DEPARTMENT OF FORESTRY AND RANGE RESOURCES (DFRR)
MINISTRY OF ENVIRONMENT, NATURAL RESOURCES CONSERVATION AND TOURISM (MENT)
REPUBLIC OF BOTSWANA

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THE PROJECT FOR ENHANCING NATIONAL FOREST MONITORING SYSTEM FOR THE PROMOTION OF SUSTAINABLE NATURAL RESOURCE MANAGEMENT

PROJECT COMPLETION REPORT

DECEMBER 2017

JAPAN INTERNATIONAL COOPERATION AGENCY（JICA）

ORIENTAL CONSULTANTS GLOBAL CO., LTD.
JAPAN FOREST TECHNOLOGY ASSOCIATION

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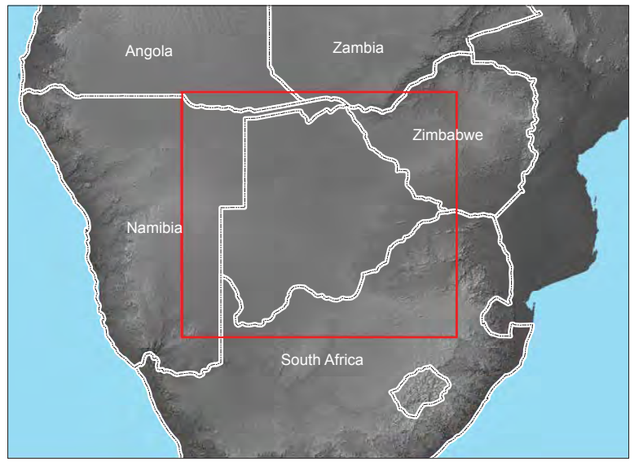
DFRR/JICA: Botswana Forest Distribution Map

Legend

- Settlement
- CountryBoundary
- Riparian Forest
- Typical Forest
- Woodland
- Bushland/Shrubland
- Savanna/Grassland/Forbs
- Baregorund
- Desert/Sand Dunes
- Marsh/Wetland
- Waterbody/Pan



N

0 50 100 200

Kilometres

Coordinate System: GCS WGS 1984
Datum: WGS 1984

Botswana Forest Distribution Map
Produced from 2015 30m Landsat-8 OLI
satellite imagery supplied by USGS.

Published March 2016

Prepared for:

Prepared By:

Hatfield CONSULTANTS

Summary

Chapter 1 The outline of the Project and the National Forest Monitoring Plan	The outline of the Project for Enhancing National Forest Monitoring System for the Promotion of Sustainable Natural Resource Management ("The Project") implemented from July, 2013 until December 2017 and the National Forest Monitoring Plan ("The Plan") which is created by utilising the outputs of the Project are described at this chapter.
❖ **National Forest Monitoring Project**	**The purpose of the project**: The state of the forest is accurately updated through regular monitoring by utilising the national forest monitoring system. Moreover, the developed system is used for sustainable forest management including forest fire management and community-based natural resource management. **Output**: 1) A nation-wide forest distribution map is produced, 2) A methodology for the national forest inventory is established, 3) DFRR is equipped with a forest GIS database, 4) A national forest monitoring plan is developed, 5) Developed NFMS will be utilised by related governmental organizations including DFRR district offices and other ministries to share information and to produce appropriate data for sustainable forest management (SFM), 6) NFMS will be applied to forest fire management which contributes to the SFM, 7) NFMS will be applied to the CBNRM as part of the SFM, 8) Knowledge and experience obtained in the Project will be shared inside/outside Botswana in collaboration with SADC and other developing partners. **Duration**: July 2013 to December 2017(54 month including Extension Phase)
❖ **Botswana Forest Distribution Map (BFDM2015)**	One of the best outputs of the project is Botswana Forest Distribution Map (BFDM2015) and it was launched officially in June 2016. According to the BFDM 2015, the forest area in Botswana is 157,279 km^2 (Forest coverage rate: 27%) including the Riparian Forest 1,552 km^2, Typical Forest 36,517 km^2 and Woodland 119,210 km^2. The definition of the forest is basically based on the definition of the Food and Agriculture Organization of the United Nations (FAO), the canopy cover is over 10%, the minimum unit is more than 0.5 ha, and the average of top layer is higher than 5m. The forest is classified into three land cover types, Riparian forest, Typical forest, and Woodland. The average tree height of the Woodland is less than 8m and has single layer of the canopy.
❖ **National Forest Monitoring Plan**	The plan is created considering the result of the Project. The purpose of the plan is "To generate and update accurately the information on the state of the forest through regular monitoring". The plan is composed of three components, 1) National Forest Inventory (NFI), 2) Forest Distribution Mapping (Forest Remote Sensing), 3) Forest GIS Database. The implementation Agency is Department of Forestry and Range Resources (DFRR), Ministry of Environment, Natural Resource Conservation and Tourism (MENT).
Chapter 2 The Rationale of the **National Forest Monitoring Plan** ❖ Examining the rationale in terms of domestic policy, national development plan, and international framework	The rationale of the plan was examined by analysing the compliance with the Forest Policy 2011 and National Development Plan (NDP) 10 and NDP11. Also the rationale of the plan was examined in terms of international frameworks such as REDD+ (Reducing Emissions from Deforestation and Degradation in developing countries) and GHG (Green House Gas) Inventory, and Paris Agreement from the UNFCCC (United Nations Framework Convention on the Climate Change), CBD (Convention on Biodiversity), UNCCD (United Nations Convention to Combat Desertification), and the Protocol on Forestry of the Southern African Development Community (SADC). After examining all of them, the plan is relevant enough with the domestic policy, national development plan, and international framework, so that the significance of implementation of the plan is high.

Chapter 3 "**National Forest Monitoring Plan**" ❖ The scope of the **National Forest Monitoring Plan,** such as the structure, the schedule, explanations of the components and implementation system	This plan will be implemented with the aim "to generate and update accurately the information on the state of the forest through regular monitoring" and the overall goal is "the information generated by the NFMS is shared with the all stakeholders not only privileged for DFRR and used in order to realise/promote sustainable forest management". The plan consists of three components such as 1) National Forest Inventory (NFI), 2) Forest Distribution Mapping (Forest Remote Sensing), and 3) Forest GIS Database. Furthermore, each component is composed of the methodology and technical manuals. **Component 1: National Forest Inventory (NFI)** The National Forest Inventory (NFI) aims at periodically collecting and recording the up-to-date, accurate data of the forests in Botswana, which can contribute to the realisation of the sustainable forest management and related decision making. 640 Permanent Sample Units (PSU) are prepared and the survey has been started since June, 2015 by the DFRR's surveyor teams. One PSU consists of three circular plots, and these sample units are randomly generated and distributed in the forest areas by GIS. The first cycle of the NFI will be completed by the end of Botswana fiscal year 2020. **Component 2: Forest Distribution Mapping (Forest Remote Sensing)** The remote sensing technology is a useful and effective method to monitor large areas and the component 2 provides the Botswana Forest Distribution Map (BFDM) on regular basis and the first forest distribution map, the BFDM 2015 was officially launched in June, 2016. The component will provide the information on forest cover changes through continuous forest monitoring by comparing two different periods of BFDM. **Component 3: Forest GIS Database** The Forest GIS Database is the core component of the plan, which compiles the data generated by the Component 1 and 2. All ground survey data, such as the georeferenced pictures taken in the field and all other outputs derived from the Component 1 will be incorporated into the database. Also, all remote sensing imagery, generated thematic map including BFDM, and the other spatial information collected or prepared by the Component 2 will be incorporated as the same. The Forest GIS Database is a simple and easy-to-use operation system and a series of manuals were developed for the administrator and the operator.
❖ Forest Information Sharing	The NFI is to be implemented in a five-year cycle and the BFDM is to be updated periodically as well. The DFRR will analyse the results of both NFI and BFDM and share the forest information / status and published as publish the Forest Status Report on a regular basis.
Chapter 4 Utilisation of the National Forest Monitoring System	The four activities about the specific methods of utilisation of the National Forest Monitoring System, the technical system under the National Forest Monitoring Plan, are described in this chapter.
❖ Building the linkage system between the district offices and HQs	The Utilisation for building the linkage system between the district offices and HQs: The contents of the database in the HQs can be always fresh by reflecting the actual ground condition directly from the district offices to HQs database. Thus, the prototype linkage system, which can share the information interactively between the HQs and district offices. Specifically, setting the internet map server, create maps for data collection by using the mobile devices in the field, and setting up map sharing operation between the HQs and the district offices on the map server.

❖ Utilisation for Global Forest Resources Assessment (FRA)/ GHG	Utilisation for the Forest Inventory Data：FAO calls for submission of forest resources information every five years to update FRA. Botswana submitted forest resources information five times over the last twenty-five years. As each country needs to follow the guide prior to the submission, it is imperative that the quality of NFI data collected is maintained, and the collected data are properly handled among the DFRR staffs in the long term for biomass estimation, for example. Thus, the methodology of handling the data to meet FRA/GHG standard was developed, and technically transferred. Specifically, the training for analysing the NFI data according to the FRA standard was accomplished.
❖ Utilisation for the Forest Fire Management	Utilisation for the Forest Fire Management: The forest fire management is the significant theme for Botswana government. The spatial information is necessary to make the forest and range fire management plan. However, the DFRR doesn't have all information required. Thus, the thematic map, which shows the fire danger index and the methods to create these information were developed after discussing with the fire division and these were technically transferred to the DFRR.
❖ Community Based Natural Resource Management (CBNRM)	Utilisation for the Community Based Natural Resource Management (CBNRM): Botswana government promotes the sustainable usage of natural resource by the community to improve the livelihood and poverty of local people. The management of the natural resource by the community using the thematic map (Tree Cover Map) and the satellite imagery was accomplished as one case study for the DFRR. Specifically, creating the thematic map and satellite imagery, which meet local people's demand by holding the workshop with them, and promoting the utilisation of the map and imagery by local people.
Chapter 5 Conclusions and Recommendations ❖ Conclusions	The BFDM2015, which will serve as a benchmark for the future analysis, was developed and the current situation of the forest was understood. As a result, the area and the distribution of the forest at the national level were confirmed. The NFI methodology was developed in the five-year cycle and the DFRR acquired the technical capacity to conduct the forest inventory survey. Moreover, the capacity development training on the forest distribution mapping by using the forest remote sensing technology was conducted and the DFRR acquired its ability. As a result, the DFRR is able to analyse and understand the forest status / information on regular basis by updating the BFDM. In addition, the direction that the utilisation of the developed outcomes such as NFI data and thematic mapping technology, was presented. In order to implement the National Forest Monitoring Plan, as examples of the utilisation and operation, the technical manuals consisting of the following 6 modules were developed for each component. They are: 1) National Forest Inventory, 2) Forest Remote Sensing, 3) Forest GIS Database, 4) Utilisation of the NFI data, 5) Forest Fire Program, 6) Community-based Natural Resource Management.
❖ Recommendations	The following recommendations were given: 1) It is required for the DFRR to establish the implementation system as soon as possible, in order to secure the sustainability of the Plan, 2) Securing the safety of the surveyors is the most important and it is recommended to make some agreement between the DFRR and the stakeholders in this regard, 3) It is necessary for the Government to secure and provide the necessary allowance and equipment for the implementation of the Plan (for the NFI, in particular), 4) Improvement of the GIS hardware and software environment in the district offices, 5) Improvement of the efficiency of the NFI operation, 6) Necessity of the forest sector Master Plan.

Acronyms & Abbreviations

A/R CDM	Afforestation / Reforestation Clean Development Mechanism
AFRRO	Assistant Forest and Range Resources Officer
AGB	Above Ground Biomass
BCA	Botswana College of Agriculture
BCEF	Biomass Conversion and Expansion Factor
BDF	Botswana Defence Force
BEF	Biomass Expansion Factor
BFDM	Botswana Forest Distribution Map
BGB	Below Ground Biomass
BIUST	Botswana International University of Science & Technology
BTO	Botswana Tourism Organisation
BUAN	Botswana University of Agriculture and Natural Resources
CBD	Convention on Biological Diversity
CBNRM	Community-Based Natural Resource Management
CBO	Community-Based Organization
CCF	Community Conservation Fund
CDM	Clean Development Mechanism
COP	Conference of the Parties
CSO	Central Statistics Office
CTO	Chief Technical Officer
DAP	Department of Animal Production
DB	Database
DBH	Diameter at Breast Height
DEA	Department of Environment Affaires
DFDM	Detailed Forest Distribution Map
DFRR	Department of Forestry and Range Resource
DMS	Department of Meteorological Service
DNMM	Department of National Museum and Monuments
DSM	Department of Survey & Mapping
DWNP	Department of Wildlife and National Parks
EAD	Energy Affair Division
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCB	Forest Conservation Botswana
FDI	Fire Danger Index
FDM	Forest Distribution Map
F-GIS-DB	Forest GIS Database
FIS	Forest Inventory Survey

FRA	Forest Resource Assessments
FRRO	Forest and Range Resources Officer
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	German Society for International Cooperation
GPS	Global Positioning System
GT	Ground Truth
HQ	Headquarters
ICT	Information and Communication Technology
JAFTA	Japan Forest Technology Association
JAXA	Japan Aerospace Exploration Agency
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
KyT	Kgetsi ya Tsie Women Resources Enterprise Community Trust
LANDSAT	Land Satellite
LIDAR	Light Detection and Ranging
LULUCF	Land Use, Land Use Change and Forestry
MENT	Ministry of Environment, Natural Resources Conservation and Tourism
MESA	Monitoring for Environment and Security in Africa
MEWT	Ministry of Environment, Wildlife and Tourism
MLH	Ministry of Land and Housing
MMEWR	Ministry of Mine, Energy and Water Resources
MRV	Measurement, Reporting, Verification
NAPCD	Botswana National Action Program to Combat Desertification
NBSAP	National Biodiversity Strategy and Action Plan
NC	National Communication (UNFCCC)
NDP	National Development Plan
NEF	National Environmental Fund
NFDM	National Forest Distribution Map
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NGO	Non-Governmental Organization
NTFP	Non Timber Forest Products
OCG	Oriental Consultants Global Co., Ltd.
O-J-T	On the Job Training
OLI	Operational Land Imager
PALSAR	Phased Array Type L-band Synthetic Aperture Radar
PC	Personal Computer
PCA	Principle Component Analysis

PCR	Project Completion Report
PDP	Performance Development Plan
PFRRO	Principal Forest and Range Resources Officer
PTO	Principal Technical Officer
QAQC	Quality Assurance / Quality Control
R	R language (open source programing language and software for statistic)
R/S	Root-Shoot Ratio
RD	Record of Discussion
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
RS	Remote Sensing
S.I.	Statutory Instruments
SADC	Southern African Development Community
SAR	Synthetic Aperture Radar
SBSTA	Subsidiary Body for Scientific and Technological Advice
SFM	Sustainable Forest Management
SFRRO	Senior Forest and Range Resources Officer
SPOT	*Satellite Pour l'Observation de la Terre*
STO	Senior Technical Officer
TAC	Technical Advisory Committee
TWG	Technical Working Group
UB	University of Botswana
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	U.S. Agency for International Development
UTM	Universal Transverse Mercator
VDC	Village Development Committee
WAD	Women's Affairs Department
WMA	Wildlife Management Area

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CHAPTER 1 OVERVIEW OF THE PROJECT AND THE NATIONAL FOREST MONITORING PLAN

1.1 Overview of the Project

1.1.1 Background and the extension phase of the Project

Forest resources in Botswana are a versatile renewable resource, providing a wide range of goods and services including fuel, a vast array of food, medicinal, cultural and spiritual purpose for people, especially to rural communities. They also provide importance ecosystem services mitigating the adverse effects of GHG emissions, harbouring biodiversity, and recreation and tourism. As for the fuelwood, it is still an indispensable fuel for many households and the principal energy source used for cooking in 46% of the households nationally and in 77% of households located in rural areas[1].

The biggest challenge in Botswana relating to the contribution of forest to the national economy has been the lack of information on the status of forest resources in the country. The Government of Botswana had no statistical data for the better management of forest resources. The use of fuelwood presents pressures on forest resources and challenges for their management and conservation. This is especially the case as the rate and manner of exploitation of the resource is not known or monitored.

The Project for Enhancing National Forest Monitoring System for the Promotion of Sustainable Natural Resource Management in the Republic of Botswana ("NFMS Botswana Project" or the "Project"), started in July 2013 in order to tackle the above-mentioned challenges and to enhance the capacity of the government for the forest monitoring, with the technical assistance of the Japan International Cooperation Agency (JICA).

Since then, the Project had made steady progress and in April 2015 before completing two years of the activity, JICA dispatched the mission in order to discuss its progress with the Department of Forestry and Range Resources (DFRR). The DFRR explained that the priority needs of the application of NFMS are; 1) Developing NFMS, 2) Applying to Forest Fire Program, and 3) Applying to Participatory Forest Management, to achieve the super goal of the project such as "Sustainable Forest Management in Botswana". As a result of the discussion, the Minutes of the Meeting were signed on 2nd October 2015.

Consequently, the "Record of Discussion" (hereinafter referred to as "RD") was amended on 5th October, 2015 and the period of the Project was extended until December 2017. According to the amended RD, four more outputs were added in order to strengthen the applied skill of the National Forest Monitoring System (hereinafter referred to as "NFMS") as a tool and the extension phase was implemented from July 2016 to December 2017. The next table shows an overview of the Project.

Table 1-1 Overview of the NFMS Botswana Project

Title of the Project	The Project for the Enhancing National Forest Monitoring System for the Promotion of Sustainable Natural Resources Management
Duration	July 2013 to June 2016 (36 months) July 2016 to December 2017 (Extension Phase: 18 months)
Project Purpose	The state of the forest is accurately updated through regular monitoring by utilising the national forest monitoring system. Moreover, the developed system is used for sustainable forest management including forest fire management and community-based natural resource management

[1] ENERGY STATISTICS 2003, STATS BRIEF February 2007

Expected Outputs	1. A nation-wide forest distribution map is produced 2. A methodology for the national forest inventory is established 3. DFRR is equipped with a forest GIS database 4. A national forest monitoring plan is developed Four outputs added in the extension phase; 5. Developed NFMS will be utilised by related governmental organizations including DFRR district offices and other ministries to share information and to produce appropriate data for sustainable forest management (SFM) 6. NFMS will be applied to forest fire management which contributes to the SFM 7. NFMS will be applied to the CBNRM as part of the SFM 8. Knowledge and experience obtained in the Project will be shared inside/outside Botswana in collaboration with SADC and other developing partners.

Source : DFRR-JICA NFMS Botswana Project

1.1.2 Work flow of the Project

The Project was conducted and achieved according to the work flow attached as Appendix-1, Work Flow of the Project (July 2013 – June 2016). In the extension phase (July 2016 – December 2017), the activities were conducted based on the Plan of Operation for the extension phase as shown in Appendix - 2.

1.1.3 Procurement of equipment

All of the planned equipment, necessary for the execution of the NFMS, had been procured and handed over to the DFRR. The certificates of handover were attached in the Appendix - 3 and the list of equipment is shown as Appendix 4. The whole sum of the equipment cost covered by the Japan side came to BWP 3,457,587.65 including tax. The breakdown is shown in the Table 1-2.

Table 1-2 Procurement Amount ordered for the procurement of the equipment

Category of Equipment	Item	Amount ordered in Botswana (BWP tax included)	Amount ordered in Japan (JPY tax included)
Satellite image	PALSAR (2sets :3 tiles)	-	331,490
	SPOT6 (6,504 km^2)	-	3,250,699
	RapidEye (6,334 km^2)	-	1,806,995
RS Software	ENVI	671,440.00	-
	eCognition	-	3,999,975
RS/GIS Hardware	RS/GIS Hardware	172,506.88	-
	Hand held PC	19,353.60	-
	LED monitor	7,100.80	-
Forest Inventory Survey	GPS, Vertex IV, TruPulse360, Calliper, Diameter tape, Measuring tape, Tree tag, etc.	26,544.00	6,358,705
Biodiversity Survey	Trail camera, Binoculars, Field Scope, Single-lens reflex camera, etc.	-	2,005,420
Project Management	Multi-function printer, Projector, Note & Desktop PC	160,051.42	-
Vehicles	Vehicles (02 Toyota Land Cruiser)	919,299.00	-
	Sub-total	**BWP 1,976,295.70**	**JPY 17,753,284**

	(1) Total amount ordered in Botswana (BWP/including tax)	(2) Total Amount ordered in Japan (BWP converted)*
Sub-total	**BWP 1,976,295.70**	**BWP 1,481,291.95**

Grand total (BWP)	(1) + (2) =	**BWP 3,457,587.65**

* Exchange rate applied: BWP 1.00 = JPY 11.985 (Average JICA exchange rate Apr.2015- Jan.2016)
http://www.jica.go.jp/announce/manual/form/consul_g/ku57pq00000kzv7m-att/rate_201601.pdf
Source: DFRR-JICA NFMS Botswana Project

1.1.4 Mobilisation of the Consultants

The consultants were input for the first half of the Project (from July 2013 to June 2016), their expertise are as following: “Team Leader / Forest Resource Management”, “Forest Remote Sensing”, “Forest GIS Database”, “Forest Inventory”, “Biodiversity”, “Administration Assistant”, “Training in Japan”. In the extension phase, “CBNRM” consultant was added in addition of them.

Consequently, the total Man-Month mobilised by the Project was 104.15 MM[2]. Appendix-7 shows the List of the Consultant and the Man-Month table realised.

1.1.5 Joint Coordinating Committee (JCC)

The Joint Coordinating Committee (JCC) was held four times in the Project. Next table shows the date and the main agenda discussed in each JCC meetings. The Record of Discussion of each meeting is attached in the Appendix-8.

Table 1-3 Date and the main agenda discussed in each JCC

JCC	Date	Main Agenda
1st JCC	30 January, 2014	Progress report of the first year and the plan of the coming term (explanation of the Completion Report FY1)
2nd JCC	3 June, 2015	Progress report of the second year (first half), the plan of the coming term and the extension phase of the Project (explanation of the Monitoring Report No. 1 (FY2-first half)
3rd JCC	21 April, 2016	Progress report of the second year (latter half), and the plan of the coming term (explanation of the Monitoring Report No.2), BFDM 2015
4th JCC	23rd March, 2017	Progress report of the second year (extension phase), and the plan by the end of the Project (explanation of the Project Monitoring Report No.3 Extension Phase)
Final JCC	3rd November, 2017	No minutes of meeting was made. The JCC meeting was held same day as the Technical Dissemination Seminar. In the JCC, the draft version of the Project Completion Report was submitted. The consultant team has requested the DFRR to submit the comments on the report by the due date.*

*Note: Submission letter for the draft version of the Project Completion Report with the signature of receiving by the Director / DFRR is attached in the Appendix for the final JCC
Source: DFRR-JICA NFMS Botswana Project

1.1.6 Record of the Training in Japan and other training

(1) Training in Japan

Training in Japan was conducted three times in the year 2013, 2014 and 2015 once a year. Nine trainees in total, three trainees by year were benefited by the training. Next table shows the list of the trainees and the period. The more details can be available in the Appendix-10 Record of the Training in Japan

[2] Except consultant company’s contribution. Total of 27.39MM (FY1) and 76.76MM (FY2 and later).

Table 1-4 List of trainees and period of the Training in Japan

No.	Term/Period*	Trainee	Post (at the time of the training)	Duty Station (At the time of the training)
1	FY1 3-20 Dec. 2013	Mr Anthony N. Tema	Chief Forestry & Range Resources Officer	Gaborone
2		Mr Motsheganyi Sekgopo	Project Manager – NFMS Project, Principal Forestry & Range Resources Officer I	Gaborone
3		Mr Keletso Seabo	Leader / SADC-MRV Project Assistant Scientific Officer	Gaborone
4	FY2 11 Nov.-19 Dec. 2014	Ms.Tshenolo Gogola	Forestry & Range Resources officer	Gaborone
5		Mr.Wazha Lucas	Forestry & Range Resources officer	Kanye
6		Mr Etsang Phokoletso	Forestry & Range Resources officer	Molepolole
7	FY3 1-18 Dec. 2015	Ms Gloria Komanyane	Senior Forest Range Resource Officer	Gaborone
8		Mr Joseph Lesenya	Forest Range Resource Officer II	Tsabong
9		Ms Thomologo Mutukwa	Chief Technical Officer	Maun

*Note: Traveling time between Botswana and Japan was not included.
Source: DFRR-JICA NFMS Botswana Project

(2) Other Training

A series of the training for the staff of the DFRR were provided by the Consultant Team of the Project. Most of those trainings were carried out in the combination of lectures and practices. In addition, the training was implemented as many staff as possible, including district officers so that the training is not provided only to the limited staff in the central office. Mobilising as many staff as possible to the training means that, even if an officer changes jobs, the outcome of the training will remain in the organisation.

Necessary allowances for the trainee from district offices were covered by the DFRR. Next table shows the number of the participants for the training and the mobilised man-day by theme and year. Totally, 396 officers were participated and 1,554 man-day were mobilised for the training. The detail by the theme is attached in the Appendix - 9 Technical Transfer Report

Table 1-5 Summary of the results of the capacity development training for the DFRR

Participants, Year, Man-Day / Theme	Number of Participants*					Man-Day mobilised					Total Participants	Total Man-Day
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017		
Forest Inventory		60	26	16	32		325	52	25	80	134	482
Forest GIS Database			33	6	5			33	6	10	44	49
Forest Remote Sensing		116	53	25	15		466	254	39	75	209	834
Training in Japan	3	3	3			54	51	54			9	159
Total	**3**	**179**	**115**	**47**	**52**	**54**	**854**	**402**	**70**	**165**	**396**	**1,524**

Note: *Results of the Training in Japan is also included. *Number of Participants is shown in Total and the overlapping trainee is included (ex.when one trainee participated in one and another theme, one participant will be counted for each trainings (two participants in total)
Source: DFRR-JICA NFMS Botswana Project

Other than the capacity development for the staff of the DFRR, the capacity development for one Community-Based Organisation, Kgetsi ya Tsie Women Resources Enterprise (KyT) was conducted as a part of the activity applying the NFMS as a tool for the Community-Based Natural Resource Management. Then, the Project trained the board member including the coordinator and the members of the KyT (19 members were mobilised in total) through the O-J-T action plan making. See “Chapter 4.5 Utilisation of the NFMS – Output 7. Utilisation for CBNRM - “about the CBNRM activities conducted by the Project.

1.2 Overview of the National Forest Monitoring Plan

The overview of the National Forest Monitoring Plan as a result given by the Project is described in this section although the overview of the Project, which was implemented from June 2013 to December 2014, as described in the former section.

1.2.1 Primary objective of the National Forest Monitoring Plan

The objective of the Project is "The state of the forest is accurately updated through regular monitoring by utilising the national forest monitoring system. Moreover, the developed system is used for sustainable forest management including forest fire management and community-based natural resource management" as mentioned in the section 1.1.

The objective of the National Forest Monitoring Plan is **"To generate and update accurately the information on the state of the forest through regular monitoring**

1.2.2 Overall Goal

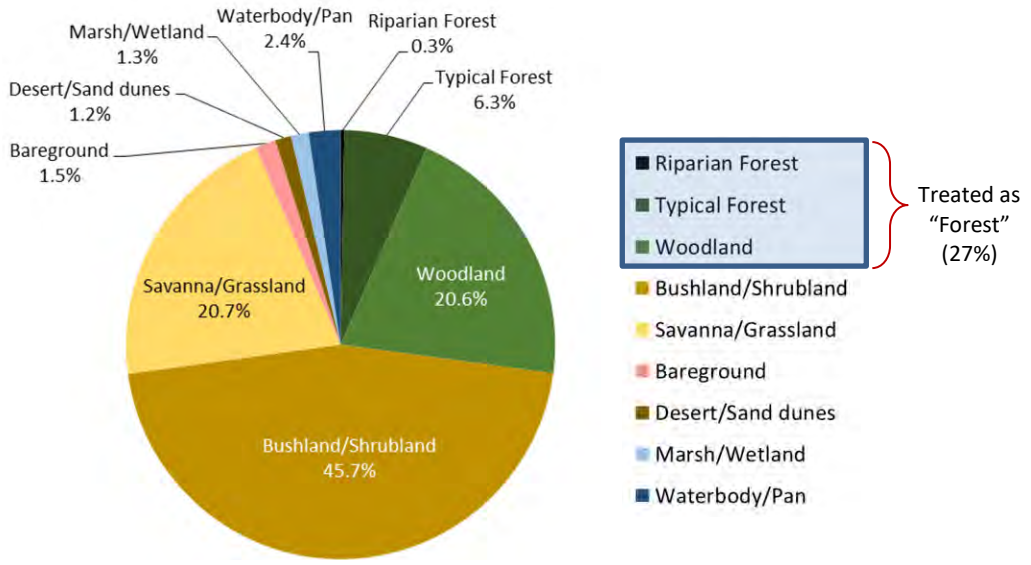
The overall goal of the National Forest Monitoring Plan developed through the Project is set that "T**he information generated by the NFMS is shared with the all stakeholders not only privileged for DFRR and used in order to realise/promote sustainable forest management**"

1.2.3 Implementation Agency

Department of Forestry and Range Resources (DFRR), Ministry of Environment, Natural Resource Conservation and Tourism (MENT)

1.2.4 Development of BFDM 2015 and the National Forest Monitoring Plan

The Project developed the Botswana Forest Distribution Map (BFDM) 2015 and launched it officially in June 2016. According to the BFDM 2015, the forest area in Botswana is 157,279 km^2 (Forest coverage rate: 27%) including the Riparian Forest 1,552 km^2, Typical Forest 36,517 km^2 and Woodland 119,210 km^2. In Botswana, these three categories are classified as the forest. The definition of the forest is basically based on the definition of FAO, the average of top layer of the Riparian Forest and Typical Forest are higher than 8 meters and has multi-layers of the canopy. The average of top layer of the Woodland is less than 8 meters and has single-layer of the canopy. The detail definition and classification of the forest is explained in "3.8.1 (1) The definition of forest, Specification of the Botswana Forest Distribution Map (BFDM)". The BFDM 2015 was developed based on the Landsat 8 satellite imageries in 2013 and 2015 with spatial resolution of 30m. The information on forest area and its distribution became available through the BFDM 2015. Moreover, the status and changes in forest resources can be analysed in combination with such remote sensing data and the ground data of the forest. In order to accumulate the ground data, the National Forest Inventory (NFI) has been continued since June 2015 under the framework of the Project and now, the first cycle of the survey is underway by the DFRR NFMS Team.



Source: BFDM2015, DFRR-JICA NFMS Botswana Project

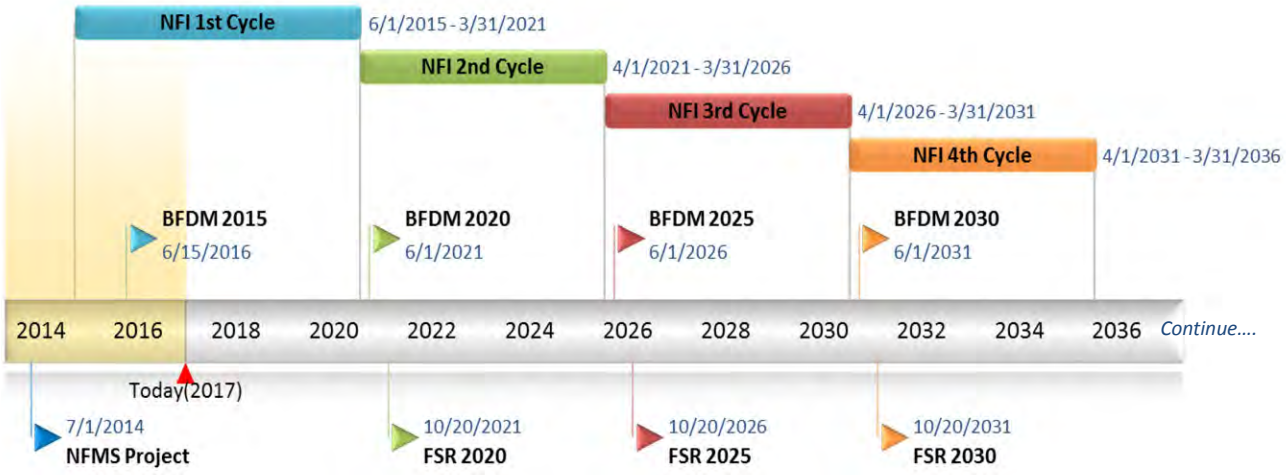
Figure 1-1 BFDM2015 distribution by land-cover types

Table 1-6 BFDM2015 distribution of land-cover types and forest rate by District

Class	Central	Chobe	Ghanzi	Kgalagadi	Kgatleng	Kweneng	Ngamiland	North East	South East	Southern	Total (km^2)	%
Riparian Forest	558	86	2				863	42			**1,552**	**0.3**
Typical Forest	14,054	8,104	22		360	1,206	11,163	949	193	467	**36,517**	**6.3**
Woodland	35,022	5,834	15,762	5,152	1,137	3,944	48,603	1,680	254	1,821	**119,210**	**20.6**
Total "Forest"	***49,634***	***14,024***	***15,786***	***5,152***	***1,497***	***5,150***	***60,629***	***2,671***	***447***	***2,288***	***157,279***	***27.1***
Forest Rate in District (%)	***33.8%***	***66.9%***	***13.7%***	***4.9%***	***19.5%***	***13.9%***	***54.1%***	***49.0%***	***22.4%***	***8.4%***		
Bushland/Shrubland	55,834	3,375	65,578	65,872	4,618	20,002	32,650	1,175	1,200	14,601	264,906	45.7
Savanna/Grassland	27,403	2,716	31,594	25,099	1,487	11,314	8,929	1,317	295	9,982	120,134	20.7
Bareground	3,220	441	1,065	1,518	50	451	1,414	244	28	475	8,905	1.5
Desert/Sand dunes				7,008							7,008	1.2
Marsh/Wetland	7	339					7,315				7,661	1.3
Waterbody/Pan	10,662	67	1,069	728	12	51	1,176	48	20	43	13,875	2.4
Total	146,759	20,961	115,093	105,377	7,663	36,968	112,113	5,455	1,991	27,388	579,768	100.0

Source: BFDM2015, DFRR-JICA NFMS Botswana Project

By analysing the BFDM 2015 and the result of the 1st cycle of the NFI which is underway, the first benchmark of the country's forest status will become evident and it will serve for the future forest monitoring and the policy making. Also the NFMS helps to review the sustainability of forests by analysing the trends of their expansion or deforestation of forest and review the sustainability of forests. As such information will serve not only for the DFRR but also needed for the stakeholders among others. Therefore, the forest status report shall be developed and published on regular basis by the DFRR and all the forest information shall be shared among the relevant stakeholders and the citizens and used for related strategic, management, and operational planning. The next figure shows the whole tentative schedule of the NFMS.



Note: NFI: National Forest Inventory, BFDM Botswana Forest Distribution Map, NFMS: National Forest Monitoring System, FSR Forest Status Report, Date format: Month/Day/Year
Source: DFRR-JICA NFMS Botswana Project

Figure 1-2 Overall schedules of the National Forest Monitoring Plan

The task in Upper line shows the cycle of NFI at a 5-year interval except the first NFI cycle which will be complete by the end of the FY2020. The milestone in the middle line shows a schedule of BFDM at a 5-year interval. Then, analysing the results of the NFI and BFDM, the forest status report shall be prepared and published on a regular basis. So, the milestone shown in the lower part shows a schedule of the Forest Status Report with 5 years interval.

1.2.5 Scope of this report

This project completion report describes the National Forest Monitoring System based on the Interim Report submitted on July 2016 by adding the outcomes in the extension phase (July 2016-December 2017) and the all outputs since the beginning, June 2013 to the end of the Project, December 2017.

CHAPTER 2 RATIONALE OF THE NATIONAL FOREST MONITORING PLAN

This chapter describes if the National Forest Monitoring Plan, which was developed through the NFMS Project, can achieve compliance with the national policy/plans and the international convention/frameworks.

The relevance of the plan was examined by analysing the compliance with the Forest Policy 2011 which is the basic policy in the forest sector, and the National Development Plan (NDP) such as NDP 10 which was effective during the Project period and the NDP 11 which is in vigour actually.

The relevance was examined also in terms of international frameworks such as the UNFCCC (United Nations Framework Convention on the Climate Change), CBD (Convention on Biodiversity), UNCCD (United Nations Convention to Combat Desertification), and the Protocol on Forestry of the Southern African Development Community (SADC) which is under the regional framework.

2.1 Compliance with the national policy and plans

2.1.1 Forest Policy 2011

Forest Policy was adopted in 2011 and it is a framework that provides guidance and facilitation in the management of forests and range resources of the country through conservation, development, and sustainable use. The policy defines basic principles, objectives, strategies and action plans for the management of forests and range resources through conservation, development, and sustainable utilisation to meet social, cultural, economic, environmental and ecological needs of present and future generations.

The policy developed the following ten principals taking into account environmentally sustainable guides;

Table 2-1 10 Principals pointed out in the Forest Policy 2011

10 Principals		Explanations
1	People-centric	Forest management must place people and their needs at the forefront of its concern, and developmental, cultural, and aesthetic interests equitably.
2	Sustainable Development	Forest management must be socially acceptable, environmentally sound and economically viable.
3	Polluter-pays/User-pays	The costs of remedying forest degradation must be borne by those responsible for causing the degradation (user-pay principle).
4	The custodianship	The forest is held in public trust for the people, the beneficial use of forest resources must serve the public interest and the forest must be protected as the people's common heritage.
5	Best Practice	Forest management must be integrated, acknowledging that all elements of the forest are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment.
6	Environmental governance	Adverse environmental impacts shall not be distributed in such manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons.
7	Equitable access	Resources, benefits, goods and services are used to meet basic human needs as well as ensure human wellbeing. Deliberate effort shall be taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination.
8	Indigenous and ordinary knowledge	Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge.
9	Community wellbeing and empowerment	It promoted through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means.
10	Precautionary approach	In order to protect the environment, the precautionary approach shall be applied. Thus, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. Therefore, the precautionary principle in biotechnology management shall be taken into account, as modern biotechnology maybe uncertain regarding some adverse effects on forest and range resources.

Source: Forest Policy, MEWT, 2011

The overall goal of this Forest Policy is "to optimize the contribution of the forest and range resources to the long-term socio-economic development of Botswana by ensuring equitable and sustainable flow of benefits to all segments of the population now and in the future". This overall goal will be attained through the following ten objectives and strategies:

1) Forest resource management
2) Wildland fire management
3) Public participation, education and awareness
4) Production forestry
5) Research and development
6) Ecotourism and other socio-economic opportunities
7) Non-wood forest products developments
8) Forestry training and capacity building
9) Multilateral environmental agreements
10) Indigenous knowledge and intellectual property rights

Among the above, 1) forest resource management and 5) Research and development are linked to the national forest monitoring system.

