3.6%	0.0%	-0.1%	-0.3%	-7.6%	-5.9%	-1.1%	0.0%	125.6%	100.0%	

CO_2 Emission for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	22,327,654	t CO_2
CO_2 Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	-4,802,549	t CO_2
CO_2 Emission / Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	17,525,105	t CO_2
Annual CO_2 Emission from 2006 to 2010 without emissions from forest conversion to forest plantation	5,581,914	t CO_2/yr
Annual CO_2 Removal from 2006 to 2010 without emissions from forest conversion to forest plantation	-1,200,637	t CO_2/yr
Annual CO_2 Emission / Removal from 2006 to 2010 without emissions from forest conversion to forest plantation	4,381,276	t CO_2/yr

Table 10: Forest Living Aboveground Biomass CO2 Emission / Removal Matrix between 2010 and 2014

Emission and removal for 2010-2014 was calculated in the same manner with the 2006-2010 AGB and BGB emission/removal as shown above. Summary of emissions/removals for 2010-2014 are shown below

Forest Type		Year 2014												Total	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2010	E	0	-11,567	0	81,916	0	468	-155	0	6,829,405	351,311	6,069	167,323,778	174,581,225	39.8%
	Se	0	0	0	0	34,507	0	0	0	4,710,461	395,408	22,598	122,854,346	128,017,319	29.2%
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	D	-2,782	0	0	0	981	0	0	0	208,821	-325,369	-1,610	166,838,174	166,718,215	38.0%
	B	0	0	0	0	0	0	0	0	-77,524	0	0	0	-77,524	0.0%
	M	0	0	0	0	0	0	-2,306	0	0	0	0	459,794	457,488	0.1%
	Mr	185	0	0	0	8,900	10,689	0	0	99,419	10,194	0	2,378,076	2,507,462	0.6%
	Ff	0	0	0	0	0	0	0	0	-15,403	0	0	14,119,492	14,104,089	3.2%
	Fr	-796,847	-951,565	0	-25,121	32,338	-3,852	-20,690	5,643	0	-91,936	-306	18,477,541	16,625,206	3.8%
	Tp	-1,205	-4,066	0	132	0	0	0	0	10,120	0	0	930,445	935,426	0.2%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	-11,063,462	-10,567,117	-6,842	-21,066,237	0	-765,936	-2,235,503	-9,077,719	-7,587,272	-2,255,654	-600,047	0	-65,225,788	-14.9%
Total		-11,864,112	-11,534,315	-6,842	-21,009,311	76,727	-759,630	-2,258,654	-9,072,076	4,178,027	-1,916,046	-572,296	493,381,646	438,643,118	100.0%
		-2.7%	-2.6%	0.0%	-4.8%	0.0%	-0.2%	-0.5%	-2.1%	1.0%	-0.4%	-0.1%	112.5%	100.0%	

CO_2 Emission for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	505,415,632	t CO_2
CO_2 Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	-67,138,872	t CO_2
CO_2 Emission / Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	438,276,760	t CO_2
Annual CO_2 Emission from 2006 to 2010 without emissions from forest conversion to forest plantation	126,353,908	t CO_2/yr
Annual CO_2 Removal from 2006 to 2010 without emissions from forest conversion to forest plantation	-16,784,718	t CO_2/yr
Annual CO_2 Emission / Removal from 2006 to 2010 without emissions from forest conversion to forest plantation	109,569,190	t CO_2/yr

Table 11: Forest Living Belowground Biomass CO2 Emission / Removal Matrix between 2010 and 2014

Forest Type		Year 2014												Total	
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF		
Year 2010	E	0	-1,910	0	14,368	0	80	-26	0	1,203,732	61,103	1,056	32,084,405	33,362,806	39.1%
	Se	0	0	0	0	6,315	0	0	0	805,360	66,833	3,820	22,481,883	23,364,210	27.4%
	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	D	-488	0	0	0	203	0	0	0	38,210	-59,074	-292	34,495,202	34,473,760	40.4%
	B	0	0	0	0	0	0	0	0	-16,275	0	0	0	-16,275	0.0%
	M	0	0	0	0	0	0	-392	0	0	0	0	89,024	88,631	0.1%
	Mr	31	0	0	0	1,704	1,819	0	0	17,510	1,772	0	455,376	478,213	0.6%
	Ff	0	0	0	0	0	0	0	0	-2,884	0	0	2,986,981	2,984,097	3.5%
	Fr	-140,450	-162,692	0	-4,597	6,789	-683	-3,644	1,057	0	-16,744	-56	3,878,973	3,557,953	4.2%
	Tp	-210	-687	0	24	0	0	0	0	1,843	0	0	188,861	189,831	0.2%
	Pp	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
	NF	-2,121,424	-1,933,743	-1,389	-4,355,622	0	-148,298	-428,075	-1,920,393	-1,592,789	-457,850	-121,797	0	-13,081,379	-15.3%
Total		-2,262,540	-2,098,032	-1,389	-4,345,828	15,011	-147,082	-432,138	-1,918,336	454,708	-403,961	-117,270	96,660,705	85,401,848	100.0%
		-2.6%	-2.5%	0.0%	-5.1%	0.0%	-0.2%	-0.5%	-2.2%	0.5%	-0.5%	-0.1%	113.2%	100.0%	

CO_2 Emission for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	98,759,749	t CO_2
CO_2 Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	-13,416,317	t CO_2
CO_2 Emission / Removal for 4 years from 2006 to 2010 without emissions from forest conversion to forest plantation	85,343,432	t CO_2
Annual CO_2 Emission from 2010 to 2014	24,689,937	t CO_2/yr
Annual CO_2 Removal from 2010 to 2014	-3,354,079	t CO_2/yr
Annual CO_2 Emission / Removal from 2010 to 2014	21,335,858	t CO_2/yr

Annex 2 Description of land use/cover types

No	Land cover class	ID	Description
1	Evergreen forest	E	Areas covered by trees maintaining their leaves during the whole year.
2	Semi-evergreen forest	Se	Contain variable percentages of evergreen and deciduous trees.
3	Deciduous forest	D	Comprised of dry mixed deciduous forest and dry Dipterocarp forests
4	Bamboo	B	Areas dominated by bamboo
5	Wood shrub	Ws	Areas dominated by evergreen and deciduous woodland with a height less than 5 meters
6	Mangrove forest	M	Areas dominated by Mangroves i.e. coastal salt tolerant species
7	Rear Mangrove	Mr	Mostly growing in coastal zone after mangrove spp. Salt tolerant species but only infrequent floods
8	Rubber plantation	Rp	Areas currently supporting, and areas reserved for, rubber plantation
9	Flooded Forest	Ff	This forest type is found in Tonle Sap Lake. Most of the forests are low and disturbed. In many cases, there is only a mosaic remaining
10	Forest Regrowth	Fr	Areas of naturally regenerated forest where there are clearly visible indication of human activities such as selective logging, areas regenerating following agricultural land use, areas recovering from human induced fire, etc. • Include forest where it is not possible to distinguish whether planted or naturally regeneration. • Include forests with mix of naturally regenerated trees and planted/seeded trees, and where the naturally regenerated trees are expected to constitute more than 50 percent of the growing stock at stand maturity. • Include abandoned forest land and bare land which will regrow into forest within ten years
11	Pine Forest	P	The area dominated by coniferous trees which is natural pine forest
12	Pine plantation	Pp	The area domunated by pine tree plantation
13	Oil palm	Po	The area dominated by oil palm tree.
14	Tree plantation	Tp	This class includes the following type: teak, eucalyptus, acacia, jatropha and others.
15	Paddy Field	Hr	Paddy field is a flooded parcel of arable land used for growing semiaquatic rice.
16	Crop Land	Hc	This category includes arable and tillage land, and agro-forestry systems where vegetation falls below the thresholds used for the forest land category
17	Grassland	G	Grasslands are characterized as lands dominated by grasses rather than large shrubs or trees. It is crucial that the rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur.
18	Built-up area	Bu	The patch of land with building and construction
19	Village	Bt	The patch of land with houses and garden surrounding house.
20	Rock	R	Land of naturally exposed rocks or strip mines, quarries and gravel pits.
21	Sand	S	In general, land of sand having thin soil or sand including deserts, dry salt flats, beaches, sand dunes.
22	Water	W	Area of fresh and sea water

Annex 3 Detailed methodology for acquiring activity data

1. Preparation of maps for FRL calculation

As of 2011 when Cambodia started its REDD+ readiness activities, maps showing forest cover of Cambodia were available for the year 1965, 1993, 1997, 2002, 2006 and 2010. Historically, the maps were made by interpreting satellite images printed on paper. From the 2002 map production, on-screen digitizing method using GIS software was introduced. The classification system and forest definition thresholds were not consistent for these maps (Brun, 2013)

Cambodia planned to establish its initial Forest Reference Level (FRL) by around September 2015 and in order to achieve this goal, development of a 2014 base map was initiated. For historical data existing maps were envisioned to be used as long as consistency could be warranted. These historical maps had the following issues as base for activity data for FRL establishment:

- The historical maps used various classification systems
- Before (2002) the forest cover threshold was 20% whereas the FRL forest definition is using a 10% threshold.
- Accuracy assessment was performed for the 2006 and 2010 maps only. That is, only these maps are suitable to be used in FRL establishment.
- Rubber and oil palm plantations, which are excluded from the Cambodia's forest definition for REDD+, were included in Other Forest class and were not separated in most historical data.
- Non-forest area is not stratified

To deal with these issues, the following measures were taken:

- Comparison of the classification and forest definitions used in historical maps and those used for FRL establishments
- Review land use/cover classes of 2006 and 2010 maps to make them consistent with six land use/cover categories defined by IPCC.
- Stratify Other Forest and Non-Forest classes of the 2006 and 2010 maps according to the new land use/cover classes and also exclude rubber and oil palm plantation classes from forest category.

2 Forest Definition for REDD+

The forest definition for REDD+ follows the definition of the National Forest Programme while rubber and oil palm plantation classes are excluded from the definition of forest. Forest under the REDD+ programme refers to a unit of an ecosystem in the form of wetland and dry land covered by

natural or planted vegetation with a height from 5 meters on an area of at least 0.5 hectares, and canopy crown cover of more than 10%. Area also included in the REDD+ programme are forest regrowth.

The land cover/use classification of Cambodia presents in 22 classes, including 9 classes of natural forests, 2 classes of plantation forest, 11 classes of non-forest, covering all 6 IPCC land use categories. Name of the 22 classes and description are in Annex 2 and the comparison of the land use class with the class of IPCCC category are show in the Table 1..

Table 1. Comparison of land use/cover classes

	Old (2006/2010) class		New class	IPCC guideline classification
1	Evergreen forest	1	Evergreen forest	Forest land
2	Semi-evergreen forest	2	Semi-evergreen forest	
3	Deciduous forest	3	Deciduous forest	
4	Bamboo	4	Bamboo	
5	Wood shrub dry	5	Wood shrub	Other land
6	Wood shrub evergreen			
7	Other forest	6	Mangrove forest	Forest land
		7	Rear mangrove	
		8	Rubber plantation	Cropland
		9	Flooded forest	Forest land
		10	Forest regrowth	
		11	Pine forest	
		12	Pine plantation	
		13	Oil palm	Crop land
		14	Tree plantation	Forest land
8	Non-forest	15	Paddy field	Cropland
		16	Crop Land	
		17	Grassland	Grassland
		18	Built-up area	Settlement
		19	Village	
		20	Rock	Other land
		21	Sand	
		22	Water	Wetland

The 22 land cover classes are based on physiognomy or biophysical appearance that are sensed by remote sensing data used (Landsat at 30m) and LCCS3 was used as a guiding tool to develop the classification.

3. Map production method

a. 2014 mapping

Unlike 2006 and 2010 mapping, all of the forest and non-forest areas were segmented for the 2014 mapping. The land use/cover classes of polygons generated by the segmentation process were identified by visual interpretation of LANDSAT images.

Several ancillary datasets (including boundary of forest plantation, Social Land concession, Economic land concession, and location of hydropower dams) were utilized during

the process of delineation, to catch additional information valuable for classification. Directive 001 land was classified as agricultural land because it was allocated for agricultural use, and SLC holders must abide by conditions that include development of the land through agricultural cultivation. The majority of lands have already been cleared, and it is reasonable to assume that all the Directive 001 land is converted to agricultural area in a very short period.

The procedure for the 2014 mapping is explained in Figure 1.

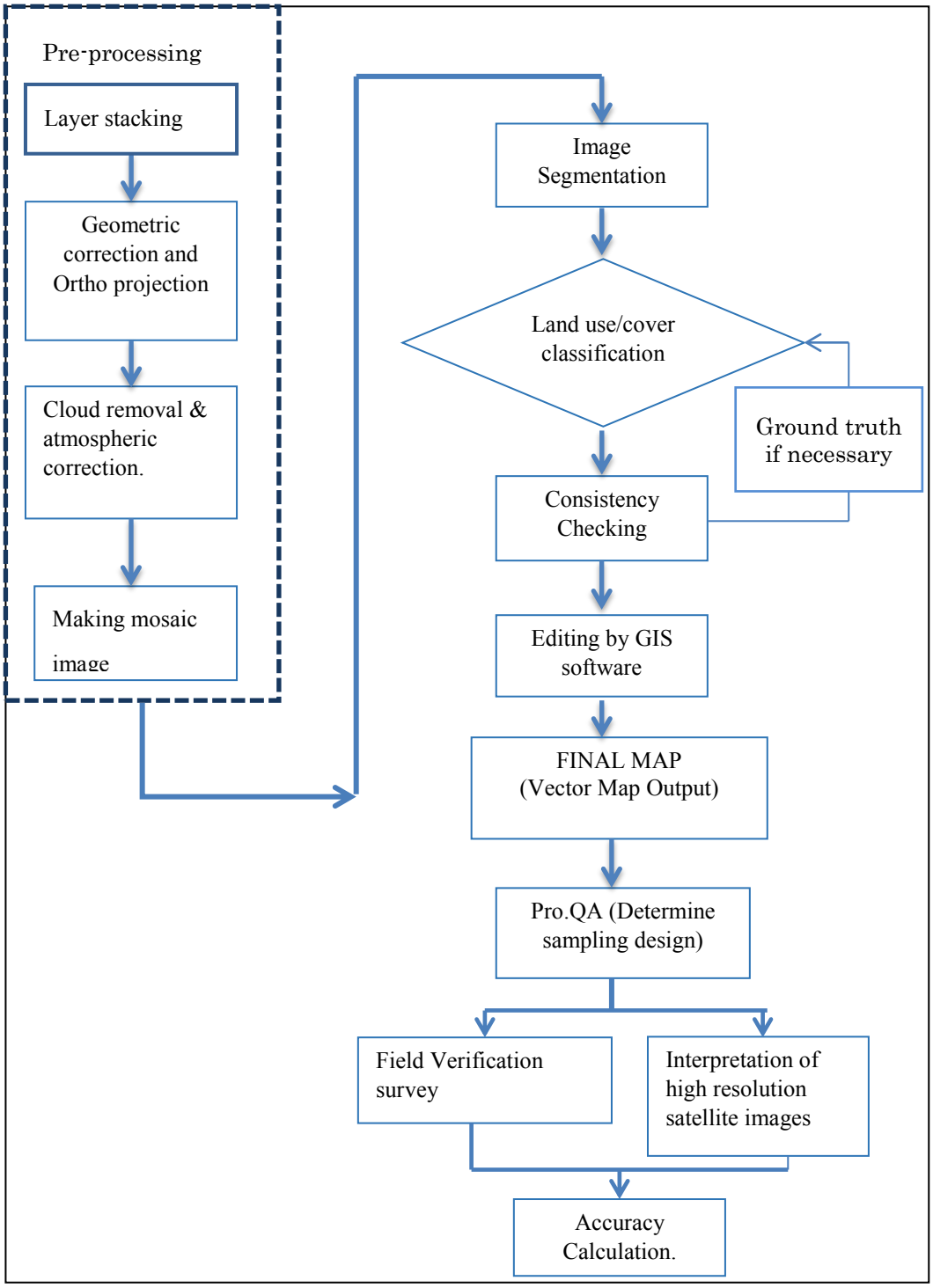

Figure 1: Procedure for develop Land Use/Cover 2014 Mapping

b. 2006 and 2010 map upgrading

"Other Forest" and "Non Forest" classes of original 2006 and 2010 maps were stratified according to newly defined land use/cover classes (Table 1) by using the same LANDSAT images used in the original mapping. In the stratification, segmentation technique was used. Land use/cover class of each segment (polygon) was identified by visual interpretation of LANDSAT images. Information such as map made by FAO and Mekong River Commission and images of GoogleEarth were also used as reference. Land use/cover class of minimum mapping unit (MMU) of Other Forest and Non Forest classes was 5ha while forest area data with a MMU of 25Ha was checked during correction stage to minimize inconsistency (See quality assurance and consistency).