Table 2-2 Description in the forest policy regarding the "Forest Resource Management" and the "Research & Development"

Objectives/ Strategy	Description
Forest Resource Management	Over the years, forests in Botswana have been subjected to depletion due to sustained pressure arising from ever-increasing demand for fuel-wood, construction materials, inadequate protection measures, frequent droughts, frequent fires, land use pressure and other uses that are not matched by compensatory afforestation and essential environmental safeguards. In relation to global warming and climate change, the government acknowledges the need to manage forests with the aim of maintaining or elevating their 'carbon sink' capacity. Like many other developing countries, Botswana is vulnerable to climate change. In this regard, failure to safeguard the integrity of the ecosystem will also inevitably affect global atmospheric circulation patterns. Conservation involves protection, restoration, maintenance, sustainable utilisation, and enhancement of the natural environment. In order to ensure that the forest resources are managed sustainably for purposes of both long-term development and the conservation of our natural heritage and bio-diversity, it is vital that issues of sustainable management, protection, conservation and cultural heritage are given explicit recognition. The Policy recognizes the value that Botswana attaches to the forests and rangelands, and the obligations to protect these resources and biodiversity adequately. This entails ensuring environmental stability and maintenance of ecological balance which are vital for the sustenance of all forms of life-human, animal and plant. It further recognizes the natural inter-relationships between native flora and fauna (both terrestrial and aquatic) and their importance in the health of the forest ecosystem. To this end, the policy advocates for the conservation of all indigenous species of fauna and flora.
Research & Development	Research and development on forest resources is at an infant stage. As a result, information on natural resources is insufficient and inaccessible for informed decision making on the management, utilization and protection of forests, forest ecosystems and other landscapes. The Policy recognizes the importance of undertaking accelerated research to support the development of more efficient forest management practices and higher productivity from the forest resource base. Research will take into account biological, physical, social, economic variables and technological development, as well as its application, in the field of conservation and production forestry. Additionally, timely and accurate information on forest and forest ecosystems will be availed for better understanding and decision-making. Forestry research shall embrace ecological research, tree breeding, socio-economic analysis amongst others as priority research areas Resource assessment will be guided by the fact that inventorying and monitoring are an integral part of sustainable forest management. Assessment of vegetation resources will be done periodically for the purposes of generating essential information for decision-making, development of management plans, and monitoring.

Source: Forest Policy, MEWT, 2011

As mentioned above, the NFMS can contribute the objective of the "Forest Resource Management" since the NFMS can contribute necessary forest information for those management in particular, the extent of the Forest and Woodland where the main source of the forest product including the fuel-wood and the habitat of the wildlife and it can be facilitated and used for the decision-making related with forest resource management.

As for the "Research and Development", the Forest Policy says that the "Research and development on forest resources is at an infant stage" and "Resource assessment will be guided by the fact that inventorying and monitoring are in integral part of sustainable forest management". Moreover, in the strategies section for the "Research and Development", it is mentioned that "Determining the resources quantity, quality and their values through periodic vegetation resources inventories and monitoring" and "Developing vegetation database to ensure that decision making is based on real time and best available information". Consequently, the relevance for the National Forest Monitoring Plan is very high since it can provide a specific solution to the issues.

2.1.2 National Development Plan (NDP)

Botswana's multi-year economic planning dates back to the time of Independence, with the drawing up of Botswana's Transitional Plan for Social and Economic Development. Since then, the National Development Plans have aimed at guiding the development of Botswana's economy and drawing up programmes of public expenditure on recurrent and development projects, based on projected revenue resources of the Government. Botswana has undergone a tremendous transformation over the 50 years since Independence, but the basic approach to national development planning remains based on the enduring national principles of democracy, development, self-reliance, and unity. The current National Development Plan (NDP) is 10th NDP (NDP10) which was started in April 2009 and was supposed to end in March 2016. This section describes that the validity of the NFMS in terms of the NDP10 which was vigour during the project period and the latest NDP (NDP11).

(1) NDP10

The NDP 10 has 10 Goals along with the lines of the Pillars of the Vision 2016 which is the national manifesto of the government. The next table shows the relationship between 10 goals in NDP and Vision 2016 Pillars.

Table 2-3 Vision 2016 Pillars and NDP 10 Goals

Vision 2016 Pillars	Key Result Areas	NDP 10 Goals
1. An Educated and Informed Nation	1. Competitive & Productive Human Resources 2. Knowledge Society	1. Adequate Supply of Qualified, Productive & Competitive Human Resources 2. Innovative & Productive Use of Information &Technology
2. A Prosperous, Productive and Innovative Nation	3. Sustainable Economic Growth 4. Sustainable Environment	3. Sustainable Rapid Economic Growth 4. Well Developed & Reliable Infrastructure 5. Sustainable Management of Natural Resources
3. A Compassionate, Just and Caring Nation	5. Enhanced Well Being & Social Responsibility	6. Eradication of Absolute Poverty 7. Adequate Social Services 8. Affordable & Quality Healthcare 9. Prevent New HIV/AIDS Infections
4. A Safe and Secure Nation	6. Safe, Secure & Peaceful Nation	10. Public Safety & Protection 11. Territorial Integrity Sovereignty
5. An Open, Democratic and Accountable Nation	7. Open & Transparent Governance 8. Participatory Democracy	12. Transparency & Accountability in All Public & Private Institutions 13. Enhanced & Sustained Participatory Democracy 14. Rule of Law
6. A Moral and Tolerant Nation	9. Morality & Tolerance	15. Enhanced Cultural Heritage & Diversity
7. A United and Proud Nation	10. National Pride & Unity	16. Strong National Identity & Unity

Source: The 10th National Development Plan (2009-2016), Ministry of Finance and Development Planning

"Accelerating Achievement of Vision 2016 through NDP 10" is the function and the theme of the NDP 10, and it aims at accelerating diversification of the economy from dependence on diamonds towards the growth of the rest of the private sector such as manufacturing, tourism and agriculture.

Vision 2016 anticipates that its quest for a "Prosperous, Productive and Innovative Nation" will be achieved through sustainable economic growth and diversification supported by a sustainable environment and also Vision 2016 reaffirms the importance of sustainable development and the protection of the environment. It places a particular focus on the development of the rural economy. Against this background, conservation and sustainable management of natural resources should be fully integrated in the development planning process emphasis on using renewable resources at a rate that is in balance with regeneration.

NDP 10 focuses on the "Sustainable Management of Natural Resources" as one of the goals and it is defined in the Section V, Chapter 11 Sustainable Environment. The NDP 10 goal of "Sustainable Management of Natural Resources" will be attained through implementation of the following strategies:

1) The mainstreaming of environment and climate change into development processes.
2) Numerical weather predictions will be enhanced to overcome constraints on meteorological forecasting experienced during NDP 9. This will improve meteorological observations and accuracy of information.
3) New strategies in the waste management sector, including separation of waste at the source, development of waste management infrastructure and improved management and collection of waste will be pursued. These strategies will facilitate public buy-in of the implementation waste management hierarchy (i.e., Reduce, Reuse and Recycle).
4) Carrying out a forest resources inventory at ecosystem level. This will inform decision making for forest resource management.
5) Improvement of wildlife management practices to retain animals within the protected areas. This will limit contact with humans and thereby reduce human-wildlife conflicts.
6) Implementation of the Community Based Natural Resource Management Policy. This will enhance conservation of the resources through empowerment of local communities.

Among those strategies, NDP 10 sets the forest inventory as important to get the basic forest information for appropriate decision-making ensuring the sustainable forest management. Therefore, the planning and carrying out of the NFMS that includes the national forest inventory system is in compliance with the goal of NDP 10 and have high validity.

(2) NDP 11

The initial NDP 10 implementation period was from 1st April 2009 to 31st March, 2016. However, this period was extended by one year up to 31st March, 2017. The adoption of the eleventh National Development Plan (NDP 11) in December 2016 followed the country's celebration of the fifty years anniversary of Independence and the launching of the Vision 2036 in September 2016.

Vision 2036 and NDP 11 were developed by aligning the Sustainable Development Goals (SDGs) under the framework of the United Nations, termed "the 2030 Agenda for Sustainable Development" in September 2015. The purpose of Vision 2036 is to achieve prosperity for all and to be a high income country by 2036 from an upper-middle income country and it has four pillars:

1) Sustainable Economic Development,
2) Human and Social Development,
3) Sustainable Environment and
4) Good Governance, Peace and Security.

The NDP 11 has been prepared to guide the medium term economic development path, as well as being the first in the series to implement Vision 2036. The theme for NDP 11 is "**Inclusive Growth for the Realisation of Sustainable Employment Creation and Poverty Eradication**".

The overall strategies for NDP 11, both at macro and thematic level, are drawn on the basis of the identified six national priority areas of:

1) **Developing Diversified Sources of Economic Growth**
2) Human Capital Development

3) Social Development
4) **Sustainable Use of Natural Resources**
5) Consolidation of Good Governance and Strengthening of National Security
6) Implementation of an Effective Monitoring and Evaluation System

The next table shows the comparison of SDGs, NDP 11 and Vision 2036 framework priorities.

Table 2-4 Comparison of SDGs, NDP 11 and Vision 2036 framework priorities

UN. Sustainable Development Goals	Vision 2036 Pillars	NDP 11 Priorities
Goal 1. End poverty in all its forms	1. Sustainable Economic Development 2. Human and Social Development	1) Developing Diversified Sources of Economic Growth 3) Social Development
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	2. Human and Social Development	3) Social Development
Goal 3 Ensure healthy lives and promote well-being for all at all ages	2. Human and Social Development	3) Social Development
Goal 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	2. Human and Social Development	2) Human Capital Development 3) Social Development
Goal 5 Achieve gender equality and empower all women and girls	2. Human and Social Development	2) Human Capital Development 3) Social Development
Goal 6 Ensure availability and sustainable management of water and sanitation for all	2. Human and Social Development	3) Social Development
Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all	1. Sustainable Economic Development	1) Developing Diversified Sources of Economic Growth 2) Human Capital Development
Goal 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	1. Sustainable Economic Development	1) Developing Diversified Sources of Economic Growth 2) Human Capital Development
Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	1. Sustainable Economic Development	1) Developing Diversified Sources of Economic Growth 2) Human Capital Development
Goal 10 Reduce inequality within and among countries	1. Sustainable Economic Development	1) Developing Diversified Sources of Economic Growth 2) Human Capital Development
Goal 11 Make cities and human settlements inclusive, safe, resilient and sustainable	1. Sustainable Economic Development	1) Developing Diversified Sources of Economic Growth 2) Human Capital Development
Goal 12 Ensure sustainable consumption and production patterns	2. Human and Social Development	3) Social Development
Goal 13 Take urgent action to combat climate change and its impacts	3. Sustainable Environment	4) Sustainable Use of Natural Resources
Goal 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development	3. Sustainable Environment	4) Sustainable Use of Natural Resources
Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	3. Sustainable Environment	4) Sustainable Use of Natural Resources
Goal 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	4. Governance, Peace and Security	5) Consolidation of Good Governance and Strengthening of National Security
Goal 17 Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	-	6) Implementation of an Effective Monitoring and Evaluation System

Source: National Development Plan 11 Volume 1, April 2017-March 2023, Botswana Government

The National Forest Monitoring Plan can contribute directly to the 4th priority area of the NDP11, such as "Sustainable Use of Natural Resources", since it can provide necessary forest information about the forest status in the country.

With respect to "Developing Diversified Sources of Economic Growth", tourism (Eco-Tourism) has been identified as an advantage economic sector with the potential to contribute to the process of economic diversification and poverty alleviation. Development and growth of the sector based on the wildlife and natural environment including forest and woodland must be underpinned by the twin concepts of conservation and sustainable use and the status of those natural resources must be monitored constantly. In addition, opening up the forest reserves for tourism is in discussion. In this regard, "the Guideline for the use of Forest Reserves for Ecotourism" has been drafted by the UNDP (July 2009, UNDP). The information derived from the NFMS can be used for the forest reserve management.

Consequently, the National Forest Monitoring Plan is in line with the "Sustainable Management of Natural Resources" in the NDP10, and the first and forth pillar of the on-going NDP11 respectively, "Developing Diversified Sources of Economic Growth" and "Sustainable Use of Natural Resources" and its relevance is high.

2.2 Compliance with the international conventions and frameworks

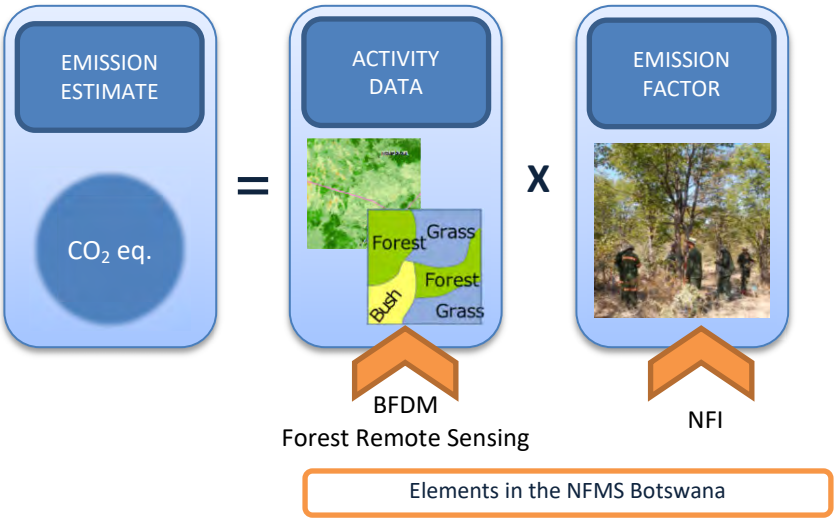
2.2.1 United Nations Framework Convention on Climate Change (UNFCCC)

(1) GHGs inventory

The convention was adopted at the United Nations Headquarters, New York on the 9 May 1992. The Government of Botswana signed on the 12 June 1992 and which came into force on 27 April, 1995. Botswana is non-Annex I country and all non-Annex I parties are required to submit a national inventory of anthropogenic emissions by sources, and removals by sinks, of all greenhouse gases (GHGs) as part of their national communications (NC).

The NC shall be submitted basically every four years for the non-Annex I parties and the Government of Botswana submitted the initial NC on October, 2001, the second NC on December 2011 and shall submit the third NC before too long. The past communication did not include the LULUCF (Land-Use and Land-Use Change and Forestry) sector because there was no reliable data on the nation-wide land-use data including the forest and woodland cover. Therefore, there was a gap between the NC and reality. Now, with the forest distribution map in particular, the NFMS can contribute to provide basic information on the LULUCF sector such as the area by land cover including forest, woodland and shrub land etc. This information is essential to calculate the total carbon uptake in the sector and also removal from the forest to other land-use is going to be analysed by comparing BFDM 2015 and BFDM which will be launched in the future.

The principle of the estimation of the emission is shown as following figure. The activity data refers to the area of forest change and the emission factor relates to the carbon stock change estimations per unit of activity. The activity data is obtained by the BFDM and the data on emission factors can be estimated by the NFI.



Source: DFRR-JICA NFMS Botswana Project

Figure 2-1 Methodology for the emission estimate

(2) REDD+ MRV

Botswana submitted on the "methodological guidance for activities relating to 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" in September 2011, to the SBSTA[1] 35th session under UNFCCC (FCCC/SBSTA/2011/MISC.7). According to this, Botswana looks forward to being able to benefit from the UNFCCC REDD+ activities in the future. Relatively, Botswana's forests cover a small land area but are immensely important for the preservation of biological diversity and also in their contribution to carbon dioxide sequestration. It is in this respect, therefore that Botswana looks forward to ensure a meaningful agreement on guidance for the activities relating to reducing emissions from deforestation and forest degradation (REDD+).

On the other hand, to implement the REDD+, the following requirements shall be met.

Requirements for the REDD+ readiness

(Decision 1/CP.16 - UNFCCC)

(a) A national strategy or action plan
(b) Forest reference emission level and/or forest reference level
(c) A robust and transparent national forest monitoring system for the monitoring and reporting REDD+ activities
(d) A system for providing information on how the safeguards are being addressed and respected

The NFMS can provide some useful data to (b) and (c) since activity data. It can also serve as a tool to (a) and (d).

Moreover, Decision 4/CP.15 defines about the establishment of national forest monitoring system as follows:

"Establishment of robust and transparent national forest monitoring system"

(Decision 4/CP.15 UNFCCC)

i. Use a combination of remote sensing and ground-based forest carbon inventory approaches
ii. Provide estimates that are transparent, consistent, as far as possibly accurate, and that reduces uncertainties, taking into account national capabilities and capacities;
iii. Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties;

[1] Subsidiary Body for Scientific and Technological Advice

This NFMS Botswana also applies an approach as a combination of remote sensing and ground-based inventory and the all methodologies applied in the NFMS may meet the international standard under the UNFCCC although some parts, such as quality control and assurance on the national forest inventory, must be reinforced to the current system. Training and planning on quality control and assurance for the DFRR will be conducted in the extension phase and the results will be reflected in the final report.

As a consequence, the National Forest Monitoring Plan is absolutely necessary to perform the convention and it can contribute to estimate the status of the GHG in LULUCF sector, to implement the REDD+ project and to submit more accurate National Communication (NC).

(3) Relevance with the Paris Agreement

In the COP21 of the UNFCCC held in Paris on December 2015, adopted the Paris Agreement, with the aim of holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change. The Government of Botswana ratified it on November 2015.

According to this agreement, 1) each party shall prepare and maintain successive nationally determined contributions that it intends to achieve and communicate every five years (Article 4.2 and 4.3), 2) each party shall regularly provide the information necessary to track progress made in implementing and achieving its nationally determined contribution and undergo a technical expert review (Article 13.7 and 13.11, and 3) the Parties to the Agreement shall undertake its first global stocktake in 2023 and every five years thereafter (Article 14.2).

Moreover, in the Article 5.1 said that “the Parties should take action to conserve sinks and reservoirs of greenhouse gases, including forests” and the Article 5.2 said that “Parties are encouraged to take action to implement and support, including through results-based payments, the existing framework as set out in related guidance and decisions already agreed under the Convention for: policy approaches and positive incentives for activities relating to 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; and alternative policy approaches, such as joint mitigation and adaptation approaches for the integral and sustainable management of forests, while reaffirming the importance of incentivizing, as appropriate, non-carbon benefits associated with such approaches.”

This National Forest Monitoring Plan proposes the issuance of the report regarding the forest information (Forest Status Report) by using the information generated from each component that constitutes the NFMS and the first Forest Status Report will be available by the end of the 2021 according to the plan. Therefore, the reporting interval set by the Paris Agreement consistent with it of the plan and the National Forest Monitoring Plan can contribute for the first global stocktake evaluation planned in 2023.

Furthermore, the forest monitoring system is an indispensable tool, for the Government of Botswana, to conserve the forest which is the GHG sink and to implement the action for the agreement. Therefore, the validity of the NFMS is high in that regard.

In the Article 10.1 said that “Parties share a long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions” and the cooperative action for it shall be taken. As for this issue, as recommended in the Chapter 5 of this report, the forest sector master plan and the forest reserve master plan development by using the plan as a tool, are proposed and this plan can contribute the sustainable forest conservation and management of Botswana.

2.2.2 Convention on Biological Diversity (CBD)

Botswana has been party to the CBD since 1995. The country submitted its first National Biodiversity Strategy and Action Plan (NBSAP) in 2004. The NBSAP was first revised in 2007, and is now revised again in order to update it and bring it in line with the CBD’s own revised Strategic Plan and the Aichi Targets. Botswana ratified also the Cartagena Protocol in 2001 and acceded to the Nagoya Protocol in 2013.

Botswana aims for a strategy that is strongly aligned to the CBD 2011- 2020 Strategy and the Aichi Targets, while being realistic to its circumstances. The Vision and Goals set in the NBSAP are as follows;

The vision and five goals of the NBSAP 2016

Vision

"By 2025, ecosystem, species and genetic diversity is valued, protected, and used sustainably and equitably, through the involvement of all sectors of society and the provision of sufficient resources for its sound management."

Goals

1) Biodiversity is mainstreamed and valued across all sectors of society
2) The pressure on biodiversity is reduced and natural resources are used sustainably
3) Ecosystems, species and genetic resources are protected through sound management
4) Fair and equitable access to the benefits of biodiversity is secured
5) Participatory planning, knowledge management and capacity-building are in place to support NBSAP implementation

Each goal has each national target and the NFMS can contribute to achieve NBSAP's Goal and target as follows:

Target 5 under Goal 2 "The pressure on biodiversity is reduced and natural resources are used sustainably", mentioned that "By 2025, the rate of natural land conversion is at least halved, and degradation and fragmentation are significantly reduced. The NFMS can contribute to this target by providing the data on forest cover change by the continuous forest monitoring.

Moreover, each target has the strategic actions and the DFRR should lead the following actions according to the NBSAP 2016 and the next table shows some strategic actions related to the NFMS.

Table 2-5 Strategic Actions related to the NFMS under Target 5 - Goal 2 - NBSAP 2016

Strategic actions		Lead institutions	Implementing Partners	Start	Completion
5-3	To implement, by 2018, Sustainable Land Management (SLM) practices on all tribal grazing land.	DFRR	DEA, DAP	2016	2018
5-4	To commission, by 2016, ecological and policy studies into the interacting causes and potential consequences of a) loss of trees and b) habitat fragmentation in the northern ecoregions, and implement the study recommendations	DFRR	DWNP	2016	2024

Note: DAP: Department of Animal Production, DEA: Department of Environmental Affairs, DWNP: Department of Wildlife and National Parks
Source: NBSAP 2016

The NFMS aims at providing useful forest information for decision making or land management. So that it can contribute to achieve the targets 5-3 and 5-4 from that perspective. Also the NFMS can serve as a tool to confirm whether the Goal 2 "The pressure on biodiversity is reduced and natural resources are used sustainably" is achieved or not, since the forest area which serve as cradle of biodiversity and deforestation can be monitored through continuous forest monitoring.

2.2.3 United Nations Convention to Combat Desertification (UNCCD)

Botswana signed and ratified the United Nations Convention to Combat Desertification (UNCCD) in 1995 and 1996 respectively. As party to the convention, the Government of Botswana developed the National Action Programme to Combat Desertification (NAPCD) as required by the UNCCD. The NAPCD was completed in 2006.

The NAPCD sets the goal and objective as follows:

The goal and objective of the NAPCD

Goal

To combat desertification and mitigate the effects of drought through participation and partnership with the various stakeholders including communities

Objective

A series of the objectives were set as indicated as follows and outputs, activities, indicators with time frames and responsibilities were developed by objective.

1) To mobilize resources to implement the National Action Program
2) To undertake research on processes of drought and desertification
3) To facilitate capacity building for stakeholders involved in combating desertification and mitigating effects of drought
4) To facilitate establishment of alternative livelihoods projects particularly for people living in marginal and degraded areas
5) To create awareness on the causes and effects of desertification and drought
6) To coordinate interventions and approaches on desertification and drought among different stakeholders
7) To improve drought preparedness and management at local and national levels
8) To ensure effective participation of all stakeholders particularly women, in decision making processes and implementation of the National Action Programme
9) To control and prevent land degradation

The NFMS can contribute to the objective 2 “To undertake research on processes of drought and desertification” through the continuous forest monitoring since the NFMS can provide the status of land-use change in future by comparing the land cover between two different time periods. In other word, the area deforested, the area changed to other land cover such as bare-land or agriculture land from forest or woodland can be identified by the remote sensing data. So the NFMS is useful for the implementation of the NAPCD.

2.2.4 SADC Protocol on Forestry

The SADC Protocol was signed in 2002 and Article 3 prescribes the objectives of the protocol as follows:

(a) promote the development, conservation, sustainable management and utilisation of all types of forest and trees

(b) promote trade in forest products through the Region in order to alleviate poverty and generate economic opportunities for the peoples of the Region; and

(c) achieve effective protection of the environment, and safeguard the interests of both the present and future generation

With respect to the forest monitoring, Article 9 prescribes the national forest assessments that the state parties shall undertake and regularly update a national assessment of forests. Article 10 is a clause about the Regional Database and aims at establishing the regional database on the status and trends, management and use of forest resources which includes data on all forest resources within the Region and complements existing databases in the Region. The NFMS can contribute directly to such efforts mentioned in these articles since the plan can provide useful information for the assessment of forests such as forest inventory and mapping data. All of those data will be stored and managed in the forest GIS database and this GIS database may harmonize with the regional database which will be developed in the future as prescribed in the article 10 of the protocol.

Beside the NFMS Botswana, the Project for Forest Conservation and Sustainable Management of Forest Resources in Southern Africa, called SADC-JICA Forestry Project, is underway. The main components

of the SADC-JICA Forest Project are; improvement of the capacity of the State Members to enhance 1) forest information system, 2) forest fire management and 3) participatory forest management. Those components are similar with the expected outputs in the extension phase of the NFMS Botswana Project and those outputs are included in the National Forest Monitoring Plan.

Consequently, the National Forest Monitoring Plan is in line with the SADC Protocol and can contribute to it so that the relevance is high.

CHAPTER 3 THE NATIONAL FOREST MONITORING PLAN

This chapter describes the National Forest Monitoring Plan, based on the results derived from the "Project for the Enhancing National Forest Monitoring System for the Promotion of Sustainable Natural Resources Management (NFMS Botswana Project / NFMS Project)" that was implemented from July 2013 to December 2017. The technical system, which is the central pillar of the plan, called the "National Forest Monitoring System (NFMS)".

3.1 Title of the Plan

National Forest Monitoring Plan

3.2 Objective

The objective of the NFMS Botswana is "**to accurately update the information on the state of the forest through regular monitoring**"

3.3 Overall goal

The information generated by the NFMS is shared with the all stakeholders not only privileged for DFRR and used in order to realise/promote sustainable forest management

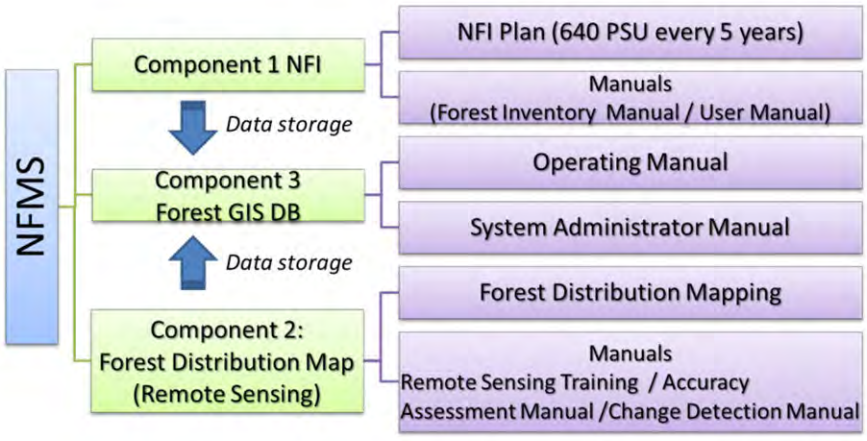
3.4 Target area

Target area of the National Forest Monitoring Plan is the whole territory of Botswana, where there are forests including typical forest, riparian forest and woodland in particular.

3.5 Components

The National Forest Monitoring Plan is composed of three components and headed by the NFMS coordinator.

Each component includes the methodology and manuals and the conceptual figure of the NFMS is shown in the following figure.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-1 Technical System (NFMS) of the National Forest Monitoring Plan

3.5.1 Component 1 National Forest Inventory (NFI)

The National Forest Inventory (NFI) aims at periodically collecting and recording the up-to-date, accurate data of the forests in Botswana, which can contribute to the realisation of the sustainable forest management and related decision making.

The detail of the NFI is described in a later section, but the main output derived from this component is the volume of wood in the forest and woodland although various data on tree height, species, regeneration, and damage by fire or animals are also captured. The carbon sink can be estimated based on the volume data, and below-ground biomass can even be estimated as a product of a conversion multiplier and above-ground biomass that is captured by the NFI.

A sample of forests, in other words, typical forest, riparian forest and woodland are surveyed, and the representative sample points of 640 are prepared and surveyed by the DFRR's surveyor teams across Botswana. One sample point consists of three circular plots, and these sample units are randomly generated and distributed in the forest areas using GIS. Those sampling units are placed permanently and stay the same for the future cycle of the survey.

The forest inventory survey started in June 2015 and as of September 2017, forest and woodland together account for approximately 27% of the total target points (i.e., 640). The first cycle of the NFI will be completed by the end of Botswana fiscal year 2020. Accordingly, the second cycle of NFI will be programmed for the period from FY2021 to FY2025.

It is essential that the NFI be carried on continuously. The growth rate of individual trees and stands can be estimated only when the results of two different periods of the NFI are compared and land-cover change is monitored. Those basic data are essential for achieving sustainable forest resource management.

In order to assure the quality of ground survey data, a QAQC (quality assurance and quality control) team has been formed in the DFRR. The QAQC survey was conducted twice in 2016 during the extension phase of the NFMS Botswana Project with an aim of identifying operations that need to be corrected or improved, which were eventually shared among the teams for securing data quality.

3.5.2 Component 2 Forest Distribution Map (Forest Remote Sensing)

Remote sensing technology is a useful and effective method to monitor large areas and the NFMS uses the combination of remote sensing and the ground survey as shown in the Component 1 National Forest Inventory. This component provides the Botswana Forest Distribution Map (BFDM) on regular basis and the BFDM 2015 was officially launched on 9th June, 2016 as the first benchmark map of the country. The BFDM provides the information regarding the area and the distribution by the type of classification such as forest and woodland. Also, the component will provide the information on forest cover changes through continuous forest monitoring by comparing two different periods of BDFM, the BFDM 2015 as a benchmark map produced by the Project and the future BFDM.

3.5.3 Component 3 Forest GIS Database

Component 3 Forest GIS Database is a key component of the NFMS. All ground survey forest inventory data, the GPS referenced pictures taken in the field and all other outputs derived from the Component 1 will be incorporated into the database. Also, all remote sensing imagery, generated thematic map including BFDM, and the other spatial information collected or prepared by the Component 2 will be incorporated as the same. The Forest GIS Database is a simple and easy-to-use and a series of manuals were developed for the administrator and the operator.

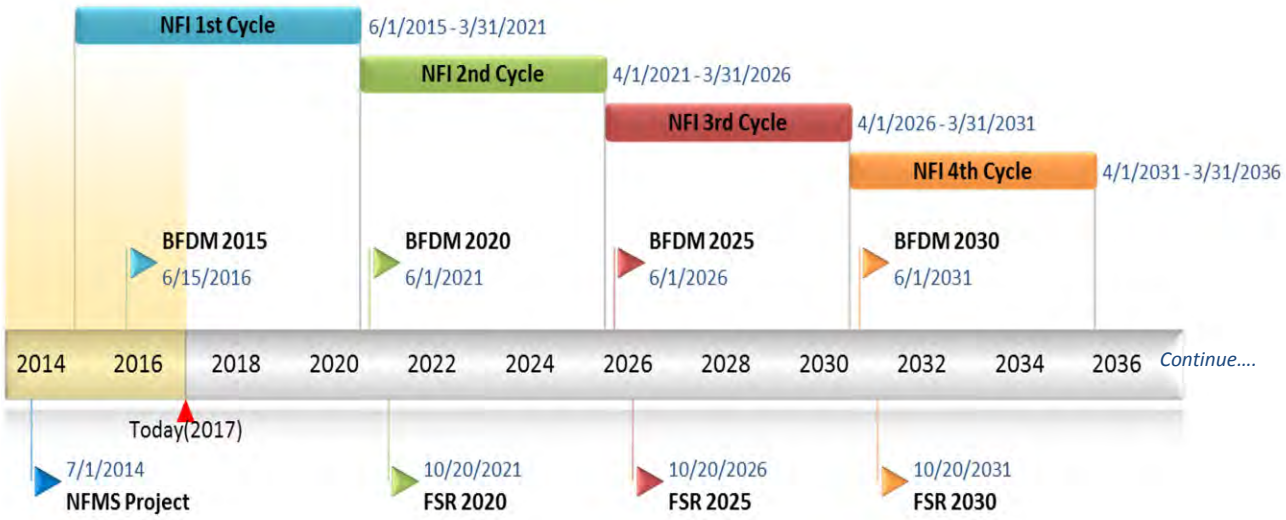
Moreover, information sharing and linkage with regional offices and other ministries will be realised through this component in the future. In that regard, the capacity development and necessary methodology development will be conducted in the extension phase of the NFMS Botswana Project and their results will be incorporated into the final report.

3.6 Overview of the National Forest Monitoring Plan cycle

The next figure shows the tentative schedule of the whole plan although the detail will be described in following sections.

The task in Upper line shows the cycle of NFI at five year intervals except the first NFI cycle which will be going to be completed by the end of the FY2020. The milestone in middle line shows the schedule of BFDM at five year intervals. Then, analysing the results of the NFI and BFDM, the forest status report

shall be published on a regular basis. So, the milestone shown in the lower part shows the schedule of the Forest Status Report.



Note: NFI: National Forest Inventory, BFDM Botswana Forest Distribution Map, NFMS: National Forest Monitoring System, FSR Forest Status Report, Date format: Month/Day/Year
Source: DFRR JICA NFMS Botswana Project

Figure 3-2 Overall schedule of the NFMS

3.7 Component 1 National Forest Inventory (NFI)

3.7.1 Objective

DFRR should have accurate forest information about the area, distribution, composition and volume to enable the sustainable forest management. Therefore, the NFMS aims at establishing a robust and transparent national forest monitoring system by using a combination of remote sensing and ground-based forest inventory approaches. The National Forest Inventory (NFI) covers one of those approaches, the ground-based survey by which the composition and volume of the forest can be estimated.

The main purpose of NFI is to give a national estimation of forest resources (volume, growth and their changes) with the precision of +- 5 %, at the 95% confidence level. For implementing the NFI objective, a number of permanent sample units (PSUs) covering the entire country are placed to monitor the spatiotemporal state of forest through the changes in tree diameter at breast height (DBH) and tree heights which are measured once every few years. By using the results of the NFI, land-use change can be analysed on the ground level, and forest carbon stock, the status of regeneration, and damage by fire or animal can be analysed through this component.

3.7.2 Methodology

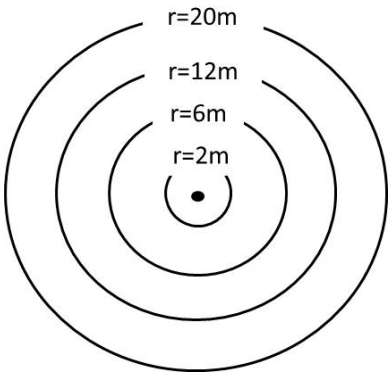
The methodology is described briefly in this chapter. Please refer to NFI Manual for the details of the methodology.

3.7.3 Sampling Plot Setting

One sampling plot is composed of four concentric circles with 2m, 6m, 12m and 20m in radius as shown in the Figure 3-3. Each circle is designated for particular target size of diameter at breast height (DBH) of trees. This designation is illustrated in Table 3-1 Survey Target and its Survey Area.

Prior to finalizing plot setting, the JICA and DFRR team reviewed old inventory methodologies which were found to be used in the 1960s, 1990s, early 2000s and 2013. As a result, we decided to adopt the plot setting methodology as shown in Figure 3-3, that was used in a SADC-JICA Forest Project in 2013,

as DFRR staffs were familiar with the Project. However, we modified the plot setting of regeneration in such a way that the location of 2m circle was re-located to the plot centre from the original location (i.e., 6m east from the plot centre). This resulted from trial survey where DFRR staffs had found it easier to carry out survey when the regeneration plot was located at the centre. Despite concerns that small trees are likely more damaged in such new plot setting for regeneration survey, no pressing concerns were expressed among the DFRR staffs.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-3 Sampling Plot Setting

Table 3-1 Survey Target and its Survey Area

Target trees to be surveyed		Target survey area (Distance from the centre point)			
		2m	6m	12m	20m
Standing trees	DBH is 30cm or above = Big tree				✔
	DBH is 15cm or above, less than 30cm = Medium tree			✔	
	DBH is 5cm or above, less than 15cm = Small tree		✔		
Regeneration (DBH is less than 5cm)		✔			
Dead lying wood (Diameter is 5cm and above)			✔		

Source: DFRR-JICA NFMS Botswana Project

Following calculations below show an equivalence of the number of trees in hectare corresponding to the area of plot for each tree size.

Big trees	Trees/ha = 10,000 m^2/(20m x 20m x 3.14)=7.96 ≒ 8 trees/ha
Medium trees	Trees/ha = 10,000 m^2/(12m x 12m x 3.14)=22.12 ≒ 22 trees/ha
Small trees	Trees/ha = 10,000 m^2/(6m x 6m x 3.14)=88.46 ≒ 88 trees/ha
Regeneration	Trees/ha = 10,000 m^2/(2m x 2m x 3.14)=796.18 ≒ 796 trees/ha

Then, volume per hectare of each size in a plot is obtained as follows;

Big trees	Volume/ha = total volume in a plot x 8
Medium trees	Volume/ha = total volume in a plot x 22
Small trees	Volume/ha = total volume in a plot x 88

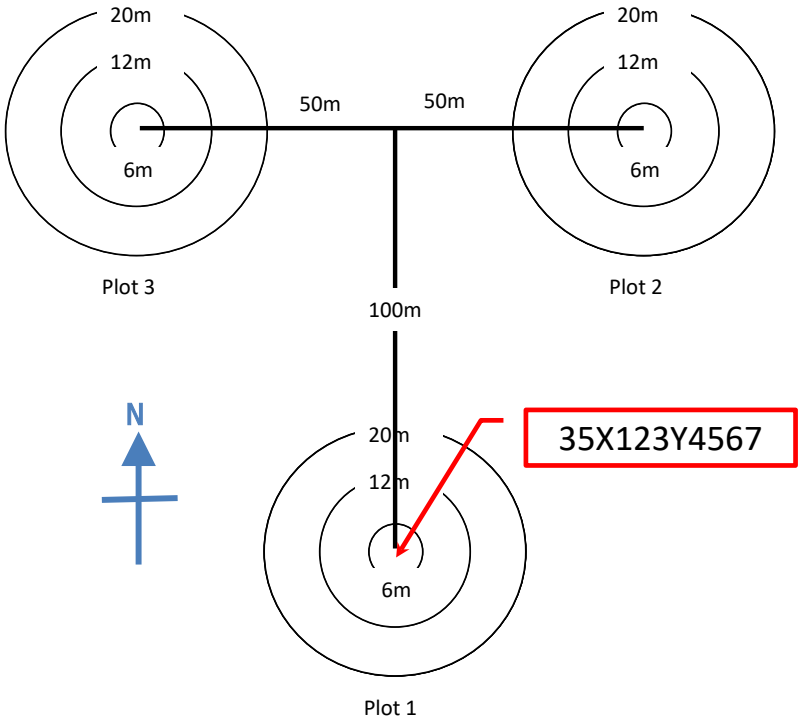
The volume is not calculated for regeneration.

3.7.4 Sampling Unit Formation

Three plots formulate one survey unit as shown in the figure below. Each plot is named as Plot-1 at the bottom (south), Plot-2 at North-east and Plot-3 at North-west. Plot-2 is located at 100m north and 50m east from the Plot-1. Plot-3 is located at 100m west from the Plot-2.

Each unit is described by a numerical code that is represented by UTM code of the centre point of Plot-1 such as “35X123Y4567”. “35X123Y4567” means that this point is located at 123km East and 4567km north of the base point of UTM zone 35. In Botswana there are two UTM zones which are

divided by 24 degrees east in longitudinal direction. West and east part from the border line falls within zone 34 and 35, respectively.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-4 Unit formation

3.7.5 Field Notes and Record Items

There are two field notes for each plot. Field note-1 is for standing trees and Field note-2 is for regeneration and lying wood. These field notes are shown in Appendix-1 and 2 of the Forest Inventory Manual. The field note should be pink in colour to protect surveyor's eyes from strong sun ray reflection.

Record items of Field note-1 are as follows;

1. Basic information
   - ✓ Date of survey
   - ✓ Unit code------This code is randomly given by GIS technics such as 35X123Y4567.
   - ✓ Plot number----- Plot 1, Plot2 or Plot3
   - ✓ Name of surveyors
   - ✓ UTM code of centre of each plot------ UTM code of plot 1 is basically same as Unit code.
   - ✓ Averaged UTM code of centre of each plot
   - ✓ Type of land cover such as Forest, Wood-land, and other types judged by surveyors on the spot.
   - ✓ Site name indicated by location of surveyor's team camps
   - ✓ Rough explanation of route from the camp
2. Survey items for standing trees
   - ✓ Species name referring list shown at Appendix-3 of the Forest Inventory Manual
   - ✓ Diameter at breast height (DBH cm)
   - ✓ Height (m)------Select three trees of standard height from each category of DBH size
   - ✓ Tag number
   - ✓ Location of tree in plot (distance from the centre point of the plot and Azimuth)
   - ✓ Damage level and damage cause (by elephant, fire or others)

- ✓ Taking photos of Field note-1 and ground views of four directions at the centre point of plot and check "Yes"

The tag number and record of location of a tree can help identify the particular tree as well as find the centre point for the next cycle of NFI.

Recorded items of Field note-2 are as follows;

1. Basic information
   - ✓ Date of survey
   - ✓ Unit code------This code is randomly given by GIS technics such as 35X123Y4567.
   - ✓ Plot number----- Plot 1, Plot2 or Plot3
2. Survey items for regeneration
   - ✓ Tree species code in reference to the code list
   - ✓ Numbers
   - ✓ Height level
3. Survey items for dead lying wood
   - ✓ Diameter in cm at the middle of wood
   - ✓ Length of wood in metres----Within the range of radius 6m
   - ✓ Decay level-----High (70-90%), Middle (40-60%), Low (0-30%)

3.7.6 Number of Sampling Units

The basic formula to calculate sampling number is as follows:

$$\text{Number of samples} = \left[\frac{t \times CV}{E}\right]^2$$

t	=	1.96 at the 95% confidence level
CV	=	Coefficient of Variation (%)
	=	(s/m) x 100%
s	=	Standard deviation
m	=	Mean value
E	=	Level of error (It is usually used as 3, 5, 10, 15, or 20%)

Standard deviation and mean value are referred from existing data if any. If there are no proper data, these values are obtained from preliminary surveys which should be conducted prior to a full scale survey.

The formula above is explaining that:

1. The greater the variance of data referred, the more sampling number will be required.
2. The smaller the "E", the more sampling number will be required.

The formula above is used not only for forest sector but also for any case of sampling survey. On the other hand, the following "Winrock Terrestrial Sampling Calculator" is prepared for both baseline survey and monitoring survey in "Sourcebook for Land use, Land use change, and Forestry Project" by Winrock international. This tool calculates the number of PSUs necessary for each forest type, based on stratified sampling and this calculator tool adopted the equations in: CDM A/R Methodological Tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" Version 2.1.0 under the UNFCCC.

Necessary information for "Winrock Calculator" is as follows;

1. Level of error 5%

2.	Confidence level	95%
3.	Area (ha) of Forest and Woodland	These data have been obtained from forest distribution map which the NFMS Botswana Project elaborated.
4.	Mean and standard deviation of tree volume	These data are referred from pre-inventory and SADC/MRV project.
5.	Plot size	0.38ha (= 20m x 20m x 3.14 x 3)

Area size, Mean and standard deviation of forest and woodland are as follows;

Table 3-2 Area size, Mean and standard deviation of forest and woodland

Land cover	Area (ha)	Mean of volume (m^3)	Standard deviation
Forest	3,833,800	70.85	32.21
Woodland	11,997,500	19.46	12.73

Source: DFRR-JICA NFMS Botswana Project

Enter values into the green cells. Use the "Tab" or "Enter" key to jump to the next green cell.

REQUIRED ERROR AND CONFIDENCE LEVEL		
e - level of error (%)	5.0%	
Error level (decimal)	0.05	
Z(1-a) - Confidence level	95.0%	
Sample statistic Z(1-a)	1.96	
Total project area size	15831300	hectares

Allowable entries are 99, 95 or 90 percent.

INTERMEDIATE CALCULATIONS		
N = sum N_h	41661316	
Total Area	15831300	hectares
Weighted Mean C	31.904902	tonnes/ha
Weighted Plot Size	0.38	ha
Weighted SD	17.44739	
Weighted Total Variance	374.05243	

SIZE AND VARIANCE OF EACH STRATA

Stratum	Stratum Name	Area (ha)	Mean C/ha (tonnes)	Standard Deviation (tonnes C/ha)	Plot size (ha)	Cost C_h if no cost, put C_h =1
stratum 1	Forest	3833800	70.85	32.21	0.38	1
stratum 2	Woodland	11997500	19.46	12.73	0.38	1
stratum 3						1
stratum 4						1
stratum 5						1
stratum 6						1
stratum 7						1
stratum 8						1
stratum 9						1
stratum 10						1

Results - Aboveground Carbon - Number of plots to be used

		Sourcebook for LULUCF Projects		AR-AM0001, AM0005, AM0006		AR-AM0003, AM0004, AM0007	
Stratum	Stratum Name	Plot Quantity	Rounded Plot	Plot Quantity	Rounded Plot	Plot Quantity	Rounded Plot Quantity
Total Sample Size		459.53	**529**	459.53	**529**	459.53	**529**
stratum 1	Forest	205.44	**237**	205.44	**237**	205.44	**237**
stratum 2	Woodland	254.09	**293**	254.09	**293**	254.09	**293**
stratum 3							
stratum 4							
stratum 5							
stratum 6							
stratum 7							
stratum 8							
stratum 9							
stratum 10							
TOTAL NUMBER OF PLOTS			**530**		**530**		**530**

Source: DFRR-JICA NFMS Botswana Project

Figure 3-5 Calculation of sampling plots for forest, woodland and total samples

From this Winrock calculation, the number of sampling units has been obtained for forest (237), woodland (293), and total samples (530). 530 samples were deemed enough from a mathematical point of view, but 20% of the samples were added to supplement the potential loss of samples by land cover change or destruction of vegetation. As a result, the total number of sampling units became 640 as follows.

Table 3-3 Land cover, Area and Number of sampling units

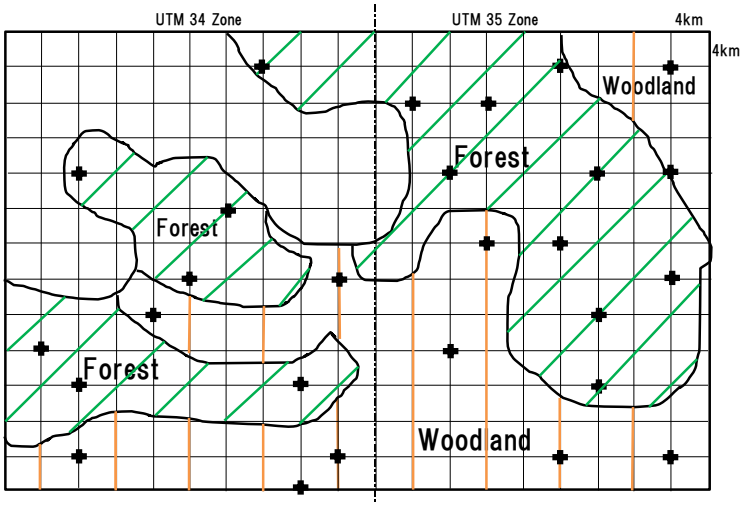
Land cover	Area(ha)	Number of sampling units		
		Winrock calculation	Reserves (20%)	Total
Forest	3,833,800	237	48	285
Woodland	11,997,500	293	62	355
Total	15,831,300	**530**	**110**	**640**

Source: DFRR-JICA NFMS Botswana Project

3.7.7 Distribution of Sampling Units

These sampling units are distributed in the following manner:

1. Sectioning Botswana nationwide using 4km-by-4km grid lines which are laid out north to south and east to west on Forest Distribution Map (FDM) using GIS software.
2. 285 and 355 points for forest and woodland areas, respectively, are randomly selected from crossing points of the grid lines.
3. Each selected point should be named as a site code with UTM code such as “35X123Y4567” or “34X234Y5678”.
4. Botswana national land spreads between UTM zone 34 and 35. “35 X123Y4567” means that the point is located at 123km east and 4,567km north of the UTM base point of zone 35.
5. These selected points will be the centre points of Plot-1 for each Unit (See Figure 3-6).
6. Figure 3-6 below shows a model map of the distribution of sampling unit points.



Note: Plus mark points “+” is the centre of the Plot-1 of the unit”
Source: DFRR-JICA NFMS Botswana Project

Figure 3-6 Model distribution map of sampling unit points

Forest Distribution Map (FDM) is not always correct. Woodland exists even in forest areas, and vice versa. Also, other land cover types sometimes exist in forest or woodland areas, which demonstrate the difficulties of analysing satellite images in the areas of the semiarid zone. All three plots in a unit are not always covered by the same type like a forest of woodland. In case that two or three plots out of three in a unit are covered by forest, the unit can be identified as forest. In case that two or three plot out of three in a unit is covered by woodland, the unit can be identified as woodland. In the case of two plots in a unit that are covered by neither forest nor woodland, the unit should be identified as another cover type and it should be excluded from 640 units.

3.7.8 NFI Work Procedure

NFI work is roughly divided into three procedures such as preparation, field work and data organization.

1. Preparation

A) Check and pack following tools prior to field work.

① GPS (Garmin GPSMAP 62s)	1 (with 2 butteries/1.5 Unit)
② Ranging Rod	2
③ Vertex set	1 (Vertex, Transponder, Spreader, Staff, two extra butteries)
④ Callipers	1
⑤ Diameter Tape	1
⑥ Measuring Tape	1
⑦ Metal Tag and nails	150 pieces per Unit
⑧ Compass	1
⑨ Metal rod and pink colour ribbon	3 rods per Unit and ribbon roll
⑩ Hatchet	1
⑪ Field Note 3 sheets per Unit for Field note-2 3 sheets per Unit for Tool check list	4 or 5 sheets per Unit for Field note-1
⑫ Pencils, rubber and sharpener	2 pencils, 1 each for rubber and sharpener
⑬ Field Board	1
⑭ Camera	1 (Two butteries should be charged and 1 SD card)
⑮ Tree Species list	1 (Plastic covered)
⑯ Rucksack	1

B) Input UTM code of a target point into GPS.
C) Arrange vehicles and camping tools
D) Coordinate with offices such as;

- ◆ DFRR head office and district offices for arranging surveyors and budget.
- ◆ Wildlife head office and district offices to request guard.
- ◆ BDF field office to inform that field survey is carried out to prevent the teams from being mistaken as poachers.

2. Field work

Refer to the “NFI Manual”, “GPS User Manual”, and “Vertex User Manual” for field work procedure. But simplified procedure is as follows;

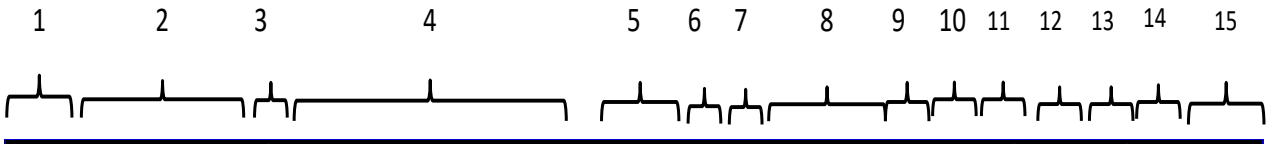
A) Using GPS, arrive at a target point which is a centre point of plot-1 of a Unit.
B) Drive a metal stick into the ground at the centre of plot-1 and put a pink coloured ribbon on it.
C) Get the averaged GPS code of the point and record it on Field note-1
D) Start survey work with regeneration first followed by standing trees and lying dead wood. Record the measurements on Field note-1 and 2.
E) Take a photo of Field note-1 first and then ground photos of four cardinal directions (North, East, South, West in this order) from the centre of the plot.

F) Check all tools using a check list before departure.

3.7.9 Data organization

All data should be entered into Excel sheet upon return from field work. At that time, three Excel sheets, "Standing trees", "Regeneration" and "Lying dead wood" should be prepared. The detail of each sheet is described as follows;

Standing Trees

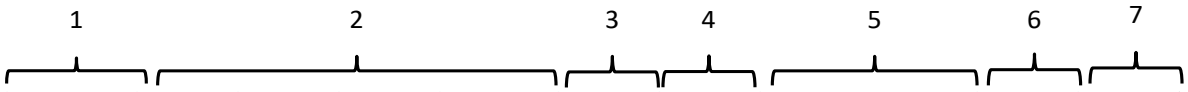


Survey date	UTM Zone	UNIT ID X	UNIT ID Y	UNIT ID	Plot No	Surveyer 1	Surveyer 2	Surveyer 3	Surveyer 4	UTM Ave. E.	UTM Ave. N.	Tag No.	Sp. Code	Sp. Name	DBH Cat.	DBH (cm)	Height (m)	Distance (m)	Azimuth (deg.)	Damage Code1	T_Vol (m^3)
11 June 2015	35	216	7961	X216Y7961	1	G. Abbbbb	B. Cddddd	W. Yxxxxx	T. Ossssss	215999	7961000	1951	37	Baikiaea plurijuga	Small	5.3	4.8	3.90	126	0	0.006
11 June 2015	35	216	7961	X216Y7961	1	G. Abbbbb	B. Cddddd	W. Yxxxxx	T. Ossssss	215999	7961000	1956	37	Baikiaea plurijuga	Medium	15.8	6.5	8.40	202	31	0.1021
11 June 2015	35	216	7961	X216Y7961	1	G. Abbbbb	B. Cddddd	W. Yxxxxx	T. Ossssss	215999	7961000	1957	37	Baikiaea plurijuga	Medium	16.1	7.1	11.40	356	0	0.1072
11 June 2015	35	216	7961	X216Y7961	2	G. Abbbbb	B. Cddddd	W. Yxxxxx	T. Ossssss	216051	7961103	1932	82	Croton gratissimus	Big	33.0	10.8	14.60	90	0	0.4394
11 June 2015	35	216	7961	X216Y7961	2	G. Abbbbb	B. Cddddd	W. Yxxxxx	T. Ossssss	216051	7961103	1933	82	Croton gratissimus	Small	8.8		4.80	26	31	0.0083
11 June 2015	35	216	7961	X216Y7961	2	G. Abbbbb	B. Cddddd	W. Yxxxxx	T. Ossssss	216051	7961103	1934	37	Baikiaea plurijuga	Small	5.7		4.40	28	0	0.0072

1. Survey date
2. UTM code
3. Plot No. 1 or 2 or 3
4. Name of surveyors
5. Averaged UTM code
6. Tag No
7. Species code
8. Name of species
9. DBH size
10. DBH
11. Height
12. Distance from center point
13. Azimuth
14. Damage code
15. Volume of tree

Coloured columns will be filled automatically in conjunction with data entered in the white columns. For examples, when you enter species code on the "7th column", the 8th column will be filled with species name automatically.

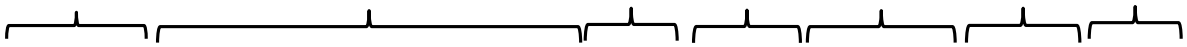
Regeneration



Survey date	UTM Zone	UNIT ID X	UNIT ID Y	UNIT ID	Plot_No	Sp. Code	Sp. Name	eg. Categoi	Reg. Count
11 June 2015	35	216	7961	X216Y7961	1	38	Baphia obovata	Small	13
11 June 2015	35	216	7961	X216Y7961	1	63	Combretum collinum	Small	2
11 June 2015	35	216	7961	X216Y7961	1	38	Baphia obovata	Medium	8
11 June 2015	35	216	7961	X216Y7961	1	63	Combretum collinum	Medium	1
11 June 2015	35	216	7961	X216Y7961	2	38	Baphia obovata	Small	13
11 June 2015	35	216	7961	X216Y7961	2	195	Ziziphus mucronata	Small	4
11 June 2015	35	216	7961	X216Y7961	2	82	Croton gratissimus	Small	2
11 June 2015	35	216	7961	X216Y7961	2	195	Ziziphus mucronata	Medium	11
11 June 2015	35	216	7961	X216Y7961	2	82	Croton gratissimus	Medium	4
11 June 2015	35	216	7961	X216Y7961	2	38	Baphia obovata	Medium	2
11 June 2015	35	216	7961	X216Y7961	2	195	Ziziphus mucronata	Big	3
11 June 2015	35	216	7961	X216Y7961	2	82	Croton gratissimus	Big	3
11 June 2015	35	216	7961	X216Y7961	3	38	Baphia obovata	Small	19
11 June 2015	35	216	7961	X216Y7961	3	82	Croton gratissimus	Small	1
11 June 2015	35	216	7961	X216Y7961	3	38	Baphia obovata	Medium	4
11 June 2015	35	216	7961	X216Y7961	3	82	Croton gratissimus	Big	1
11 June 2015	35	216	7961	X216Y7961	3	38	Baphia obovata	Big	1

1. Survey date
2. UTM code
3. Plot No. 1 or 2 or 3
4. Species code
5. Name of species
6. Height category
7. Number of regeneration

Lying dead wood



Survey date	UTM Zone	UNIT ID X	UNIT ID Y	UNIT ID	Plot_No	Decay Level	Diameter (m)	Length (m)	Dec_Vol
11 June 2015	35	216	7961	X216Y7961	1	M	8.0	3.5	0.017584
11 June 2015	35	216	7961	X216Y7961	2	M	6.7	1.0	0.003524
17 June 2015	35	308	7933	X308Y7933	1	M	5.6	0.8	0.001969
17 June 2015	35	308	7933	X308Y7933	2	H	5.8	0.7	0.001849
04 June 2015	35	328	7961	X328Y7961	1	M	12.0	1.5	0.016391
04 June 2015	35	328	7961	X328Y7961	1	M	9.7	1.4	0.010340
04 June 2015	35	328	7961	X328Y7961	1	M	10.1	1.8	0.014414
04 June 2015	35	328	7961	X328Y7961	2	H	8.9	0.8	0.004663
04 June 2015	35	328	7961	X328Y7961	2	M	18.0	2.2	0.054683
04 June 2015	35	328	7961	X328Y7961	3	H	14.3	0.8	0.012842
09 June 2015	35	220	7893	X220Y7893	1	M	9.1	2.2	0.014301

1. Survey date　2. UTM code　3. Plot No. 1 or 2 or 3
4. Decay level　5. Diameter　6. Length
7. Volume(m^3)

3.7.10 Formation of Survey Teams

One survey team is composed of four surveyors. The main roles of each surveyor are as follows:

1. Recorder　Taking field note
2. Measurer　Measuring DBH, Height, Diameter, Length, Distance, Azimuth
3. Botanist　Identifying name of species
4. Helper　Holding transponder for Vertex, Putting tags and others

Among the four surveyors, one should be appointed as a team leader who supervises team members to ensure that the field work goes smooth and safe.

3.7.11 Achievement of the National Forest Inventory Survey

As of September 2017, the first cycle of the NFI survey was completed about 27% of the total target as shown in the table below. For “Forest” and “Woodland” account for 18% (52) and 34% (119) of the target unit numbers (285 and 355) respectively. In addition, the units identified as “others” is equivalent to 20% (215) of the total target (640).

Table 3-4　Achievement of the NFI (as of September 2017)

Term / Category	NFI-1 Jun. 2015	NFI-2 Feb. 2016	NFI-3 Jun. 2016	NFI-4 Aug. 2016	NFI-5 Jun. 2017	Total Completed	Target
Forest	9	15	12	14	2	52	285
Woodland	22	16	20	25	36	119	355
Others	12	9	10	3	10	44	-
Total	43	40	42	42	48	215	640

Source：DFRR-JICA NFMS Botswana Project

3.7.12 Operation Schedule

(1) Schedule of the first cycle of the NFI

The next table shows the schedule of the first cycle of the NFI. The highlighted part is the number of PSU surveyed, and the first cycle of the NFI will be completed by the end of FY2020 by implementing the field survey once in quarter.

Table 3-5 Operation schedule of the first cycle of NFI by the end of FY2017

Target number of the PSU: 640 (285 forests + 355 woodland)

Year	FY2015												Total
Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
No. PSU			43								40		83
Cumlative total	0	0	43	43	43	43	43	43	43	43	83	83	83

Year	FY2016												Total
Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
No. PSU			42		42								84
Cumlative total	83	83	125	125	167	167	167	167	167	167	167	167	167

Year	FY2017												Total
Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
No. PSU			48					36		36			168
Cumlative total	167	167	215	215	215	215	215	251	251	287	287	287	287

Year	FY2018												Total
Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
No. PSU		36			36			36			36		144
Cumlative total	287	323	323	323	359	359	359	395	395	395	431	431	431

Year	FY2019												Total
Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
No. PSU		36			36			36			36		144
Cumlative total	431	467	467	467	503	503	503	539	539	539	575	575	575

Year	FY2020												Total
Month	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
No. PSU		36			36			36					108
Cumlative total	575	611	611	611	647	647	647	683	683	683	683	683	683

Note: The cells hatched in grey are the PSU surveyed at the present.
The estimated implementation capacity: 12 Units per month per 1 team, one team is composed; one team leader, three surveyors, two drivers and the additional staff as needed (ex. the escort), four teams may be mobilised at once
Source: DFRR-JICA NFMS Botswana Project

(2) Tentative cycle of the NFI

The next table shows the tentative cycle of NFI. The NFI will be conducted repeatedly at a five-year interval. However, the interval of the 3rd cycle may be reviewed if the difference between the results in the 1st and 2nd cycle is not significantly large. In that case, the interval of the 3rd NFI may be set at six years or more. Considering the planning period of five or six years of the National Development Plan (NDP), it is proposed that, at least, one NFI cycle shall be completed in response to each of the NDP planning periods.

Table 3-6 Tentative cycle of the NFI

Cycle of NFI	Period	Number of PSUs
1st cycle	until FY 2020 (6 years)	640
2nd cycle	FY 2021 – FY 2025 (5 years)	640
3rd cycle	FY 2026 – FY 2030 (5 years)	640

Source：DFRR-JICA NFMS Botswana Project

3.7.13 QAQC

QAQC stands for “Quality Assurance and Quality Control” and its objectives are;

1. To check existence of survey error if any.
2. To study occurrence tendencies of survey error.
3. To study how to improve survey work.
4. To assure the survey results.

For these objectives, four units are selected from complete units and resurveyed by DFRR NFI teams. All the inventory information is resurveyed according to operation steps described in the NFI Manual. Using a red pointed ball pen, the information is recorded on a photo-copy version of an original field note, and then the recorded data between NFI and QAQC work are compared and analysed. Eventually, operations identified as required for review are shared, corrected, and standardized among the team members. This QAQC procedure helps maintain the precision and accuracy of field data collected through capacity development of NFI teams.

DFRR teams conducted QAQC work training twice in August 2016 and November-December 2016 as part of O-J-T. Two teams participated in the training for each term, so four teams participated in total.

As a result of the QAQC training, the following observations were made and the manual was improved based on them. When the QAQC activities reveal additional findings that can be used for future improvement, workshop shall be held by DFRR NFI team in order to unify the methodology and improve the quality of the work. Accordingly, NFI manual shall be revised.

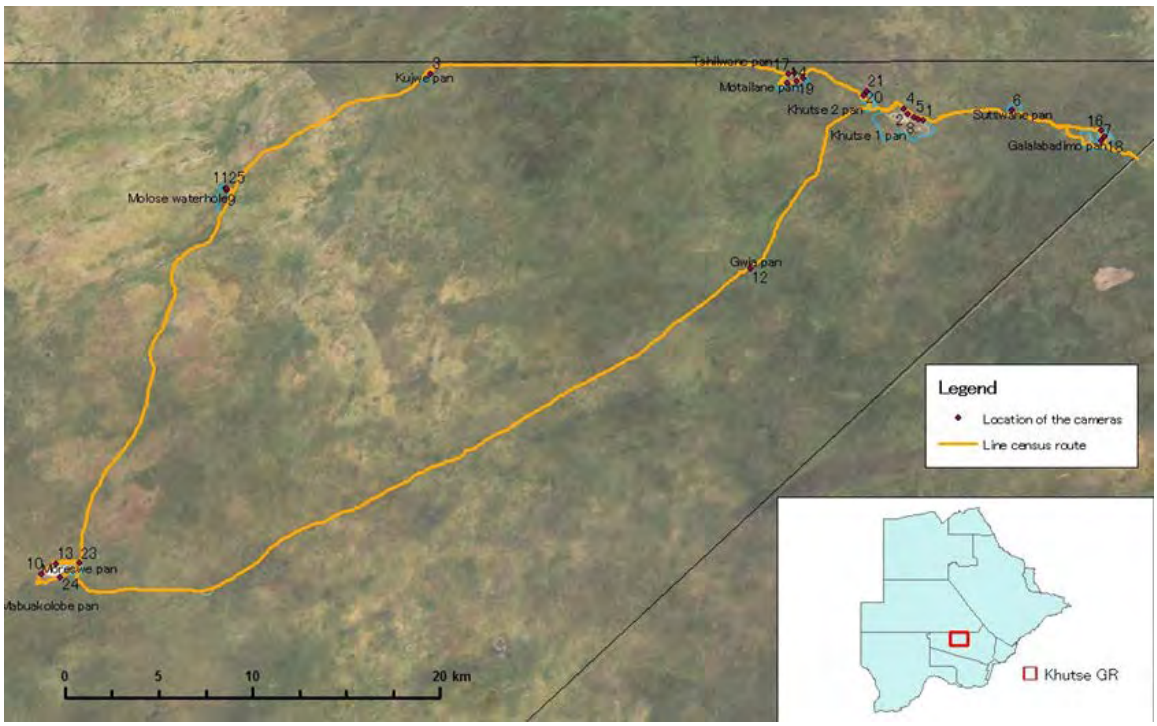
Table 3-7 Summary of QAQC activity, results and review contents

	Operation Item	Results	Review item	Confirmation work item
QAQC Operation	Arrival to target points at the Unit	✓ QAQC teams had no trouble reaching target points using GPS.	-	-
	Finding field plots	✓ Teams had no trouble finding the plot centre.	-	-
	Field measurements	✓ It was observed that there was slight difference in DBH measurements between NFI and QAQC records.	✓ It is recommended that the height of 1.3m should always be checked using a red-and-white rod. ✓ It is recommended to standardize DBH measurement for forked stems and/or irregularly shaped stems.	✓ It was confirmed that tip of the rod should not be included in 1.3m height measurement for DBH. ✓ Measurement of the irregularly shaped stems was re-confirmed using diagrams. ✓ Also confirmed was DBH measurement of forked stems. It was also decided that DBH must be measured for all branched stems that exceed 5.0cm or greater in diameter.
		✓ There was some slight confusion for counting regeneration between trees and shrubs.	✓ It is recommended that a counting method is standardized.	Counting regeneration was standardized among teams.
	Field-note taking	✓ Teams had no trouble recording measurements on the photocopied field note using a red pen.	-	-
Others (other noticed points observed during the QAQC)		✓ It was observed that metal tags were firmly attached to tree stems. ✓ Records of tree heights and distances from plots centre slightly deviated from the original, which was found to be acceptable.	-	-
	Field-note taking	✓ Wrong unit code for Plot-3	✓ The same Unit code must be recorded for all three plots on field notes.	✓ It was re-reconfirmed to use the same Unit code, regardless of plot numbers.
		✓ Recording wrong Unit code when survey Unit is shifted.	✓ Within a 2km distance from original plot centre point, the same Unit code as the original must be used and recorded for the shifted.	✓ It was confirmed that survey teams use the same Unit code as the original for the shifted Unit.
		✓ Plot-2 and Plot-3 were recorded in the opposite order.	✓ Regardless of surveying order of Plots, Plot numbers must be treated, recorded, and sorted as is	✓ It was re-confirmed not to modify recording plot numbers on field notes based on surveying orders. Also confirmed was to sort field notes in an ascending order of plot numbers to avoid confusion.

Source: DFRR-JICA NFMS Botswana Project

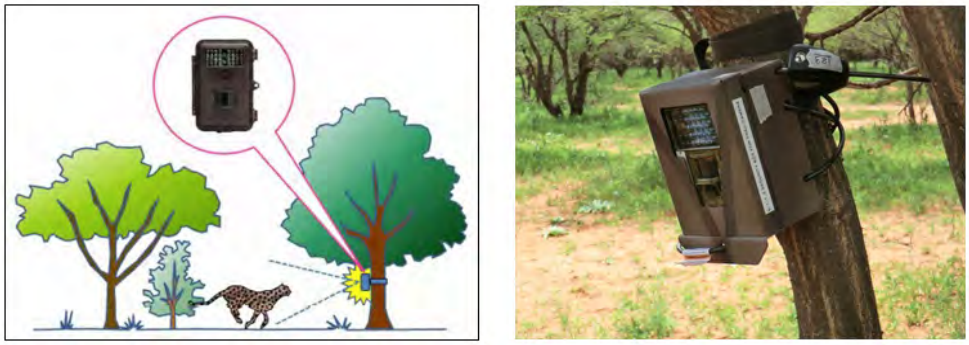
3.7.14 Trail Camera

In order to develop the methodology for biodiversity evaluation, the basic studies such as the trail camera trap survey and line census survey were conducted at the Khutse Game Reserve which is considered as one of the typical natural environments in Botswana. The trail camera trap survey was started with 25 trail cameras in July 2014 and ended in February 2015 to cover both natural environments of the wet and dry seasons.



Source: Base map is created based on ESRI Imagery World 2D, DFRR-JICA NFMS Project

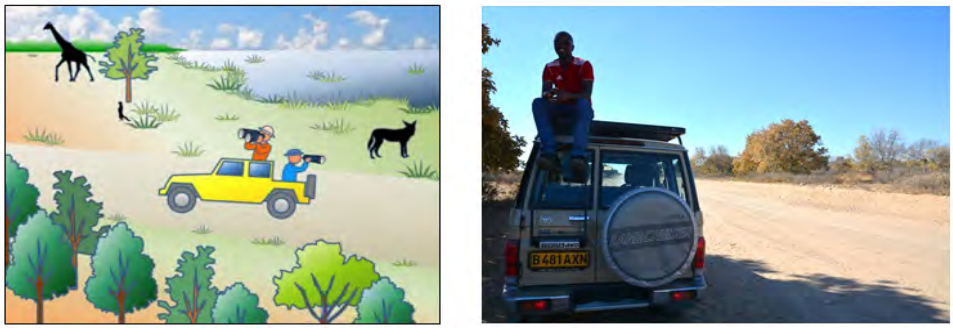
Figure 3-7 Location map of trail camera and the census line



Trail camera clicks automatically when it senses movement

Source: DFRR-JICA NFMS Botswana Project

Figure 3-8 Trail camera trap survey



Surveyors record species, number and location when animals are confirmed from the vehicle which is driving slowly

Source: DFRR-JICA NFMS Botswana Project

Figure 3-9 Line census survey

The trail cameras were checked and the data were collected five times during the survey period in July, September, and November in 2014 and in January and February 2015. All cameras were taken off at the end of the survey. The line census survey was conducted five times, two times in July 2014, and once in September 2014, January 2015, and February 2015.

The data of the trail camera trap survey and line census survey were organized and analysed. The confirmed animal species were 38 by camera trap and 22 by line census as shown in the following table:

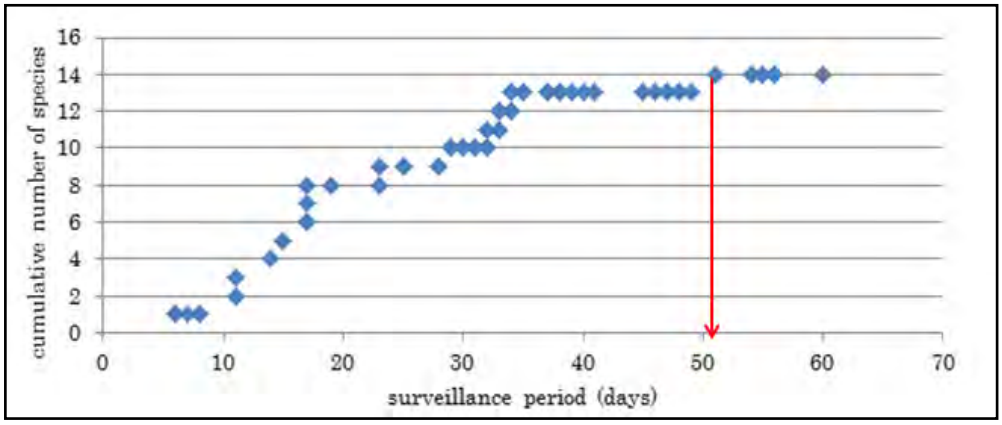
Table 3-8 Results of Camera trap and Line senses

Animal species identified by camera trap			
1	African elephant	21	Northern black korhaan
2	African wild cat	22	Orange river francolin
3	African wild dog	23	Ostrich
4	Bat-eared fox	24	Other birds
5	Black-backed jackal	25	Red hartebeest
6	Blue wildebeest	26	Red-billed francolin
7	Brown hyena	27	Scrub hare
8	Cape Porcupine	28	Secretary bird
9	Caracal	29	Slender mongoose
10	Cheetah	30	Small-spotted genet
11	Eland	31	Southern African ground squirrel
12	Giraffe	32	Southern African springhare
13	Greater kudu	33	Southern oryx（Gemsbok）
14	Ground pangolin	34	Springbok
15	Guinea fowl	35	Steenbok
16	Honey badger (Ratel)	36	Vulture sp.
17	Kori bustard	37	Warthog
18	Leopard	38	Yellow mongoose
19	Lion		
20	Mouse sp.		

Animal species identified by line census			
1	African white backed vulture	11	Kori bustard
2	Black backed jackal	12	Kudu
3	Black korhaan	13	Lion
4	Gemsbok	14	Ostrich
5	Giraffe	15	Red-crested korhaan
6	Ground squirrels	16	Secretary bird
7	Guinea fowl	17	Springbok
8	Hammerkop	18	Steenbok
9	Scrub hare	19	Stork sp.
10	Hartebeest	20	Vulture sp.
		21	Warthog
		22	Wildebeest
		23	Other birds

Source: DFRR-JICA NFMS Project

Moreover, the ideal survey period for the trail camera survey was analysed based on those data. The next figure shows that the number of animal species observed do not increase after the 50th day of the survey. This suggests that nearly **two months is enough for this survey in view of the time and cost**.



Source: DFRR-JICA NFMS Project

Figure 3-10 Surveillance period of trail camera and number of species confirmed

3.7.15 Manual

The following manuals have been prepared for the component 1 (Module 1)

1. Forest Inventory Manual	The manual consists of five chapters; I Introduction, II Tree measurement in the field, III the distribution of survey units, and IV Data entering and analysis and V. QAQC.
2. GPS User Manual	Use GPS not only for reaching at the target points but also for getting back to the camp safely.
3. TruPulse User Manual	The TruPulse is useful tool to measure distance and height though it is recommended to use properly to get correct data. The TruPulse uses laser to measure the distance.

3.8 Component 2: Forest Distribution Map (Forest Remote Sensing)

3.8.1 Objective

(1) The definition of forest, Specification of the Botswana Forest Distribution Map (BFDM)

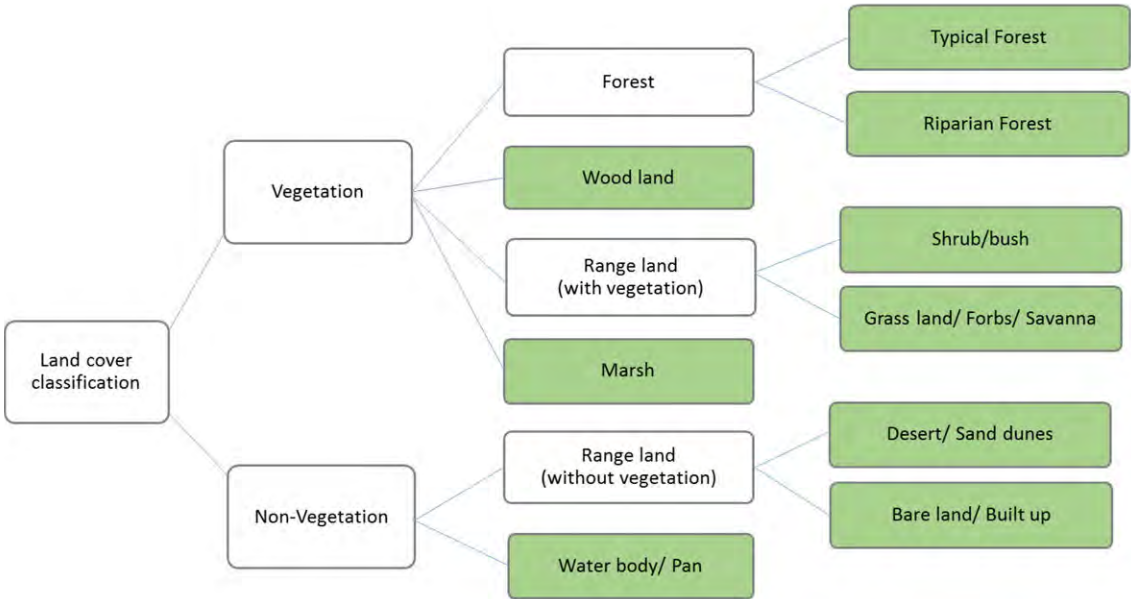
- The next table shows the comparison of the definition of forest by Forest Policy 2011, Global Forest Resources Assessment (FRA) 2015 by FAO and the UNFCCC. Minimum unit, tree height and canopy cover rate are used as the indicators. The definition of forest applied in Botswana is same as FAO's definition according to the Forest Policy 2011.