Explanation Text: 1. Cambodia's forest definition was applied a minimum area of 0.5 hectares, but the minimum mapping unit for forest types was 5 hectares used in 2014 and 25 hectares in 2006 and 2010 by visual interpretation, it is impossible to identify from medium resolution satellite.

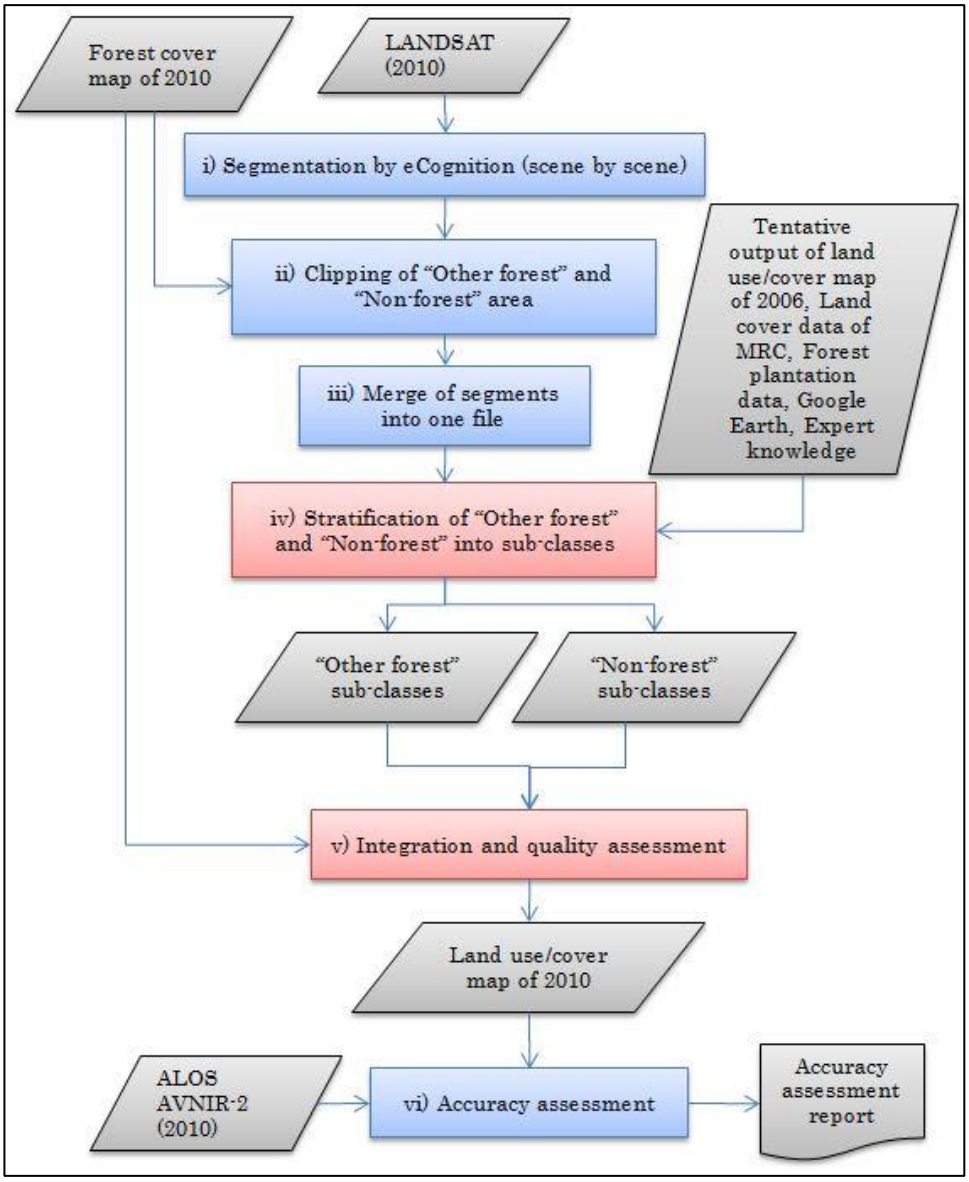

Figure 2: Procedure for upgrading Land Use/Cover 2010 Map

c. Quality assurance and consistency

New map of 2014 and upgraded maps of 2006 and 2010 were prepared for the purpose of obtaining land use/cover change information between 2006-2010 and 2010-2014. While the accuracy of each of the three maps is important, it is also important that land use/cover change information derived from the three maps is accurate.

To eliminate miss interpretation completely, thorough inspection of generated polygons is required. However, it is not practical to do this. Alternative method for checking is to identify land use/cover change patterns which are considered not likely and inspect land use/cover class of identified polygons. Process of land use/cover change pattern inspection is divided into three steps as shown in Figure 3.

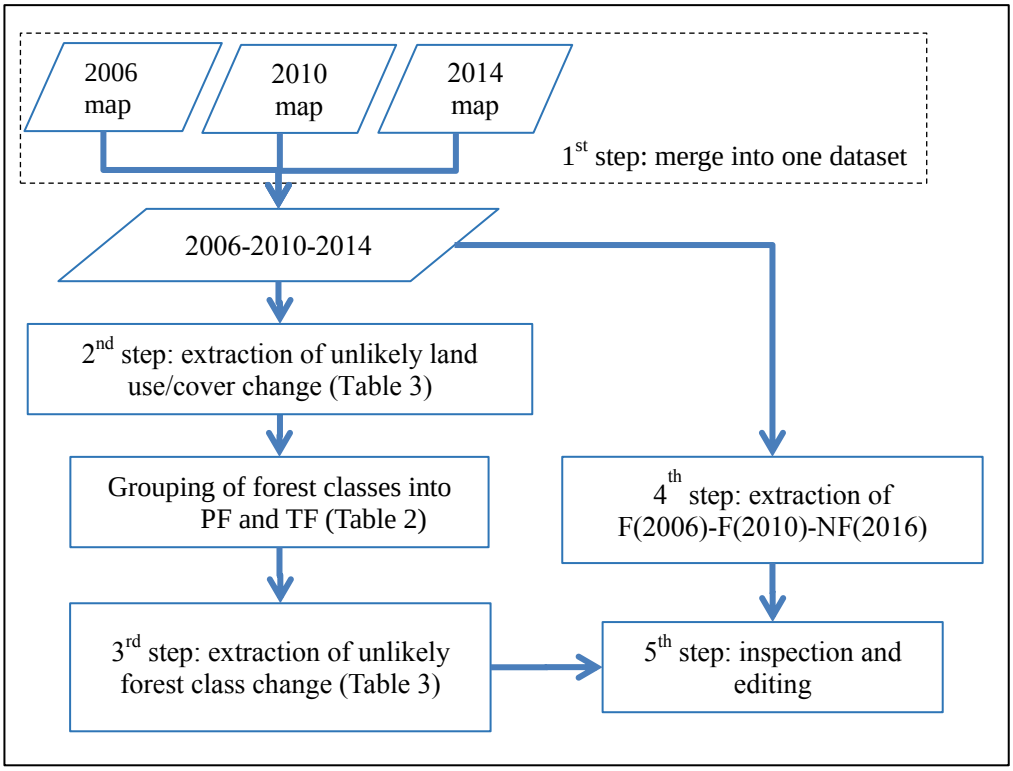

Figure 3: Procedure of quality assurance

In the 1st Step, map data of 2006, 2010 and 2014 were merged (intersected) into one file by using GIS.

In the 2nd Step, polygons with one of the following two land use/cover change pattern were selected.

F(2006)-NF(2010)-F(2014)
NF(2006)-F(2010)-NF(2014)

These two patterns were selected because it is unlikely that NF changes to F within a short period of time such as 4 years. However, if F is actually Forest Regrowth, NF to F change could be possible. So, for further inspection of land use/cover change, land use/cover classes belonging to Forest are divided into two groups as shown on Table 2.

Table 2. Grouping of forest classes into PF and TF

Permanent forest classes (PF)	Temporary forest classes (TF)
Evergreen forest (E)	Forest regrowth (Fr)
Semi-evergreen forest (Se)	Tree plantation (Tp)
Pine forest (P)	Rubber plantation (Rp)
Deciduous forest (D)	Oil palm plantation (Po)
Mangrove (M)	Pine plantation (Pp)
Rear Mangrove (Mr)	
Flooded forest (Ff)	
Bamboo (B)	

For the purpose of above grouping, Permanent Forest class is defined as those forests where their conditions continue for a long time if there are no anthropogenic or natural disturbances. Temporary Forest class is defined as those forests where their conditions change in relatively short period such as a few years to a few decades.

Then, as shown on Table 3, F-NF-F and NF-F-NF patterns were divided into 6 sub-patters. And among the 6 land use/cover change patterns, 3 patterns were considered as unlikely change. And, polygons which belong to one of these 3 patterns were extracted. The extracted polygons were stratified by the decision criteria, and the classes of polygons were inspected and corrected based on the class assignment procedure set for each decision criterion.

Table 3. Pattern of unlikely land use/cover change

Forest (F)/ non-forest (NF) change	Forest type change	Unlike liness	Decision criteria	Decision	Class assignment procedure	Magnitude		
						No. of polygon	Total area (ha)	% of country area
F(2006)-NF(2010)-F(2014)	PF(2006)-NF(2010)-PF(2014)	Yes	Permanent forest class of 2006 and 2014 coincides or not?	Yes	Replace NF(2010) with an attribute of permanent forest class of 2006 & 2014	71,489	18,224	0.1%
				No	An attribute of permanent forest class of 2014 is copied to 2006 and 2010 assuming that classification of 2014 is the most accurate and permanent forest class did not change between 2006 and 2014.	13,682	3,645	0.0%
	TF(2006)-NF(2010)-PF(2014)	Yes	Polygon area ≧5ha or not?	Yes	Check satellite imagery and edit attributes of 2006, 2010 and 2014.	36	331	0.0%
				No	An attribute of permanent forest class of 2014 is copied to 2006 and 2010 assuming that classification of 2014 is the most accurate and permanent forest class did not change between 2006 and 2014.	1,799	477	0.0%
	TF(2006)-NF(2010)-TF(2014)	No						
	PF(2006)-NF(2010)-TF(2014)	No						
NF(2006)-F(2010)-NF(2014)	NF(2006)-PF(2010)-NF(2014)	Yes	Polygon area ≧5ha or not?	Yes	Check satellite imagery and edit attributes of 2006, 2010 and 2014.	2,980	27,505	0.2%
				No	Non-forest class of 2014 is copied to 2010.	103,149	34,928	0.2%
	NF(2006)-TF(2010)-NF(2014)	No						

In the 3rd step, change patterns F(2006) – F(2010) – F(2014) were divided into 8 sub-patterns and 4 of them were labeled as unlikely change as shown in Table 4. And, polygons which belong to one of these four patterns were extracted. The classes of extracted polygons were inspected and corrected based on the class assignment procedure set for each unlikely forest type change.

Table 4. Pattern of unlikely change among forests

Permanent forest (PF)/ Temporary forest (TF) change	Forest type change	Unlike liness	Class assignment procedure	Magnitude		
				No. of polygon	Total area (ha)	% of country area
F(2006)-F(2010)-F(2014)	PF(2006)-TF(2010)-PF(2014)	Yes	An attribute of permanent forest class of 2014 is copied to 2006 and 2010 assuming that classification of 2014 is the most accurate and permanent forest class did not change between 2006 and 2014.	8,593	6,337	0.0%
	TF(2006)-TF(2010)-PF(2014)	Yes		14,515	42,668	0.2%
	TF(2006)-PF(2010)-PF(2014)	Yes		2,731	873	0.0%
	TF(2006)-PF(2010)-TF(2014)	Yes	An attribute of temporary forest class of 2014 is copied to 2010 assuming that classification of 2014 is the most accurate.	1,765	1,338	0.0%
	PF(2006)-PF(2010)-TF(2014)	No				
	PF(2006)-TF(2010)-TF(2014)	No				
	TF(2006)-TF(2010)-TF(2014)	No				
	PF(2006)-PF(2010)-PF(2014)	No				

Inconsistency among non-forest classes was not checked because, for the calculation of initial FRL of Cambodia, carbon stock of non-forest classes was considered as zero.

There are two possible reasons for unlikely changes. One is miss interpretation of satellite images. The other is caused by different Minimum Mapping Units (MMU) used in new 2014 map and those used in upgraded 2006 and 2010 maps. MMU of the 2014 map is 5ha while the MMU of 2006 and 2010 map for forest land was 25ha. As shown in Figure 4, a small patch of land which is less than 25ha and larger than 5ha could not be captured in 2006 and 2010 maps but captured in 2014 map. In the inspection and correction stage the use of different MMU was considered as a potential cause of unlikely change.

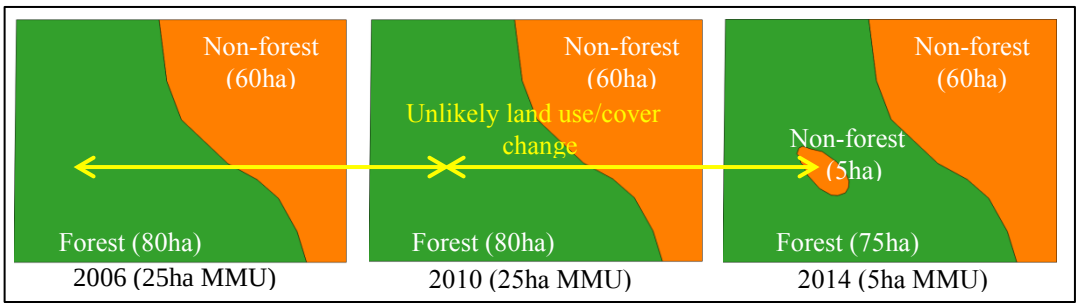

Figure 4. Unlikely land use/cover change caused by inconsistent MMU

In the 4th Step, target of inspection was F(2006)-F(2010)-NF(2014) change pattern. This is because there was possibility that small openings (non-forest areas) within forest class were not identified on 2006 and 2010 maps because of larger MMU.

First, Non-Forest areas on 2014 map were selected. Then, the selected Non-Forest areas which were classified as Forest on 2006 and 2010 maps were extracted. And among the extracted areas, areas which could be Non-Forest were identified by using Normalized Difference Vegetation Index (NDVI). And finally, 2006 and 2010 land use/cover class of the identified areas was determined by interpreting LANDSAT images.

F(2006-PF)-F(2010-PF)-NF (2014) :The area of NF class (<25ha and >5ha) in year 2014 were selected. Then, the selected Non-Forest areas which were classified as Forest on 2006 and 2010 maps were extracted. And among the extracted areas, areas which could be Non-Forest were identified by using Normalized Difference Vegetation Index (NDVI) generated from LANDSAT (resolution 0.09 ha) used in the mapping. And finally, 2006 and 2010 land use/cover class of the identified areas was determined by interpreting LANDSAT images.

Note: If identified land is more than 5ha, then, LANDSAT images of 2006, 2010 and 2014 were checked and correction of land use/cover class was made if necessary. If the size of the identified land is less than 5ha, they were corrected automatically based on the class assignment procedure set for

each land use/cover change pattern.

4. Accuracy Assessment

a. 2006 map

Accuracy assessment of the original 2006 forest assessment map was performed by Geographic Resource Analysis & Science A/S (GRAS). The report was compiled as Accuracy Assessment Report (draft final) (2007). Overall accuracy of the five classes – Evergreen Forest, Semi-evergreen forest, Deciduous Forest, Other Forest and Non-Forest, was 74%.

b. 2010 map

Accuracy assessment of the original 2010 forest assessment map was performed by GRAS. Overall accuracy was around 85%. After upgrading of the 2010 map and initial editing the Forestry Administration continued to check consistency among the three maps – 2006, 2010 and 2014 – and made necessary correction. The accuracy assessment was performed after the completion of consistency check and editing.