Table 3-9 Criteria for forest definition

Indicator	Forest Policy	FRA2015	UNFCCC
Minimum unit	0.5ha	0.5ha	0.05-1.0ha
Tree height	5m	5m	2-5m
Canopy cover	10%	10%	10-30%

Source::Forest Policy 2011 / Government of Botswana, Global Forest Resource Assessment 2015 / FAO, FCCC/KP/CMP/2005/8/Add.1 Page 63 / Kyoto Protocol / UNFCCCFRR-JICA NFMS Botswana Project

- BFDM is a land cover map covering the whole of Botswana including 1 kilometre outside of the border. Its classification scheme is shown in the Figure 3-11 and Table 3-10 shows characteristics of each class.
- BFDM was created using 41 scenes of Landsat-8 OLI imager in both wet (year 2015) and dry (2013) season and the image in 2014 also partially used.
- First, pixel-based classification was conducted. Then the results were filtered by 3 x 3 windows to eliminate small size polygons and isolated pixels in order to meet minimum mapping unit (1ha).
- The overall accuracy of BFDM is 71.7%



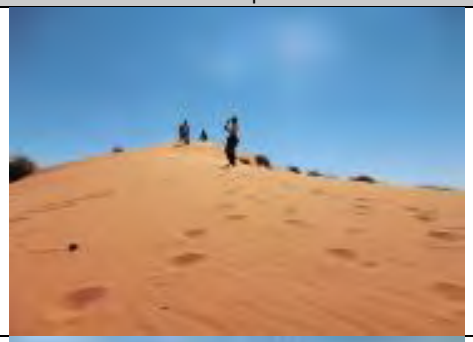
Note: Green coloured boxes are officially recognized as a land cover class in BFDM. Also, forest defined in Botswana consists of "Typical Forest", "Riparian Forest" and "Wood land".
Source: DFRR-JICA NFMS Botswana Project

Figure 3-11 Classification scheme of BFDM

Table 3-10 Characteristics of classification class for BFDM

Classes	Ground photo	Pattern diagram	Description
Riparian forest			Forest class is divided into two classes; Typical Forest and Riparian Forest. These both forests are structured as multi-layers of the canopy with closed to neighbouring trees. Typical forest does not stand beside the water body however riparian forest stands beside it. It does not include land that is predominantly under agricultural or urban land use. Land spanning more than 1 hectare with trees of top layer higher than 8 meters or trees able to reach these thresholds in situ.
Typical forest			
Woodland			Woodland is structured as single-layer of the canopy. Trees stand alone or scatter in small groups. Tree height and volume are richer than Shrub/bush, but poorer than Forest. It does not include land that is predominantly under agricultural or urban land use. Woodland is included as Forest under the international forest definition i.e. FAO. Land spanning more than 1 hectare with trees higher than 5 meters or trees able to reach these thresholds in situ.

Classes	Ground photo	Pattern diagram	Description
Bush/ Shrub			Shrub refers to vegetation types where the dominant woody elements are shrubs i.e. woody perennial plants, generally less than 5 meters in height at maturity and without a definite crown.
Grassland/ Forbs/ Savanna			Grass/Forbs consists of all open land, used primarily for pasture and grazing. Savanna is structured as scattering tree with grass covering on the floor.
Marsh			Land covered wet grass/ forbs

Classes	Ground photo	Pattern diagram	Description
Desert/ Sand dunes			Land covered sand
Waterbody/ Pan			Pan is a land covered bare sands/grasses during dry season, and covered water, bare sands or grasses during rainy season. Waterbody is covered water, such as river, lake, pond, and so on.
Bare land/ Build up			Bareland is a land covered bare soil with less herbal vegetation, such as clearing, mining and rocky area. Build up is a land covered build up area such as settlement and urban, and industrial area.

Source: DFRR-JICA NFMS Botswana Project

(2) Objective

The BFDM (Component 2) provides the following information as one component of the National Forest Monitoring System;

a. Estimating forest distribution and its area in Botswana
b. Estimating the total amount of forest resources such as its volume and biomass in combination with NFI data
c. One of materials used in forest planning to conduct sustainable forest management

Detailed forest map will be used for the development of a forest stands distribution map with a view to monitor the timber resource usage by local residents under DFRR forest planning. In the monitoring activities, the information on the distribution of forest resources is necessary.

3.8.2 Methodology

To update BFDM, there are two considerations for the selection of the methodology. One is the selection of the target area and the other is selection according to the methodology as shown in Figure 3-12.

(1) Target Area

To select target area, there are two options. One is selecting all classes and the other is selecting only forest area. The former has the advantage checking and correcting misclassification on non-forested area of a base map. As the disadvantage, longer time is required to analyse compared to the latter option because the target area is larger than forest area. On the other hand, the latter can save time because forest area is a quarter of area of the country, but the problem of misclassification on non-forested area is still remained.

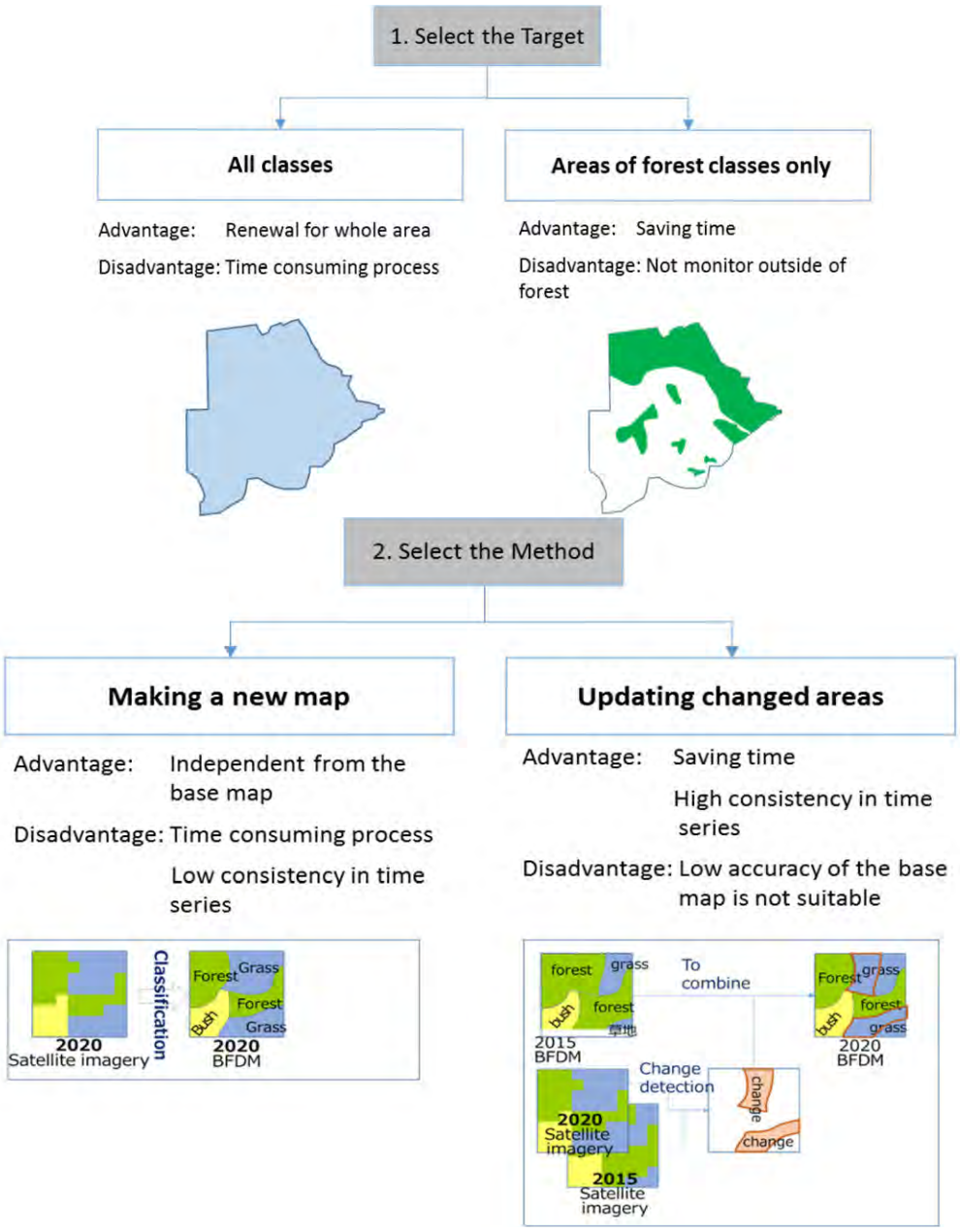
(2) Method

There are two major methods for renewing map; developing the new map with the new time-point imagery in the same method as BFDM, and developing map using different time point imagery by time-series analysis to detect changed area. The former is time consuming, and it is difficult to keep consistency among time-series maps. However this method is effective in case the base map has low accuracy, because this is independent from the base map.

The latter methodology has high time efficiency because analysing only changed area and high consistency because it's based on using base map. If accuracy of the base map is very low, this method is not suitable.

Since the accuracy of 71.7% is secured for BFDM which is the base map, change detection is proposed as updating method.

Inexpensive or free of charge materials are preferable for updating. Landsat 8 imagery is available by downloading through earth explorer website of the USGS for free and this imagery is used in BFDM 2015. In this reason, this imagery is suitable for updating.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-12 Steps to decide the method

In order to maintain forest monitoring system for long time and sustainable, it should be considered efficiency of time and cost, although accuracy is also important. The difficulty of classifying semiarid forests where boundary of vegetation types is indistinct, not only imagery but also in the field should be considered. Therefore, BFDM has misclassification between typical forest and woodland, and woodland and shrub/bush. One solution is using the imageries of both dry and wet season for classification and this makes BFDM more accurate. In addition, interpretation table was created to reduce personal error in interpretation (Appendix-11).

The combination of the target area and method as described above with appropriate selection based on the situation, can realise the sustainable update of the BFDM.

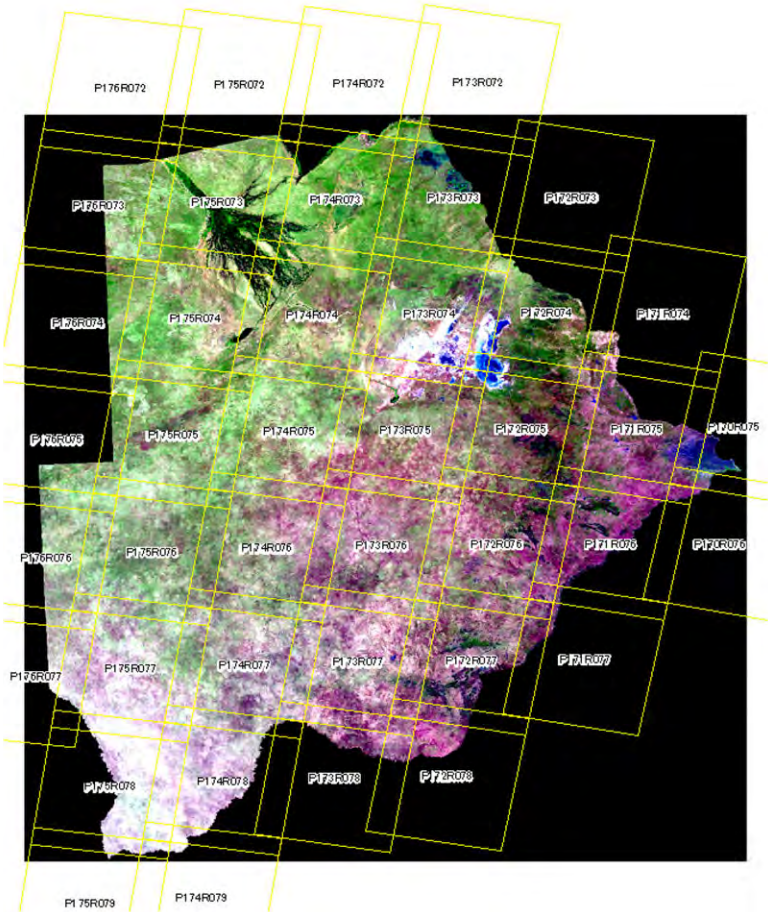
3.8.3 Implementation system

(1) Issues regarding mapping

Creating the map by using remote sensing technology requires the expert who can spend much time to it and have much experience of analysing satellite image.

Forty one scenes of Landsat imagery are necessary to cover the whole land (Figure 3-13). 10 to 15 days per person are seemed to be necessary to update one scene by using changed area method. This means completing updating the whole of the land by one person will require 200 to 300 days.

The expert on remote sensing is desired to have abilities to interpret imageries and to analyse it by using the software. Enough experiences are required to obtain these abilities.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-13 Scenes of Landsat covering Botswana

(2) Implementation system

Implementation system will be divided into 8 parts (Table 3-11) considering the methodology as mentioned above. It is important to compare them based on the budget and manpower to decide the implementation system. “ORDER OF THE COST” and “MANPOWER OF DFRR” was assumed based on a normal workload.

Table 3-11 Implementation system divided into 8 options

OPTION	MAPPING STAFF	TARGET	METHOD	ORDER OF THE COST 1 is most expensive	MANPOWER OF DFRR 1 is most consumptive
1	DFRR	All classes	Renewal	5	1
2	DFRR	All classes	Updating changed area	7	2
3	DFRR	Forest area	Renewal	6	3
4	DFRR	Forest area	Updating changed area	8	4
5	Contractor	All classes	Renewal	1	5
6	Contractor	All classes	Updating changed area	3	5
7	Contractor	Forest area	Renewal	2	5
8	Contractor	Forest area	Updating changed area	4	5

Source: DFRR-JICA NFMS Botswana Project

The differences between 4 and 5 in "MANPOWER OF DFRR" can be very large because implementing system requires much workload. In option 5 to 8, the DFRR staff will make the Terms of Reference and manage contractor's works with expert knowledge.

TOR at least should include specifications as follows;

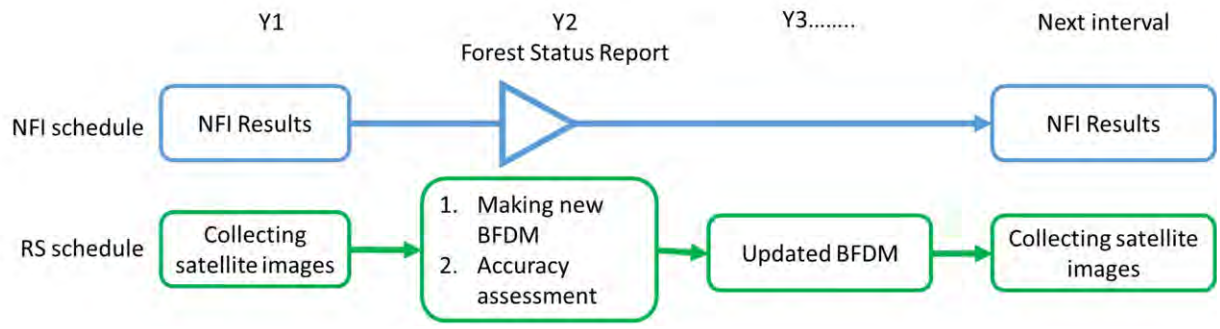
a. Data: sensor name (e.g. Landsat-8), season (Dry, rainy season or mixture of both season if accuracy is low), the period of acquiring images.
b. Target area: the whole land of Botswana or the forest area. Some buffer area outside the borderline should be included as target if the forest area is selected.
c. Pre-processing: 1. Atmospheric correction, 2. Geometric correction (if necessary), 3. Making mosaic-image (if necessary)
d. Classification scheme
e. Classification method: 1. Renewing or Updating changed area, 2. Object classification or Pixel classification, 3. Supervised classification or Unsupervised classification, 4. Minimum unit area of the polygon
f. Acceptable accuracy: accuracy assessment will be conducted by DFRR or the third-party.
g. Deliverables: 1. Raster and vector map, 2. Original and mosaic image, 3. Interpretation table, 4. Activity report

3.8.4 Operation Schedule

It will take three years before an updated map is approved. The process of updating is showed as follows;

1st year: Collecting satellite images
2nd year: Making new BFDM and conducting accuracy assessment
3rd year: Approving updated BFDM

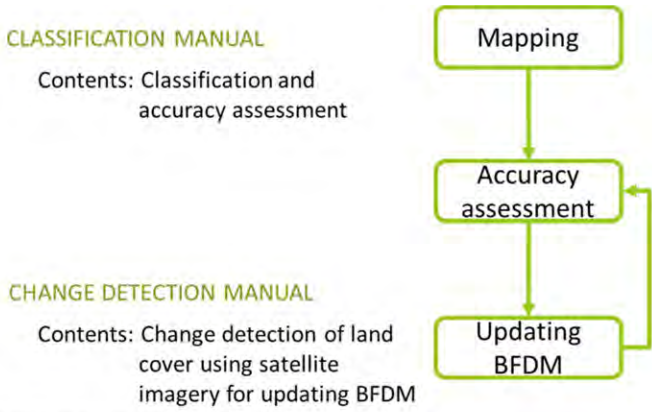
Figure 3-14 shows tentative updating cycle of BFDM and NFI.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-14 Tentative updating cycle of BFDM and NFI

3.8.5 Manual



Source: DFRR-JICA NFMS Botswana Project

Figure 3-15 Manuals for BDFM development

Three manuals have been prepared for monitoring forest by using remote sensing technique, as shown in Figure 3-15. The objective and contents of each manual are in below;

1. Classification Manual

   Objective: To conduct all processes of satellite image analysis
   Contents: Image interpretation, Processing analysis, and Classification and Accuracy assessment

2. Change Detection Manual

   Objective: To update the map detecting changed areas
   Contents: Difference image analysis, Change detection, Overlaying

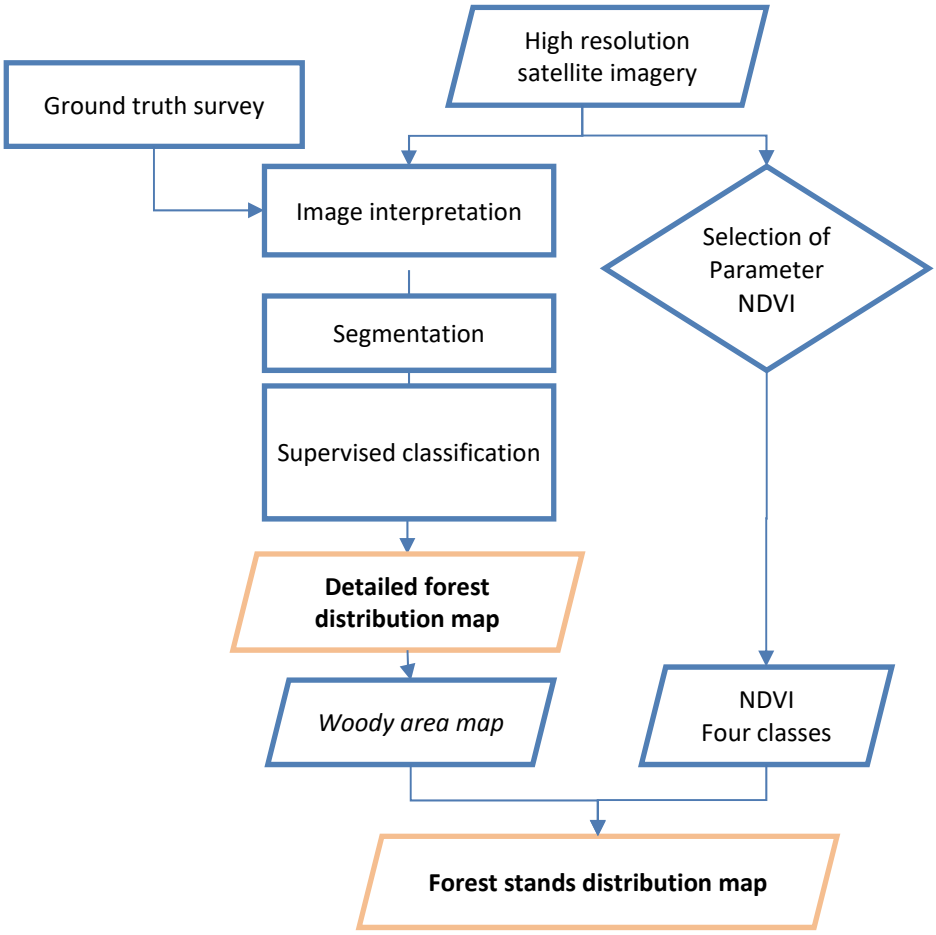
3.8.6 Detailed forest distribution map

Since smaller scale monitoring using BFDM is not unsuited, development of detailed forest distribution map and forest stand distribution map which were small-scale maps than BFDM was conducted using high resolution satellite imagery for two pilot area, Gaborone and the surrounding area (hereinafter Gaborone pilot area) and Francistown and the surrounding area (Francistown pilot area). The forest stand distribution map referred to here is the map relatively divided of forest stand into four categories; extra-large, large, middle and small. RapidEye imagery (5m resolution) was used for Gaborone pilot area and SPOT6 imagery (1.5m resolution) was for Francistown pilot area. Forest monitoring at smaller scale will be possible to utilize these distribution map.

The next figure shows the flow of map development. The Detailed Forest Distribution Map (DFDM) has been developed using object-based classification. The forest stand distribution map was classified by forest stand size to four categories based on NDVI, in the area covered by woody vegetation such as forest, woodland and shrub/bush extracted from detailed forest distribution map. Detailed forest distribution map and the forest stands distribution map are shown in Figure 3-17 and Figure 3-18 for Gaborone area, and Source: DFRR-JICA NFMS Botswana Project

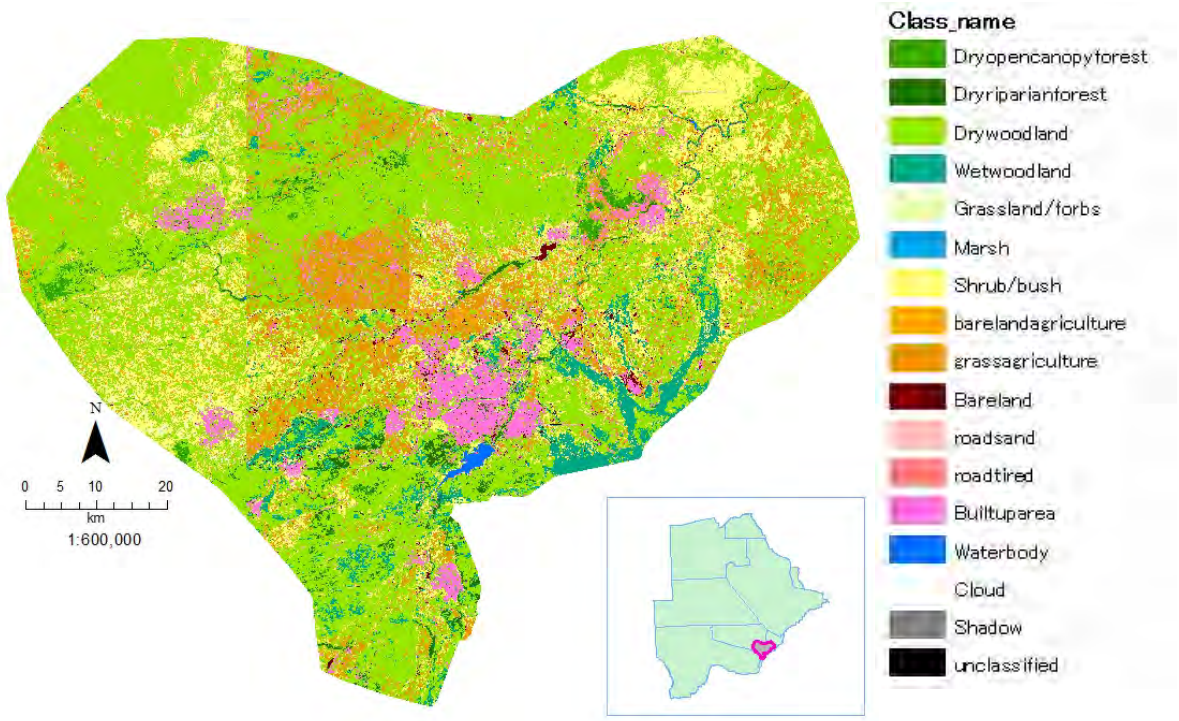
Figure 3-19 and Source: DFRR-JICA NFMS Botswana Project

Figure 3-20 for Francistown area respectively.



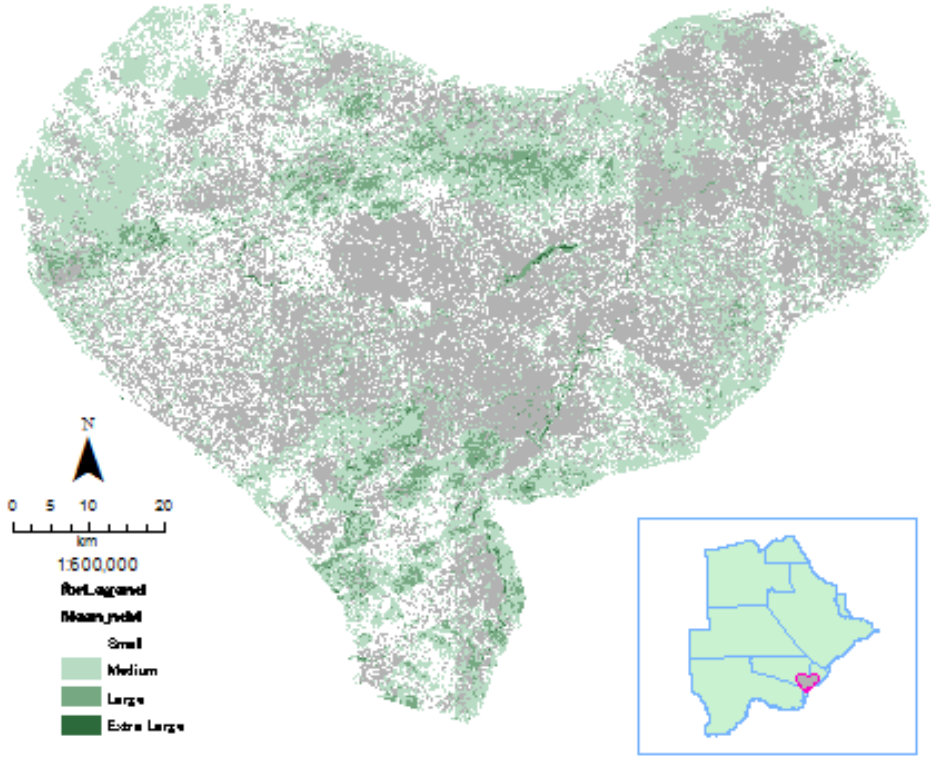
Source: DFRR-JICA NFMS Botswana Project

Figure 3-16 Flow of development detailed forest distribution map and forest stands distribution map



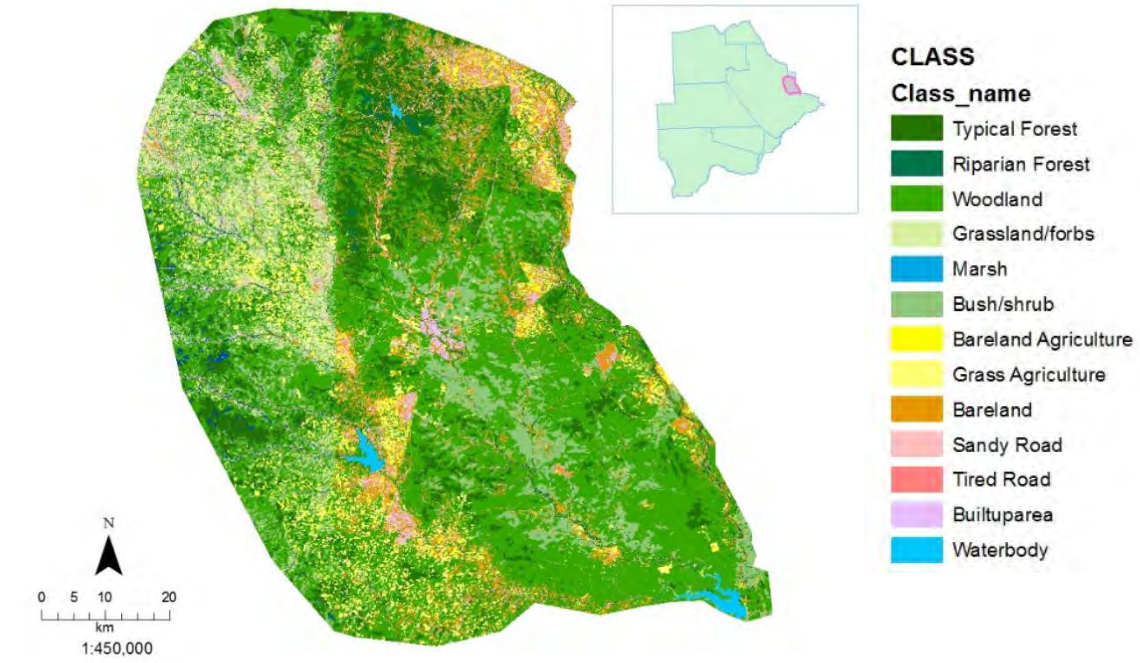
Source: DFRR-JICA NFMS Botswana Project

Figure 3-17 Detailed forest distribution map of Gaborone pilot area



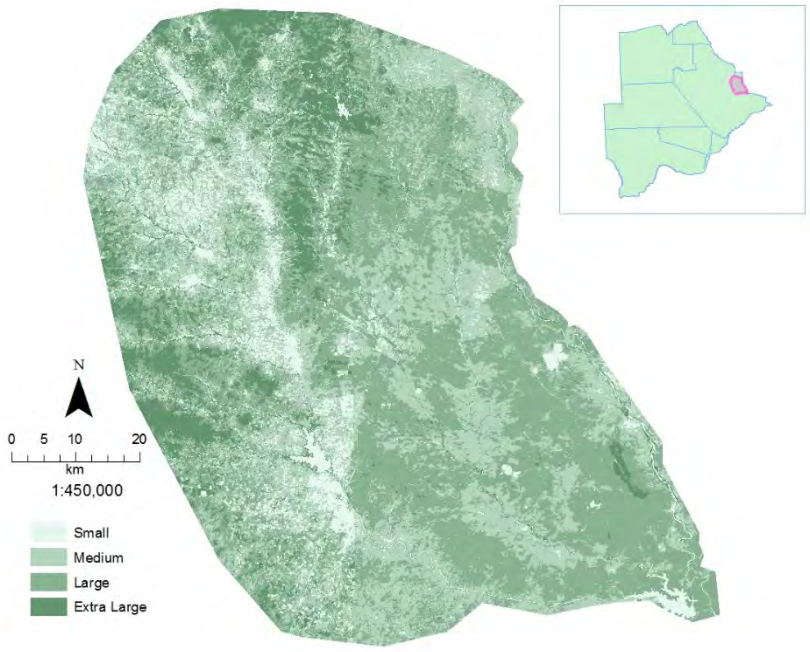
Source: DFRR-JICA NFMS Botswana Project

Figure 3-18 Forest stands distribution map of Gaborone pilot area



Source: DFRR-JICA NFMS Botswana Project

Figure 3-19 Detailed forest distribution map of Francistown pilot area



Source: DFRR-JICA NFMS Botswana Project

Figure 3-20 Forest stands distribution of Francistown pilot area

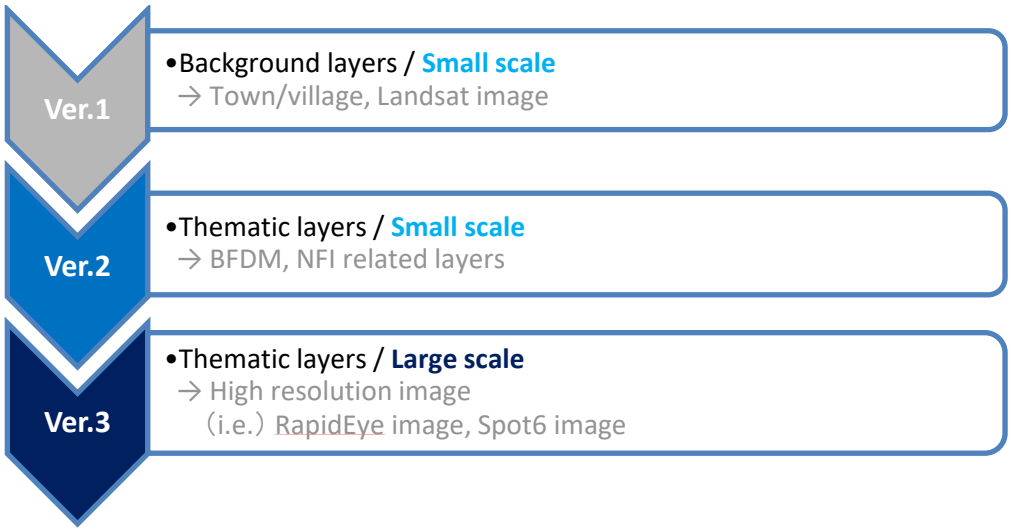
3.9 Component 3 Forest GIS Database (F-GIS-DB)

3.9.1 Objective

The objective of the Forest GIS Database is to manage the forest information properly which is brought from other components such as NFI, RS and datasets from other organizations. The Forest GIS Database is one of the key systems for the sustainable operation of the NFMS. The system should be constantly managed, maintained and modified if necessary, taking the NFMS sustainability into consideration. One of the tips for the sustainable maintenance of the system is to allocate a GIS-Database officer or a consultant in charge in order to maintain the daily operations of the NFMS as described in the section 3.8.3 “Implementation System”.

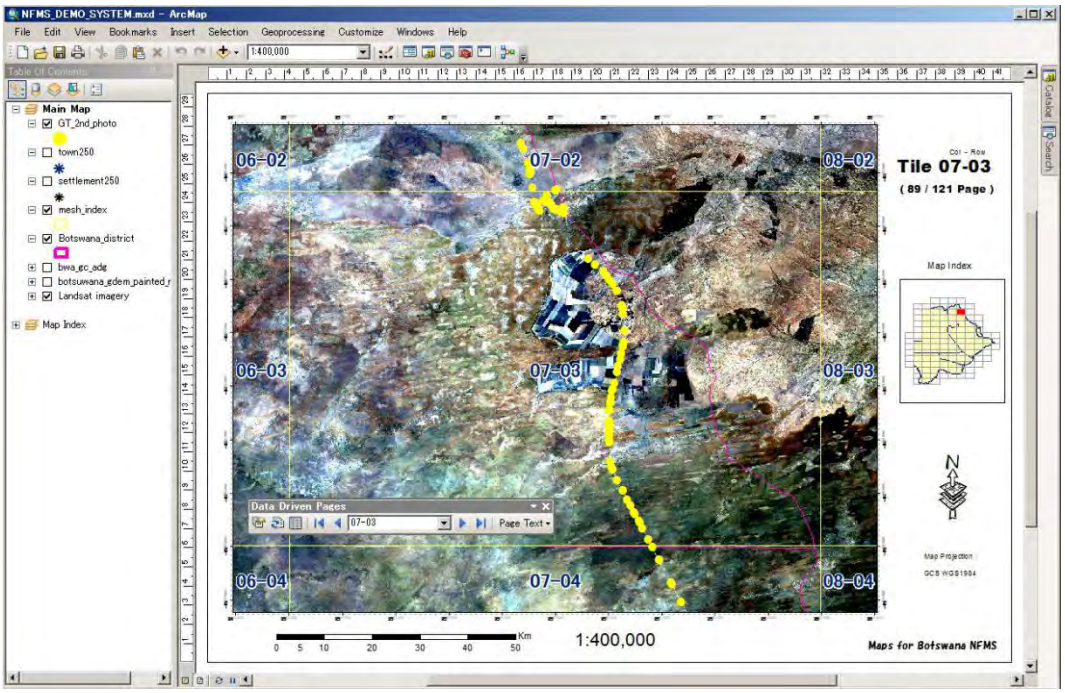
3.9.2 Methodology

In the NFMS, the central Forest GIS database has been developed by adopting the prototype system development approach. That approach is effective especially for users (likely to be DFRR HQ officers) who do not have a clear image about the system, since the system development process involves users interacting with the showing developed interface from time to time. The following figure shows version transition of the prototype forest GIS database.



Source: DFRR-JICA NFMS Botswana Project

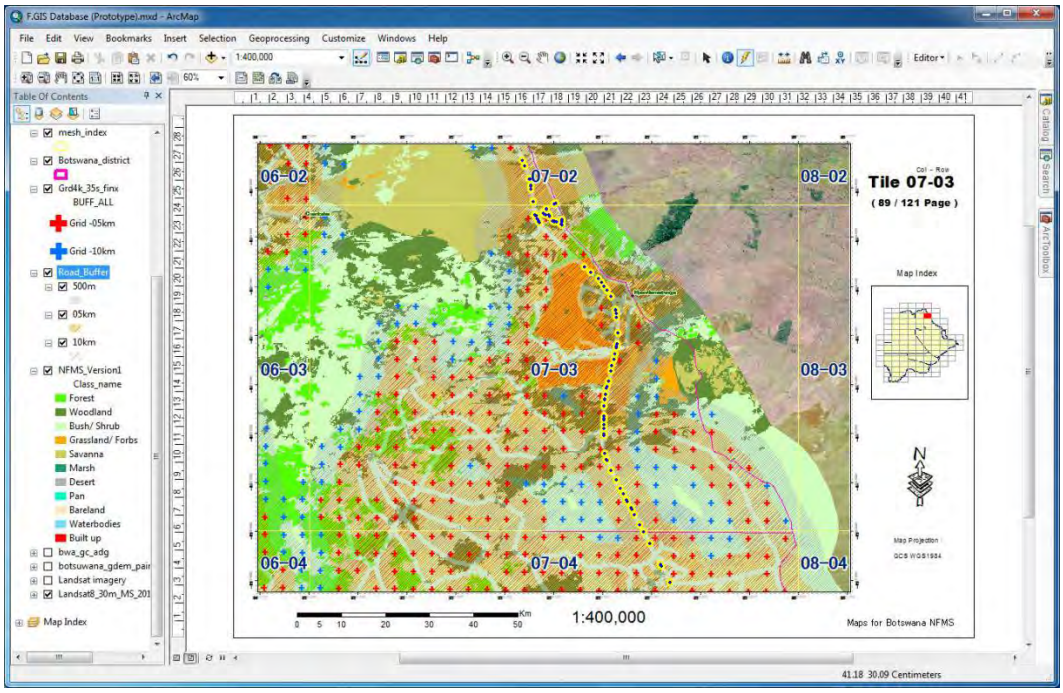
Figure 3-21 Version transition of the Prototype forest GIS database



Source: DFRR-JICA NFMS Botswana Project

Figure 3-22 Prototype F-GIS-DB interface of the Ver.1

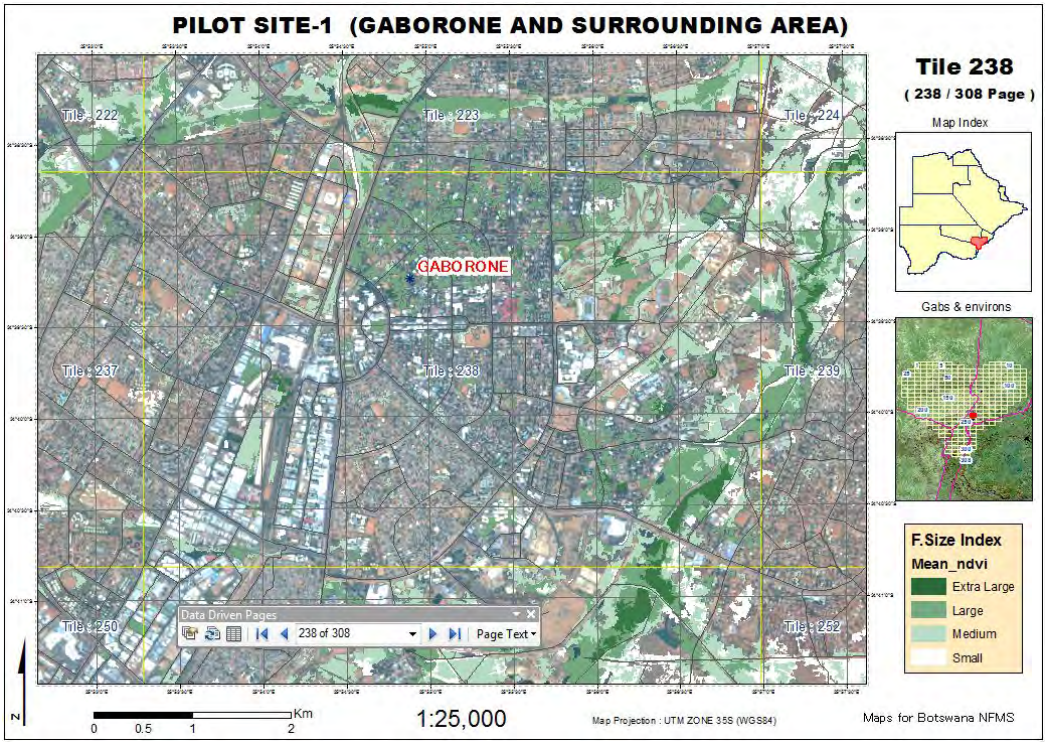
The first version of the prototype Forest GIS database was very simple with limited layers such as town/village point layers, and Landsat satellite imagery (30m pixel resolution) as background layer.



Source: DFRR-JICA NFMS Botswana Project

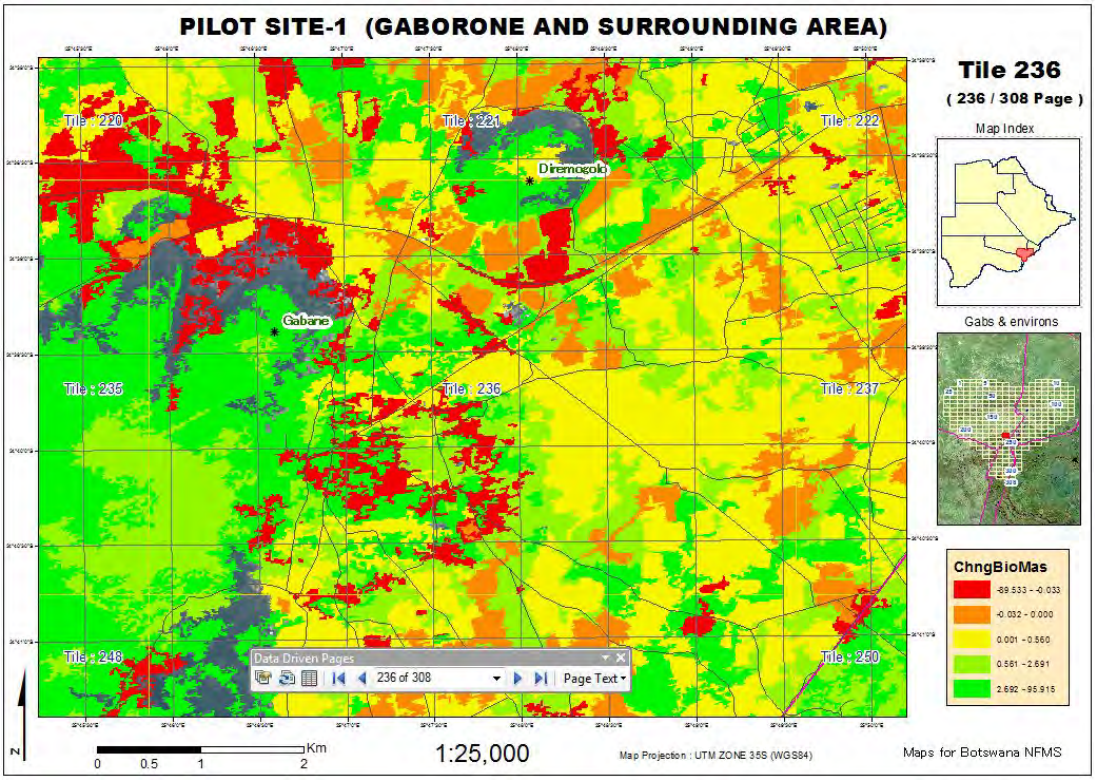
Figure 3-23 Prototype F-GIS-DB interface of the Ver.2

The second version of the prototype Forest GIS database includes important thematic layers such as BFDM (Botswana Forest Distribution Map), NFI (National Forest Inventory) related layers which include 4km Survey Grids, Road buffer polygon to consider the accessibility and effectiveness for surveying. Users can take a look at Inventory Survey Grids with various attribute which includes survey priority numbers randomly assigned by the system, and the distance from the nearest road (overlay result with road buffer polygons). As for the national level scale (small scale), this second version provides necessary functions for the map operations.



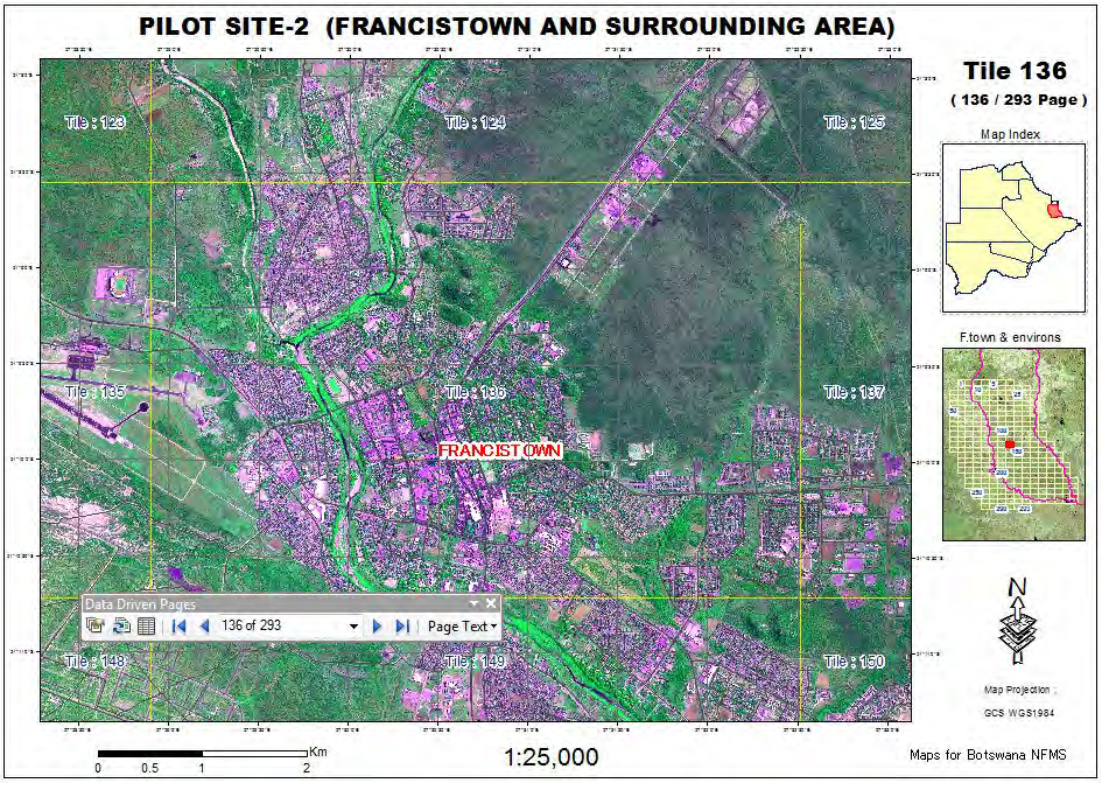
Source: DFRR-JICA NFMS Botswana Project

Figure 3-24 Prototype F-GIS-DB Interface of Ver.3 (RapidEye image – 5m pixel resolution)



Source: DFRR-JICA NFMS Botswana Project

Figure 3-25 Prototype F-GIS-DB Interface of Ver.3 (Biomass change theme map)



Source: DFRR-JICA NFMS Botswana Project

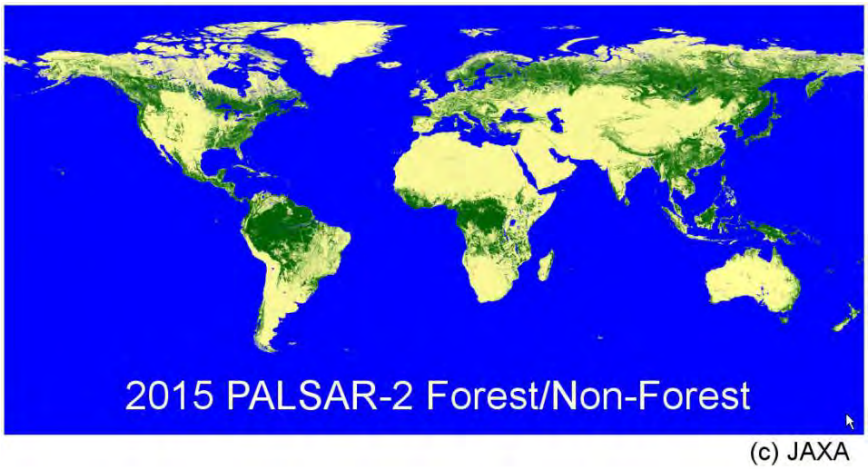
Figure 3-26 Prototype F-GIS-DB Interface of Ver.3 (Spot6 image - 1.5m pixel resolution)

The third version of the prototype Forest GIS database can handle high resolution imagery such as RapidEye image (5m pixel resolution), and Spot6 image (1.5m pixel resolution). In the project, two different pilot sites (1. Gaborone and surrounding area, 2. Francistown and surrounding area) were selected to drill down the analysis. For the pilot site analysis, this version is useful for the map operations.

For sustainable operation of the forest GIS database by the DFRR officers, the following key concepts should be taken note as the methodology on how to achieve goals of the Forest GIS Database.

- ✓ Storing time series BFDM and NFI data constantly with specific time intervals.
- ✓ Keeping DFRR HQ's DB contents updated to the latest status all the time.

With regard to time series BFDM, it will be updated by every five (5) years in conjunction with the implementation plan of the NFI survey. Map updates every one to two years short time intervals will lead to a possibility that it will be difficult to distinguish actual forest area change by uncertainty arising from classification errors of the satellite imageries. DFRR has prepared a BFDM2015 in the past four years. Aside from the NFI, when focusing on preparing the next activity data (BFDM) in the future, there might be a great concern, especially in feasibility, on whether DFRR can properly manage it or not, even with capacity building for the creation of the BFDM which has already been done, since image analysis to produce BFDM is a time consuming process and it costs too much Regarding cost analysis, refer to table 3-9. In this regard, two (2) additional options can be introduced as supplementary information for DFRR to conduct BFDM updates in the near future. The first alternative option is to make better use of open datasets which are available for free. JAXA (Japan Aerospace Exploration Agency) has generated open datasets called "The global forest/non-forest map (FNF)". This open datasets are scheduled to post in the internet website every year since 2015 by mosaicking PALSAR/PALSAR2 image with 25m spatial resolutions, which is equivalent to the Landsat imagery. The following figure shows this open datasets.



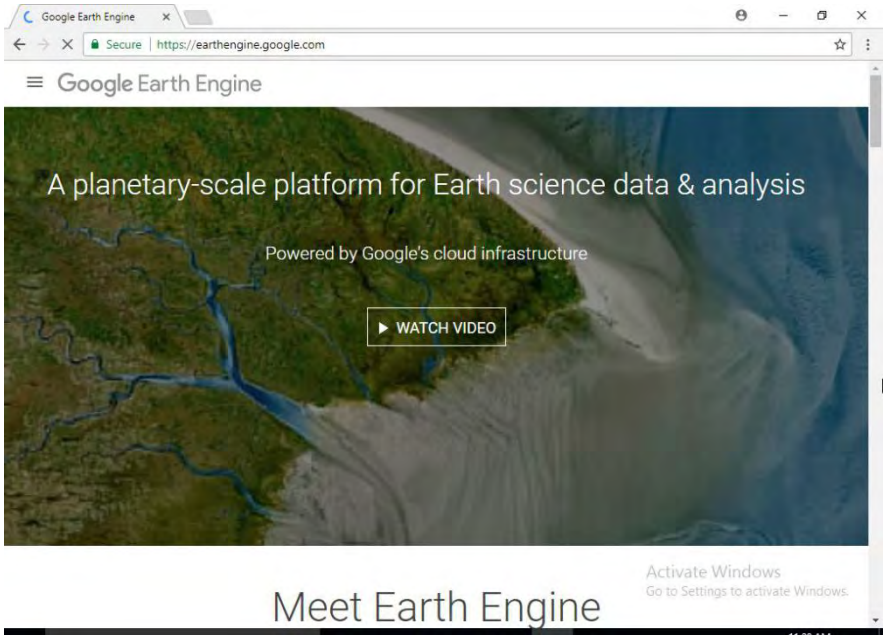
Source: ALOS Research and Application Project of EORC, JAXA, Whole ball 25m Resolving Power PALSAR-2/PALSAR Mosaic and Forest/Non Forest Map (http://www.eorc.jaxa.jp/ALOS/palsar_fnf/fnf_jindex.htm)(July 21, 2016)

Figure 3-27 Open Dataset Periodically Available for Free

It is possible to simply update the BFDM with methodology as following. First, just extract forest area change by using two different times of open dataset (i.e. 2015 dataset and 2020 dataset), then overlay it onto the BFDM2015. However, the classification type of this open datasets is only two (Forest or Non-Forest). It should be noted that these open datasets can be applied only for the temporary use or it can be used for the rough estimation of the forest area change, taking advantage of the one year temporal interval. SADC-JICA Forestry Project (started in June, 2015) has a plan to make use of these open datasets for the capacity building of the NFIS (National Forest Information System) in each SADC Member State. The DFRR can contribute to this multilateral project by sharing the experience of the project. Especially ground truth data collected by the NFI (Forest status with pictures) can be highly

contributed for verifying the accuracy of the open datasets in Savanna/Dry Forest/Semi Dry Forest regions. As a result, it will be advantageous to both sides (Botswana DFRR, SADC Secretariat).

The second alternative option of the next updated activity data (BFDM) is using internet cloud tool which is recently available due to technical innovation. With regard to preparation of the next updated activity data (BFDM), there might be other options using internet cloud tools not only making use of the above open datasets. For example, Google is providing powerful tools called “Google Earth Engine” for scientists, researchers and developers to detect changes, map trends, and quantify differences on the Earth’s surface. It provides ready to use datasets including historical Landsat, Sentinel imageries and simple, yet powerful API (Application Program Interface) is available in Python and JavaScript for free. See following figure.



Source: Google Earth Engine, Google, (https://earthengine.google.com/)(October 30, 2017)

Figure 3-28 Google Earth Engine (One of the option tools for updating BFDM)

Following table shows the above mentioned additional options for the BFDM updates considering criteria of option selection and applicable conditions.

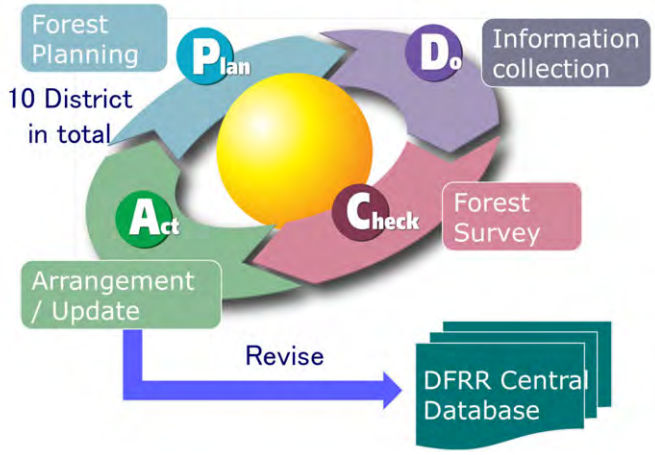
Table 3-12 Additional options for the BFDM updates

Available Options	Criteria of Option selection	Applicable conditions
Using JAXA Open Global Data (F/NF Map)	To make rough estimated BFDM not to spend too much time. (It will be low accuracy map.)	It requires to make time span longer of the two different times of the datasets as much as possible to keep certain accuracy when extracting forest area change.
Using Google Earth Engine which is an internet cloud based system (tool)	To keep accuracy of the BFDM with reducing time for the map update. (Time for the map update will be almost one fifth compared to the current methodology.)	It requires know-how on Remote Sensing Image Analysis Flow to some extent. It requires basic knowledge about program script language such as Python, JavaScript.

The “keeping central database contents updated to the latest status all the time” is an important concept since no one shows interest to the obsolete contents of the database. With regard to the importance of it, see section 3.8.3 in detail. Regarding the concrete methodology for keeping central database contents fresh, see section 3.8.4 in detail.

3.9.3 Storing time series BFDM and NFI data with specific time interval

Generally speaking, the DB contents are updated with specific time intervals as shown in the following figure.



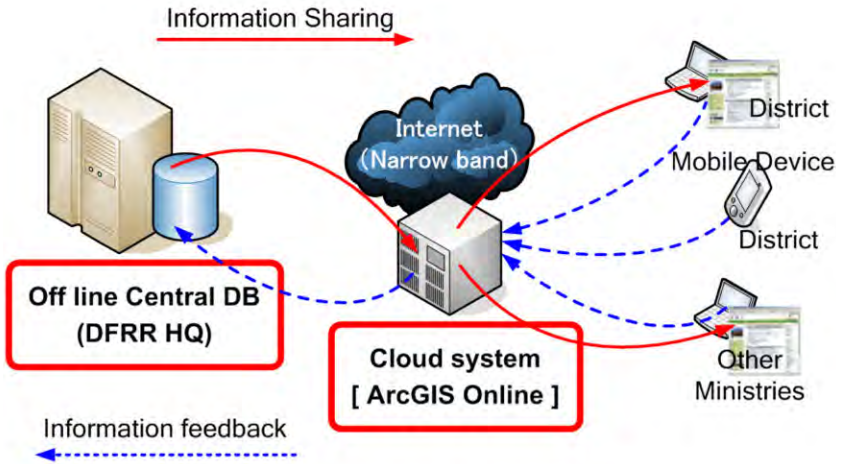
Source: DFRR-JICA NFMS Botswana Project

Figure 3-29 Concept for Updating DB Contents by PDCA Cycle

The most important thing in the above figure is keeping the DFRR central database updated to the latest status all the time since nobody is interested in obsolete contents. It must be difficult to maintain the system without a sense of ownership/awareness about the database system. One of the solutions to this concern is to get District officers involved in the DB contents update process as described in the following section.

3.9.4 Keeping DFRR HQ's DB contents updated to the latest status

ESRI, which is a giant GIS software vendor in the world, provides unique software called "ArcGIS Online". This software provides a system development environment making use of internet cloud based infrastructure. ArcGIS Online provides various functions for sharing information interactively among HQ and local offices. The following figure shows a logical system design using this internet cloud based environment.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-30 Logical System Design Considering Feedback by Local Offices

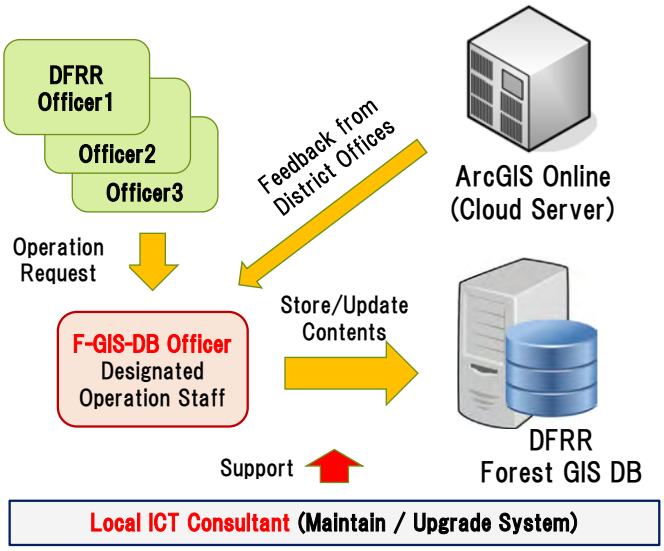
In the above figure, various information stored in the central database at DFRR HQs shall be disseminated to the rest of the local offices. And information feedback such as data corrections based on the actual ground truth shall be shared to the HQs in return. This kind of interactive information sharing services is the key concept for the brilliant success of keeping the database contents fresh all the time. And it also leads to keep stakeholders' interest in the database system itself.

3.9.5 Implementation System

The DFRR officer including Districts' have been well trained on how to operate the Forest GIS database by using self-training materials in past four years. But it is a different story when it comes to maintaining/upgrading the system. In order to maintain the system sustainably, a designated staff member who is responsible for the system and who has ICT knowledge to some extent should be assigned as "F-GIS-DB Officer". The following lists are the key concepts for the sustainable operation/maintenance of the system.

- ✓ ICT staff or Local ICT consultant should be involved for maintaining/updating the system.
- ✓ Designated operation staff should be assigned as F-GIS-DB officer (GIS Specialist).
- ✓ Operation staff should be trained at regular basis using training materials prepared by the Project.

And the following figure shows the operation flow by focusing on the designated operation staff.

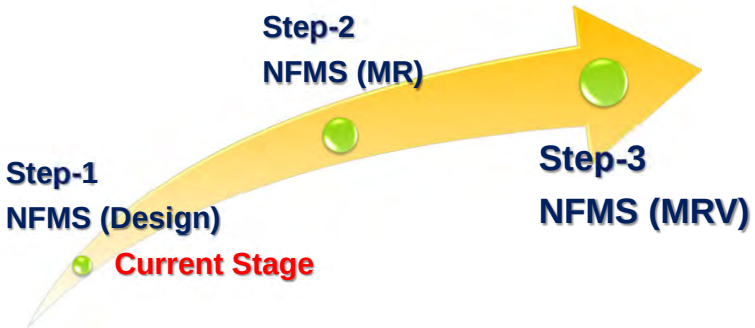


Source: DFRR-JICA NFMS Botswana Project

Figure 3-31 Operation flow by focusing on the designated operation staff

3.9.6 Operation Schedule

When developing Forest GIS database which is the core system of the NFMS (National Forest Monitoring System), it is important to know the current system status where we are. The following figure shows the general system development status of the NFMS. The most sophisticated system (Step-3 in the following figure) has MRV (Measuring/Reporting/Verifying) functions for both activity data and NFI data.

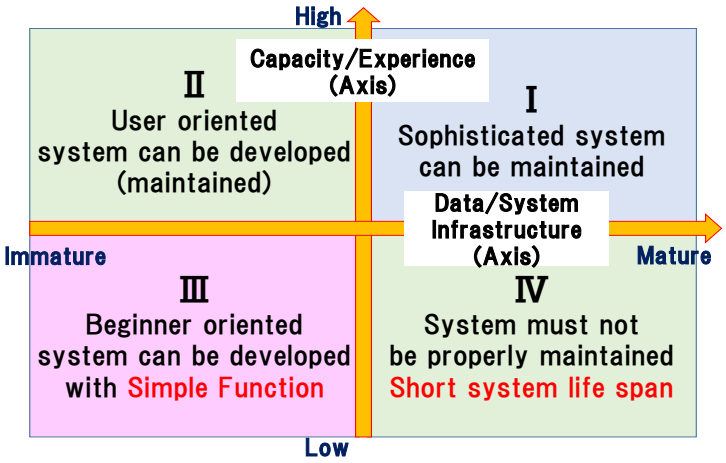


Source: DFRR-JICA NFMS Botswana Project

Figure 3-32 Stepwise Approach for Developing NFMS

In the DFRR case, we are still in Step-1 (Design stage), with just one stored snap shot base map (BFDM 2015). The NFI surveying (cycle one) is also undergoing and it has not yet been completed. In order to develop functions properly for measuring, reporting, and verifying, time series activity data and complete set of the NFI data should be stored to analyse/monitor on how the forest areas (or volume) have been decreased or increased. Anyway, we have come to the stage to store one snap shot of the base map and with the DFRR officers who have a high potential to operate the system in terms of the capacity and experience, it is recommended to continuously develop the system by applying the stepwise approach illustrated in the above figure.

The following figure shows general indicator of the co-relation between Capacity/Experience and Data/System Infrastructure when developing system such as NFMS, taking sustainability into account.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-33 Indicator of the Sustainable System Development

The DFRR is now in the second quadrant in the above figure. Four years ago, it was located in the third quadrant the DFRR officers have been well trained in the past four years and now they have enough capacity and experience to operate/maintain the system.

When it comes to the software in Step-2 (NFMS with MR functions) in the Figure 3.9-12, SADC-JICA Forestry Project is about to develop it by using open source software (QGIS). The DFRR can also effectively collaborate with this project and can expect the output from this project. It must be cost efficient in terms of the investment for the system development.

3.9.7 Manuals

The following manuals have been prepared for the Forest GIS database (Module 3).

(1) Operation Manuals

- Map Booklet Creation System

  Objective: System Operation Manual for small scale database (For Version.1 and Version.2)

  Contents: System Overview, Easy operations (Data Driven pages, Pop up JPEG photos, Add data), Reference (Confirm Dataset)

- Large Scale Mapping System

  Objective: System Operation Manual for large scale database (For Version.3)

  Contents: System Overview, Easy operations (Navigate to any map page to move, General tools for main map frame), Show “large scale map” theme, Export series of map, Reference (Confirmation on dataset)

(2) Practice Manuals

- Preparation for the National Forest Inventory

Objective: To learn monitoring forest area/carbon change using time series map

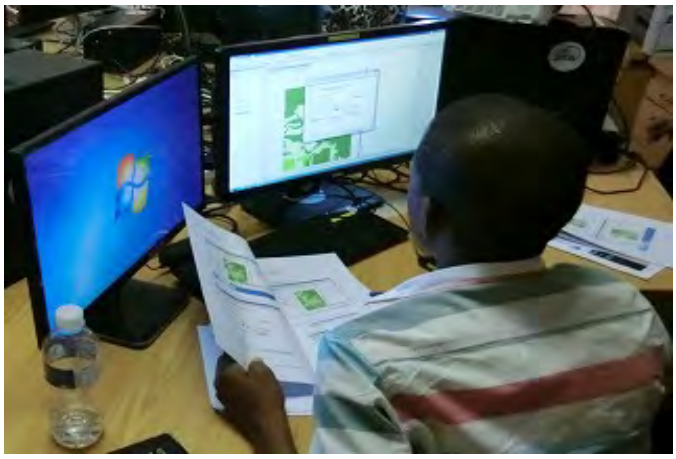
Contents: How to create mesh polygon, How to extract labels from the mesh polygon, How to design/create GRID-IDs, How to join attribute from the FDM polygon to the Grid point, How to create road buffer polygons, How to join attribute from the buffer polygon to the GRID point, Data conversion (Table to excel)

- How to monitor Forest Area Change

Objective: To learn monitoring forest area/carbon change using time series map

Contents: Exercise a. two different times of FDMs overlay by ArcGIS, b. Create forest area change matrix

Practice manual



Self - practice using practice manual

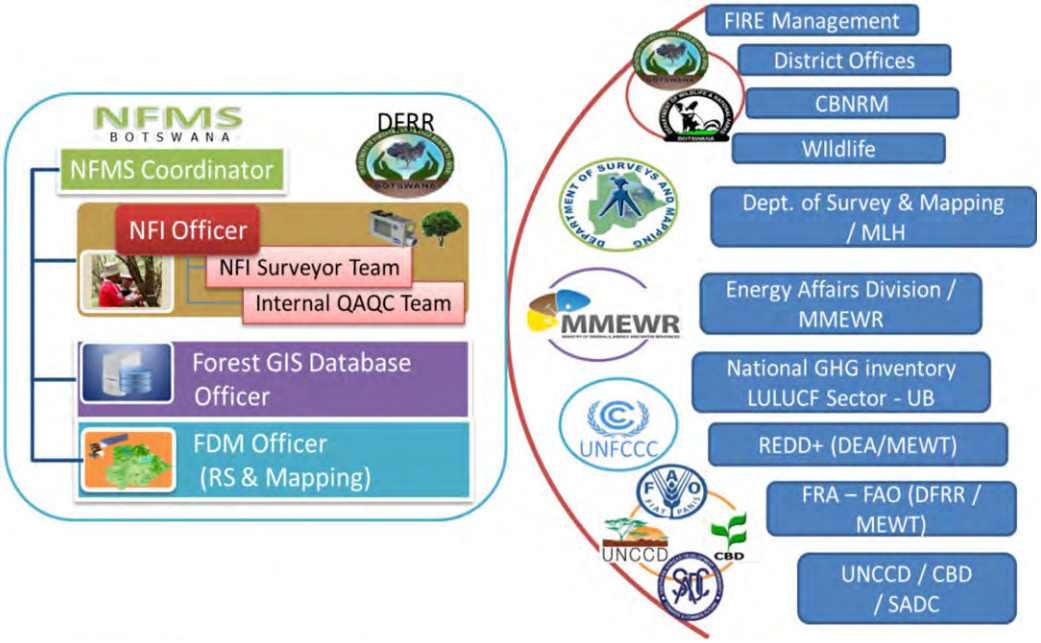
Source: DFRR-JICA NFMS Botswana Project

Figure 3-34 Practice manual and self – practice using the manual

3.10 Institutional arrangement

3.10.1 NFMS Management Structure

To maintain and to implement the National Forest Monitoring Plan smoothly and appropriately, a management unit is required. Next figure shows the tentative implementation structure of the National Forest Monitoring Plan under the DFRR. The management unit shall be formulated in the DFRR and it will be headed and managed by one coordinator called “NFMS Coordinator” and the three officers from each component such as National Forest Inventory, Forest Distribution Map (Forest Remote Sensing) and Forest GIS database, support the coordinator. Moreover, under the NFI officer, NFI surveyor team and QAQC team will be formed. Actually, there is no QAQC team but it will be established in the extension phase of the Project.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-35 Tentative structure of the National Forest Monitoring Plan management unit under the DFRR and related agencies

3.10.2 Tasks and qualification required for the officers in charge

Tasks and qualification required for the officers are described in this section in order to establish the NFMS implementation system mentioned in former section. A certain level of the capacity development has already done and there are several staff who satisfy these requirements in the DFRR, Therefore, the DFRR shall appoint these officers (or recruit as necessary) and add the following tasks explicitly to the PDP (Performance Development Plan) which is one of personnel management system in the DFRR

(1) NFMS Coordinator

1) Qualifications / special skills or knowledge

The NFMS Coordinator (the Coordinator) should have: an advanced degree (Master or Ph. d) in forestry or environmental management. The Coordinator needs to have the following experience/skills:

- A minimum of 10 years professional experience specifically related to forestry, forest, environmental, wildfire or wildlife management, forest conservation, forest planning in or out of the country.
- Substantive knowledge and experience of forest inventory survey, forest remote sensing and forest GIS database.
- Proven ability to research and prepare reports of a similar nature.
- Ability to coordinate the issues with the stakeholders such as district office, DWNP and BDF in particular, and other ministries and the international conventions' offices.
- Proven ability to present the NFMS and its progress for a technical and non-technical audience.

2) Terms of Reference

2)-1 Overall Responsibilities

The Coordinator serves as a head of the NFMS team which composed of three components such as 1) NFI, 2) Forest Distribution Mapping (Remote Sensing), and 3) Forest GIS database and is responsible for coordinating the smooth and successful implementation of the NFMS.

2)-2 Tasks

- Planning of the activities

- ❖ Budget / financial management and negotiations for the implementation of the NFMS
- ❖ General monitoring of the progress of the NFMS (holding a regular meeting, supervising the progress and providing necessary advices and instructions)
- ❖ Coordinate timely implementation of all aspects of the NFMS
- ❖ Reporting, redacting and reviewing the annual report, the Forest Status Report and other reports as necessary

2)-3 Expected Output

- ❖ NFMS annual report (once per year; internal administrative report)
- ❖ Forest Status Report (once per five year; being opened to public in principle)

3) Recruit of the NFMS Coordinator

- ❖ There are some Officers even now who meet the above requirements 1) and 2) in DFRR. Thus it must be important to appeal to incorporate the above requirements into PDP (Performance Development Plan) which is one of the evaluation systems of the human resource in DFRR so that the task of the NFMS Coordinator can clearly be recognised.

(2) NFI Officer

1) Qualifications / special skills or knowledge

The National Forest Inventory Officer (the NFI Officer) should have the adequate survey skills on the forest inventory survey and the ability to analyse the data by using MS-Excel and F-GIS Database. The NFI Officer needs to have the following experience/skills:

- ❖ Proven ability to survey on the ground and prepare reports.
- ❖ Ability to plan of the survey and manage the team
- ❖ Ability to coordinate with the related structure on the implementation of the NFI, such as district office, DWNP and BDF in particular.
- ❖ Substantive knowledge and experience of GIS mapping/operation using the ArcMap.

2) Terms of Reference

2)-1 Overall Responsibilities

The NFI Officer serves as a leader of the NFI surveyor team and he is responsible for planning, managing, coordinating and reporting on the NFI's activities.

2)-2 Tasks

- ❖ Planning of the annual activities on NFI and preparation of the budget.
- ❖ Planning, coordinating and securing of the transport for surveyor team in coordination with the transport office.
- ❖ Organising the surveyor team with the coordination with the District Offices and HQs office.
- ❖ Coordinating and communicating to DWNP and BDF as necessary about safety/security issue on the implementation of the NFI in the North area.
- ❖ Managing the field data and checking, analysing the results
- ❖ Making a report of NFI to the NFMS Coordinator to inform the progress of the survey, the results and the problem
- ❖ Inventorying the survey equipment once a year at least and replenishing the malfunction equipment.
- ❖ Preparing or procuring necessary expendable goods for the NFI in coordination with the supply office, such as, the field note, batteries for GPS handheld navigator, nails, chalks, pencils and so on.

2)-3 Expected Output

- ❖ Annual Report to the NFMS Coordinator
- ❖ Data set of NFI executed (shall be entered into the Forest GIS database)

3) Recruit of the NFI Officer

- These requirements should be included into the PDP so that the task of the NFI Officer can be clearly recognized.

(3) FDM Officer (Remote Sensing & Mapping)

1) Qualifications / special skills or knowledge

The RS & Mapping Officer (the FDM Officer) should have skills of basic satellite imagery analysis and GIS on how to operate image analysis software (e.g. ENVI) and GIS software (e.g. ArcGIS). The FDM Officer needs to have the following experience/skills:

- A little knowledge related to forestry, forest, environmental, wildfire or wildlife management, forest conservation, forest planning in or out of the country.
- Substantial knowledge and experience of mapping using remote sensing analysis
- Ability to classify of forest types by visual interpretation of satellite imagery, and to discern of forest types in the field
- Ability to evaluate the map with accuracy assessment
- Proven ability to make presentations about procedure and characteristics of the map.

2) Terms of Reference

2)-1 Overall Responsibilities

The FDM Officer is responsible to updating the BFDM, communicating with the DFRR officers, the NFMS coordinator, the NFI Officer and Forest GIS Database Officer for smooth and successful implementation.

2)-2 Task

In case mapping by the officer

- Planning of the activity for updating map
- Processing updated BFDM
- Conducting accuracy assessment (preferable to be conduct by the 3rd-party)
- Reporting the progress report, the accuracy assessment repot, and other reports as necessary

In case mapping by the contractor

- Planning of the activity for updating map
- Preparing the terms of reference for contractor
- Managing contractor's works.
- Conducting accuracy assessment (by the Officer or the third-party)
- Reporting the progress report, the accuracy assessment repot, and other reports as necessary

2)-3 Expect Output

- BFDM progress report (once per year; internal administrative report)
- Accuracy assessment report (updated year)

3) Recruit of the FDM Officer

- These requirements should be included into the PDP so that the task of the FDM Officer can be clearly recognized.

(4) Forest GIS Database Officer

1) Qualifications / special skills or knowledge

The Forest GIS Database Officer (the F-GIS-DB Officer) should have basic GIS/ICT skills on how to operate ArcMap/MS-Office. The F-GIS-DB Officer needs to have the following experience/skills:

- A little knowledge related to forestry, forest, environmental, wildfire or wildlife management, forest conservation, forest planning in or out of the country.
- Substantive knowledge and experience of GIS mapping/operation using the ArcMap.