Number of accuracy assessment points was calculated by using a formula of Congalton & Green (Congalton, R. G. and Green, K., 2009) presented below.

$$n = B/4b^{\wedge}2$$

where

Confidence level (95%)	α	0.05
Number of class	κ	22
upper (α/κ) x 100th percentile of the $\chi 2$ distribution with 1 degree of freedom	B	9.3151
Desired precision	b	5% (0.05)

hence

$$n = B/4b^{\wedge}2 = 9.3151 / 4 \times (0.05)^{\wedge}2 = 932$$

While the calculated total number of the point was 932 minimum 50 points were assigned for each class where possible.

First, total 932 points were distributed to each land use/cover class in proportion to the area of each class. And minimum number of the assessment points was set as 50. If calculated number of the assessment point was less than 50, it was replaced by 50 to determine temporary number of the points.

On the other hand, Forestry Administration decided that accuracy assessment points should be selected among from national forest inventory (NFI) points, which cover Cambodia in a systematic way with a fixed distance. Based on this condition, number of NFI points included in each land use/cover class was calculated and compared with the temporary number of the points.

If the number of NFI point is less than the temporary assigned number, it was replaced by the number of NFI points. Table 4 shows the number of the calculated accuracy assessment points. As the result of the adjustment described above, total number of the accuracy assessment point was 1233.

Table 4 Accuracy assessment points for each land use/cover class for 2010 map

Class	Area (km2)	%	Calculated Number of points	Temporary number	NFI Point included in polygon	Final Number of points
Bamboo	1,280.99	0.71%	7	50	40	40
Village	2,948.46	1.62%	15	50	108	50
Built up area	437.03	0.24%	2	50	14	14
Deciduous	45,115.69	24.84%	232	232	1234	230
Evergreen	36,512.05	20.11%	187	187	1018	183
Flooded forest	5,126.93	2.82%	26	50	306	50
Forest regrowth	2,534.33	1.40%	13	50	70	50
Grass land	5,132.26	2.83%	26	50	238	50
Agriculture	11,824.51	6.51%	61	61	379	65
Paddy field	38,466.57	21.18%	197	197	1530	198
Mangrove	314.43	0.17%	2	50	34	40
Rear mangrove	274.36	0.15%	1	50	30	29
Pine forest	81.29	0.04%	0	50	2	2
Oil palm	50.35	0.03%	0	50	3	3
Rock	6.92	0.00%	0	50	0	
Rubber	1,117.87	0.62%	6	50	32	36
Sand	100.04	0.06%	1	50	4	4
Semi-evergreen	14,132.79	7.78%	73	73	398	71
Tree plantation	170.61	0.09%	1	50	7	5
Water	4,561.38	2.51%	23	50	236	50
Wood shrub	11,392.86	6.27%	58	58	426	58
	181,590.57	100.00%	932		6105	1,233

For the selected accuracy assessment points, their land use/cover class was interpreted on AVNIR2 images of ALOS satellite. Then, the result of the interpretation was compared to the land use/cover class of the upgraded 2010 map. The overall accuracy assessment of upgraded 2010 map is 73.97% with the kappa accuracy is 70.98%. The result of the accuracy assessment is summarized as a confusion matrix as presented in Table 5.

Table 5 Confusion matrix of upgraded 2010 map

Land use/cover classes		Verificaiton Result																				
		E	Se	P	D	Fr	B	M	Mr	Ff	Tp	Rp	Po	Hc	Hr	G	Ws	W	Bu	Bt	S	Sum	User Acc.
Classification on Map	E	165	8		1	1						1		4		1	2					183	90.16%
	Se	15	34		12	1								7		1				1		71	47.89%
	P			2																		2	100.00%
	D	8	31		169									13	1	2	5			1		230	73.48%
	Fr	3				29								5	2	1	10					50	58.00%
	B	12	1			5	15							1	1	1	9					45	33.33%
	M							36							1		1	2				40	90.00%
	Mr					1		4	20						1	1		2				29	68.97%
	Ff									39					1	5	5					50	78.00%
	Tp										5											5	100.00%
	Rp					1						33		1						1		36	91.67%
	Po												2	1								3	66.67%
	Hc				2							1		50	6		4			2		65	76.92%
	Hr				1	1								7	169		3	2		15		198	85.35%
	G	2	1							1				5	4	30	2	5				50	60.00%
	Ws	1			5	1				2				12	8	3	25			1		58	43.10%
	W									1					2		2	45				50	90.00%
	Bu													1	1	1			11			14	78.57%
	Bt					1								1	16		2			30		50	60.00%
	S					1															3	4	75.00%
	Sum	206	75	2	190	42	15	40	20	43	5	35	2	108	213	46	70	56	11	51	3	1233	16.71%
	Prod.Acc.	80%	45%	100%	89%	69%	100%	90%	100%	91%	100%	94%	100%	46%	79%	65%	36%	80%	100%	59%	100%		

c. 2014 map

Just like the accuracy assessment of the upgraded 2010 map, total number of accuracy assessment points was calculated by using the same Congalton & Green formula and then they were distributed for each class in proportion to the area of each class. Then, actual number of the points was adjusted in the same manner with the 2010 map accuracy assessment. Total number is 1252. Their location is shown in Figure 4.

All procedures in the sampling strategy follow the methodology described by Congalton & Green (1999, 2009), which is the most commonly used procedure for accuracy assessment of maps derived from remote sensing.

A summary table of the sample selection has shown in Table 6.

212 of the 1252 points were visited in the field. Remaining 527 points were checked on satellite images – 165 on Rapid Eye images, 527 using Google Earth high resolution images and 348 by careful visual interpretation of LANDSAT8 images.

Table 6: Summary of samples used in the accuracy assessment of the 2014 land use and land cover assessment

ID	Class LU/LC	Area		Number of sample				
		Ha	**%**	**Field Collection**	**Google earth**	**Rapid eye**	**Landsat 8**	**Total**
1	Evergreen Forest	3018031	16.62%	1	36	43	73	153
2	Semi Evergreen forest	1146937	6.32%	2	23	10	24	59
3	Deciduous Forest	3662553	20.17%	14	65	32	80	191
4	Pine Forest	8161	0.04%			2		2
5	Flooded Forest	478768	2.64%	6	29	7	5	47
6	Bamboo	137852	0.76%	4	15	4	17	40
7	Forest Regrowth	245348	1.35%	8	26	1	11	46
8	Mangrove	32898	0.18%	2	14	15	5	36
9	Rear mangrove	27072	0.15%	1	7	14	3	25
10	Pine Plantation	3751	0.02%	1	1		1	3
11	Tree Plantation	49237	0.27%	10	2		4	16
12	Oil Palm Plantation	34107	0.19%		2	1	9	12
13	Rubber Plantation	482822	2.66%	15	10	7	18	50
14	Paddy field	4122259	22.70%	72	120	4	20	216
15	Agriculture	2538572	13.98%	24	60	11	38	133
16	Wood shrub	629303	3.47%	12	19	5	9	45
17	Village	339941	1.87%	20	24	1	2	47
18	Built up area	42864	0.24%	11	3		0	14
19	Grassland	345826	1.90%	5	22	4	15	46
20	Rock	2141	0.01%				1	1
21	Sand	44311	0.24%	2	9	2	3	16
22	Water	767932	4.23%	2	40	2	10	54
	Total area	**18160674**	**100%**	**212**	**527**	**165**	**348**	**1252**

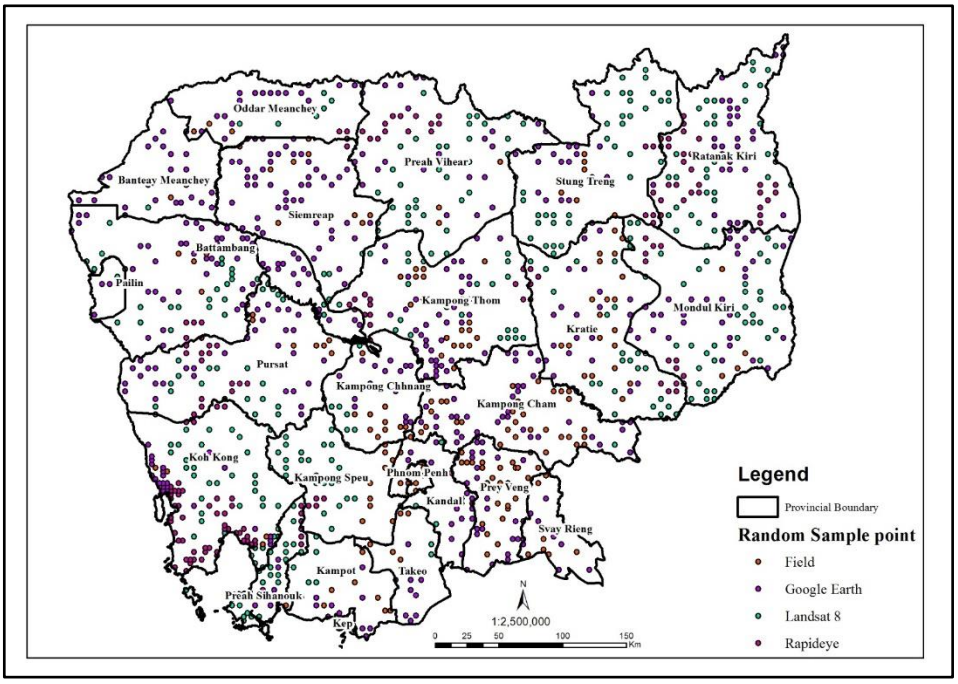

Figure4: Map of random sample 1252 points for accuracy check land use /land cover 2014

In total, 201 of the planned 212 points were visited in the field. The reason for the visited points being lower than the planned points was due to restricted access (9 cases), Seven of these points were situated in the flooded forest area which could not be reached due to extended dry season which prevented access by boat and two points were situated in prohibited area (Military station and economic land concession). The distribution of the field samples covered 22 provinces out of 24 (Table 7).

Table7: Summary of random sample point assess by province

No	Province	Point	Assess point
1	Kampong Spueu	10	9
2	Kaoh Kong	4	4
3	Krong Preah Sihanouk	1	1
4	Krong Kaeb	1	1
5	Kampot	7	7
6	Takaev	5	5
7	Kandal	8	8
8	Bat Dambang	5	4
9	Pousat	14	9
10	Kampong Chhnang	14	12
11	Phnom Penh	8	8
12	Kampong Cham	31	9
13	Kampong Thom	20	19
14	Preah Vihear	3	3
15	Otdar Mean Chey	3	3
16	Banteay Mean Chey	2	2
17	Siem Reap	9	9
18	Stueng Traeng	6	6
19	Kratie	22	21
20	Mondol Kiri	4	4
21	Prey Veaeng	28	28
22	Svay Rieng	7	7
TOTAL		212	201

Assessment of land use/cover consistency between field verification data collected in 2015 and Landsat image of 2014

1 year had elapsed between satellite image acquisition and field survey. So, it was necessary to check whether the site had changed during the one year period in order to verify the result of field survey for accuracy assessment.

For the purpose of this verification, Landsat 8 images of the year 2014 and 2015 were compared as shown in Figure 5. In Figure 5, the land cover class observed during field survey differed from the land cover class interpreted on 2014 satellite image. Therefore, this field verification data was excluded from the samples of accuracy assessment.

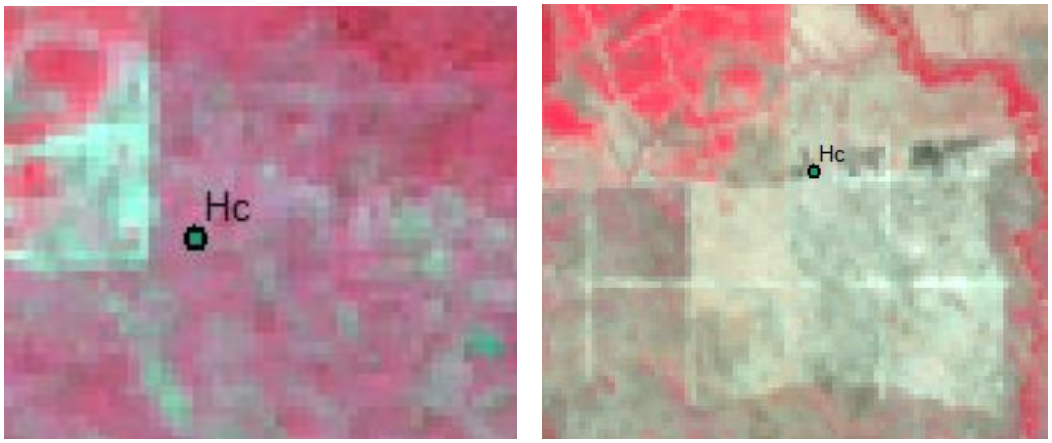

Figure5: Landsat image 2014 Landsat image 2015

The result of the accuracy assessment on land use and land cover 2014 is shown in Table 8.

Table 8 Confusion Matrix of 2014 map

LU/LC classes		Field sample																						
		BB	Bt	Bu	D	E	Ff	Fr	G	Hc	Hr	M	Mr	P	Po	Pp	R	Rp	S	Se	Tp	W	Ws	Sum	User acc.
Classified	BB	25				8				3										3			1	40	62.5%
	Bt		42							2	3													47	89.4%
	Bu		1	8															3				2	14	57.1%
	D	3			147			2	3	3	2									22			9	191	77.0%
	E				4	139		1	1	2										5			1	153	90.8%
	Ff						46															1		47	97.9%
	Fr		1				2	37	1	3	1												1	46	80.4%
	G				1		1		32	3	3								1			1	4	46	69.6%
	Hc		1		6			2	2	102	4		1					3	1			3	8	133	76.7%
	Hr	1	7	1	1				1	2	196								1			3	2	216	90.7%
	M										1	29	4									1	1	36	80.6%
	Mr											5	19									1		25	76.0%
	P													2										2	100.0%
	Po											1			11									12	91.7%
	Pp								1							2								3	66.7%
	R																1							1	100.0%
	Rp								2	4								44						50	88.0%
	S								1	1	1								10			2	1	16	62.5%
	Se	1			5					2	1									45		1	4	59	76.3%
	Hc				1					3											11		1	16	68.8%
	W		1	1			2		1		3											46		54	85.2%
	Ws		1		4	2	1	3	4	2	1	1									1	2	23	45	51.1%
	Sum	30	54	10	169	149	52	45	49	132	216	36	24	2	11	2	1	47	16	75	12	61	58	1252	
	Sum Prod. Acc	83.33%	77.78%	80.00%	86.98%	93.29%	88.46%	82.22%	65.31%	77.27%	90.74%	80.56%	79.17%	100.00%	100.00%	100.00%	100.00%	93.62%	62.50%	60.00%	91.67%	75.41%	39.66%		

The overall accuracy with respect to the combination of field verification and high resolution images is 81.23% with user's accuracy is 78.70, producer's accuracy is 82.17% and Kapa accuracy is 79.49%. The accuracy showed lowest results in the Wood shrub and grass land classes. Some of these errors are inevitable given the difficulties of separating certain classes, e.g. deciduous forest from wood shrub.

References:

Congalton, R.G. and Green, K. 2009. Assessing the Accuracy of Remotely Sensed Data Principles and Practices

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Brun, S. (2013) Land cover and forest classification systems of Cambodia. UN-REDD Programme, Phnom Penh, Cambodia.

Annex 4 Detailed methodology for acquiring AGB values for emission factors

Introduction

For the purpose of compiling a national Greenhouse Gas inventory for the forestry sector and also of establishing a national forest reference level (FRL)[5] for REDD+, volume of carbon sequestrated in five carbon pools in the forest need to be estimated. In Cambodia, various forest inventory surveys have been carried out. However, nationwide systematic forest inventory survey has not yet been implemented.

In the absence of nationwide data on forest carbon, carbon stock for each forest type of Cambodia need to be estimated based on available data sources. First, JICA Technical Assistants Team carried out a literature survey to identify value of biomass density of each forest type of Cambodia. On the other hand, under UN-REDD program FAO collected raw data of various forest inventory surveys implemented in Cambodia and analyzed values of biomass density (Sola et al., 2014).