- ❖ Ability to prepare Geo spatial data such as “Shape files”, ”Geo-tagged Images ”.
- ❖ Ability to coordinate the issues with the ICT consultants/GIS software vendor when upgrading the system/in case of system failure.
- ❖ Proven ability to make presentations about the Forest GIS Database system and the contents stored into the system when needed.

2) Terms of Reference

2)-1 Overall Responsibilities

The F-GIS-DB Officer is responsible for managing/maintaining/upgrading/presenting the Forest GIS Database and stored contents, communicating with the DFRR officers, the NFMS coordinator, GIS software vendor (i.e. GIMS) /ICT consultants for the smooth and sustainable operation of the system.

2)-2 Tasks

- ❖ System operations such as storing and updating contents upon request by the DFRR officers.
- ❖ Supporting the NFMS coordinator with analysing forest resources information stored into the database.
- ❖ System administrative operations such as backup and recovery of the system including data contents.
- ❖ Trouble shooting in case of system failure / contacting ICT consultants/GIS software vendor.
- ❖ Managing training materials and conducting training as a trainer at regular basis.
- ❖ Planning of system maintenance / upgrade.

2)-3 Expected Output

- ❖ System operation/maintenance report (at regular interval)
- ❖ Training materials and manuals

3) Recruit of the Forest GIS-DB Officer

- ❖ These requirements should be included into the PDP so that the task of the Forest GIS-DB Officer can be clearly recognized.

3.10.3 Collaboration with other ministries, department and institutions

The management unit of the National Forest Monitoring Plan have to collaborate with a number of ministries, departments and the institutions – the most important of them are the District Offices of the DFRR, the Department of Wildlife and National Parks (DWNP) and the Botswana Defence Forces (BDF) in terms of mobilisation and safety/security of the NFI surveyor. The National Forest Monitoring Plan shall also closely collaborate with the transport office in order to arrange the transportation for the surveyors.

Some universities like University of Botswana (UB), Botswana University of Agriculture and Natural Resources (BUAN) and Botswana International University of Science and Technology (BIUST) are likely to be called upon for collaborative works in the field of GHG inventory, forest measurement and other climate change issues.

For the forest remote sensing and mapping works and the publishing the BFDM, it is necessary to collaborate with the Department of Survey and Mapping. The need for collaboration with other ministries, department and institutions is summarised as next table and it is expected that the outputs from the NFMS Botswana will be used for the sustainable forest management and helping their decision making.

Table 3-13 Collaboration with other ministries, department and institutions

Institution			Area of collaboration
MENT	DFRR	District Office	Collaboration and mobilisation of surveyor and transportation arrangement for NFI
		Division Technical Support Services	Fire management issues. Data sharing and analysing on fire with the Forest GIS-Database,
		Transport Office	Transportation arrangement for NFI
		Extension Services	Information and knowledge sharing and accumulation on the Non Timber Forest Products and CBNRM with the forest GIS database
	DWNP	Wildlife offices	Escort the NFI surveyor team (securing surveyor safety)
	DEA (Department of Energy Affaires)		Coordination with the international convention such as UNFCCC (REDD+), UNCCD and CBD and providing necessary forest information through the Forest GIS-Database
	DMS (Department of Metrological Service)		Information sharing on the weather station data and fire risk. Collaboration with DMS as Designated National Authorities of UNFCCC
MLH	DSM (Department of Survey & Mapping)		Remote sensing and GIS technology and publication of the BFDM
MMEWR	EAD (Energy Affairs Department)		Forest resource assessment and monitoring as a source of energy
CSO (Central Statistics Office)			Provision of forest information such as forest area and volume
UB		Botswana GHG Inventory Project	Information such as area, stock and changes on LULUCF sector in the national GHG inventory
			Technology development and collaboration on forest measurement and forest resource assessment. Human resource development in forestry
BUAN			
BIUST			

Source: DFRR-JICA NFMS Botswana Project

3.10.4 Securing Surveyor Safety

Regarding the surveyor (DFRR officials) safety in the NFI implementation, some preventive measures against the risk have been already taken. However, this safety issue is a top priority in the NFMS implementation and it must be surely secured.

In order to ensure the DFRR officer's or surveyor safety at the time of NFI or some field survey, they will face various risks from wildlife, poachers, the risk to be misidentified as poachers by the BDF anti-poaching unit, injury and accident etc., as shown in the following figure. Therefore, it is necessary to take preventive measures in advance.

(1) Uniform

The current protective clothing is not suitable for this kind work. Closed forests are very difficult to navigate as they are characterized by spiky bushes, leaning branches, thickets and sometime sharp-edged rocks. Up in the north where there are many incidents of poaching, a uniform is not only a necessity for protection against injuries, but also critically important for identification reasons, especially for security agents operating in that part of the country. Therefore, some special protective clothing/uniform for inventory field work should be given serious consideration by the DFRR.

(2) Threats from wild animals

Some plots are located within areas traversed by dangerous wild animals such as lions, buffaloes, elephants, and others. Although the department (DFRR) does sometimes get support as and when needed from the Department of Wildlife and National Parks (DWNP), it is the process to secure that kind of support (escort) that has in the past proved to be the most difficult thing to do. The process is too long and bureaucratic. Therefore, it is necessary to improve those relationships and collaborate well with the DWNP in the future.

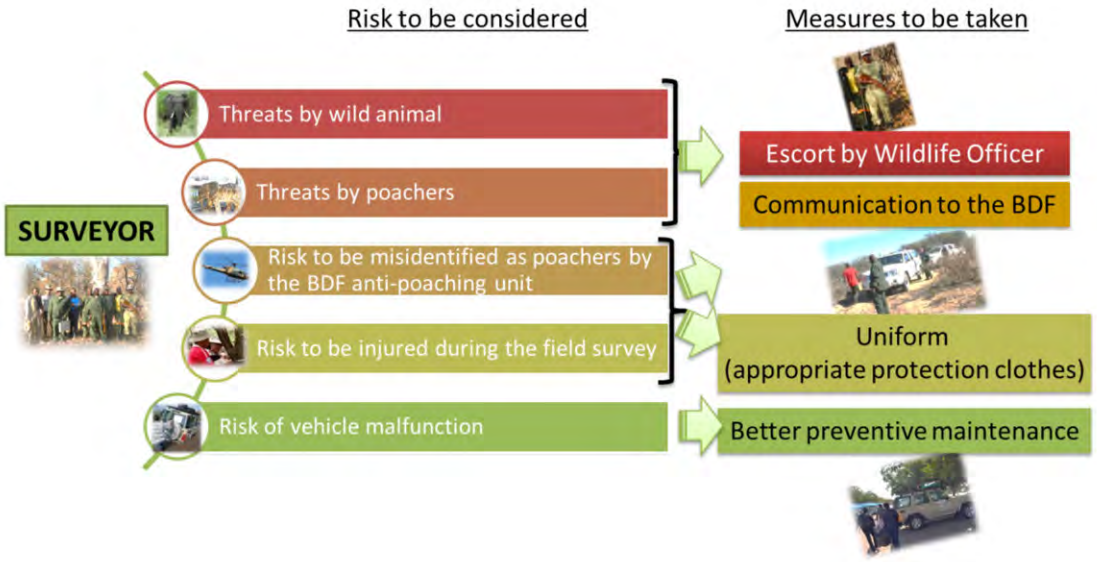
(3) Threats from Poachers

Up in the north, the teams are sometimes faced with the problem of going to some plots which are located in areas prone to poaching. There is always a danger of the army mistaking the teams for

poachers or poachers feeling threatened by their presence as they may reveal their hideouts to the security agents.

It is also very important to highlight that the threat from poachers transcends beyond the boundaries of the protected areas, and sadly the DWNP service is only limited to the protected areas under their jurisdiction. Therefore any incident arising from interaction with the poachers is not their responsibility by any stretch of imagination.

In conclusion, there must be a formalised agreement between DFRR and other stakeholders like DWNP and Botswana Defence Force (BDF) to ensure the safety and security for the surveyor teams during operations of NFI.



Source: DFRR-JICA NFMS Botswana Project

Figure 3-36 Risks surrounding the surveyors

CHAPTER 4 UTILISATION OF THE NFMS

4.1 Utilisation of the NFMS

Achieving the overall objective of the Project, "Sustainable Forest Management" and "providing key data for international reporting obligations such as National Communications", the following activities mentioned in the next table were conducted by using the NFMS as a tool in the extension phase of the Project from July 2017 to December 2017. This chapter describes the examples how the NFMS can be used from those experiences of the activities.

Table 4-1 Utilisation of the NFMS that the Project worked on

Utilisation of the NFMS	Related output of the Project
◆ Utilisation of Forest GIS Database 1 (Linkage system between district offices and HQ) (See Chap. 4.2) ◆ Utilisation of Forest GIS Database 2 (Providing the data to the international mechanism such as FRA and/or GHG inventory) (See Chap. 4.3)	Output 5 Developed NFMS will be utilised by related governmental organizations including DFRR district offices and other ministries to share information and to produce appropriate data for sustainable forest management (SFM) Output 5.1 Linkage with the district offices and other ministries Output 5.2 Providing the data to the international mechanism such as FRA and/or GHG inventory
◆ Utilisation for fire management (See Chap. 4.4)	Output 6 NFMS will be applied to forest fire management which contributes to the SFM
◆ Utilisation for the Community-Based Natural Resource Management (CBNRM) (See Chap. 4.5)	Output 7 NFMS will be applied to the CBNRM as part of the SFM

Source: DFRR-JICA NFMS Botswana Project

In addition to the above, the information and knowledge sharing by the Project have been carried out at every opportunity. This chapter describes also the result of Output 8 which is the one of the output in the extension phase of the Project, "Knowledge and experience obtained in the Project will be shared inside/outside Botswana in collaboration with SADC and other developing partners." (See Chap. 4.6) Also the current situation regarding the utilisation of the NFMS and their challenges and countermeasures are summarised in the 4.7.

4.2 Linkage System between the district offices and HQ–

4.2.1 Background and Objective

When considering sustainable operation of the central Forest GIS Database, it makes sense for the District Offices to develop a feedback mechanism since it creates an accurate reflection of the actual ground condition directly and it leads to maintaining fresh database contents as a consequence. For sustainable database management, this kind of interactive data sharing system must be one of the key factors. Objective of this section includes developing a prototype linkage system between local offices and HQs as an electrical communication tool and conducting training on how to operate it so that DFRR officers can sustainably maintain the central Forest GIS Database as a result. This section describes about the prototype linkage system developed in the project based on the conceptual design already mentioned in Chap. 3.9.4, system usability tests conducted in the actual field in order to verify whether the system is functional as a tool or not in the organization, and the possible application field of the system if any for future usage as well.

4.2.2 Utilisation of the Output / Good practice

(1) Prototype system development

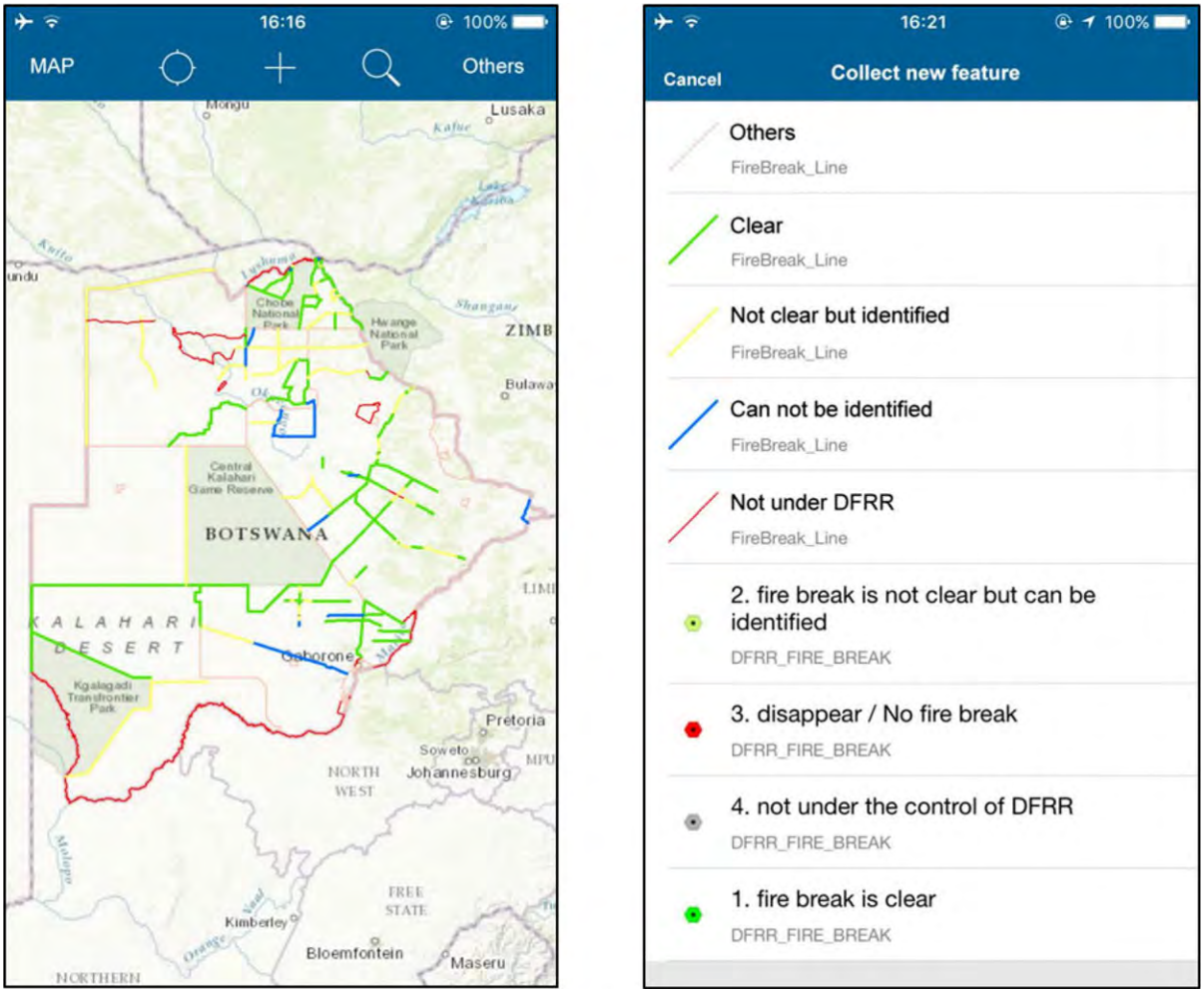
The prototype linkage system was developed based on the conceptual design stated in Chap. 3.9.4. The system development includes Internet map server configuration, and can create/share maps for data

collection. When users (likely to be district officers) collect data in the field, it is necessary to prepare for background maps normally which includes administrative boundaries (i.e. district boundaries), rivers, roads, village/town name and location, and so on so that users can know where they are in the field using mobile devices such as smart phones. Internet map server configuration includes storing this map information in the server and setting up map sharing operation in the organization. The following figure shows the internet map server configuration for sharing maps.

Source: DFRR-JICA NFMS Botswana Project

Figure 4-1 Internet Map Server Configuration for Sharing Maps

As a next step of the internet map server configuration, it is important to decide a theme map. The theme map means: the objective of a survey in the field as to what kind of data users want to collect there. As for the prototype linkage system development, fire break line data was selected as a theme map since the maintenance issue for the fire break is one of the common interests in the organization and it leads to good practice if it's functioning well. The fire break line data (shape file format) was initially created by the Department of Survey and Mapping (DSM for short) based on the interpretation method using satellite imageries. There is a common negative issue that some of these line data do not reflect actual ground status due to incorrect interpretation or other reasons such as fire break maintenance status. Normally, well maintained fire breaks can be clearly seen even based on the interpretation method but it is difficult to distinguish those fire breaks if they are not well maintained. They have high possibilities to be incorrectly interpreted as small streams, non-paved roads, or other line shaped features in the actual field. The following figure shows these fire break line data images on the mobile device was developed and configured in the project. Coloured line data which stands for the fire break status whether they are clearly to be seen or not are shown based on the attribute data which is called as 'Confident level'. The attribute 'Confident level' was newly added to the fire break line shape file and edited by the DFRR officers under the remote sensing image interpretation training activities in the project. That means the output of the remote sensing training was used as the theme map for the data collection in the field.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-2 Theme map image (Fire break line data) on the mobile device

(2) System usability test (Verification process in the system development procedure)

The system usability test was conducted in the actual field as already mentioned in the previous section in order to verify whether the developed system is functional as a tool or not in the organization. The procedure is as follows.

<System usability test procedure>

1) Customise attribute data of the fire break shape file. Concretely add new field “Confidence level” by interpreting Landsat imagery. Status flag whether fire break can clearly identified or not are stored. In this stage, there must have some uncertainty by interpreters’ incorrect interpretation.
2) Upload/Register the above “Fire Break Shape file” to the internet map server (ArcGIS Online Server).
3) Then check actual status by doing ground truth survey. Surveyors can use mobile device such as “iPhone” in the field to see “Fire Break Shape file” on the internet map server.
4) Verify effectiveness of the system (prototype linkage system) based on analysis of the results of the above activities.

The following figures show some pictures of the system usability test process conducted by GIS/DB experts with DFRR officers at northern part of Molepolole.

Data transmission by Mobile device

- Be-Mobile SIM was used for the survey which covers most villages in Botswana.

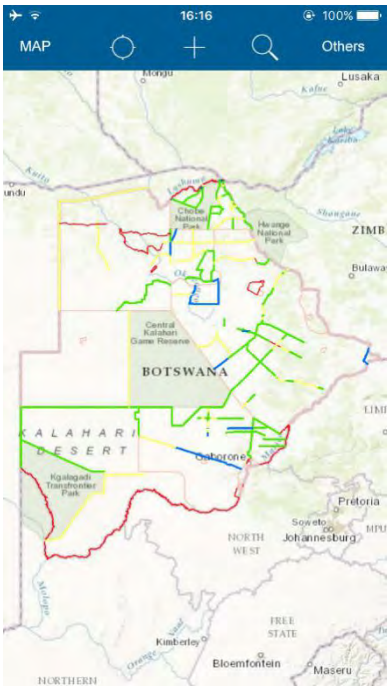
Field survey of the Fire Break

- Positions by GPS (Automatic), Pictures, Comments can be stored intuitively.

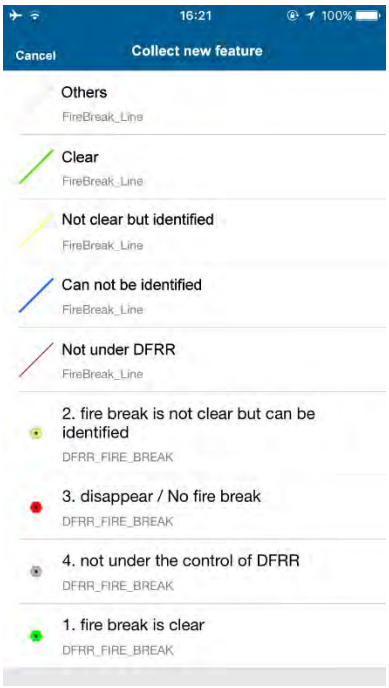
Source: DFRR-JICA NFMS Botswana Project

Figure 4-3 Field survey to verify the effectiveness of the pilot system

The filed survey was conducted by the two Forest GIS database expert from the project accompanied by one DFRR HQ officer and one Molepolole District officer. It is worth specially mentioning that the map operation of the client mobile phone can be done even no internet connection, without Wi-Fi environment by just selecting 'Offline mode'. In that case, collected data by the surveyor in the field shall be transferred to the internet map server as soon as the surveyor comes back to the office and the mobile device finds connection to the internet.



- Fire Break data categorized by the "Confidence level"(iPhone image)

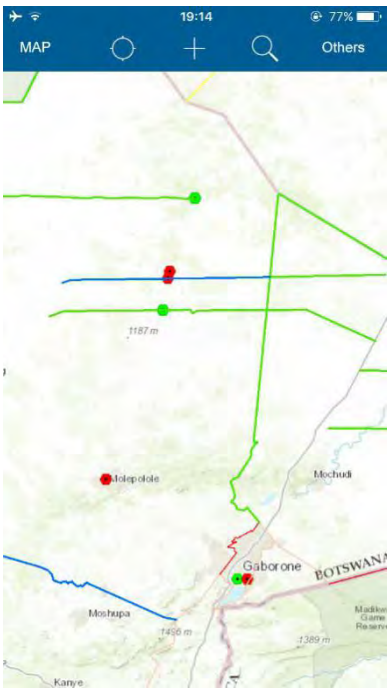


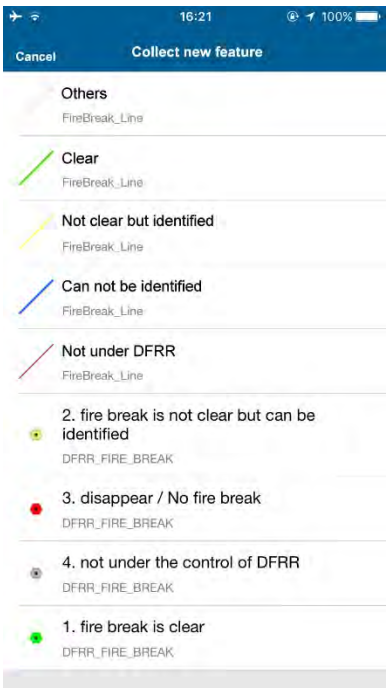
- 'Confidence level' of the Fire Break (Outputs of the RS Image interpretation training)

Source: DFRR-JICA NFMS Botswana Project

Figure 4-4 Materials to be used for the system usability test

Surveyors can show Fire Break data which was uploaded onto the internet map server (ArcGIS Online) by using mobile device. Operation is easy and intuitive.



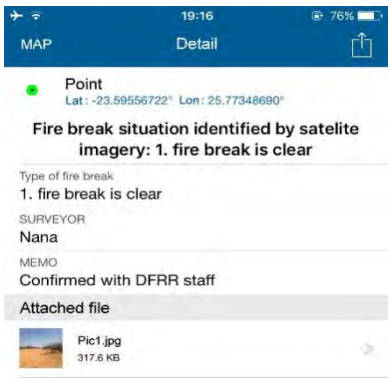


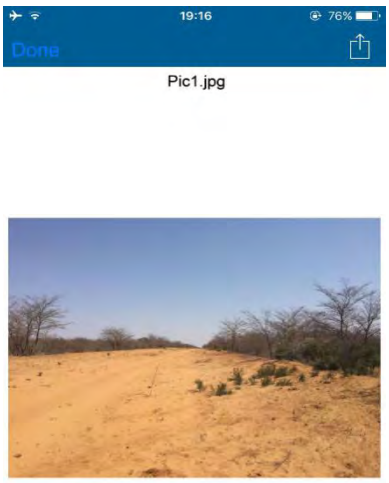
- Field survey was conducted at some Fire Breaks at the northern part of Molepolole.
- "Confidence level" of the Fire Break (Outputs of the RS Image interpretation training)

Source: DFRR-JICA NFMS Botswana Project

Figure 4-5 Overview of the field survey site

In the Figure 4-5, point markers (Red, Green colour point markers) show the actual position surveyed in the field. These data were input by using mobile device in the field.



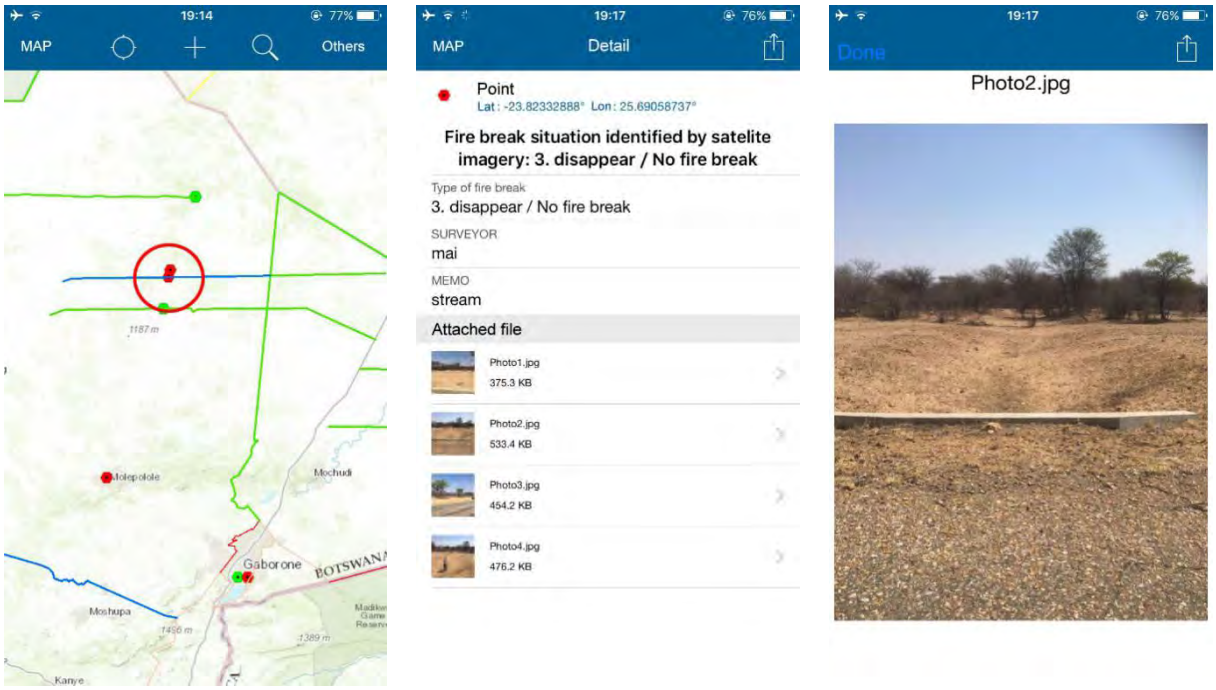


- The green line clearly identifies the fire break by image interpretation
- Interface of the Field. User can choose "On line" mode or "Off line" mode)
- A picture taken in the field. (Well managed Fire Break by the community)

Source: DFRR-JICA NFMS Botswana Project

Figure 4-6 Field Survey Results at a Well Managed Fire Break

There are two modes within the client software of the prototype system: One is “On line” mode which connects internet with SIM card, and the other is “Off line” mode which disconnects internet, but the field survey data would be sent as soon as users go back to area where an Internet connection available. Thus, users can input/store field survey data regardless of internet connection.



- Survey position
- Blue line shows a not clearly identified fire break by image interpretation

- Interface of the Field. User can choose “On line” mode or “Off line” mode)

- A picture taken at the field. (Incorrect Fire Break) Confirmed small stream was incorrectly interpreted as the Fire Break.

Source: DFRR-JICA NFMS Botswana Project

Figure 4-7 Field Survey Results at a Position Incorrectly Interpreted as a Fire Break

Figure 4-7 is the case that should especially be highlighted. The blue line shown on the mobile device means “Not clearly identified as fire break” when interpreting fire break on the Landsat imagery by the DFRR officers, while the original fire break shape file which was prepared by the DSM, it was registered as a fire break line. But this blue line was identified as small stream not a fire break when the field survey was conducted. It suggests that local offices could play an important role to collect field information and they could give feedback to the HQ for keeping central DB’s contents updated all the time. In that sense, the effectiveness of the linkage system was verified through the system usability test in the actual field.

(3) Possible application field of the system

Possible application field of the system was studied for future usage of the system based on the survey getting from specific local office. In view of sustainable forest management, the Chobe District which has seven forest reserves, where the forest cover rate is relatively high in the country and forest fires occur in high frequency, was selected as a target organisation of the study. The study results were categorised in three activities, one is “Monitoring fire related activity”, two is “Monitoring status / utilisation of Forest Resources”, and the last is “Monitoring compliances in Forest Reserves”. The following table shows the possible application field of the system in the near future based on the study results.

Table 4-2 Possible application field of the system

Possible application field of the system	Reporting Frequency
Monitoring fire related activity	
・Wildfire situation at district level	Monthly
・Fire frequency in the field	Monthly
・Burnt scar analysis	Monthly
・Fire-break maintenance (as already mentioned as a good practice in the report)	Quarterly
Monitoring status / utilisation of Forest Resources	
・Forest cover ground truth	Monthly
・Fuel wood biomass	Monthly
・Distribution of specific tree species (i.e. Mukuwa is gradually reducing)	Monthly
・Outbreak of disease on trees (i.e. Dieback) - Mukuwa species	Monthly
・Intrusion of invasive species	If identified
・Distribution of special interest species for research purpose (i.e. Distribution of Plotea species in Chobe District (Area 256))	Quarterly
・Newly established wildlife water points *correlation with forest cover density since elephants destroy trees	Quarterly
・Mortality of trees planted (number of trees) - nursery section	Quarterly
Monitoring compliances in Forest Reserves	
・Illegal game drives / camping	If identified
・Illegal harvesting of fuel wood / thatching grass	If identified
・Illegal dumping waste (mount of litters)	If identified
・Illegal sand mining	If identified
・Illegal poaching wildlife	If identified

Source: DFRR-JICA NFMS Botswana Project

The prototype linkage system developed in the project has a variety of local specific possible application fields based on the needs analysis of the local offices. It is very interesting that the system might have the possibility to contribute even real time reporting for monitoring compliances in forest reserves according to the study results.

4.2.3 Manuals

Manuals for the prototype linkage system have been prepared. Manuals are consisting of four system administration manuals and one operation manual for client application (mobile device).

<System Administration Manual>

1) Manual for account setting

Objective : To manage your own map server (web site)
Contents : License management, Language, region configuration, Invite members, Create group, Share contents to group, etc.

2) Prepare your data in ArcGIS Desktop

Objective : To prepare for background map for your own map server (web site)
Contents : Create geodatabase, Define geodatabase domains, Define feature class, Set up the fields, Theme your data, Publish your data

3) Create and share a map for data collection

Objective : To create theme maps for web publishing
Contents : Create a map, Add layer to the map, Save the map, Share your own map

4) Backup your own data

Objective : To back up your own data
Contents : Sign in to your web site, Export, Download

<System Operation Manual for client application>

1) Manual for the prototype linkage system (Data collector) using smartphone or tablet

Objective : To operate Data collector (client application of the linkage system) in the field
Contents : Install Data Collector, Open the map, Input fire break assessment information, Review the fire break assessment, Offline mode

Two days of training using the above System Administration Manuals were also conducted for specific DFRR officers who are in charge of system maintenance as well. Various positive comments about the prototype linkage system were given by the participants. The system will be able to contribute to various fields other than the needs listed in Table 4-2.

4.3 Use of the NFI data for FRA/GHG reporting

4.3.1 Background

Forest is an important carbon sink and reservoir, playing a vital role in curbing global warming through the protection of forest degradation and deforestation. As such, international organizations such as FAO (Food and Agricultural Organization) and UNFCCC (United Nations Framework Convention on Climate Change) call for countries to make coordinated and concerted efforts to maintain and promote existing forest carbon reservoir and its sink through sustainable management of forests. The FAO and UNFCCC strive to collect essential forest resources information such as forest area, forest biomass and carbon content from countries for the purpose of capturing a global trend of forest dynamics. Therefore, as part of national communication, it is of central importance for DFRR to develop a NFI system that is able to sustain utilization of forest inventory data that are collected on the ground.

4.3.2 Concept

FAO calls for submission of forest resources information every five years to update FRA (Global Forest Resources Assessment). Botswana submitted forest resources information five times over the last twenty-five years. As each country needs to follow the Guide prior to the submission, it is imperative that the quality of NFI data collected is maintained, and the collected data are properly handled among DFRR staffs in the long term for biomass estimation, for example. Thus, for the practical application of NFI data, the following two concepts were taken into consideration.

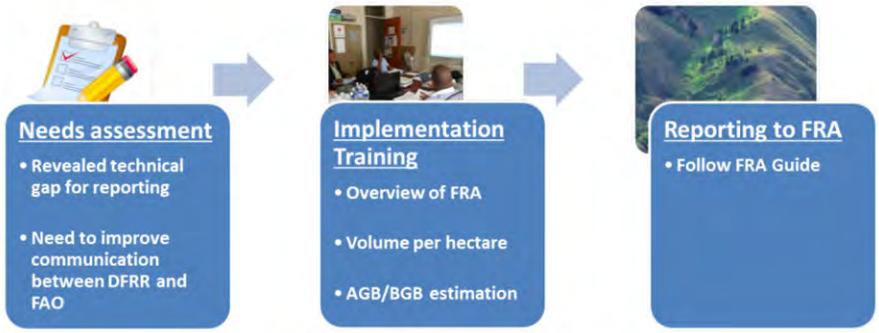
1. Long-term usage of NFI data among DFRR staffs
2. Development of data handling method to meet FRA/GHG standard

4.3.3 Methodology

To put the concepts into practice, a manual was designed and created for practical application of NFI data in line for FRA/GHG. The manual was designed so that inexperienced DFRR staffs can still carry out the calculation of forest biomass and carbon contents with a high level of accuracy, so please refer to the following manual for the details: Module 4: A Manual for Practical Application of NFI Data.

4.3.4 Utilization of NFI data

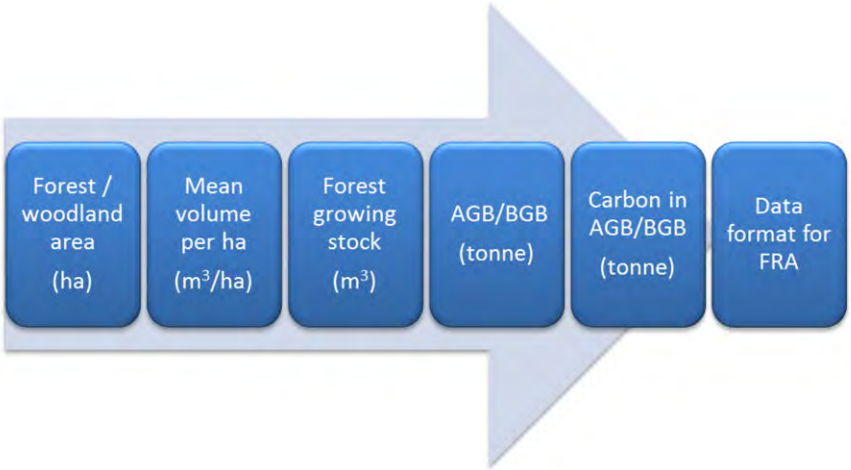
NFI data were used for estimation of volume per hectare, AGB (above-ground biomass), BGB (below-ground biomass), and AGB/BGB's carbon contents in line for FRA (Global Forest Resources Assessment). In an attempt to fill a knowledge and technical gap in the estimation among DFRR staffs, needs assessment and a series of implementation trainings were carried out using existing GIS and NFI database (See following figure).



Source: DFRR-JICA NFMS Botswana Project

Figure 4-8 Simplified operation flow of utilization of NFI data

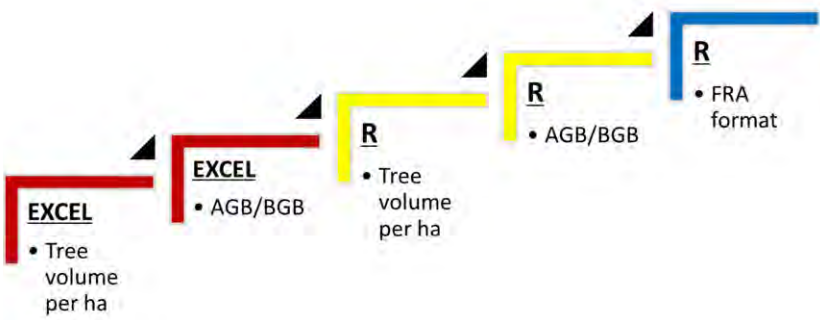
More specifically, forest growing stock was first computed as a product of forest/woodland area and mean volume per hectare, followed by quantifying AGB/BGB and their carbon contents using the corresponding conversion factors. Finally, the calculated values were re-formatted to meet FRA standard (Figure 4-9).



Source: DFRR-JICA NFMS Botswana Project

Figure 4-9 Calculation steps of AGB/BGB and carbon contents in line for FRA Guide

As there was lack of understanding carrying out the calculation step of Figure 4-9 among DFRR staffs, a step-wise approach was employed to fill the technical gap (Figure 4-10). Excel had been initially used to increase the level of understanding of DFRR staffs for how to calculate tree volume per hectare and AGB/BGB. As Excel has been found to be inadequate for handling a large volume of NFI data accumulated over time, R programming language was adopted. R is open-source statistical software that is capable of automating lengthy, complicated calculation steps using R codes and has become increasingly popular in the field of forestry. Therefore, the functionality of R aids in keeping methodological accuracy of the AGB/BGB calculation.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-10 Diagram of step-wise approach (EXCEL to R) used for carrying out implementation trainings

Table 4-3 shows the preliminary results of R calculation that was carried out during a workshop for reporting FRA's target information such as total forest growing stock, AGB/BGB, and carbon contents (bold values). There is a caveat, however, that the results are not final values, as the first NFI cycle is still in progress. Also, note that the BGB seems to be very low relative to the AGB, as it accounts for only 28% of the AGB. The conversion factor called Root-Shoot ratio was used to convert from AGB to BGB; however, it is dictated by two pieces of information from FRA Guide (Guide for country reporting for FRA 2015): eco-zone of target country and threshold values of AGB in tonne per ha. As the preliminary results only account for incomplete NFI datasets, the BGB value requires validation once the first NFI cycle is complete.

Table 4-3 Preliminary results of R calculation using GIS database and NFI datasets in line for FRA topics

TOPIC/Variable	FRA Reporting year			
	2005	2010	2015	Preliminary Results
3.1 Total forest growing stock	770	735	725	**394**
3.5 Above-ground biomass	893	881	868	**749**
3.6 Below-ground biomass	500	493	485	**210**
3.8 Carbon in AGB	420	414	407	**352**
3.9 Carbon in BGB	235	232	229	**99**

Source: DFRR-JICA NFMS Botswana Project

4.4 Utilisation for Fire Program

4.4.1 Background

Spatial information is necessary to make the forest and range fire management plan. However, DFRR doesn't have all information required. Five thematic maps for fire management were identified in the interviews and discussions with the fire division of Technical Support Services were especially requested (Table 4-4). These maps were created based on the technique of remote sensing and GIS learned in the past training sessions using the Botswana Forest Distribution Map (BFDM) produced during the previous phase of this project and other existing data.

In this activity, the objective is not to make final maps but to translate techniques and approaches to make maps which DFRR needs.

Table 4-4 List of fire-related thematic maps requested by DFRR

No	Item	Scale	Concept
1	Firebreak GIS	National	Creating firebreak GIS pertinent to fire management in Botswana
2	Fire danger index, FDI	National	Creating original FDI for Botswana
3	Fire zoning map	National	Creating a zoning map based on fire history, vegetation map and other existing data
4	Asset map	National/District	Creating a map showing assets which should be protected from fire
5	Burnt scar	National/Pilot	Creating burnt scar polygons

Source: DFRR-JICA NFMS Botswana Project

The backgrounds of the requests are:

1) Information of existing firebreak GIS data is insufficient for fire management.
2) Currently, the FDI map is provided by MESA using meteorological satellite data but does not show the reality in Botswana. Therefore DFRR needs a proper FDI for Botswana.
3) The fire zoning map and the asset map are needed to make the fire management plan.
4) The efficient methods to make burnt scar polygons are required to report its location and area to the Government and local offices immediately.

In addition of five thematic maps, making the biomass change map using two time-points PALSAR imagery to measure the loss of forest and range resources by fire was developed. The methods to create each map were instructed in training sessions for DFRR officers. The contents of the manuals are described in the section 4.4.2(6).

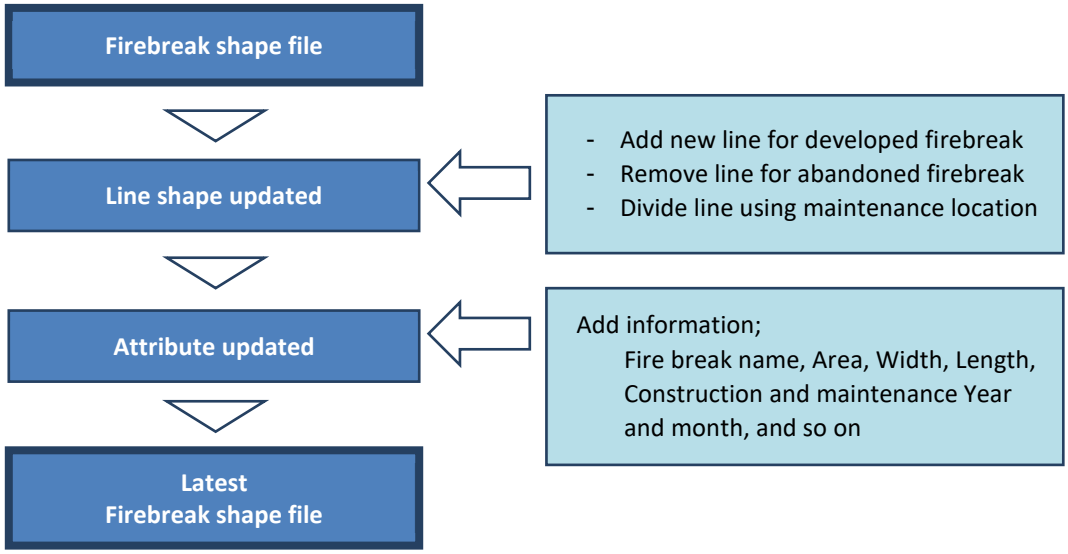
4.4.2 Utilisation of the Output / Good practice

Utilising for operations, methods of mapping and sample images of each thematic map are described in the following sections.

(1) Firebreak

The firebreak management is one of the most important tasks in fire management. Geospatial information of the firebreaks is already developed as line shape file by the Department of Survey and Mapping, Ministry of Lands and Housing. However, its attribute is not necessarily suitable for what the DFRR needs to manage firebreaks. The DFRR intends to create its own firebreak data revising and updating the existing data and adding new information to manage firebreaks.

The DFRR is going to use these GIS data for understanding the actual situation and the status of the maintenances of the firebreaks, by adding the updated information on it. The update method is shown in Figure 4-11. Additional and unmanaged firebreaks are updated and the firebreak name, maintenance situation and so on (Table 4-5) are added to the attribute. The attribute table is easy to be updated using GIS software. Hereby, DFRR keeps up to date firebreak information. Figure 4-12 shows the attribute table and distribution of firebreaks on GIS software.



Source: DFRR-JICA NFMS Botswana Project

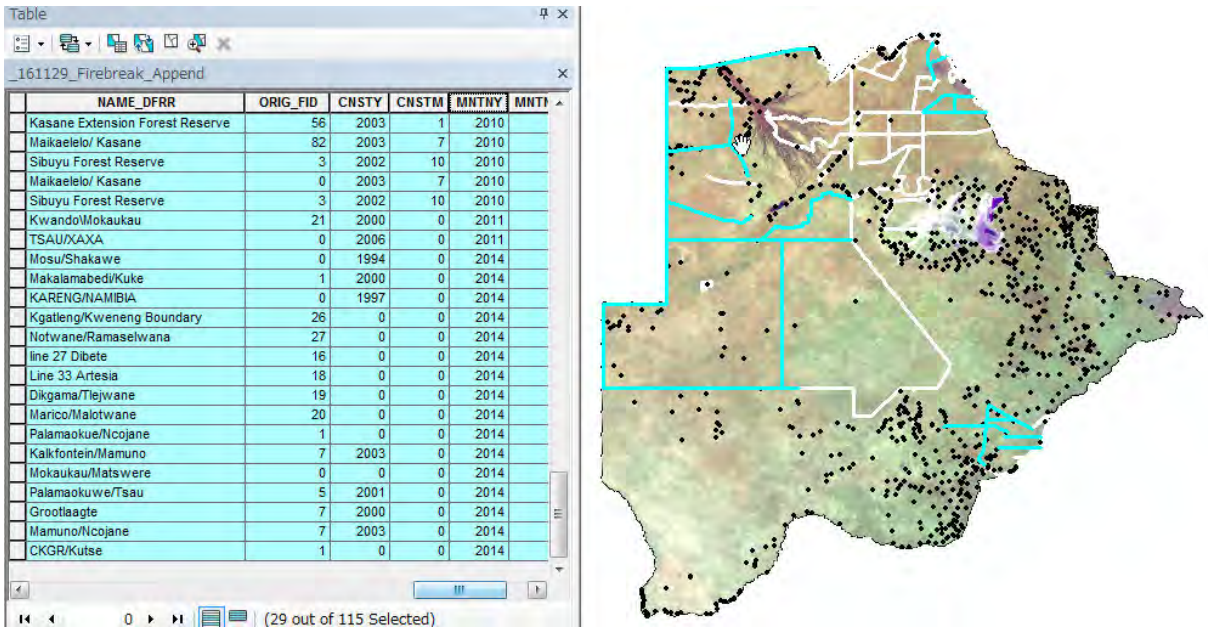
Figure 4-11 Flow of update of firebreak shape file

Table 4-5 List of necessary attributes for firebreak management

No	Information
1	Name *
2	Area *
3	Width *
4	Construction Length *
5	shape length
6	Construction Year *
7	Construction Month*
8	Maintenance Year*
9	Maintenance Month*
10	Vegetation
11	Terrain
12	Soil
13	Fire break situation
14	Boundary type
15	Administrative dist.

No	Information
16	Access road name
17	Village/settlement
18	Heritage site
19	active *
20	Coordinate of start point latitude *
21	Coordinate of start point longitude*
22	Coordinate of end point latitude *
23	Coordinate of end point longitude *

Source: DFRR-JICA NFMS Botswana Project



Table

_161129_Firebreak_Append

NAME_DFRR	ORIG_FID	CNSTY	CNSTM	MNTNY	MNTM
Kasane Extension Forest Reserve	56	2003	1	2010	
Maikaelelo/ Kasane	82	2003	7	2010	
Sibuyu Forest Reserve	3	2002	10	2010	
Maikaelelo/ Kasane	0	2003	7	2010	
Sibuyu Forest Reserve	3	2002	10	2010	
Kwando\Mokaukau	21	2000	0	2011	
TSAU/XAXA	0	2006	0	2011	
Mosu/Shakawe	0	1994	0	2014	
Makalamabedi/Kuke	1	2000	0	2014	
KARENG/NAMIBIA	0	1997	0	2014	
Kgatleng/Kweneng Boundary	26	0	0	2014	
Notwane/Ramaselwana	27	0	0	2014	
line 27 Dibete	16	0	0	2014	
Line 33 Artesia	18	0	0	2014	
Dikgama/Tlejwane	19	0	0	2014	
Marico/Malotwane	20	0	0	2014	
Palamaokue/Ncojane	1	0	0	2014	
Kalkfontein/Mamuno	7	2003	0	2014	
Mokaukau/Matswere	0	0	0	2014	
Palamaokuwe/Tsau	5	2001	0	2014	
Grootlaagte	7	2000	0	2014	
Mamuno/Ncojane	7	2003	0	2014	
CKGR/Kutse	1	0	0	2014	

0 (29 out of 115 Selected)

Source: DFRR-JICA NFMS Botswana Project

Figure 4-12 Developed attribute table and firebreak GIS data

(2) Fire Danger Index

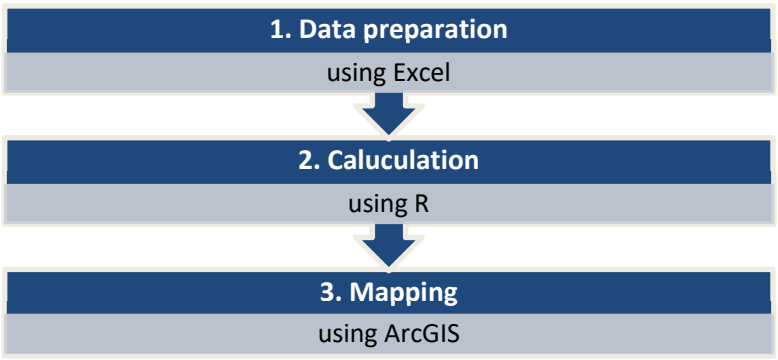
FDI is calculated using R, free statistical software. The flow of developing the FDI map is shown in Figure 4-13.

A meteorological data set (temperature, rainfall, relative humidity, and wind speed) is necessary to calculate FDI. Seventeen of meteorological stations have been set up in Botswana but some of them are not available at present. Even the other stations cannot observe continuously and all subjects. Wind speed is not available at all stations. Thus dummy data were used in this case.

Fire Weather Index (FWI) which is an important component of the Canadian Forest Fire Danger Rating System introduced in several countries was adopted as FDI and was calculated using R in the second step.

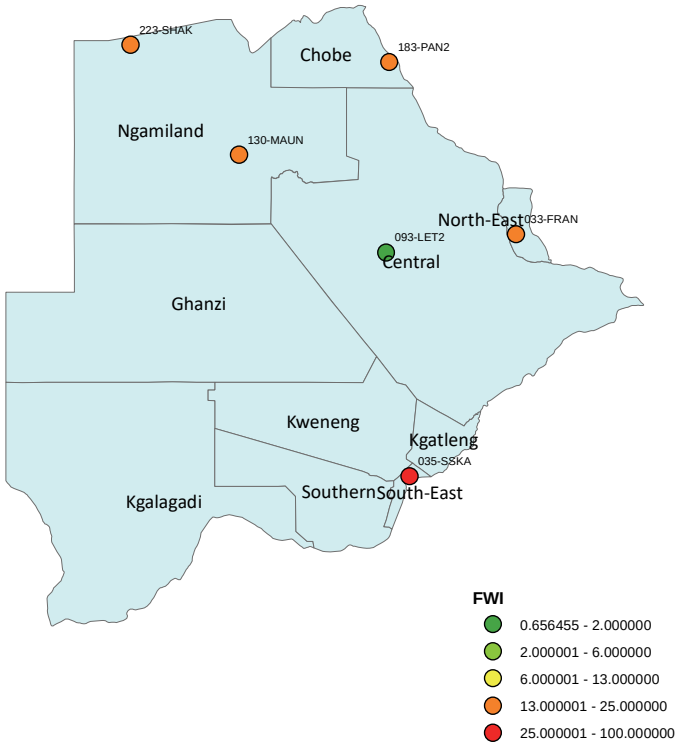
Figure 4-14 shows an image of FWI map. This map shows points coloured according to FWI value calculated using six available meteorological stations on June 1st, 2016. High fire risk is shown in higher value.

It is possible to announce the daily fire danger forecast to the public when all of the meteorology data will be available in the future.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-13 Flow of development of FDI map



Source: DFRR-JICA NFMS Botswana Project

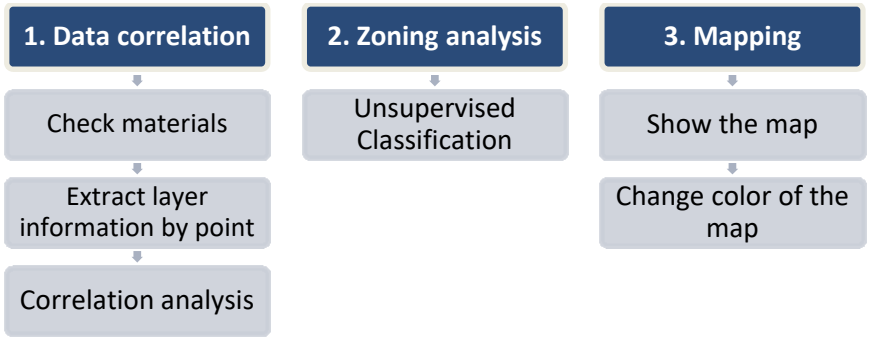
Figure 4-14 Fire Weather Index Map Sample on June 1st, 2014

(3) Fire zoning map

The fire zoning map is created using several data points such as fire frequency, meteorological characteristics, vegetation and so on and shows potential fire risk.

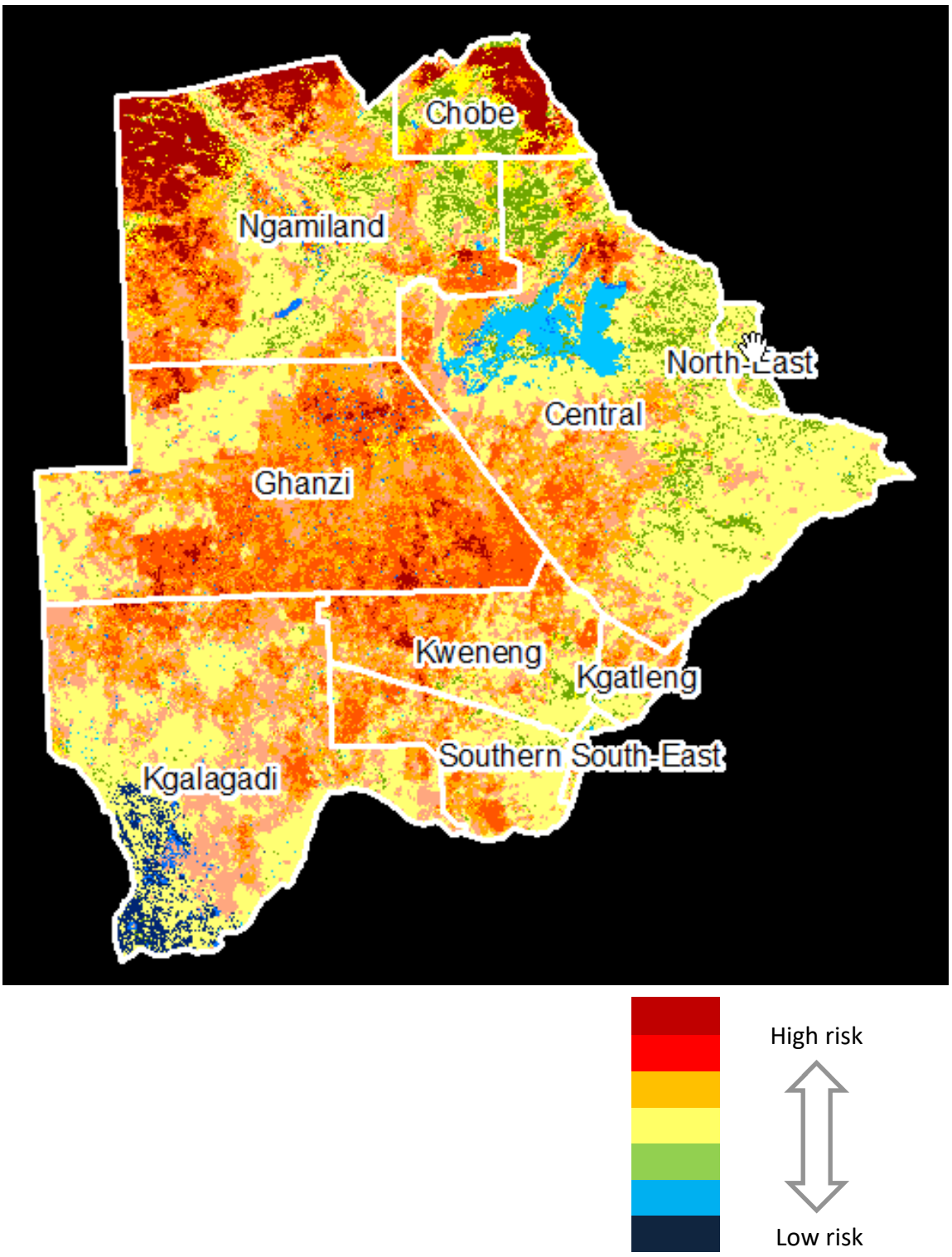
Figure 4-15 shows the flow of creating the fire zoning map. Firstly, four raster data, past fire occurrence map, FDI (to use air temperature if not available), vegetation (BFDM), and digital elevation model, are selected as materials. Secondly correlated analysis using these materials is conducted to avoid multicollinearity among them and clear materials are used in the next step. Finally, adopted materials are stacked and classified by unsupervised classification which is a classification method of grouping pixels without setting classification classes in advance.

The result of classification shows several potential fire risk level of national scale. Sample of the fire zoning map is shown in Figure 4-16.The red colour shows a higher fire risk area, and blue is a lower one.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-15 Flow of Fire Zoning Map Development



Source: DFRR-JICA NFMS Botswana Project

Figure 4-16 Fire Zoning Map Sample

(4) Asset map

High density asset areas with high fire risk can be identified overlaying the distribution of assets on the fire zoning map. This map contributes to the making of a fire management plan because the area where there should be a budget and human resources become clear.

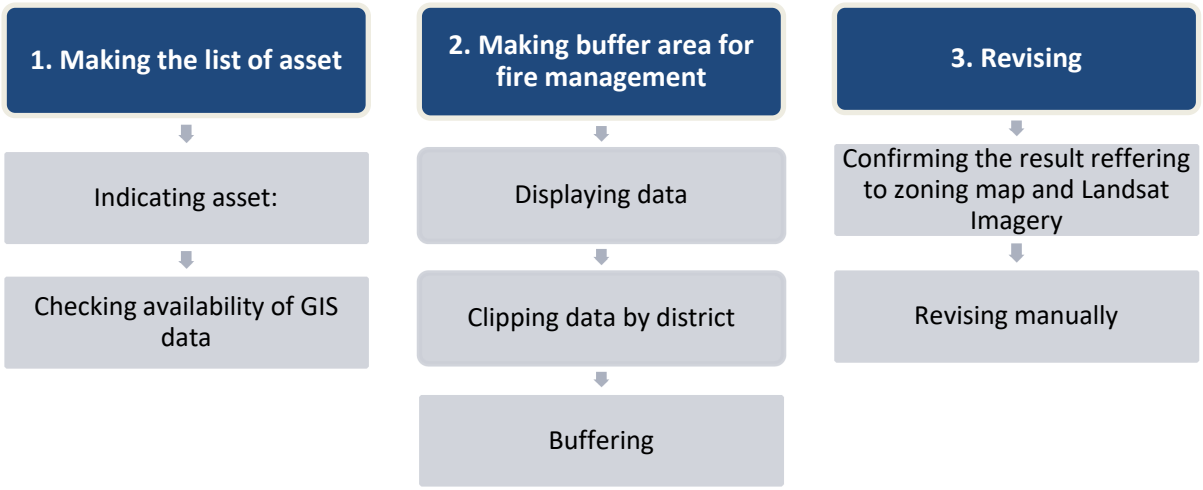
The next figure shows the flow of creating the asset map. Firstly assets which should be protected against fire are decided and data availability is checked. Secondly, the size of the buffer for each kind of asset is decided. Fire activities are prohibited in the buffer area. Then the assets and buffer areas are overlaid on a zoning map, described in the former section. Asset data are revised manually when they are not correct.

The assets list made in training sessions is shown in Table 4-6. Making an asset list by each district in Botswana is recommended because the factors of fire, land use and main assets are different from each district. A realistic asset map on a national scale is created combining asset maps on a district scale.

The asset map of Kweneng District created by an officer in a training session is shown in Figure 4-18. The GIS assets data such as conservation area (transparent light blue colour), settlement (red circle), road (green line), cattle post (blue circle) and firebreak (red line) are overlaid on zoning map (red colour shows high fire risk and yellow is low).

Based on the asset map, high fire risk with high density assets area and high risk with low density asset area are able to be identified.

From the above, the asset map contributes to making a fire management plan including layout planning of firebreaks taking account of assets.



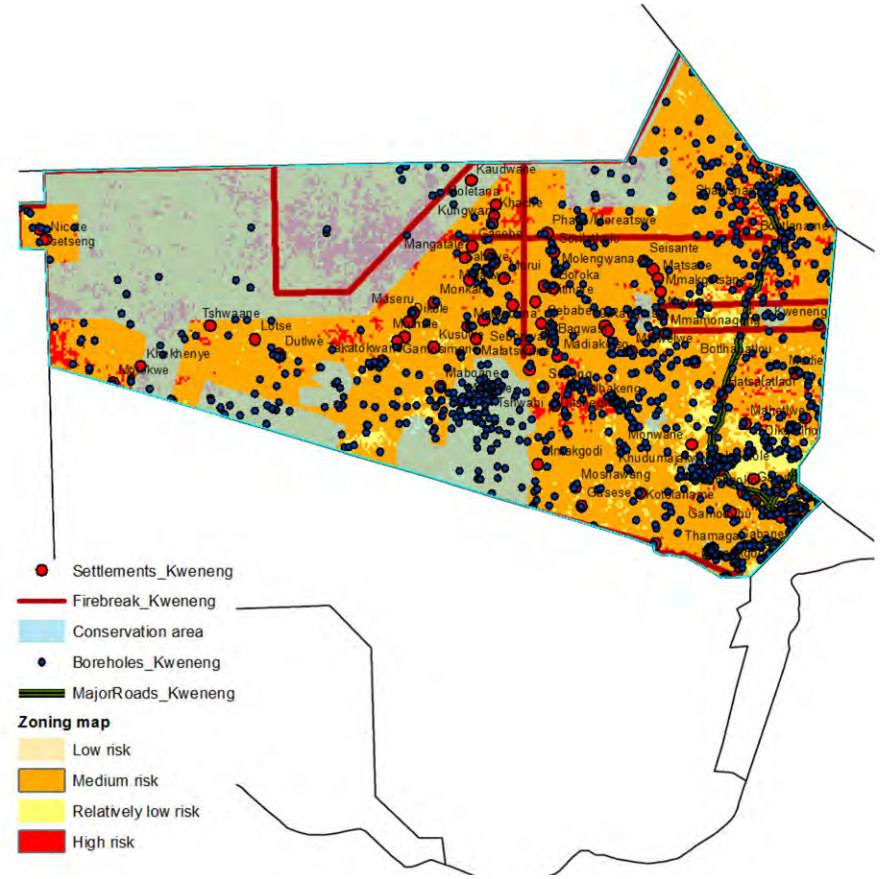
Source: DFRR-JICA NFMS Botswana Project

Figure 4-17 Flow of Development of Asset Map

Table 4-6 List of Asset, Data Availability and Buffer Distance

Assets	GIS data	Buffer (m)
Buildings	Settlement	500
Roads	Road	10
Wildlife		
Power line		
Farms	Farm	12
Livestock	Livestock	
Forest reserved	Land use	20
National park	Land use	20
Game Reserve	Land use	20
Heritage site		
Water pipeline		
Water borehole	water borehole	1000

Source: DFRR-JICA NFMS Botswana Project



Source: DFRR-JICA NFMS Botswana Project

Figure 4-18 Asset Map Sample for Kweneng District

(5) Burnt area map

Division of Technical Support Services of DFRR has to generate data on burnt area during the fire season for daily reports. The data processing is operated by one headquarters officer interpreting MODIS satellite imagery provided from MESA manually. The results of the interpretation must be reported immediately to the district office to inform when the fire occurs. However, sometimes, the constraint on human resources in the headquarters makes it difficult to respond immediately.

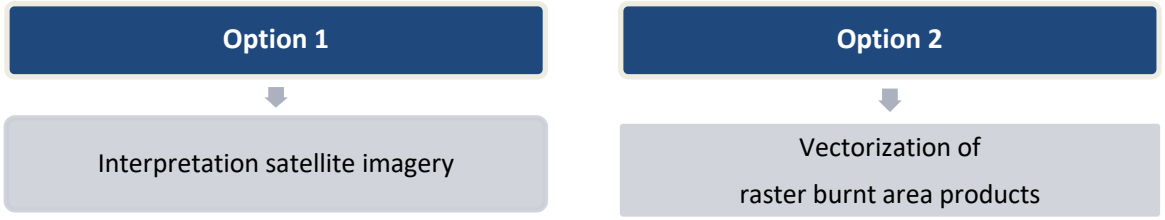
The operation can be shared when the other headquarters officers and the district officers learn how to create burnt area polygons. In addition, a fire-fighting activity plan can be made at the district level if the satellite imagery is analysed by the district offices.

There are two methods to create burnt area polygon as shown in Figure 4-19. One is the method described above, interpretation of satellite imagery, and another is vectorization using burnt raster image produced by MESA, University of Maryland and so on. The advantage of the former is to obtain materials earlier but it takes time to interpret. The advantage of the latter is that the processing time is quicker but it takes time to receive products from the provider. The method is selected depending on the internet access speed. In both ways, making a polygon is possible in the district office as this operation can be implemented using free GIS software.

Flow of option 1 is shown in Figure 4-20. Firstly, satellite imagery is downloaded and burnt areas are interpreted. After that, digitizing burnt areas is conducted in order to make polygons on GIS software. A dimension of burnt area polygon is calculated using a GIS area calculation tool.

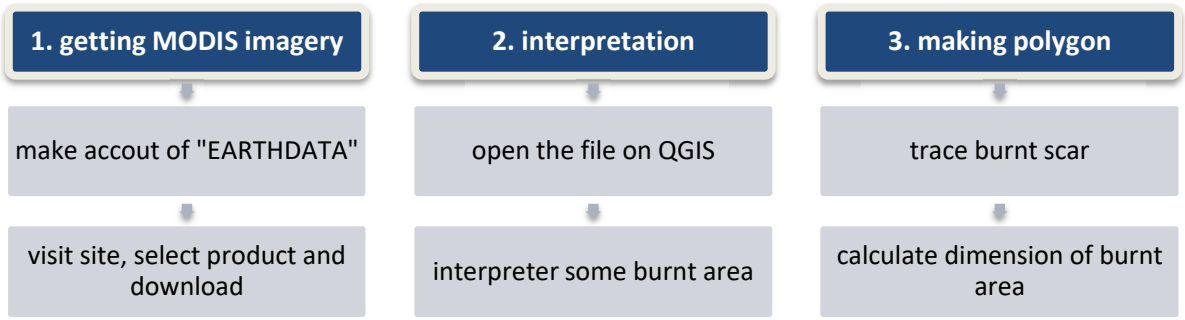
Figure 4-21 is the result of making burnt area polygon in Chobe District on September 2016. When the burnt area expands from that day on, new area will be added to previous records.

Output 2 is processed using a GIS tool which converts raster data to vector data. Polygons include Information on the date when fire occurred. A sample image is shown in Figure 4-22.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-19 Two Options for Development of Burnt Area Polygon



Source: DFRR-JICA NFMS Botswana Project

Figure 4-20 Flow of Burnt Area Extraction

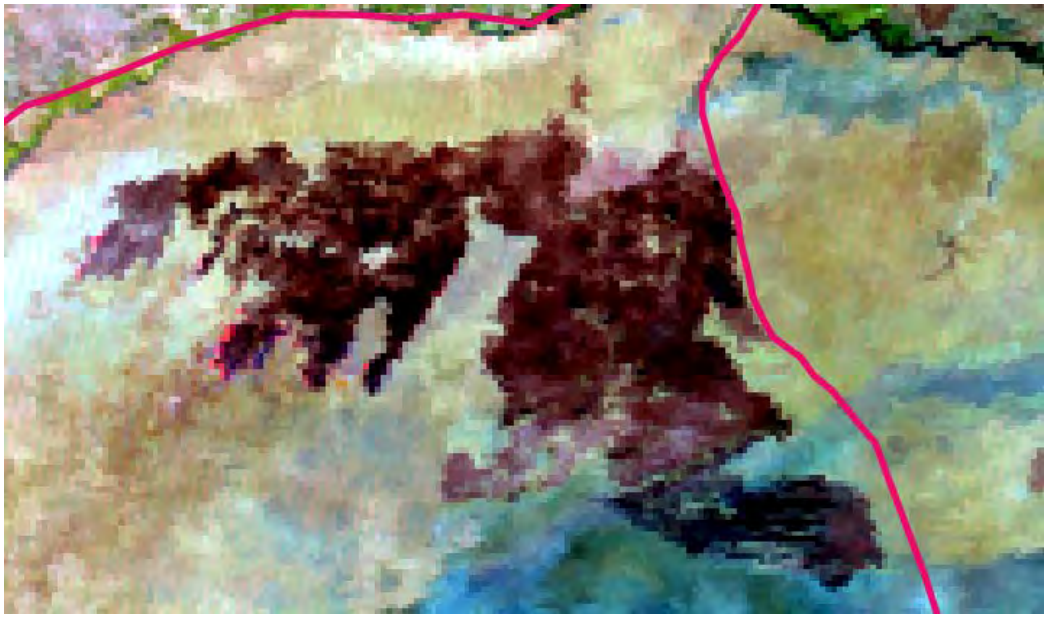


Image 1: Original satellite imagery (MODIS)

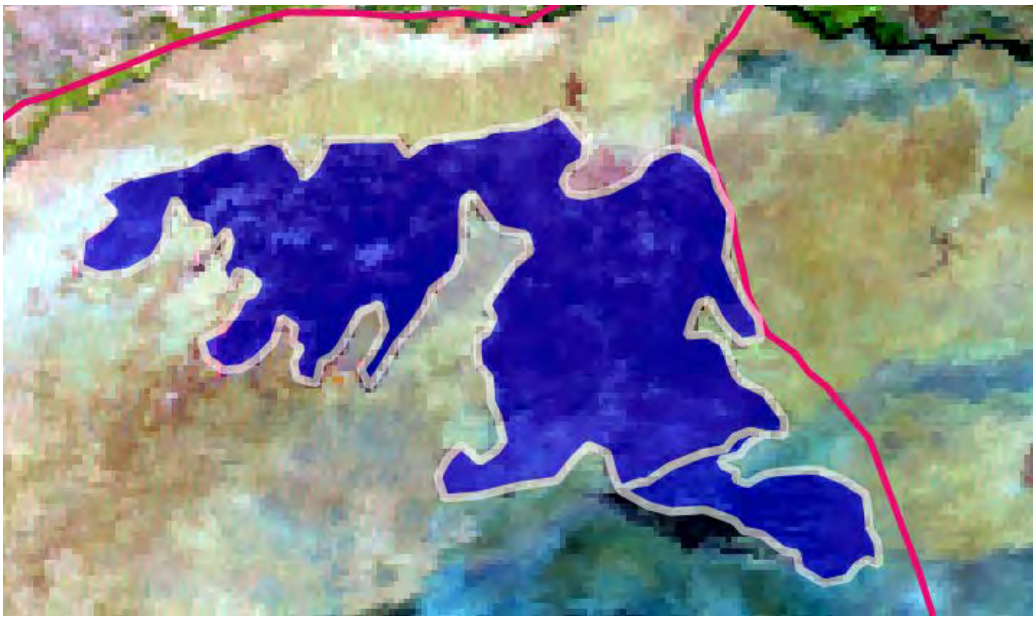
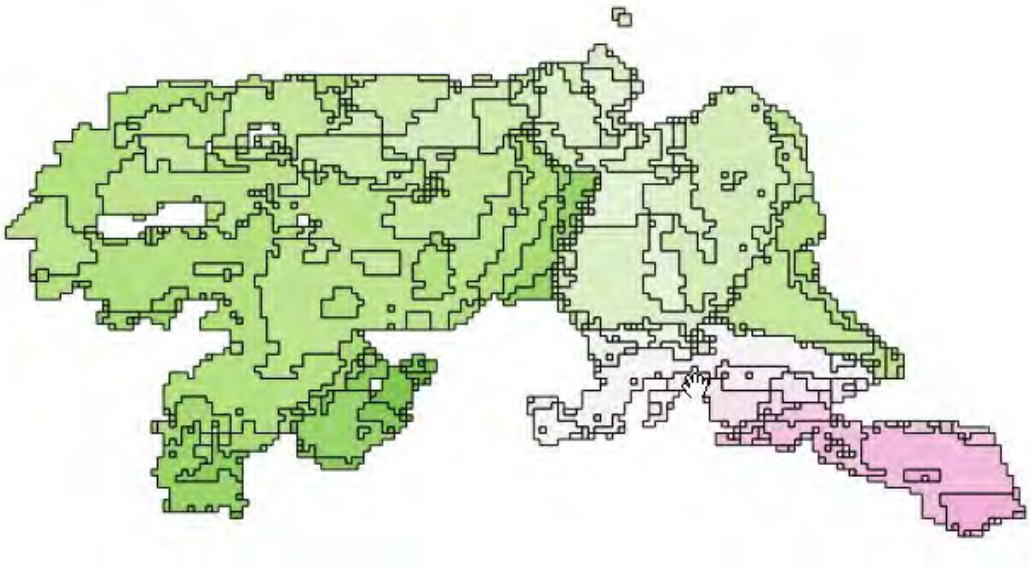


Image 2: Burnt area polygon by interpretation MODIS imagery

Source: DFRR-JICA NFMS Botswana Project

Figure 4-21 Comparison of the original satellite imagery (image1) and the burnt area polygon generated (image2)



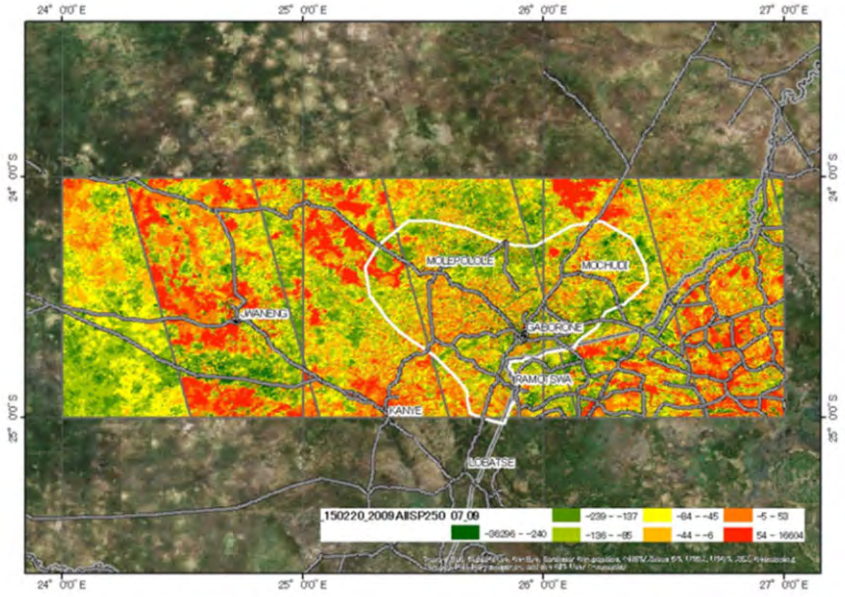
Source: DFRR-JICA NFMS Botswana Project

Figure 4-22 Vectorization of Burnt Area Product

(6) Biomass estimation

The loss quantity of forest and range resources by fire is difficult to be estimated using optical satellite imagery or even conducting field surveys. In the meantime, forest above ground biomass (AGB) can be estimated using Synthetic Aperture Radar (SAR) data. Then the AGB change can be estimated by using two points of time SAR data. The detailed method is described in the monitoring report No.2.

The next figure shows a sample of stand volume change map. The red area shows where the stand volume was decreased and the green area shows it was increased. AGB is calculated multiplying stand volume by expansion factor.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-23 Stand Volume Change Map Using PALSAR Satellite Imagery

4.4.3 Manuals

The fire management-related manuals (Output 6) are developed as shown in the following table.

Table 4-7 List of fire management-related manual

Manuals	Contents
1) Updating of firebreak information 1 : Editing the fire break GIS data using satellite imagery	・Checking firebreak condition using satellite imagery ・Classifying a firebreaks into four groups according to the condition interpreting satellite imagery ・Deciding necessary information for firebreak management and adding them to attribute information of firebreak GIS data ・Field survey: Comparing satellite imagery and actual situation in the ground truth
2) Updating of firebreak information 2 : Editing the attribute of GIS data using firebreak maintenance information	・Checking documents reported from firebreak maintenance contractors ・Updating maintenance period and place of the firebreak GIS data
3) Calculation method of fire danger index	・Preparing data set using EXCEL to calculate ・Calculating Fire Weather Index using R software ・Converting FWI information to GIS data and mapping
4) Development of fire zoning map and asset map	・Correlation analysis to select materials to make the zoning map ・Classifying fire risk area using un-supervised classification method ・Evaluating the result and mapping ・Deciding important assets ・Creating buffer against fire based on assets ・Creating asset map
5) Extracting of burnt scar	・Creating burnt area polygon interpreting MODIS satellite imagery ・Vectorising burnt area products (raster)
6) Estimating above ground biomass changes using PALSAR	・Introduction of time-series analysis to estimate biomass change using PALSAR imagery ・Correlation between ground survey and PALSAR data ・Mapping biomass change

Source: DFRR-JICA NFMS Botswana Project

4.5 Utilisation for CBNRM

4.5.1 Background

The Botswana government adopted the CBNRM (Community Based Natural Resource Management) Policy in 2007 in the parliament, and promotes the sustainable usage of natural resource management by the community to improve the livelihood of local people and reduce poverty in Botswana.

The CBNRM was introduced in Botswana in 1990 by the Botswana government and USAID establishing the Natural Resource Management Project (NRMP)[1]. The CBNRM projects in these days were almost only focused on wild animals such as Chobe Enclave Community Trust, which benefited from allowing hunting and safari activity in their area[2]. Even though hunting was banned in 2014, the location of CBO (Community Based Organisations) by the districts is high in Ngamiland, where there are many wild animals.