Based on these works, values of forest biomass density to be used in GHG inventory and FRL establishment for Cambodia were selected. Additional literature survey was conducted for searching regional data if suitable country specific values were not found in the two works mentioned above. This paper explains the process of the selection and selected values. Since the data other than Above Ground Biomass (AGB) are rather limited for Cambodia, this paper focuses only on AGB.

1 Recommended AGB values for Emission Factors

Recommended values of AGB for each forest type are summarized in

[5] Forest Reference Level is a benchmark for assessing each country's performance in implementing REDD+ activities which is expressed in tons of carbon dioxide (CO2) per year. Forest biomass can be converted to carbon volume and then to the CO2 volume by using existing formulas.

Table 1. All land use/cover types other than forest category used in present land use/cover mapping by Forestry Administration are also shown. The area and ratio of major forest types of Cambodia as of 2010 is summarized in Table 2. As Table 2 shows, three principal forest types, i.e. Evergreen, Semi-evergreen and Deciduous forests, occupy 90.54% of entire forest land of Cambodia. Since AGB values of these three forest types are country specific, emission factors of Cambodia's forest could be substantially considered as Tier 2 level.

Table 1 Recommended unit AGB values

Land use/cover			Recommended AGB (t/ha)	Data source*	References Used for
Category		Sub-category			
Forest land	Natural forest	Evergreen	163	Country specific	UN-REDD (2014)
		Semi-evergreen	243	Country specific	UN-REDD (2014)
		Deciduous	85	Country specific	UN-REDD (2014)
		Pine forest	100	IPCC Default	IPCC (2003), MoE/UNDP (2003)
		Bamboo	0	-	(Nil)
		Mangrove	150	Regional	MoE/UNDP (2003)
		Rear mangrove	165	Regional	Tran (2015)
		Flooded forest	70	IPCC Default	MoE, 2002, MoE/UNDP (2003)
		Forest regrowth	75	Country specific	CFI (2008) cited in Sar (2010)
	Planted Forest	Pine plantation	100	IPCC Default	IPCC (2003), MoE/UNDP (2003)
		Tree plantation	100	IPCC Default	IPCC (2003), MoE/UNDP (2003)
Cropland		Rubber plantation	43**	Country specific	Toriyama et.al. (2011)
		Oil palm plantation	42**	Regional	Kotowska et.al (2015)
		Cropland	-	-	-
		Paddy field	-	-	-
Grass land		Grass land	-	-	-
		Wood shrub	-	-	-
Wetland		Water	-	-	-
Settlement		Village	-	-	-
		Built-up area	-	-	-
Other land		Rock	-	-	-
		Sand			

* Country specific: based on studies of forest in Cambodia, Regional: based on the study in neighbor countries in Southeast Asia

** These figures of Rubber plantation and Oil palm plantation were not used in the initial FRL calculation.

Table 2 Forest cover in Cambodia (2010)

Forest Type	Area (ha)	Ratio (%)
Evergreen forest	3,573,437	34.19
Semi-evergreen forest	1,391,117	13.31
Deciduous forest	4,498,397	43.04
Other forest	988,472	9.46
Total forest land	10,451,423	100.00

90.54% of total forest land

Source: Cambodia Forest Cover 2010 (Kingdom of Cambodia, 2011)

2 Selection of an AGB value for each forest type

First of all, in Cambodia, forest is classified into 11 types as shown in Table 1. In this chapter, the reasons for the selection of an AGB value for each forest type are explained. Section 2.1 is dedicated to Evergreen, Semi-evergreen, and deciduous Forests, Section 2.2 is for the other forest types, and Section 2.3 is for rubber and oil palm plantations.

2.1 Above Ground Biomass for Evergreen, Semi-evergreen, and deciduous Forests

2.1.1 Data source examined for selecting the values

1) Initial National Communication (INC) of Cambodia (MoE, 2002)

This is the official document of Cambodia submitted to UNFCCC in 2002. The document used default AGB values provided in the Revised 1996 Guidelines for National GHG Inventories (IPCC, 1997).

2) CCEAP Phase 2, final report (MoE/ UNDP, 2003)

Cambodia Climate Change Enabling Activity Project (CCEAP) was carried out to assist Cambodia to prepare an initial National Communication. One of the objectives of Phase 2 of the project was to improve activity data and emission factors used in the INC so that better figures would be used in the future National Communications. Activity data and emission factors identified in the report were used in the second National Communication which is planned to be submitted to UNFCCC in the near future.

In this report, AGB values were collected from two sources. One is a field survey carried out by the CCEAP project in 14 sample plots in seven sites. The other is the results of forest biomass studies conducted in the past in the region of South East Asia.

3) Forest biomass in Cambodia (Sola et al., 2014)

In the past, Cambodian government carried out forest inventory surveys at various locations in collaboration with different institutions. Under UN-REDD program, FAO collected part of the raw data of these forest surveys - 40 permanent sample plots (PSP), 668 plots of REDD+ related projects, and 1,047 plots in Community forests - and harmonized them to create allometric equations and estimate unit AGB values for different forest types (UN-REDD, 2014, unpublished). The location of each plot is shown in in Figure 1.

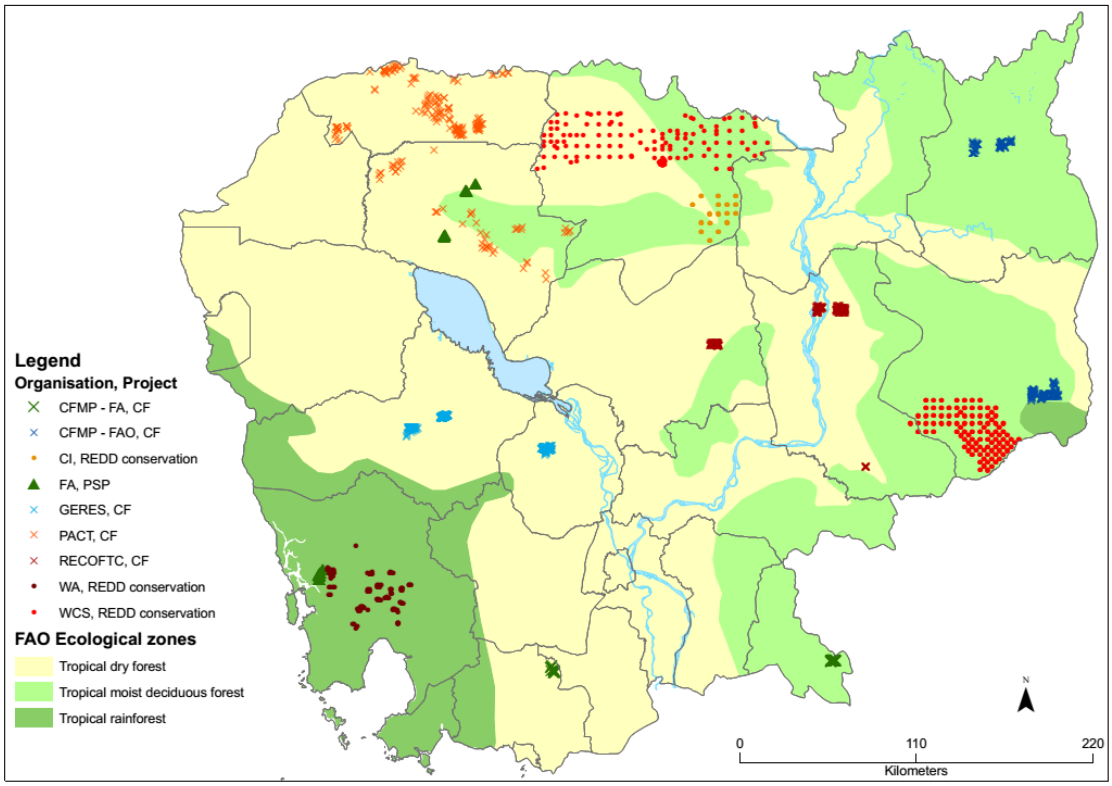

Figure 1: Location of forest inventories used in UN-REDD (2014) (Cited from Sola et al. 2014)

Under those efforts, the values of AGB for Evergreen, Semi-evergreen, and deciduous Forests are calculated by using the data of 39 permanent sample plots (PSP), 474 plots of REDD+ related projects, and 528 plots in Community forests for which the authors of this UN-REDD paper judged that those data were collected in those three forest types. The results are not explicitly shown in the paper. Therefore the values were re-calculated using the back data of this paper of UN-REDD which were offered by one of the authors with his courtesy. Table 3 is the result if the re-calculation.

In Table 3, values in the column of "Average AGB value in each study" are those calculated for each of PSP, REDD+ project plots and community forestry plots (columns (a), (b), and (c)). "n" means the number of plot used for the calculation. Columns (d) and (e) are the average of AGB values of PSP, REDD+ project plots and Community Forestry plots by different combination.

Table 3 Summary of AGB values identified in UN-REDD (2014)

Forest type	Average AGB value in each study*			**(d)** Average of (a) + (b)	**(e)** Average of (a)+(b)+(c)
	(a) PSP (n=39)	**(b)** REDD (n=474)	**(c)** CF (n=528)		
Evergreen	325 t/ha (n= 35)	232 t/ha (n= 270)	47 t/ha (n= 210)	243 t/ha (n= 305)	163 t/ha (n= 515)
Semi-evergreen	- -	356 t/ha (n= 54)	51 t/ha (n= 32)	356 t/ha (n= 54)	243 t/ha (n= 86)
Deciduous	100 t/ha (n= 4)	193 t/ha (n= 150)	29 t/ha (n= 286)	190 t/ha (n= 154)	85 t/ha (n= 440)

* PSP: permanent sample plots, REDD: REDD+ related projects, CF: Community forests.

** The values are calculated from back data of UN-REDD (2014)

*** Only the values of (c) and (d) are shown in UN-REDD (2014). Moreover, the values are slightly different from those calculated from back data. This is the reasons why the value was re-calculated from the back data.

2.1.2 Selection of the values of unit AGB

In order to select recommendable values of unit AGB, those used in the INC of Cambodia (MoE, 2002), those identified in CCEAP (MoE/ UNDP, 2003), and those from UN-REDD (2004) were shown in Table 4.

Table 4: Comparison of AGB values of three main forest types (ton/ha)

Forest type	INC (MoE, 2002)	CCEAP (MoE/UNDP, 2003)	UN-REDD (2014)	
			Average of PSP and REDD	Average of PSP, REDD and CF
Evergreen	295	200	243	163
Semi-evergreen	370	250	356	243
Deciduous	120	100	190	85

The data sets of UN-REDD (2014) are acquired from raw data of forest inventory survey. Therefore, traceability and transparency of the data for acquiring those values are much higher than the other two. Moreover, the values in UN-REDD (2014) are suitable for Tier 2 level GHG inventory because all of the data used are acquired by field survey conducted in Cambodia.

Among two datasets of UN-REDD (2014), the values of "average of PSP and REDD+ related project" is higher than those of CCEAP (MoE/UNDP, 2003) for all of the three forest types. As a figure in Annex I shows, most of PSP and REDD+ related project plots are located in protected areas or protected forests with high biomass density forest. Therefore, the average of only PSP and REDD+ related project plots might result in the overestimation for a national scale AGB.

In the sense of avoiding overestimation, the averaged AGB using all available data of PSP, REDD+ related project plots and community forest plots is more recommendable, although it might result in underestimation of AGB to the contrary because quantity of data collected from Community forest plots was larger than those collected from PSP and plots of REDD+ related projects. This is considered as being conservative.

As a result, selected AGB values of Evergreen forest, Semi-evergreen forest and Deciduous forest are 163 t/ha, 243 t/ha and 85 t/ha, respectively.

2.2 Above Ground Biomass for other forest types

There are eight other forest types in the land use/cover classification of Cambodia REDD+. Those are Pine Forest, Bamboo, Mangrove, Rear Mangrove, Flooded Forest, Forest regrowth, Pine plantation and Tree plantation.

2.2.1 Pine forest

For Pine forest AGB, only one data source was found. CCEAP (MoE/UNDR, 2003) conducted a field study at two plots in Cambodia, and the ABG is calculated as 57 t/ha and 102 t/ha respectively, which average is 80t/ha. Any other studies in South East Asia on Pine forest AGB have not been found. Since only two data are not sufficient to estimate appropriate value of Pine forest AGB, 100 t/ha, the value selected for Pine plantation is substituted for Pine forest AGB.

2.2.2 Bamboo

The distribution of bamboo is very limited in Cambodia, hence, it is not significant sink/source of carbon. No value of bamboo is presented neither in INC (MoE, 2002) nor CCEAP (MoE/UNDP, 2003). Any country specific Bamboo AGB is not found by us except one data from uncertain source, which presents 77 t/ha. Some regional data was found, however, it is rather difficult to justify that those regional values are appropriate for Bamboo AGB of Cambodia. Considering this information Bamboo AGB is set to zero.

2.2.3 Mangrove

Mangrove AGB used in INC (MoE, 2002) and selected in CCEAP (MoE/UNDP, 2003) are 175 and 150 t/ha, respectively. CCEAP (Moe/UNDP, 2003) also shows the result of a field study on Mangrove biomass conducted at two plots in Cambodia, and the ABG is calculated as 89 t/ha and 198 t/ha respectively, which average is 144t/ha.

According to JICA Technical Assistants Team (2015), the range of Mangrove AGB from eight studies conducted in neighbor countries varies from 92 t/ha to 299 t/ha.

Under the circumstances of limited information of country specific data, it is considered to be reasonable to use the same value identified in CCEAP (Moe/UNDP, 2003) for Mangrove forest, that is 150 t/ha.

The Fisheries Administration (FiA) under Ministry of Agriculture, Forestry and Fisheries (MAFF) of Cambodia has implemented field survey of mangrove forest in 2015 with the assistance of USAID. The Mangrove AGB could be updated based on that result when it comes out.

2.2.4 Rear mangrove

Rear Mangrove forest is mainly composed of *Melaleuca leucadendron* in Cambodia (Theilade et al., 2011). No value of Rear mangrove is presented neither in INC (MoE, 2002) nor CCEAP

(MoE/UNDP, 2003).

Only one study found for Rear mangrove of Cambodia is Hozumi et.al. (1969). AGB shown in the study is 13 t/ha. Since only one plot was surveyed in Hozumi et.al. (1969) and this value seems to be very low, it is rather hesitated to select this value as Rear mangrove AGB of Cambodia, although this value is country specific.

Another study found for Melaleuca biomass in the region is Tran, D.B., (2015). This study was conducted for M. cajuputi forest in Phu Quoc National Park along the coast of Vietnam close to Cambodia. As it is a study for a taxonomically very close species and the growing environment is assumed to be similar to that of Cambodia, the value in Tran, D.B. (2015), 165 t/ha (the range is 48 – 235 t/ha), is recommended to be used for Rear Mangrove AGB.

2.2.5 Flooded forest

Flooded forest AGB both used in INC (MoE, 2002) and selected in CCEAP (MoE/UNDP, 2003) is 70 t/ha.

CCEAP (MoE/UNDP, 2003) also presents AGB values as a result of two plot surveys conducted in Cambodia, which are 39 t/ha and 60 t/ha. Three other studies mentioned to Flooded forest AGB of Cambodia were found, and those values are 160, 170, and 175 t/ha, respectively (JICA Technical Assistants Team, 2015).

CCEAP (MoE/UNDP, 2003) also shows the result of two past studies in the region whose range is between 15 t/ha and 342 t/ha.

Since only limited field survey data are available for Flooded forest of Cambodia and the values vary among them, 70 t/ha in INC (MoE, 2002) and CCEAP (MoE/UNDP, 2003) is considered to be appropriate as AGB value for flooded forest until more reliable country specific data becomes available.

Fisheries Administration (FiA) of MAFF has implemented forest survey of flooded forest in Kampong Chhnang and Batambang in 2015 under the technical and financial assistance of FAO. Flooded forest AGB can be updated based on the result of this survey of FiA when it is available.

2.2.6 Forest regrowth

Forest regrowth AGB used in INC (MoE, 2002) and selected in CCEAP (MoE/UNDP, 2003) are 190 t/ha and 120 t/ha, respectively.

CCEAP (MoE/UNDP, 2003) also presents 41 t/ha and 53 t/ha estimated from two plot survey in Cambodia. On the other hand, 6 studies on forest regrowth AGB in Cambodia were found whose range is between 39 t/ha and 75 t/ha, although some caution is required for citing them because the definition for forest regrowth could be different among studies (JICA Technical Assistants Team, 2015).

The range of the regional AGB values for forest regrowth cited in CCEAP (2003) is 32‐230 t/ha. The reason for the big differences among those figures is probably the large variance in the growing stage of this forest type.

Since all the country specific values mentioned above are smaller than that of INC (MoE, 2003) and CCEAP (MoE/UNDP, 2003) and there is no more material for justifying these figures, 75 ton/ha (CFI (2008) cited in Sar (2010)), which is the maximum value found in the past studies in Cambodia and could avoid possible overestimation, is recommended until more reliable data becomes available.

2.2.7 Pine plantation and Tree plantation

Plantation AGB used in INC (MoE, 2002) and selected in CCEAP (MoE/UNDP, 2003) are 80 and 100 t/ha, respectively.

Forest plantation species in Cambodia are mainly Pine, Acacia and Eucalyptus. However, country specific values of AGB in Cambodia for those plantations were not found, but some regional data are only available.

The range of acacia plantation AGB which are found in some literatures in various countries from Asia to South Pacific regions is between 56 t/ha and 245 t/ha (see Annex II). Eucalyptus plantation AGB found in some past studies in the same region also varies from 62 t/ha to 275 ton/ha (see Annex II). Pine plantation AGB value could not be found even in the region. CCEAP (MoE/UNDP, 2003) also shows the range of 60-153 t/ha as AGB cited from past studies of the region, however the planted species is not clear.

Plantation AGB must be largely influenced by the growing stage, or years after planting. However, it is difficult to collect the information on the age of each forest plantation from all over the country for the moment. Under these circumstances, it is appropriate to choose the value 100 t/ha for both Pine plantation ABG and Tree plantation AGB, which is selected in CCEAP (MoE/UNDP, 2003). This value is also provided in Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003) as a default AGB value of forest plantation (other species) in “Moist with short dry season in Asia.

2.3 Rubber and oil palm plantation

Although rubber and oil palm plantations are not included in forest category under the forest definition for Cambodia’ s REDD+, examining unit AGB for these plantations is useful when the simulation of actual biomass emission/removal including non-forest areas is required.

2.3.1 Rubber plantation

Two studies were found on Rubber plantation biomass in Cambodia, those are Khun et.al. (2008) and Toriyama et.al. (2011).

In Khun et.al. (2008), the volumes of stems (m3/ha) of rubber trees which were collected at 15 plots of 6 to 48 years old plantations are presented. 11 plots out of 15 are from 37 years old and older plantations. The values of stem volume were converted to the values of AGB by JICA Technical Assistants Team (JICA Technical Assistants Team, 2015). The range of values of AGB is 42 - 331 t/ha (the average is 218 t/ha).

The range of values in Toriyama et.al. (2011) is 0.9 – 81 t/ha (the average is 43 t/ha) which were collected at eight plots from 1 to 9 years old plantations. CCEAP (MoE/UNDP, 2003) also conducted two plot survey of rubber plantation in Cambodia and the estimated AGB is 88 and 113t/ha, respectively.

The values are also found in some studies in the region which vary from 8 to 191 t/ha (see Annex II)).

The values vary depending on the age class and probably on growing environment. Considering the available information on the values, the average biomass density estimated in Toriyama et.al., (2011), that is 43 t/ha, is recommended for Rubber plantation AGB for the moment. Although the age class of the plots in Toriyama et.al., (2011) tends to be young (up to 9 years old), this can fit to the situation of rubber plantation in Cambodia most of which are newly established.

2.3.2 Oil palm plantation

Country specific value for AGB of oil palm plantation has not been found. Then, Kotowska et al. (2015) conducted in Indonesia is referred. According to this study, average biomass of oil palm plantation is 42 t/ha (the figures of 2 sites are 37 t/ha and 47 t/ha respectively, each of which consists of 8 plots). Since this is the only figures found for the moment, this figure is suggested to be used for Oil palm AGB.

3 Summary of recommended unit AGB

In Table 5, the recommended values of AGB (t/ha) for each forest type in Cambodia are listed and compared with the other datasets of INC (MoE, 2002), CCEAP (MoE/UNDP, 2003) and other studies. Values in other studies were identified either by JICA Technical Assistants Team (2015), CCEAP (MoE, 2003) or in the literature review in this working paper.

As Table 5 shows, most of the recommended values are more or less at the midst of the ranges of the values in other studies, which might imply the recommended values are appropriately selected.

Table 5 Comparison of the AGB values (t/ha)

Land use/cover			INC	CCEAP	Range of values in other studies (Value is country specific)	Recommended AGB
Category		Sub-category				
Forest	Natural forest	Evergreen	295	200	96 - 380 (*1)	163
		Semi-evergreen	370	250	164 - 382 (*1)	243
		Deciduous	120	100	70 - 245 (*1)	85
		Pine forest	n.a.	n.a.	57, 102 (*2)	100
		Bamboo	n.a.	n.a.	45 - 242 (*3)	0
		Mangrove	175	150	89, 198 (*2) 92 - 299 (*1)	150
		Rear mangrove	n.a.	n.a.	48 - 235 (*3)	165
		Flooded forest	70	70	160, 170, 175 (*1) 39, 60 (*2) 15 - 342 (*2)	70
		Forest regrowth	190	120	39 - 75 (*1) 41, 53 (*2) 32 - 230 (*2)	75
		Pine plantation	80	100	n.a.	100
		Other plantation	80	100	56 - 245 (Acacia,*3) 62 - 275 (Eucalyptus,*3) 60 - 153 (*2)	100
Cropland		Rubber	n.a.	n.a.	0.9 - 81 (*1) 42—331 (*1) 88, 113 (*2) 8 - 191 (*3)	43
		Oil palm	n.a.	n.a.	37, 47 (*3)	42

References* 1: JICA TA Team (2015), 2: MoE/UNDP (2003), 3: Annex II of this Working Paper #14.

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Appendix 5

Seminar Material

(Note: Khmer translation is still in the process of review)

Toward Phase II of REDD+

Achievements and Next Step

REDD+ of Cambodia

"Reducing Emission from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries" (REDD+) is a mechanism to provide finance to activities to reduce greenhouse gases emitted by deforestation and forest degradation. Value of forest resources has long since been recognized by the Royal Government of Cambodian and sustainable use of natural resources is listed as one of the strategies in "Rectangular Strategy for Growth, Employment, Equity and Efficiency" of Cambodia.

Cambodia considers REDD+ as an effective measure to reduce deforestation and forest degradation and in 2009 a REDD+ Roadmap, which states actions to be taken to become REDD+ ready, was completed. In order to implement actions identified in the roadmap, multiple development partners including JICA pledged support.

In the past 6 years, Cambodia made a great progress in its REDD+ activities including submission of Forest Reference Level document to the United Nations Framework Convention on Climate Change (UNFCCC), preparation of a National REDD+ Strategy (NRS), design of a National Forest Monitoring System (NFMS) and its components, improvement in land use/cover assessment techniques, and implementation of REDD+ demonstration projects. Prototype design of a Safeguard Information System (SIS) was also worked out.

REDD+ activities is usually divided into three phases. Phase I is REDD+ readiness phase, Phase II is demonstration or implementation phase and Phase III is for full implementation of REDD+ for results-based payment. Cambodia is now in the transition stage from Phase I to Phase II although some parts of activities of Phase II have already been implemented.

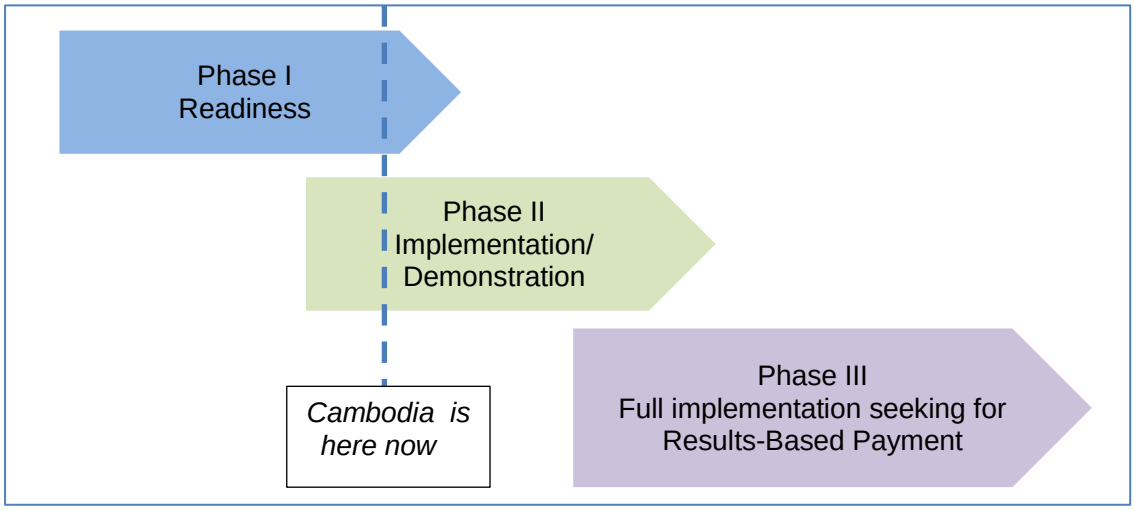
This short paper summarizes achievements made by Cambodia on REDD+ readiness activities as well as future actions to be taken.

October 17, 2017

MRV/REL Technical Team
Cambodia REDD+ Taskforce

REDD+ Phases

Cambodia is in the transition from Phase I to Phase II of REDD+



Conditions to apply for Results-based payments

Requirements to become eligible to apply for results-based payments:

- Preparation of National REDD+ Strategy (NRS)
- Establishment of Forest Reference Level (FRL)
- Establishment and operationalization of National Forest Monitoring System (NFMS)
- Establishment and operationalization of Safeguard Information System (SIS)

Among the four, FRL needs to be assessed by Technical Assistance of UNFCCC.

Achievements of Cambodia

National REDD+ Strategy (NRS)

NRS is in the process of approval by the Cambodian government.

Vision

Contribute to national and global climate change mitigation through improving the management of its natural resources and forest lands, and biodiversity conservation and sustainable development.

Mission

Strengthen the functioning and capacity of national and sub-national institutions for effective implementation of policies, laws and regulations to enhance management of natural resources and forest lands, and biodiversity conservation.

Goal

Reduce deforestation and forest degradation while promoting sustainable management, conservation of natural resources and contribute to poverty alleviation.

Scope and Scale

- Prioritizes deforestation measured through land use change and conversion of forest land. Build capacity alongside to address degradation.
- Implement REDD+ at the national level under the results-based payments mechanism of the UNFCCC.
- Consider implementation of sub- national and voluntary market based REDD+ projects subject to specific criteria.

Milestones and Results

By 2026 reduce its annual deforestation by half compared to the rate during the FRL period of 2006-2014.

Forest Reference Level (FRL)

Cambodia submitted a FFRL document to UNFCCC on November 2016. The assessment by a team of experts appointed by UNFCCC started in March 2017. After a series of question and answer sessions with the assessment team, Cambodia just returned its comment on the draft of assessment report to UNFCCC.

Scope of FRL

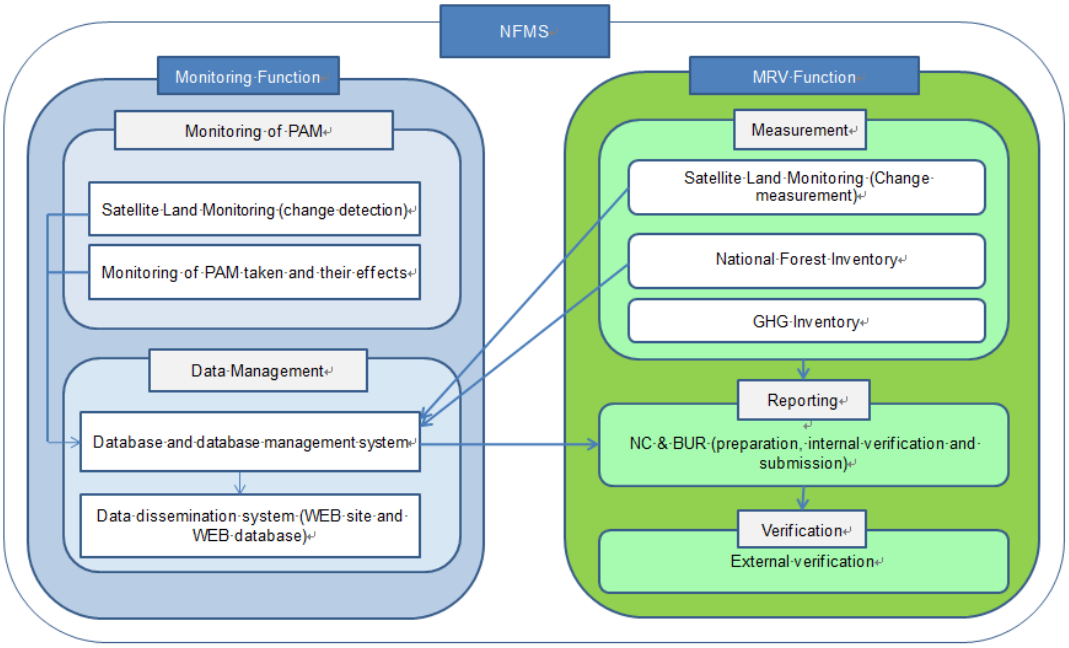
(1) Scale: National
(2) Activity data: Deforestation and also forest degradation and enhancements in areas of forest land remaining forest land but with changes in forest sub-categories, and removal of CO_2 from the atmosphere through afforestation where other land uses are converted to forest land.
(3) Carbon pool: AGB and BGB
(4) GHG: CO_2 only.
(3) Forest definition: 5 meters high at maturity, occupying minimum 0.5 hectares and minimum crown cover 10%.
(4) Reference period: 8 years between 2006 and 2014
(5) Methodology: Historical average of emission and removal
(6) Activity data: Land use/cover map of 2006, 2010 and 2014
(7) Emission factor: In principle selected from existing forest inventory survey data in Cambodia. If such data are not available used default value of IPCC guidelines.

National Forest Monitoring System (NFMS)

NFMS design document was prepared. NFI and WEB site were designed.

2nd National Communication was submitted to UNFCCC in 2015. Now the submission of a Biennial Update Report is being considered.

NFMS has two functions – MRV function and Monitoring function. MRV function is to measure GHG emission/removal which is used as the base for GHG inventory and reporting to UNFCCC. Monitoring part is for checking the effect of measures taken to address deforestation and forest degradation. Satellite land monitoring system is useful for both functions.



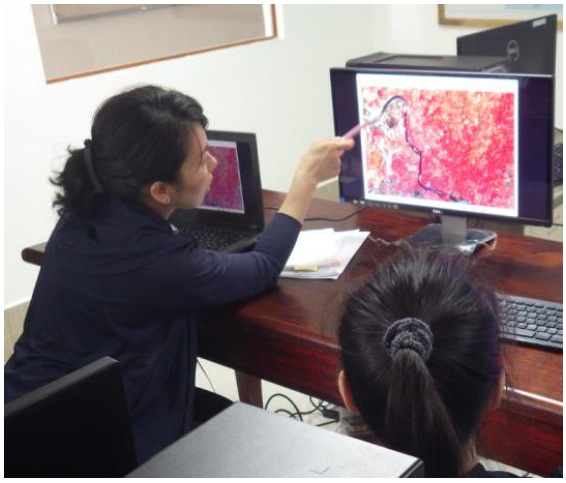
Included in Monitoring Function is Data Management function consisting of 1) Database and database management system and 2) Data dissemination system (WEB site and WEB database). By October 2017, a prototype data management system was designed including WEB design by the support from UN-REDD. For the moment, database is not connected to internet because of security reasons. A rule for data disclosure is now being examined to decide types of data to be uploaded to WEB site.

Phase I is a preparatory stage between 2011 and 2015.
Phase II is a development stage between 2016 and 2020
Phase III is an operational stage starting from 2021.

Need to make detailed design of monitoring part after policies and measures to address drivers of deforestation and forest degradation are determined.

Satellite Land Monitoring

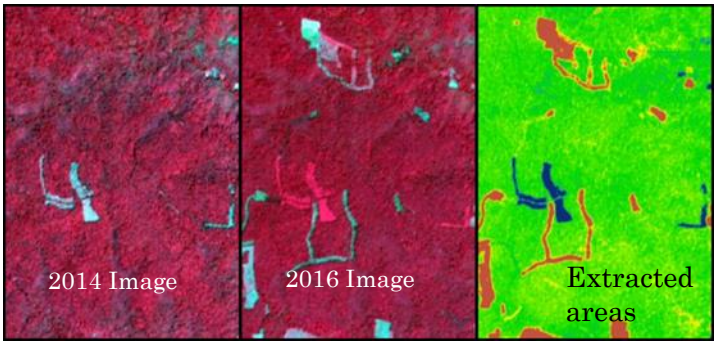
New methodology to improve efficiency and reliability of land use/cover mapping was introduced. Using the introduced methodology, 2006 and 2010 maps were upgraded and 2014 and 2016 maps were created.



Cambodia has been using satellite images for forest assessment even before the start of REDD+ readiness activities. Based on the basic capacity of Cambodian government officials, method to use satellite image for land use/cover mapping was upgraded. As a tool for accuracy assessment of land use/cover maps and also for quick assessment of forest area, Collect Earth tool of FAO was introduced.

Improved methodology

- Segmentation
- Logical check
- Principal component analysis for change detection

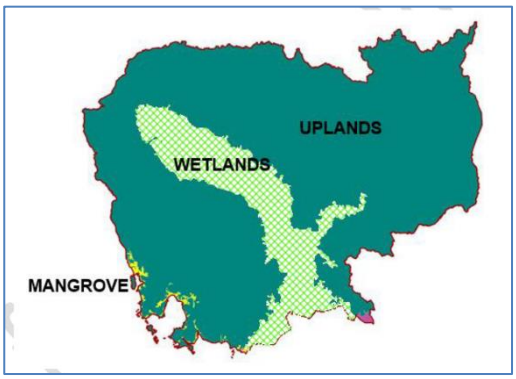


Extraction of areas of high possibility of land use/cover change by using Principal Component analysis.

National Forest Inventory (NFI)

The main objective of the sampling design for forest inventory is to reach a multipurpose, representative, consistent and realistic design for forest assessment in Cambodia. NFI manual and field forms have been developed and updated through field testing and NFI trials.

The proposed NFI design recommends stratifying the country into three strata: uplands, wetlands and mangrove areas. In each stratum, systematic cluster sampling is applied.



Allocation of plots:

Mangrove: 1st phase every 1km x 1km, 2nd phase every 3km x 3km (97 clusters)

Wetland: 4km x 4km :322 clusters

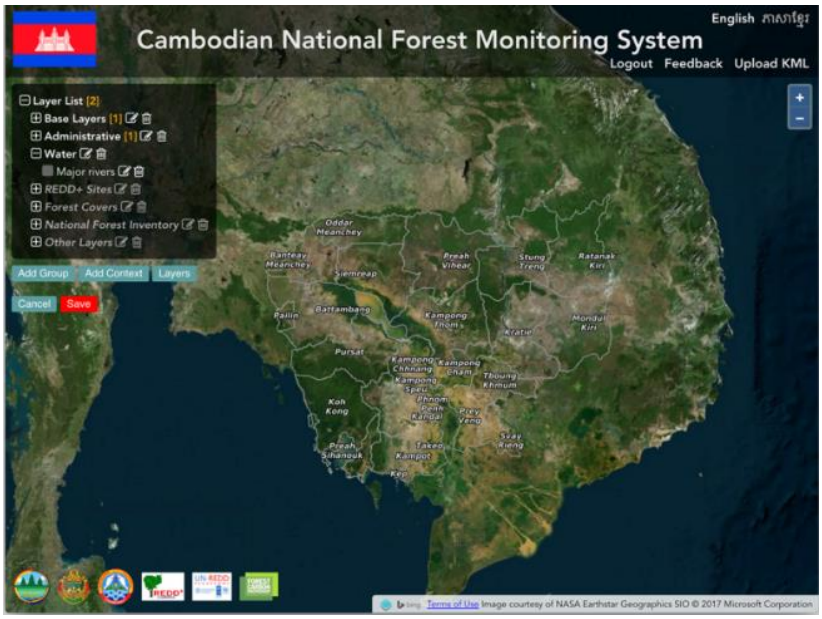
Upland: 6km x 6km: 2,751 clusters

Rectangular plot was chosen for upland forest while circular plot was chosen for mangrove. The proposed NFI design considers all the five carbon pools which have to be reported under the UNFCCC: aboveground biomass, belowground biomass, deadwood, soil organic carbon and litter.

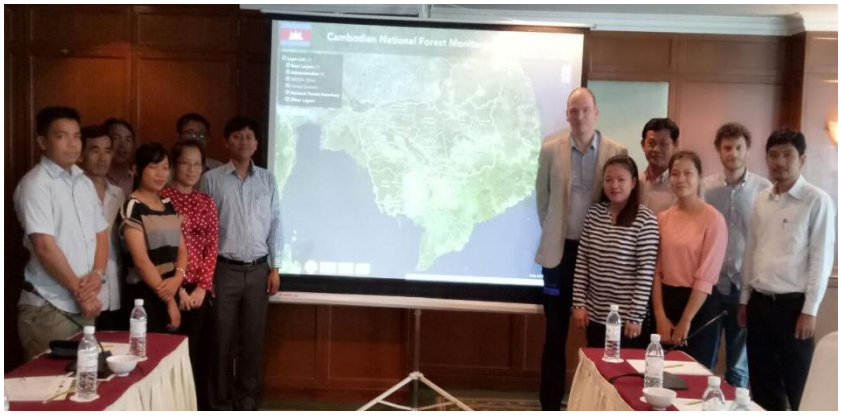
Trial NFI was implemented in 25 clusters in conservation areas administered by the Ministry of Environment and in 25 clusters in community forests administered by the Forestry Administration of the Ministry of Agriculture, Forestry and Fisheries.

WEB Portal

The Cambodia NFMS WEB portal was developed as a part of Monitoring Function of the NFMS to provide the information of Cambodia's REDD+ activities to keep transparency of the information. In addition to updated report of Cambodia's REDD+ activities, spatial data will also be provided.



A fully functional web platform (which was based on technologies developed by FAO-UNREDD) has been setup in a shared server in France and customized based on the comments from MRV/FRL team.



For building up the Capacity of the MRV /REL team, two consultation meetings and three hand-on training on the management of web platform were conducted.

Next Steps

1. Preparation of Action Plan

Some policies and measures to address the drivers of deforestation and forest degradation are not the same for entire country. So, they should be selected for each sub-national area. Procedure to make REDD+ action plan will be as follows:

- Determine criteria for the selection of a sub-national area
- Select sub-national area using the criteria
- Analyze region specific drivers
- Determine policies and measures to address the drivers
- Design a mechanism to monitor the performance of selected policies and measures

Now, Cambodia is ready to prepare detailed action plan of REDD+.

2. Improvement and Further Development

Cambodia establishes its REDD+ related mechanism in a phased approach. While Cambodia has already prepared NFMS and FRL, they can be improved or developed further along with the availability of more reliable data or advanced techniques. Also, some parts of the design have not been fully developed due to the drastic reform of forestry and environmental sector of the government.

For NFMS, institutional arrangement needs to be worked out. For FRL, Activity Data and Emission Factor can be improved by increasing number of reliable land use/cover maps and by implementing one cycle of NFI.

Also, Cambodia may need to compile a Biennial Update Report if it seeks for the fund of pilot programme of Green Climate Fund. A new GHG inventory needs to be made.

ការឈានឆ្ពោះទៅដំណាក់កាលទី ២ នៃគម្រោងធនធានកសិកម្ម

សមិទ្ធផល និងជំហានបន្ទាប់

សេចក្តីព្រាង

ព្រៃឈើកម្ពុជា

កម្មវិធីកាត់បន្ថយការបំភាយឧស្ម័នពីការបាត់បង់ព្រៃឈើ និងការរិចរិលព្រៃឈើ និង តួនាទីនៃការអភិរក្ស ការគ្រប់គ្រងព្រៃឈើប្រកបដោយនិរន្តរភាព និង ការបង្កើនស្តុកកាបូនព្រៃឈើក្នុងបណ្តាប្រទេសកំពុងអភិវឌ្ឍ(ព្រៃឈើ) គឺជាយន្តការផ្តល់នូវហិរញ្ញវត្ថុ លើសកម្មភាពដើម្បីកាត់បន្ថយឧស្ម័នផ្ទះកញ្ចក់ដែលបំភាយដោយការបាត់បង់ព្រៃឈើ និងការរិចរិលព្រៃឈើ។ តម្លៃនៃធនធានព្រៃឈើត្រូវបានរដ្ឋាភិបាលកម្ពុជាទទួលស្គាល់ជាយូរមកហើយ ហើយការប្រើប្រាស់ធនធានធម្មជាតិប្រកបដោយនិរន្តរភាពត្រូវបានដាក់បញ្ចូលជាមុំមួយក្នុងចំណោមមុំទាំងបួននៃ "យុទ្ធសាស្ត្របតុភោណសម្រាប់កំណើនការងារសមធម៌ និងប្រសិទ្ធភាព" នៃប្រទេសកម្ពុជា។

ប្រទេសកម្ពុជាចាត់ទុកព្រៃឈើ ជាវិធានការប្រកបដោយប្រសិទ្ធភាពមួយ ដើម្បីកាត់បន្ថយការបាត់បង់ព្រៃឈើ និងការរិចរិលព្រៃឈើ ហើយក្នុងឆ្នាំ ២០០៩ ផែនទីបង្ហាញផ្លូវព្រៃឈើ ដែលមានបញ្ហាក់អំពីសកម្មភាពដែលត្រូវធ្វើ ដើម្បីអាចត្រៀមខ្លួនរួចរាល់សម្រាប់ព្រៃឈើ ត្រូវបានបញ្ចប់រួចរាល់។ ដើម្បីអនុវត្តសកម្មភាពដែលត្រូវបានកំណត់ឃើញក្នុងផែនទីបង្ហាញផ្លូវ ដៃគូអភិវឌ្ឍជាច្រើន រួមទាំងអង្គការ JICA ផងបានសន្យាផ្តល់ការគាំទ្រ។

ក្នុងរយៈពេល ៦ ឆ្នាំកន្លងមកនេះ ប្រទេសកម្ពុជាមានការឈានឡើងយ៉ាងធំធេញក្នុងសកម្មភាពព្រៃឈើ របស់ខ្លួន រួមទាំងការដាក់របាយការណ៍កម្រិតយោងព្រៃឈើកម្ពុជា(FRL) ទៅអនុសញ្ញាក្របខ័ណ្ឌសហប្រជាជាតិស្តីពីការប្រែប្រួលអាកាសធាតុ (UNFCCC) ការរៀបចំយុទ្ធសាស្ត្រព្រៃឈើជាតិ (NRS) ការរៀបចំប្រព័ន្ធតាមដានត្រួតពិនិត្យព្រៃឈើជាតិ (NFMS) និងធាតុផ្សំរបស់ប្រព័ន្ធនេះ ការធ្វើឱ្យប្រសើរឡើងនូវបច្ចេកទេសវាយតម្លៃ ការប្រើប្រាស់ដី/ គម្របដី និងការអនុវត្តគម្រោងបង្ហាញសម្រាប់ ព្រៃឈើ។ រចនាបទគំនូរនៃប្រព័ន្ធសុវត្ថិភាពព្រៃឈើ (SIS) បានទឹងកំពុងរៀបចំ។

សកម្មភាពព្រៃឈើ ត្រូវបានចែកជាបីដំណាក់កាល **ដំណាក់កាលទី ១** គឺជាដំណាក់ការត្រៀមខ្លួនរួចជាស្រេចសម្រាប់ព្រៃឈើ **ដំណាក់កាលពី ២** គឺជាការអនុវត្តបង្ហាញ ឬដំណាក់កាលអនុវត្ត ហើយ **ដំណាក់កាលទី ៣** គឺជាការអនុវត្តព្រៃឈើញលេញ សម្រាប់ការទូទាត់ដោយផ្អែកលើលទ្ធផល។ ប្រទេសកម្ពុជាបច្ចុប្បន្ន គឺស្ថិតនៅក្នុងដំណាក់កាលអន្តរកាល ដោយឈានចេញពីដំណាក់កាលទី ១ ទៅកាន់ដំណាក់កាលទី ២ ថ្វីបើចំណែកមួយចំនួននៃសកម្មភាពក្នុងដំណាក់ទី ២ ត្រូវបានអនុវត្តរួចហើយក្តី។

ឯកសារដ៏ខ្លីនេះ សង្ខេបឱ្យឃើញអំពីសមិទ្ធផលដែលប្រទេសកម្ពុជាសម្រេចបានទៅលើសកម្មភាពត្រៀមខ្លួនរួចជាស្រេចសម្រាប់ព្រៃឈើ ក៏ដូចជាសកម្មភាពដែលត្រូវអនុវត្តនាពេលអនាគត។

ថ្ងៃទី ៥ ខែតុលា ឆ្នាំ ២០១៧

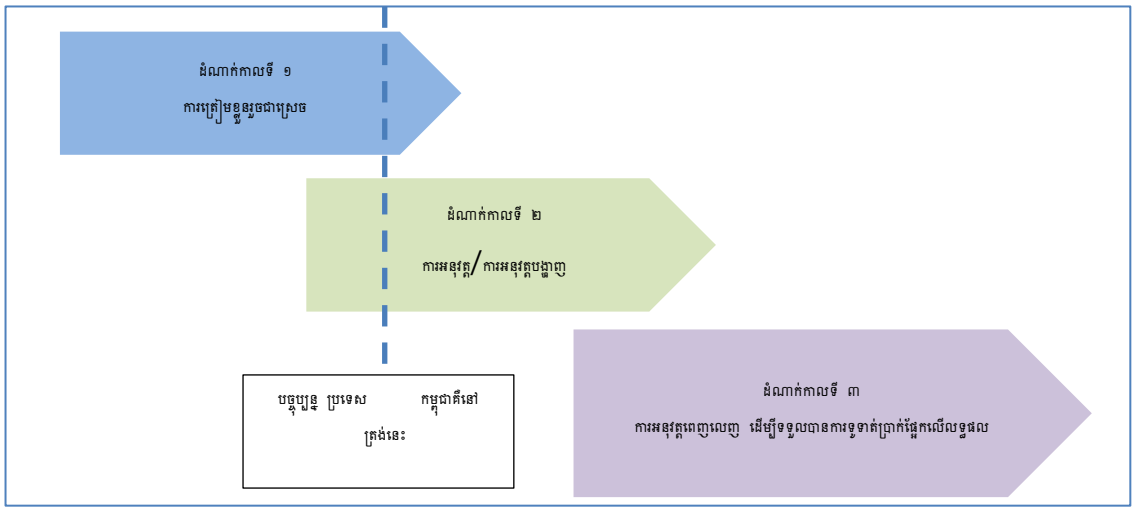
ក្រុមការងារបច្ចេកទេស MRV/REL

ក្រុមការងារព្រៃឈើកម្ពុជា

ដំណាក់កាលរបស់រេដប្លូក

ប្រទេសកម្ពុជាកំពុងស្ថិតក្នុងដំណាក់កាលអន្តរកាលដោយផ្លាស់ចេញពីដំណាក់កាលទី ១ ទៅដំណាក់កាលទី ២ នៃ រេដប្លូក

លក្ខខណ្ឌ ដើម្បីស្នើសុំការទូរទាត់ ផ្អែកលើលទ្ធផល



លក្ខខណ្ឌតម្រូវដើម្បីឱ្យមានលក្ខណៈសម្បត្តិគ្រប់គ្រាន់សម្រាប់ស្នើសុំការទូទាត់ ផ្អែកលើលទ្ធផលជាក់ស្តែង៖

- ការរៀបចំឯកសារយុទ្ធសាស្ត្ររេដប្លូកជាតិ (NRS)
- ការរៀបចំឯកសារកម្រិតយោងព្រៃឈើ (FRL)
- ការបង្កើត និងការដាក់ឱ្យមានប្រតិបត្តិការនូវប្រព័ន្ធត្រួតពិនិត្យ តាមដានព្រៃឈើជាតិ (NFMS)
- ការបង្កើត និងការដាក់ឱ្យមានប្រតិបត្តិការប្រព័ន្ធព័ត៌មានសុវត្ថិភាពរេដប្លូក (SIS)

ក្នុងចំណោមតម្រូវការឯកសារ និងសមត្ថភាពទាំងបួននេះ ឯកសារកម្រិតយោងព្រៃឈើ(FRL) ចាំបាច់ត្រូវទទួលការវាយតម្លៃបច្ចេកទេស ពីក្រុមអ្នកបច្ចេកទេស UNFCCC។

សមិទ្ធផលរបស់ប្រទេសកម្ពុជា

យុទ្ធសាស្ត្រអនុវត្តបួកជាតិ (NRS)

យុទ្ធសាស្ត្រអនុវត្តបួកជាតិ កំពុងស្ថិតក្នុងដំណើរការ ស្នើសុំការអនុម័តពីទីស្តីការគណៈរដ្ឋមន្ត្រី។

ចក្ខុវិស័យ

យុទ្ធសាស្ត្រអនុវត្តបួកជាតិរួមចំណែកក្នុងការកាត់បន្ថយការប្រែប្រួលអាកាសធាតុជាតិ និងពិភពលោកតាមរយៈការធ្វើឱ្យប្រសើរឡើងការងារគ្រប់គ្រងធនធានធម្មជាតិនិងដីព្រៃឈើ ការអភិរក្សជីវៈចម្រុះ និងការអភិវឌ្ឍដោយចីរភាព។

បេសកកម្ម

ពង្រឹងមុខងារនិងសមត្ថភាពស្ថាប័ននៅថ្នាក់ជាតិ និងថ្នាក់ក្រោមជាតិ ព្រមទាំងពង្រឹងប្រសិទ្ធភាពការអនុវត្តគោលនយោបាយ ច្បាប់ និងបទបញ្ជាគ្តិនានាដែលមានជាធរមាន ដើម្បីធ្វើឱ្យប្រសើរឡើងលើការងារគ្រប់គ្រងធនធានធម្មជាតិ និងដីព្រៃឈើ និងការអភិរក្សជីវៈចម្រុះឱ្យមានចីរភាព។

គោលបំណង

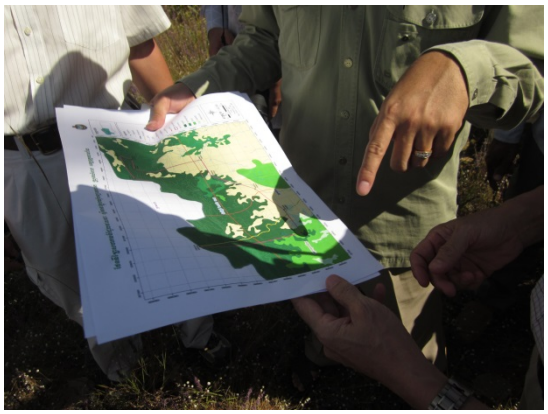
កាត់បន្ថយការបាត់បង់និងរួចរីលព្រៃឈើ

បន្តលើកកម្ពស់ការគ្រប់គ្រងនិងការអភិរក្សធនធានធម្មជាតិឱ្យមានចីរភាព

និងចូលរួមកាត់បន្ថយភាពក្រីក្រ ។

វិសាលភាព និងកម្រិតអនុវត្តន៍

- ចាត់អាទិភាពចំពោះការបាត់បង់ព្រៃឈើ ដែលនឹងធ្វើការវាស់វែងតាមរយៈការប្រែប្រួលការប្រើប្រាស់ដីនិងការបម្លែងដីព្រៃឈើ



- អនុវត្តរួមបួក នៅថ្នាក់ជាតិនៅក្រោមយន្តការទូទាត់ផ្អែកលើលទ្ធផលនៃអនុសញ្ញាក្របខ័ណ្ឌសហប្រជាជាតិស្តីពីការប្រែប្រួលអាកាសធាតុ
- ពិចារណាអនុវត្តគម្រោងរួមបួក ផ្អែកលើទីផ្សារនៅថ្នាក់ក្រោមជាតិ និងក្រោមមូលដ្ឋាននៃការស្ម័គ្រចិត្ត ដែលជាកម្មវត្ថុនៃលក្ខខណ្ឌវិនិច្ឆ័យជាក់លាក់។

រំណាក់កាលសំខាន់ៗ និងលទ្ធផល

ត្រឹមឆ្នាំ ២០២០ កាត់បន្ថយការបាត់បង់ព្រៃឈើប្រចាំឆ្នាំរបស់ខ្លួនមកនៅត្រឹមរាក់កណ្តាល បើប្រៀបធៀបជាមួយអត្រាបាត់បង់ក្នុងអំឡុងរយៈពេលយោងនៃកម្រិតយោងព្រៃឈើ(FRL) ក្នុងចន្លោះឆ្នាំ ២០០៦-២០១៤។

កម្រិតយោងព្រៃឈើ (FRL)

ប្រទេសកម្ពុជាបានដាក់ឯកសារកម្រិតយោងព្រៃឈើ (FRL) ជូនទៅអនុសញ្ញាក្របខ័ណ្ឌសហប្រជាជាតិស្តីពីការប្រែប្រួលអាកាសធាតុ (UNFCCC) នៅខែវិច្ឆិកា ឆ្នាំ ២០១៦។ ការវាយតម្លៃបច្ចេកទេសដោយក្រុមអ្នកជំនាញការបច្ចេកទេស UNFCCC ចាប់ផ្តើមដំណើរការវាយតម្លៃក្នុងខែមីនា ឆ្នាំ ២០១៧។ បន្ទាប់ពីកម្រងវគ្គសំណួរ និងចម្លើយជាច្រើនជាមួយក្រុមការងារវាយតម្លៃបច្ចេកទេសមក ប្រទេសកម្ពុជាទើបតែបានផ្តល់មតិយោបល់របស់ខ្លួនទៅលើសេចក្តីព្រាងរបាយការណ៍វាយតម្លៃបច្ចេកទេសជូន UNFCCC វិញ។

វិសាលភាពរបស់ កម្រិតយោងព្រៃឈើ FRL

(១) កម្រិត៖ ថ្នាក់ជាតិ

(២) ទិន្នន័យសកម្ម៖ ការបាត់បង់ និង ការរិចរិលព្រៃឈើ និង ការធ្វើឱ្យប្រសើរឡើងនៅតំបន់ដីព្រៃឈើដែលនៅតែជាដីព្រៃឈើ ប៉ុន្តែមានការផ្លាស់ក្នុងចំណាត់ថ្នាក់ប្រភេទព្រៃឈើ និងការស្រូប CO_2 ពីបរិយាកាស តាមរយៈការដាំដុះព្រៃនៅត្រង់កន្លែងដែលការប្រើប្រាស់ដីដទៃទៀតត្រូវបានប្រែក្លាយទៅជាដីព្រៃ។

(៣) អាងកាបូន៖ ជីវម៉ាស់លើដី និងជីវម៉ាស់ក្រោមដី

(៤) ឧស្ម័នផ្ទះកញ្ចក់ ៖ ឧស្ម័ន CO_2

(៣) និយមន័យព្រៃឈើ៖ កម្ពស់ ៥ ម៉ែត្រ នៅក្នុង វ័យចំណាស់ គ្របដណ្តប់យ៉ាងតិច ០,៥ ហិចតា និងកំពូលចុងឈើអប្បបរមាគ្របដណ្តប់ ១០%

(៤) រយៈពេលយោង៖ ៨ ឆ្នាំ ចន្លោះពី ឆ្នាំ២០០៦ ដល់ ឆ្នាំ២០១៤

(៥) វិធីសាស្ត្រ៖ មធ្យមភាគកម្រិតយោងនៃការបំភាយ និងស្រូបឧស្ម័ន

(៦) ទិន្នន័យសកម្ម៖ ផែនទីប្រើប្រាស់ដី/គម្របដីព្រៃឈើក្នុងឆ្នាំ ២០០៦ , ២០១០ និង ២០១៤

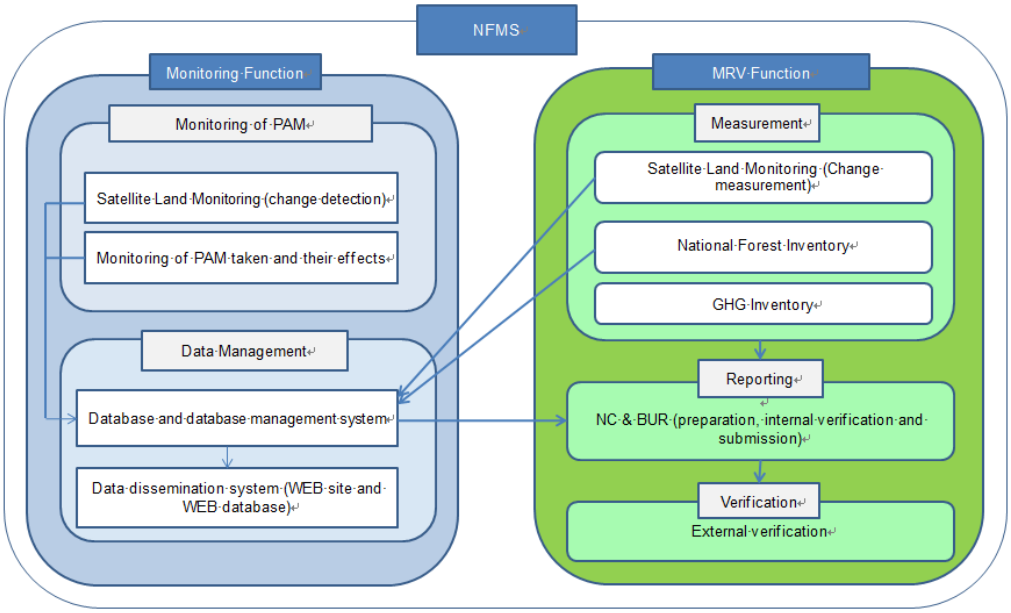
(៧) មេគុណបំភាយ៖ ជាគោលការណ៍មេគុណបំភាយត្រូវបានដកស្រង់ចេញពីបញ្ជីរទិន្នន័យសារពើភ័ណ្ឌព្រៃឈើក្នុងប្រទេសកម្ពុជា។ ប្រសិនបើមិនមានទិន្នន័យប្រភេទនេះទេ តំលៃសន្មតនៅក្នុងឯកសារគោលការណ៍ណែនាំរបស់ IPCC ត្រូវបានយកមកប្រើ។

ប្រព័ន្ធត្រួតពិនិត្យ តាមដានព្រៃឈើជាតិ

ឯកសារប្រព័ន្ធត្រួតពិនិត្យ តាមដានព្រៃឈើ ត្រូវបានរៀបចំតាមរយៈការ កសាង ទីតាំង NFI និង WEB

របាយការណ៍ជាតិលើកទីពីរ ត្រូវបានដាក់ជូនទៅ UNFCCC ក្នុងឆ្នាំ ២០១៥ និងពេលបច្ចុប្បន្នកំពុង ពិចារណាផ្តល់ជូនរបាយការណ៍ BUR។

NFMS មានមុខងារពីរជាអាទិ៍ មុខងារ MRV និងមុខងារ ត្រួតពិនិត្យ។ មុខងារ □□□□□□□ រ□ណ៍ □□□□□□□□□□□□□□□ (MRV) គឺដើម្បីវាស់វែងការបំភាយ/ការស្រូប ឧស្ម័នផ្ទះកញ្ចក់ ដែលត្រូវបានប្រើប្រាស់ជាមូលដ្ឋាន សម្រាប់ សារពើភ័ណ្ឌឧស្ម័នផ្ទះកញ្ចក់ (GHG) និងការរាយការណ៍ជូនទៅ UNFCCC។ មុខងារត្រួតពិនិត្យគឺដើម្បីវាស់វែង និងកំណត់ការបាត់បង់ និងការរិចរិលព្រៃឈើ។ ប្រព័ន្ធ ត្រួតពិនិត្យដ៏ដោយប្រើប្រាស់ផ្កាយរណប មានសារៈប្រយោជន៍សម្រាប់មុខងារទាំងពីរនេះ។



នៅក្នុងមុខងារត្រួតពិនិត្យ គឺការគ្រប់គ្រងទិន្នន័យដែលក្នុងនោះរួមមានសមាសធាតុ ១) មូលដ្ឋានទិន្នន័យ និងប្រព័ន្ធគ្រប់គ្រងមូលដ្ឋានទិន្នន័យ និង ២) ប្រព័ន្ធផ្សព្វផ្សាយទិន្នន័យ (គេហទំព័រ អ៊ីនធើណែត និង គេហទំព័រមូលដ្ឋានទិន្នន័យ)។ គិតមកត្រឹមខែតុលា ឆ្នាំ ២០១៧ ប្រព័ន្ធគ្រប់គ្រងទិន្នន័យបឋម ត្រូវបានរចនា ដោយក្នុងនោះមានការរចនាគេហទំព័រ ដែលគាំទ្រ ដោយ UN-REDD។ សម្រាប់ពេលនេះ មូលដ្ឋានទិន្នន័យនៅមិនទាន់ភ្ជាប់ទៅកាន់អ៊ីនធើណែតឡើយ ដោយសារតែមូលហេតុផ្នែកសន្តិសុខទិន្នន័យ។ ការដាក់បង្ហាញទិន្នន័យ បច្ចុប្បន្នកំពុងត្រូវ បានពិនិត្យ ដើម្បីសម្រេចចិត្តលើប្រភេទទិន្នន័យដែលនឹងត្រូវដាក់បង្ហាញទៅក្នុង គេហទំព័រ

ដំណាក់កាលទី ១ គឺជាដំណាក់កាលត្រៀមរៀបចំនៅចន្លោះឆ្នាំ ២០១១ ដល់ឆ្នាំ ២០១៥។

ដំណាក់កាលទី ២ គឺជាដំណាក់កាលអភិវឌ្ឍនៅចន្លោះឆ្នាំ ២០១៦ ដល់ ឆ្នាំ ២០២០។

ដំណាក់កាលទី ៣ គឺជាដំណាក់កាលប្រតិបត្តិ ដោយចាប់ផ្តើមពីឆ្នាំ ២០២១ តទៅ។

ចាំបាច់ត្រូវធ្វើការរចនាលម្អិតលើផ្នែកត្រួតពិនិត្យ បន្ទាប់ពី បានកំណត់ នូវគោលនយោបាយ និងវិធានការដែលអាចវាស់វែង បុព្វហេតុឬកត្តាជម្រុញឱ្យមានការបាត់បង់ និងការរិចរិលព្រៃឈើ។

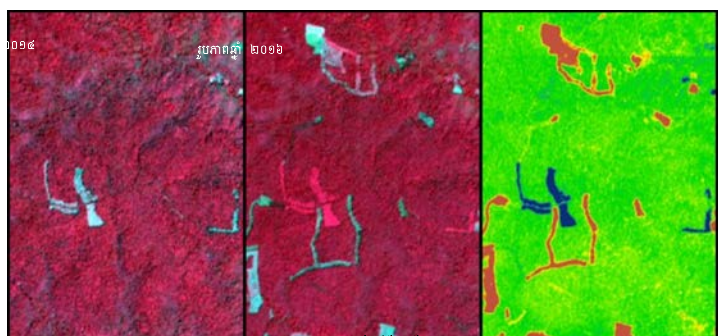
ការត្រួតពិនិត្យដីដោយប្រព័ន្ធផ្កាយរណប

បច្ចេកវិទ្យាថ្មីត្រូវបានណែនាំ ដើម្បីកែលម្អប្រសិទ្ធភាព និងភាពជឿជាក់នៃការផលិតផែនទីប្រើប្រាស់ដី/គម្របដីព្រៃឈើ។ តាមរយៈការណែនាំ បច្ចេកវិទ្យាថ្មី ត្រូវបាន ប្រើប្រាស់សម្រាប់កែលម្អផែនទីឆ្នាំ២០០៦ និង ២០១០ និងសម្រាប់ ផលិតបន្ថែមផែនទី ឆ្នាំ ២០១៤ និង ២០១៦ ។

ប្រទេសកម្ពុជាបានប្រើប្រាស់រូបភាពផ្កាយរណបសម្រាប់ការវាយតម្លៃព្រៃឈើ តាំងពីមុនការចាប់ផ្តើមសកម្មភាពត្រៀមលក្ខណៈ សម្រាប់រេដបូក មកម្ល៉េះ។ ផ្អែកលើសមត្ថភាពជាមូលដ្ឋានរបស់មន្ត្រីរដ្ឋាភិបាលកម្ពុជា ការប្រើប្រាស់រូបភាពផ្កាយរណបសម្រាប់ការធ្វើផែនទីប្រើប្រាស់ដី/គម្របដីព្រៃឈើត្រូវបានកែលម្អ។ Collect Earth របស់អង្គការស្បៀង និងកសិកម្មនៃសហប្រជាជាតិ (FAO) ត្រូវបានណែនាំឱ្យប្រើប្រាស់ សម្រាប់វាយតម្លៃសុក្រឹត្យភាពនៃផែនទីដីព្រៃឈើ ព្រោះវាជាឧបករណ៍វាយតម្លៃរហ័សមួយ ជាពិសេសតំបន់ដីព្រៃឈើ ។

វិធីសាស្ត្របានកែសម្រួល

- ការញែកព្រំប្រទល់ទៅតាមបណ្តុំពណ៌ផ្កាយរណប
- ការពិនិត្យតក្កភាព
- ការវិភាគសមាសធាតុគោលសម្រាប់ការរកឱ្យឃើញនូវការប្រែប្រួល

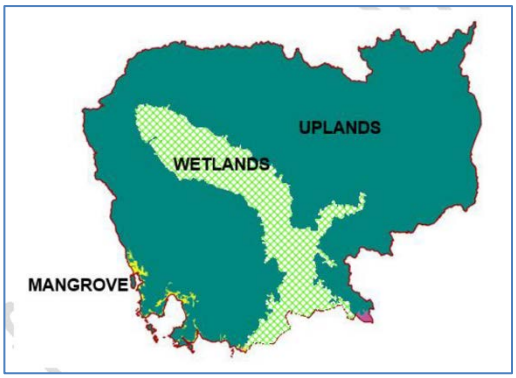


តំបន់មានមានការផ្លាស់ប្តូរខ្លាំងទៅលើការប្រើប្រាស់ដី/គម្របដី តាមរយៈការប្រើប្រាស់ការវិភាគសមាសធាតុគោល

បញ្ជីសារពើភ័ណ្ឌព្រៃឈើជាតិ (NFI)

គោលបំណងចម្បងនៃការរចនាសំណាក គឺការរៀបចំក្នុងគោលបំណងច្រើនយ៉ាង តំណាងឆាយ សង្គតភាព និងភាពអាចជឿជាក់បាន សម្រាប់ការប៉ាន់ប្រមាណព្រៃឈើក្នុងប្រទេសកម្ពុជា។ សៀវភៅណែនាំសារពើភ័ណ្ឌព្រៃឈើជាតិនេះ (NFI) ត្រូវបានបង្កើតឡើង និងកែសម្រួលទៅតាមការធ្វើតេស្តសាកល្បងប្រើប្រាស់នៅទីវាល។

សំណើនៃការរៀបចំសារពើភ័ណ្ឌព្រៃឈើជាតិ(NFI) ជាអនុសាសន៍បែងចែកប្រទេសកម្ពុជាទៅជាបីស្រទាប់ ពោលគឺ តំបន់ព្រៃលើ តំបន់ដីសើម និងតំបន់ព្រៃកោងកាង។ នៅក្នុងស្រទាប់នីមួយៗ សំណាកនៃកម្រងឡូត៍ជាលក្ខណៈប្រព័ន្ធត្រូវបានអនុវត្តសម្រាប់ការតាំងសំណាកនៅទីវាល។ កម្រងឡូត៍គំរូ គឺជាឯកតាសំណាកបឋម។ បណ្តាឡូត៍ និងដើមឈើ គឺជាឯកតាការកត់ត្រាសម្រាប់ការកត់ត្រាទិន្នន័យ។



ទីតាំងឡូត៍៖

ព្រៃកោងកាង៖

ដំណាក់កាលទី ១ ១គ.ម × ១គ.ម

ដំណាក់កាលទី ២ ៣គ.ម × ៣គ.ម (៩៧ កម្រងឡូត៍)

តំបន់ដីសើម៖ ៤គ.ម × ៤គ.ម (៣២២ កម្រងឡូត៍)

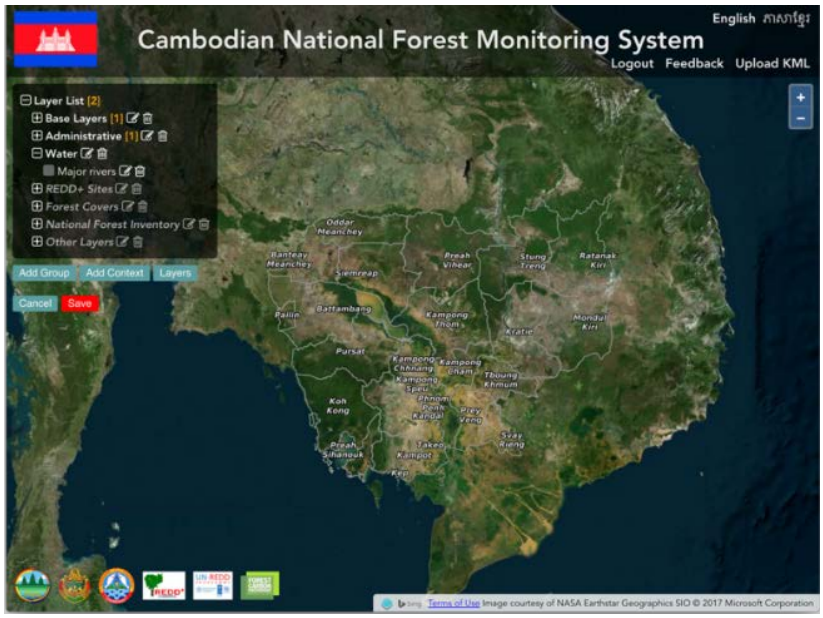
តំបន់ខ្ពស់៖ ៦គ.ម × ៦គ.ម៖ (២៧៥១ កម្រងឡូត៍)

សៀវភៅណែនាំ NFI រចនាឡូត៍រាងជាចតុកោណ និងឡូត៍ជារង្វង់ ដោយផ្អែកលើសណ្ឋានដី និងស្រទាប់រុក្ខជាតិ។ សំណើនៃការរៀបចំសារពើភ័ណ្ឌព្រៃឈើជាតិ NFI ដែលត្រូវបាន ពិចារណាលើអាងការបូនទាំងប្រាំ ដែលចាំបាច់ត្រូវរាយការណ៍ជូន UNFCCC មានដូចជា ជីវម៉ាសនៅលើដី ជីវម៉ាសនៅក្រោមដី ឈើងាប់ កាបូនសរីរាង្គដី និងកំទេចកំទីលើដី។

សាកល្បង NFI ត្រូវបានអនុវត្តនៅ ចំនួន ២៥ កម្រងឡូត៍ ក្នុងតំបន់អភិរក្សក្រោមក្រសួងបរិស្ថាន និង ២៥ កម្រងឡូត៍ នៅក្នុងព្រៃសហគមន៍ ក្រោមរដ្ឋបាលព្រៃឈើ នៃក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ។

គេហទំព័រ (WEB portal)

គេហទំព័រប្រព័ន្ធ ត្រួតពិនិត្យ តាមដានព្រៃឈើ (NFMS) កម្ពុជា ត្រូវបានកសាងឡើងសម្រាប់គាំទ្រមុខងារត្រួតពិនិត្យ ផ្សព្វផ្សាយការណ៍ និងចែករំលែកព័ត៌មានទាក់ទងនឹងវឌ្ឍន៍ភាពសកម្មភាពរដឋបឋកកម្ពុជា ។ គេហទំព័រ NFMS សម្រាប់ដើម្បីចូលរួមបង្ហាញពីតម្លាភាព ភាពត្រឹមត្រូវ នូវរាល់ការអនុវត្តសកម្មភាព បច្ចេកទេសនានារបស់កម្មវិធីរដឋបឋកជូនសហគមន៍ជាតិ និងអន្តរជាតិ។



មុខងាររបស់គេហទំព័រ (ផ្អែកលើបច្ចេកវិទ្យាអភិវឌ្ឍ ដោយក្រុមការងារ UNREDD) ត្រូវបានតម្លើងនៅក្នុង server ប្រទេសបារាំង និងកែតម្រូវ តាមតម្រូវការរបស់ប្រទេស ស្របតាមមតិយោបល់ពីក្រុមការងារ MRV/FRL។

សម្រាប់ការកសាងសមត្ថភាពក្រុមការងារ MRV /REL កិច្ចប្រជុំពិគ្រោះយោបល់ចំនួនពីរ និងការបណ្តុះបណ្តាលអនុវត្តផ្ទាល់ចំនួនបីស្តីពីការគ្រប់គ្រងប្រើប្រាស់ និងកែសម្រួល គេហទំព័រ ត្រូវបានរៀបចំឡើង។

ជំហានបន្ទាប់

1. ការរៀបចំផែនការសកម្មភាព

គោលនយោបាយ និងវិធានការដែលអាចវាស់វែង បុព្វហេតុ ឬកត្តាជម្រុញឱ្យមានការបាត់បង់ និងការរិចរិលព្រៃឈើ គឺមិនអាចប្រើប្រាស់តែមួយវិធី សម្រាប់អនុវត្តទូទាំងប្រទេសទេ។ ហេតុនេះ គួរជ្រើសរើសគោលនយោបាយ និងវិធានការសម្រាប់តំបន់ថ្នាក់ក្រោមជាតិនីមួយៗ។ នីតិវិធីដើម្បីធ្វើផែនការសកម្មភាពរេដបូក នឹងមាន លក្ខណៈដូចខាងក្រោម៖

- កំណត់លក្ខខណ្ឌវិនិច្ឆ័យសម្រាប់ជ្រើសរើសតំបន់នៅថ្នាក់ក្រោមជាតិ
- ជ្រើសរើសតំបន់ថ្នាក់ក្រោមជាតិ ដោយប្រើប្រាស់លក្ខខណ្ឌវិនិច្ឆ័យ
- វិភាគទីតាំងទៅតាមសូចនាករ
- កំណត់គោលនយោបាយ និងវិធានការដើម្បីឆ្លើយតបទៅនឹងសូចនាករ
- រចនាយន្តការ ដើម្បីពិនិត្យតាមដានលទ្ធផលការងារនៃគោលនយោបាយ និងវិធានការដែលត្រូវបានជ្រើសរើស

ពេលនេះ ប្រទេសកម្ពុជាបានត្រៀមខ្លួនរួចរាល់ ដើម្បីរៀបចំផែនការសកម្មភាពលម្អិតសម្រាប់រេដបូក។

2. ការកែលម្អ និងផែនការណ៍សកម្មភាពនាពេលអនាគត់

ប្រទេសកម្ពុជាបានបង្កើតយន្តការពាក់ព័ន្ធជាមួយរេដបូក របស់ខ្លួនក្នុងយុទ្ធវិធីតាមដំណាក់កាល។ ថ្វីបើ កម្ពុជាបានរៀបចំឯកសារ NFMS និង FRL រួចហើយក្តី ប៉ុន្តែនៅតែមានលទ្ធភាពអាចកែលម្អ ឬធ្វើបច្ចុប្បន្នភាពឯកសារទាំងនេះបន្ថែមទៀត នៅពេលមានទិន្នន័យកាន់តែគួរឱ្យទុកចិត្តបាន ឬបច្ចេកវិទ្យាជឿនលឿនថែមទៀត។ ដូចគ្នានេះដែរ ផ្នែកមួយចំនួននៃការរចនានៅពុំទាន់បានអភិវឌ្ឍពេញលេញនៅឡើយ ដោយសារតែកំណែទម្រង់ដ៏គំហុកនៅក្នុងវិស័យព្រៃឈើ និងបរិស្ថានរបស់រដ្ឋាភិបាល។

សម្រាប់ NFMS ចាំបាច់ត្រូវធ្វើការដោះស្រាយបញ្ហាការរៀបចំផ្នែកស្ថាប័ន។

សម្រាប់ FRL, ទិន្នន័យសកម្ម និង មេគុណបំភាយ អាចកែលម្អបន្ថែមទៀតតាមរយៈការបង្កើនចំនួនផែនទីប្រើប្រាស់ដី/ផែនទីគម្របដីដែលគួរឱ្យទុកចិត្តបាន តាមរយៈការអនុវត្តវដ្តមួយជុំនៃ NFI។

ដូចគ្នានេះដែរ ប្រទេសកម្ពុជាចាំបាច់ត្រូវចងក្រងរបាយការណ៍បច្ចុប្បន្នភាពរៀងរាល់ពីរឆ្នាំម្តងប្រសិនបើ កម្ពុជាធ្វើការស្នើសុំហិរញ្ញប្បទានពីមូលនិធិអាកាសធាតុបៃតង។

Appendix 6

List of Equipment Procured by JICA

List of Equipment Procured by JICA

1st Period (Nov 2011 – Mar 2013)

For FA

No.	Item	Quantity	
		RS/GIS unit	Forest Inventory Unit
1	File server（Server machine)	1	
2	HDD	1	
3	UPS	1	
4	Desktop computer (for RS/GIS)	2	
5	Desktop computer　(for forest inventory)		1
6	Laptop computer	1	2
7	Color laser printer A3	1	1
8	Color scanner A3	1	1
9	Handy GPS receiver (Garmin 62S)	2	2
10	Hypsometer (Haglof Vertex Laser VL402)	2	2
11	Diameter measuring tape (5m)		5
12	Measuring tape (50m)		5
13	Clinometer (SILVA)		2
14	Compass (SILVA)		2
15	Distance measure (Haglof Model DME)		2
16	Electric balance (Shimazu UX6200H)		1
17	Image analysis software (ERDAS Imagine Advantage)	1	
18	GIS software (ArcGIS ArcView License)	3	
19	Satellite image（ALOS AVNIR-2)	5	
20	Satellite image（ALOS Prism)	3	
21	Satellite image（ALOS Palsar)	3	

For FiA

No.	Type	Specifications	Quantity
1	Desktop PC (For RS/GIS)	Windows 7, Microsoft Office Pro and antivirus software	1

2	Laptop PC	Windows 7 professional, Microsoft Office Home and Business and antivirus software	2
3	Printer	A3 Color inkjet printer/scanner	1
4	GPS	Handy GPS receiver (Garmin 62S)	2
5	GIS software	GIS software (ArcGIS Ver.10 ArcVie w single user license)	2
6	Wifi adapter	Wifi adapter for desktop computer	1
7	External HDD	1TB	1

2nd Period (May 2013 – Mar 2015)

For MoE

#	Type	Specifications	Quantity
1	Desktop PC	Windows 8 Pro OS, with Microsoft Office Pro	1
2	Laptop PC	Windows 8 Pro OS with Microsoft Office Home and Business	1
3	Printer/Scanner	All in one type (Printing, scanning and copying)	1
4	Anti Virus Software	For 3 PCs	1
5	Distance Measure	Haglof DME	1
6	GIS software	ArcGIS Desktop Basic single license	2
7	GPS	Garmin GPSMap 64S with Cambodia Map installed	2

3rd Period (Jun 2015 – Oct 2017)

For MoE for land use planning of protected areas

#	Type	Specifications	Quantity
1	Desktop PC	Windows 8 Pro OS and Microsoft Office Home and Basic	2
2	Laptop PC	Windows 8 Pro OS and Microsoft Office Home and Business	1
3	Anti Virus Software	For 3 PCs	2
4	GIS software	ArcGIS Desktop Pro	1

5	GIS software	ArcGIS Spatial Analyst Extension	1
6	HDD	3.5” 4TB	2

For MoE for land use/cover mapping

#	Type	Specifications	Quantity
1	Desktop PC	Windows 8 Pro OS and Microsoft Office Home and Basic	1
2	Anti Virus Software		1