On the other hand, the forest in Botswana decreased 21.0% from 1990 to 2015[3]. The main causes are forest degradation from forest fires, over-gathering firewood by local people, and damage by wild animals such as fallen trees and eating. The local people in Botswana uses forest resources such as Mopane (*Colophospermum mopane*) as firewood, and Morukuru (*Spirostachys africana*) as fences as

[1] Arntzen J., Buzwani B., Setlhogile T., Kgathi D.L., Motsholapheko.M.R., 2007 Community-Based Resource Management, Rural Livelihoods, and Environmental Sustainability, IUCN-South Africa Office and USAID Frame (Phase Three)
[2] Arntzen et al.,2007
[3] Source: Global Forest Resources Assessment 2015, FAO

part of their livelihoods. And so, it's important to use forest resources sustainably by local people to prevent forest decrease and degradation in Botswana.

The promotion of Sustainable Forest Management is also the goal for The National Forest Monitoring System (NFMS) project. Various outputs were created such as a forest distribution map and making a forest GIS data-base for sustainable forest management in this project. The CBNRM activity in our project started in 2016 by utilising previous outputs of the project to improve present CBNRM activity.

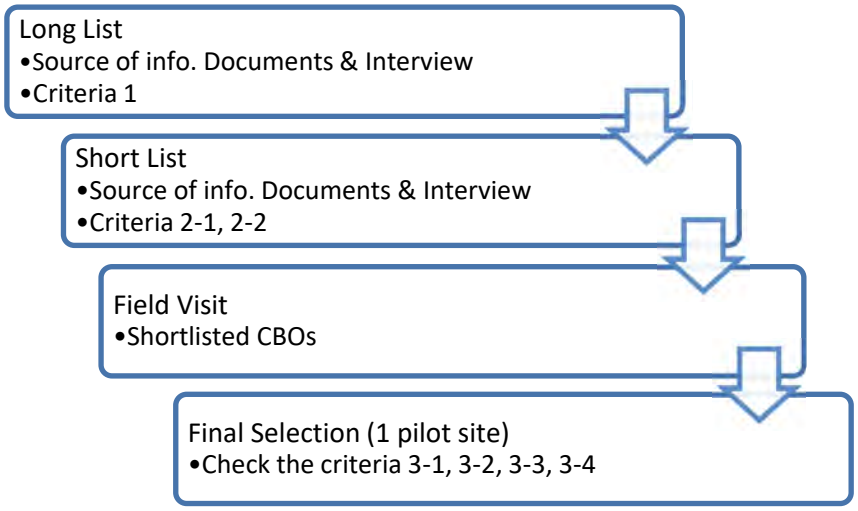
4.5.2 Utilisation the output / Good Practice

(1) The tool for utilising the outputs of NFMS

In the outputs of NFMS project since 2013, there is the thematic map such as the detailed forest distribution map or above ground biomass changes analysis by using high resolution satellite data. The thematic map can simply show the features such as forest cover of the each area, so it takes an important role in making a natural resource management plan. Thus, the thematic map was used as a tool from the outputs of NFMS for CBNRM activity.

(2) Selection of the pilot area

To implement the CBNRM activity using the thematic map, the project selected the pilot area from CBOs which is active at the moment. The selection was done through the method and the criteria shown in below.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-24 Selection process of the pilot area

The pilot area is selected based on the following four steps: 1) Long list making[4], 2) Short list making, 3) Field visit of the selected CBOs, and 4) Final selection. There are criteria in each step which is mentioned in the next table.

[4] Please refer the appendix for the longlist and shortlist.

Table 4-8 Selection criteria by the stage

Selection stage	Criteria for the selection
1. Long list	**Criteria 1.** The CBOs which are active at present.
2. Short list, Field visit	**Criteria 2-1.** The activity of protecting or using natural resources is done or planned. Especially, the activities of the usage of NTFP and management of forest resources are highly expected. Also it is favourable that the activities have already started. **Criteria 2-2.** The activity has been supported by the DFRR.
3. Final Selection	**Criteria 3-1.** There are no conflicts in the CBOs and nor are serious problems to manage CBOs. **Criteria 3-2.** The members of CBOs' attitude are active. Activeness is judged by the two criteria below through the field visit **Criteria 3-2-1.** Activities are regularly done. Especially, recent regular activities are highly evaluated. **Criteria 3-2-2.** Frequency of the activity. **Criteria 3-3.** Geographically easy to access to CBOs from Gaborone. **Criteria 3-4.** The activities of CBOs are related to the usage of NTFP and management of forest resources.

Source: DFRR-JICA NFMS Botswana Project

From the Longlist, 6 CBOs are selected, and a field visit was done in each CBO. After that, the final selection was operated. As a result, Kgetsi ya Tsie Women Resources Enterprise Community Trust (KyT) was selected as the pilot area. The table below shows the scorecard of the final selection.

Table 4-9 The scorecard for final selection

Criteria / Shortlisted CBOs	3-1(1-5)	3-2-1(1-5)	3-2-2(1-5)	3-3(1-5)	3-4(1-5)	Total
Mapoka VDC	4	3	3	2	4	**16**
Nhlapkhwane Lingilila Environment Conservation Trust	4	4	4	2	4	**18**
Kgetsi ya Tsie Women Resources Enterprise Community Trust (KyT)	5	5	5	3	5	**23**
Nthantlhe VDC	5	3	2	5	3	**18**
Kawii Development Trust	3	1	1	2	1	**8**
Matsheng Community Trust	1	2	2	4	2	**11**

Source: DFRR-JICA NFMS Botswana Project

KyT doesn't have big conflicts inside of the Trust, and their activities were actively done compared to the other five organizations. Also, KyT have been implementing the project to monitor the natural resources cooperating with University of Botswana (UB). The Monitoring project is mainly consisted of two parts. The one is monitoring natural resources such as Marula (*Sclerocarya birrea*) and Mopane (*Colophospermum mopane*). The other is implementing capacity building for young people in the village to learn IT skills to manage monitoring data. This capacity building has been done since September 2016, and the monitoring has been done since July 2017. Since there was a possibility to apply the thematic map and satellite imagery to KyT-UB project, the sustainability of this project's outputs was expected, even though it's out of the selection criteria.

(3) Introduction of the Pilot area

Kgetsi Ya Tsie Women Resources Enterprise Community Trust (KyT) is located in the middle east area of Botswana, which is called "Tswapong". KyT is composed of 27 villages, with 832 members in these areas. The members are mainly women, and the objective of the KyT is to improve the local economy, livelihood, and empowerment of women socially and economically through collecting, processing, and marketing natural resources. The main activity of KyT is buying natural resources from the members and selling them to customers. The table below shows the plants collected by the members and purchased by KyT.

Table 4-10 Collected plants in the activity

	Setswana name	Scientific name	Main purpose	Part to use	Harvest season
1	Marula	*Sclerocarya birrea*	Food	Fruit	March and April
2	Gala la tshwene	*Myrothamnus flabellifolius*	Medicinal	Leaf and stalk	all season
3	Monepenepe	*Cassia abbreviata*	Medicinal	Bark and root	all season

Source: DFRR-JICA NFMS Botswana Project

Marula is processed into oil, jam, and soap. Customers who buy them are mainly from the outside of KyT area. In 2016, KyT sold twelve litres of Oil and six soaps. Until 2009 KyT had been exported Marula Oil to the outside of Botswana to destinations such as the EU and U.S.A. The table below shows the amount of Marula oil which was exported to overseas. KyT is now lacking in funds, so they can't purchase enough Marula fruits from the members. Because of this situation, they are not able to produce Marula jam at present.

Table 4-11 Amount of Marula oil exported to overseas

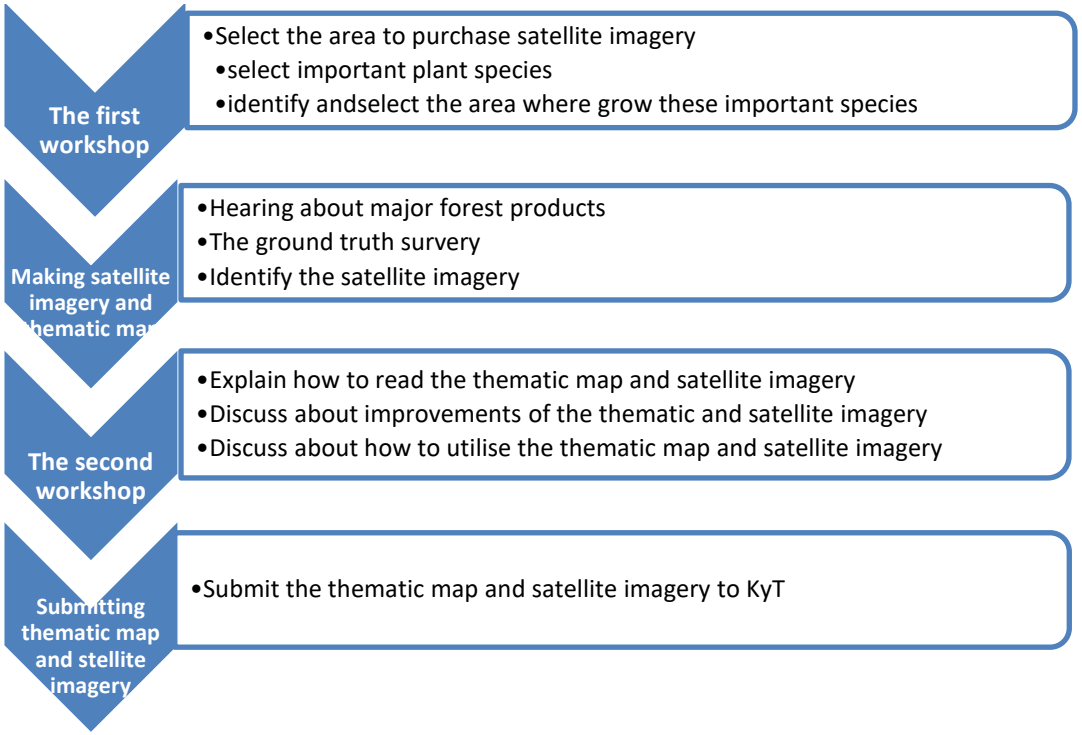
Year	Litre	Country
2003	800	France
2007	11	Germany
2007	11	UK
2009	150	US

Source: DFRR-JICA NFMS Botswana Project

(4) Utilisation of the thematic map in the pilot area

1) Holding a workshop

The procedure after selecting the pilot area until submitting the thematic map and satellite imagery to KyT is shown in the figure below.



Source: DFRR-JICA NFMS Botswana Project

Figure 4-25 The procedure after selecting the pilot area until submitting the thematic map and satellite imagery to KyT

The workshop was held in November, 2016 with the members of KyT and JICA Consultants to decide the area to purchase the high resolution satellite imagery which is necessary to make the thematic map. In the beginning of the workshop, KyT members discussed the important plants they want to manage in their area. The table below shows the result of it.

Table 4-12 A list of plants proposed in the discussion

	Setswana name	Scientific name	Main purpose	Part to use	Harvest season
1	Marula*	*Sclerocarya birrea*	Food	Kernel and pulp	Mar. & Apr.
2	Gala la tshwene*	*Myrothamnus flabellifolius*	Medicinal	leaf and stalk	All season
3	Mosata*	*Orthanthera jasminiflora*	Food	Fruit and root	Feb.
4	Monepenepe*	*Cassia abbreviata*	Medicinal	Bark and root	All season
5	Motlopi	*Bosicia albitrunca*	Food	Fruit	Jan. - Feb.
6	Mopane*	*Colophospermum mopane*	Food (Mopane worm)	Mopane worm	Dec. & Apr.
7	Motsikiri	*Motshikiri spp.*	roofing and broom	Every part except root	Jul. – Sep.
8	Mogwana	*Grewia bicolor*	food	Fruit	Jan. & Feb.
9	Mmupudu	*Mimusops zeyheri*	food	Fruit	Sep.-Oct.
10	Mmilo	*Vangueria infausta*	food	Fruit	Jan.-Feb.
11	Moretlwa	*Grewia flava*	food	Fruit	Dec. – Jan.
12	Moretologa	*Ximenia americana*	food	Fruit	Dec. – Jan.

Note: * the plants are considered highly important among others in terms of the activity of KyT and communities' livelihood.
Source: DFRR-JICA NFMS Botswana Project

After these twelve species were proposed by the members of KyT, five species: Marula, Gala la tshwene, Mosata, Monepenepe, Mopane were selected by the members as the most important species in terms of the activity of KyT and the livelihood of local people including KyT members. At the end, the five areas where these five species are relatively found in the wild were selected by the members for buying the satellite imagery.

2) Making the thematic and satellite imagery map

After the workshop, the thematic map was created based on the area discussed in the workshop. The thematic map for KyT in the CBRNM pilot area was developed using rainy season imageries of SPOT 6/7 in 1.5 m resolution. Five areas were selected for the map development as a result of the workshop mentioned above. Table 4-13 and Figure 4-26 show the image ID list and area of the acquired images, respectively.

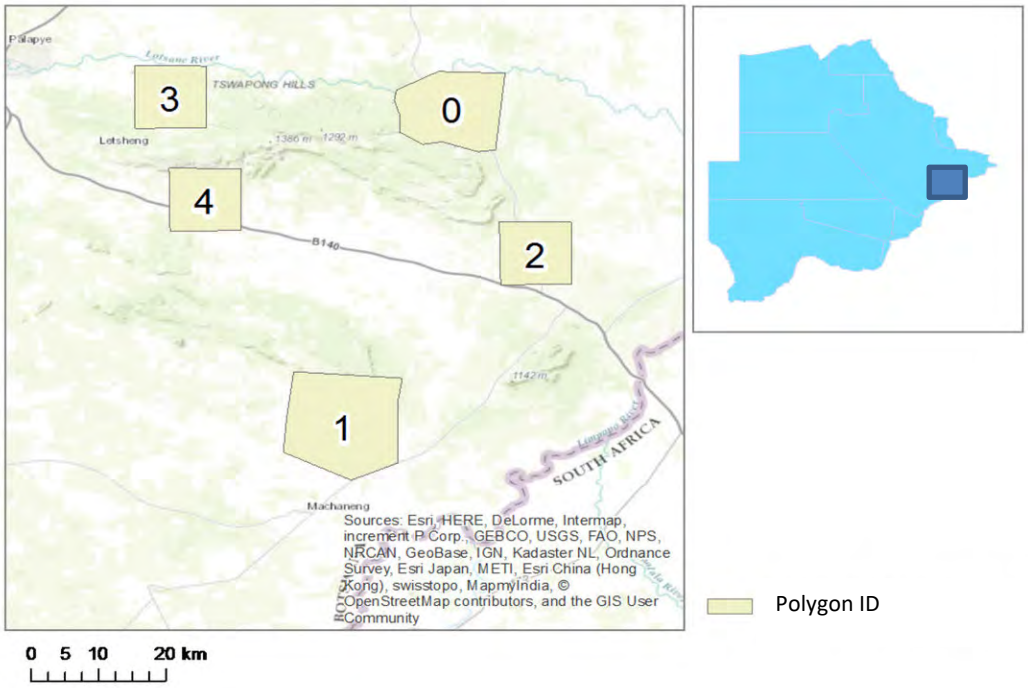
A ground truth survey of major forestry products in KyT and hearings were also conducted at the production site on November 2016. The major products include Marula, Mopane and so on. Figure 4-27 shows SPOT imageries which were used for the CBNRM and the survey points of the ground truth. We found it difficult to identify vegetation at the species level using the satellite imagery but easy to identify trees.

In order to display the location of trees, we created a tree cover map as a thematic map using object-oriented classification method.

Table 4-13 Scene ID of the satellite image (SPOT6 & 7)

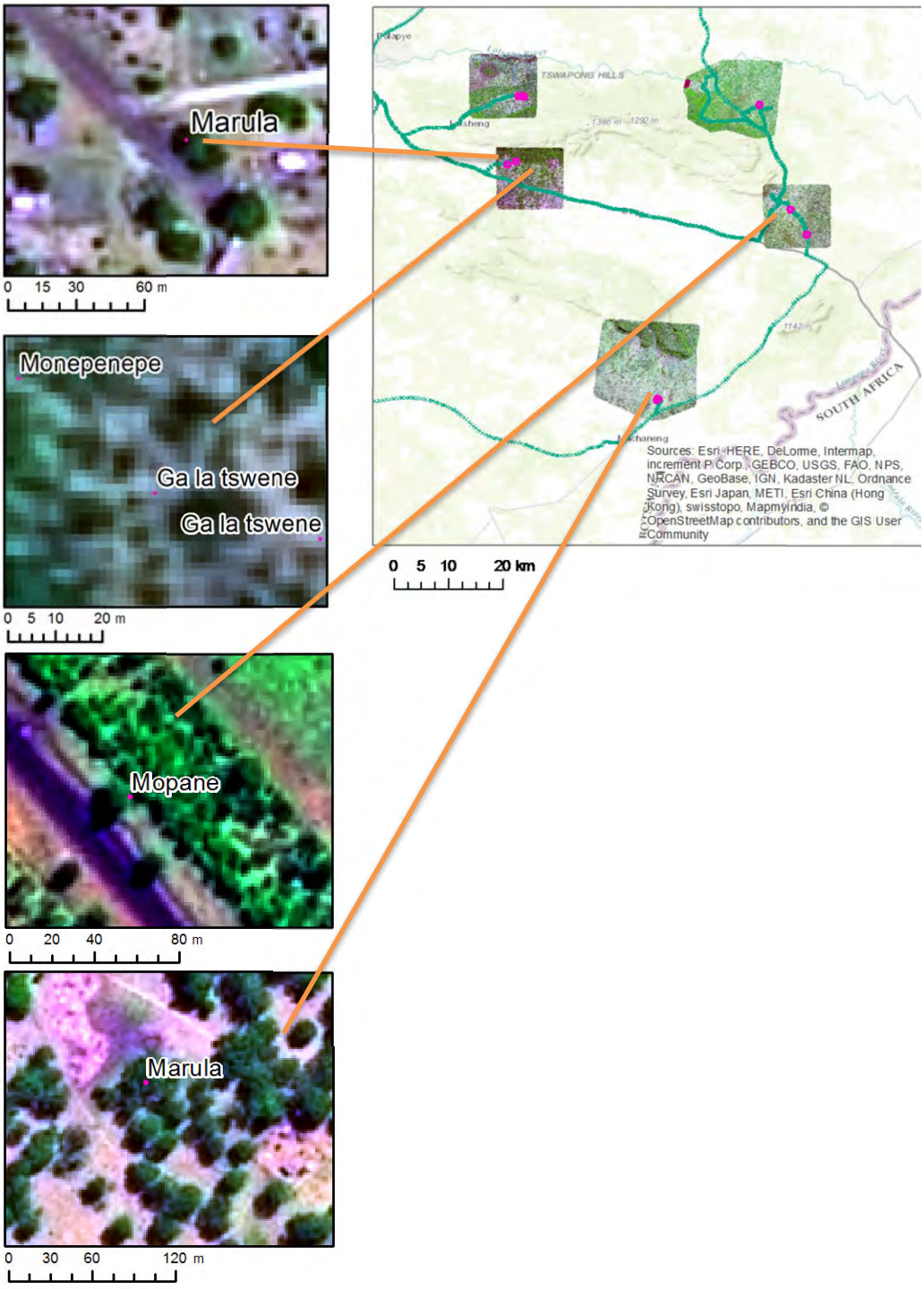
Acquired date	Scene ID	Polygon ID
2016-03-31	DS_SPOT7_201603310800572_FR1_FR1_SE1_SE1_E028S22_01871	0
2016-05-03	DS_SPOT7_201605030757581_FR1_FR1_FR1_FR1_E028S23_01871	1, 2, 4
2016-01-19	DS_SPOT6_201601190805581_FR1_FR1_SE1_SE1_E027S23_03251	3

Source: DFRR-JICA NFMS Botswana Project



Source: DFRR-JICA NFMS Botswana Project

Figure 4-26 The area of the acquired images



Note: Enlarged views of SPOT imageries at ground truth points (left), and all SPOT imageries and ground truth points (right) in the KyT area. The pink points in the images represent the ground truth points.
Source: DFRR-JICA NFMS Botswana Project

Figure 4-27 The Areas of the SPOT imageries used for the CBNRM

As output map types, the original satellite imagery and the tree cover map were prepared for five regions. The output types are described in Table 4-14.

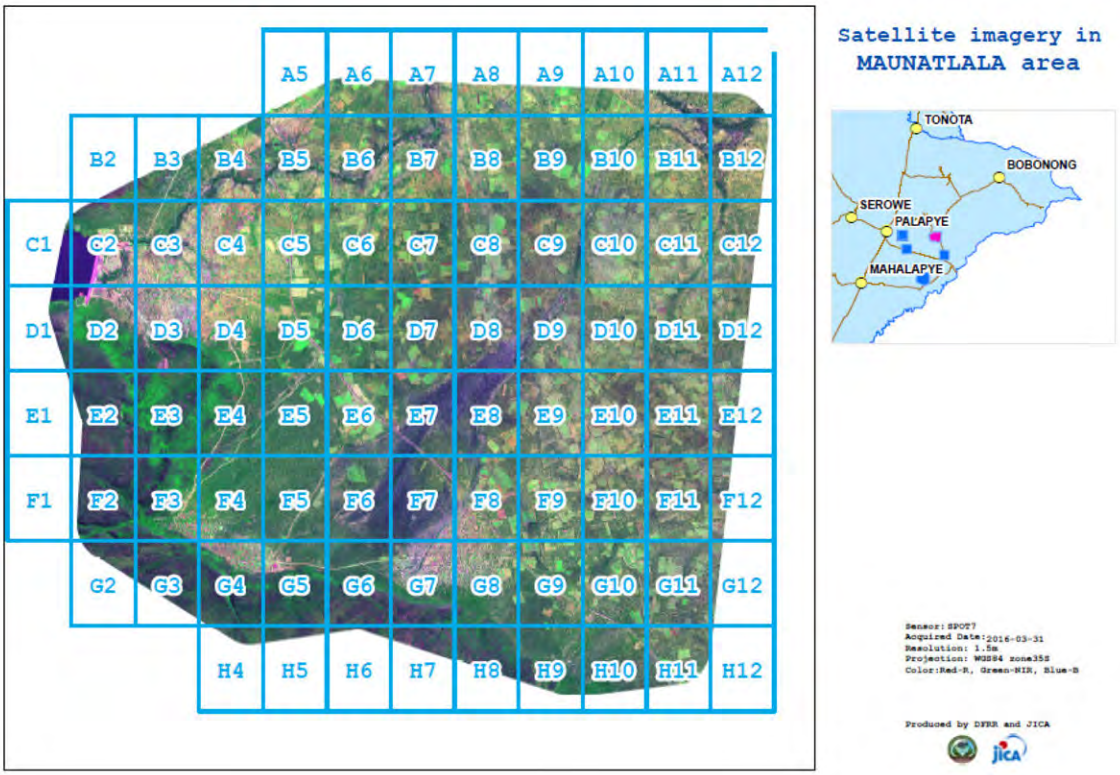
Each of the five regions is printed out on a large paper size of A0 as well as a booklet. The booklet includes these kinds of pages: an inside cover page, index pages (sample is shown in Figure 4-28 and Figure 4-29)

The SPOT imagery and tree cover map are prepared at different scales of 1:10,000 and more detailed 1:2,500. The latter covers only settlement areas.

Table 4-14 Output map types

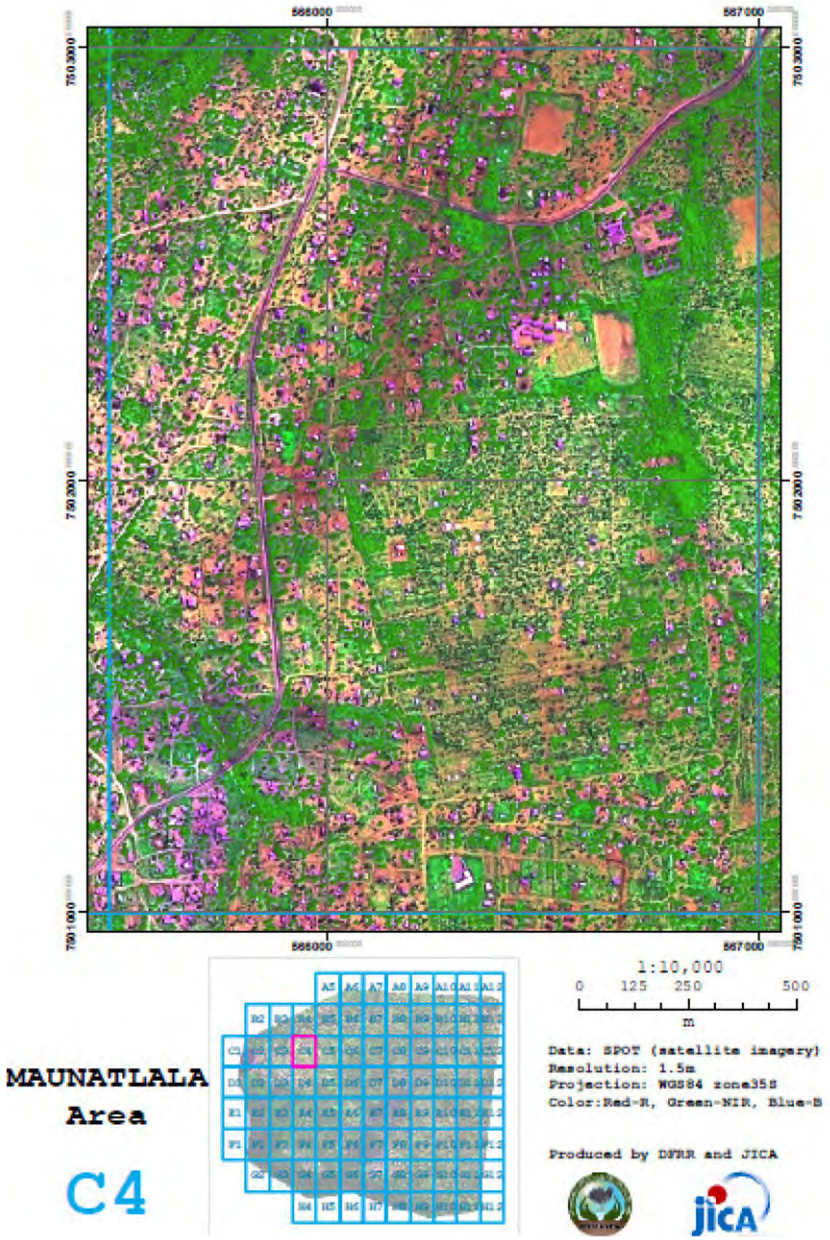
Output types	size	Contents	Remarks
Large paper	A0	SPOT6/7 covered each region	
Booklet	A4	Inside cover page	
		Index page (sample is shown in Figure 4-28)	
		SPOT6/7 imagery	Using 1:10,000 and 1:2,500 scale. 1:2,500 scale covers only settlement area.
		Tree cover map (sample is shown in Figure 4-29)	Using 1:10,000 and 1:2,500 scale

Source: DFRR-JICA NFMS Botswana Project



Source: DFRR-JICA NFMS Botswana Project

Figure 4-28 A sample image of index pages for the booklet. The index box size is 1.5x2 km



Note: The location of trees is displayed with light green in the upper figure.
Source: DFRR-JICA NFMS Botswana Project

Figure 4-29 A sample image of the tree crown map

After creating the thematic map and the satellite imagery map, the second workshop was held to get the feedback from KyT members. In the workshop, the consultant explained how to read satellite imagery by cross-referencing the imagery and local feature such as Marula tree. Also they discussed about how to utilise the maps. In the discussion, the participants requested alteration in some map features that could improve their operational performance: index view and display of village names on the map. As a result, the consultant revised these points and gave the improved maps to KyT members. Also, the data of the thematic map and satellite imagery were submitted to UB after the discussion about applying the thematic map and satellite imagery, which was going to be created in this project. These data are expected to be utilised in the KyT-UB project and the monitoring will be done more effectively.

(5) The action plan for the pilot area

As stated above, the workshop aimed at KyT members in order for them to learn how to utilise the thematic and satellite imagery for managing natural resource management. In the workshop, the participants were divided into some groups and had a discussion about how to manage natural resources such as (1) What kind of natural resources should be managed, (2) Where they were to be managed, (3) Who should manage, (4) How to be managed, and (5) When to be managed, in the KyT area by using the maps. The objective of this discussion is to provide the members with opportunities for utilising the maps and being part of creating the action plan[5] by adopting the discussion contents. The results of the discussion are described below.

Source: DFRR-JICA NFMS Botswana Project

Figure 4-30 KyT members are discussing in the Workshop

1) What kind of natural resources should be managed

Eight plant species are suggested including Marula (*Sclerocarya birrea*), Gala la tshwene (*Myrothamnus flabellifolius*), Mosata (*Orthanthera jasminiflora*), Monepenepe (*Cassia abbreviata*), Motlopi (*Bosicia albitrunca*), Mopane, Mmupudu (*Mimusops zeyheri*), and Moretlwa (*Grewia flava*), because they are closely related with communities' livelihoods. The details of these species are noted in Table 4-12.

2) Where to be managed

Where the suggested plants above grow wild are target areas. Also, there were some members who can recognize the area by reading the map during the discussion.

3) Who should manage

Proposed is that not only KyT but also DFRR, Kgosi (Village chief), Conservation Committee, and Village Development Committee (VDC) should manage resources.

[5] Please refer the appendix for the action plan.

4) How to be managed and When to be managed

The following four suggestions were proposed as below.

- Set the permissions to harvest suggested plants during harvest seasons.
- Conduct research on the ecology (e.g., habitat) of suggested plants and monitoring during rainy season.
- Prohibit harvesting suggested trees throughout a year
- Leave roots of suggested plants when people harvest during the harvest seasons.

These results of the discussion are incorporated with the action plan for managing natural resources in KyT. Besides, the consultant suggested the way to utilise the maps not only for managing natural resources but also for other purposes. These suggestions are written below.

5) Utilisation for clarifying land boundaries

After the survey, the consultant found that the recognition of the land boundaries among villagers in some areas of KyT is different. Then the consultant suggested using the satellite imageries for clarifying land boundaries and reconciling the recognition among them. Also the consultant suggested villagers can propose their land boundaries to the Land Board by using the imagery.

6) Utilisation for Ecotourism activity

There are some plants that grow in some parts of a village designated for the ecotourism in Lerala and Chadibe. The consultant suggested that villagers can utilise the map when discussing about the land use for ecotourism with stakeholders. Also, there is a high possibility that an organisation has to be registered as a Trust to implement ecotourism. So the consultant also suggested the map can be used for showing the activity area of a Trust when they make a management plan.

7) Utilisation for applying to donors

KyT had received funds from almost twelve donors. The consultant suggested using the maps for introducing the KyT area when they need to explain about their activities in the document applying to donors.

Both the KyT members and KyT coordinator were positive about the suggestions. This indicates that the maps are useful tools to be utilised for natural resource management and that the suggestions made are incorporated as a part of the action plan.

4.5.3 Recommendation for applying the NFMS to the CBNRM - The good practice manual for utilising the outputs of NFMS

(1) Introduction

The previous section 4.5.2 “Utilisation the output / Good Practice” shows what this CBNRM activity have done in KyT. This record is one example of CBNRM activity by utilising the outputs of NFMS and can be the manual to DFRR. Thus, main part of the good practice manual is shown in 4.5.2. In addition, some recommendations are suggested to DFRR in this manual to utilise the outputs of NFMS to CBNRM activity in the manual. So, these suggestions are written in below.

(2) Cooperating with Deeds of Registry

According to the Botswana CBNRM status report 2016, there are 53 active CBOs in Botswana. DFRR is one of the organisations to organize these CBOs, but sometimes it’s difficult for DFRR to grasp the Trusts’ entire situation because some Trusts don’t cooperate with DFRR or Technical Advisory Committee. Nowadays, some Trusts make their constitution or management plan and register to Deeds of Registry directly by themselves. It is important for DFRR to grasp the situation of Trusts that work on forest and veld products. So it’s better for DFRR to collaborate with Deeds of Registry to observe the Trust better.

(3) Sharing the information about making thematic map and satellite imagery among DFRR staff

1) Training among officers

The district office of DFRR mainly monitors Trusts, so they recognize the situation and needs of Trusts. But the knowledge about a thematic map and satellite imagery for meeting Trusts' needs and solving their issues is no shared enough among DFRR officers. So it's important to share the information about thematic and satellite imagery map among DFRR staff. Some officers attended the training of the making thematic maps and understanding satellite imagery, thus it's better if these officers will be able to share their knowledge. The training for the district officers by the officer who already has the knowledge can be the one of the example to share the knowledge.

2) Sharing information between the head office and the district office

To make the thematic map and satellite imagery map, the cooperation between the head office and a district office, because the required tools for making them are there in the head office. For example, when the Trust needs to make a map to show their activity area to start the ecotourism, the district officer is the first person to be consulted by local people. If the district officer can share these Trusts' situation or needs with the head office, making the thematic map or satellite imagery map according to the Trusts demand is much easier. To realize it, sharing the Trusts' information between the head office and the district office is important.

4.6 Information and Knowledge Sharing

4.6.1 Results of the Output

As mentioned in the previous chapter, the following knowledge has been identified through the Project

- National Forest Monitoring Plan was drafted (This report)
- Botswana Forest Distribution Map was developed
- Following items are promoted and realised by using the NFMS;
  - ✧ the direction about the interactive-information exchange system between central database in the DFRR and district offices is presented to realise the sustainable forest resource management,
  - ✧ Reporting the forest status and providing the forest information such as forest stock and forest area.
  - ✧ Supporting the fire management
  - ✧ CBNRM

The above mentioned items were shared through the opportunities as the following table shows;

Table 4-15 Knowledge and information sharing by the Project

Organiser	Meeting / Workshop	Period (Y-M-D)	Venue	Contents Shared
SADC-JICA*	the 1st Joint Coordinating Committee (JCC)	2015/11/24-27	Tokyo/Japan	Knowledge sharing about the NFMS Botswana Project in the SADC member country and JICA
	the 2nd JCC	2016/9/7-8	Dar es Salaam / Tanzania	Discussion and information exchanges on 3 thematic pillars (FIS*, FFM*, PFM*)
	the 3rd JCC	2017/4/25-26	Johannesburg/ South Africa	Discussion and information exchanges on 3 thematic pillars (FIS*, FFM*, PFM*)
	Expert Working Group (EWG) Meeting : PFM* 1	2016/11/28-12/2	Moshi / Tanzania	Knowledge sharing and information exchange on the participatory forest management with the SADC member states
	EWG-PFM* 2	2017/2/2-2/12	Bangkok / Thailand	Discussion and information exchanges on the Good practice in Thailand

Organiser	Meeting / Workshop	Period (Y-M-D)	Venue	Contents Shared
	EWG-PFM* 3	2017/5/23-25	Johannesburg/ South Africa	Cooperation to the Participatory Forest Management Guideline
	EWG-PFM* 4	2017/10/2-6	Arusha, Tanzania	Cooperation to the Participatory Forest Management Guideline
	Expert Working Group Meeting : FIS* 1, FFM* 1	2016/11/7-8	Johannesburg/ South Africa	Cooperation to Forest Information System Management and Forest Fire management
	The 1st Basic Training on the FIS Management 1	2017/6/26-30	Gaborone / Botswana	Cooperation to Forest Information System Management
NFMS Project	the 1st Stakeholder Meeting	2014/7/7	Gaborone / Botswana	Information sharing on the progress of the project (Presentation and exhibition)
	the 2nd Stakeholder Meeting	2015/7/24	Kasane / Botswana	
	Technical Dissemination Seminar	2016/6/8	Phakalane / Botswana	Knowledge and information sharing on the outcomes of the NFMS Project (presentation and exhibition)
	Technical Dissemination Seminar	2017/11/3	Gaborone / Botswana	
DFRR	the 6th National Fire Management Conference	2017/5/31-6/2	Kasane / Botswana	Collaboration on Fire Management in the NFMS Project (presentation and exhibition)

* SADC-JICA: Project for Forest Conservation and Sustainable Management of Forest Resources in Southern Africa
* FIS: Forest Information System, * FFM: Forest Fire Management, * PFM: Participatory Forest Management
Source: Project for Forest Conservation and Sustainable Management of Forest Resources in Southern Africa, SADC-JICA

4.6.2 Botswana Forest Status Report

As a tool for the information sharing and the duty of the DFRR, the regulatory forest status report which provides the forest information by using the information generated by the NFMS will be prepared and published.

(1) Objective

The objective of the Botswana Forest Status Report (FSR) is to provide forest information to the stakeholders inside and outside the Botswana, which can contribute for decision making in sustainable forest management and climate change issues etc.

(2) Reporting interval

This FSR will be produced at five-year intervals as same as the interval of the NFI and BFDM because the FSR must be prepared by using the results from those researches and this interval matches the interval of the Global Forest Status Report (FRA) to FAO. Then all stakeholders in the country and international community are able to obtain the results generated through the NFMS on a continuous basis. The schedule of the status report is shown as Figure 3-2 Overall schedules of the NFMS.

The first report (Forest Status Report 2020) will be published by using the results of the 1st cycle NFI and the BFDM2015. Thereafter, at five years intervasl, the Forest Status Report 2025 and 2030 will be published by using the results of the 2nd NFI and BFDM2020, and the 3rd NFI and BFDM2025, respectively.

(3) Sharing method

The FSR will be prepared in printed and electronic version. The printed version will be available through the governmental printing and publishing services and the electronic version will be available in the DFRR or some governmental web-site.

(4) Tentative Contents of the FSR

The contents of the report do not need to stick strictly to the below-mentioned items. It could be reviewed in line with the governmental policy, public opinion of the moment and or international trends on the climate change or forest policy.

Table 4-16 Tentative contents of the Botswana Forest Status Report

Chapter	Contents
1	**Introduction**
2	**Area of forest, woodland, other land-covers and their changes** Forest information obtained from the analysis of the BFDMs shall be described in this chapter. The information on area of the Forest, Woodland and other land-cover classes for national and district level, and the analysis on land-use change shall be described.
3	**Forest Resources and economic valuation**
3.1	Estimation of woody biomass (forest and woodland stock volume) by using the combination of the results of the NFI and the BFDM
3.2	Economic valuation of NTFP
4	**Forest and Fire** Burnt area history and trends
5	**Forest and Tourism**
6	**Community-Based Natural Resource Management with regard to forestry**
7	**Forestry and Policy**
8	**Recommendations**

Source: DFRR-JICA NFMS Botswana Project

4.7 Current situation, challenges and countermeasures on the utilisation of the NFMS

The current situation regarding the utilisation of the NFMS and their challenges and countermeasures are summarised in the next table, although the specific application of the NFMS has been described as mentioned above. The DFRR shall recognise these situations and take proactive measures.

Table 4-17 Current situation, challenges and countermeasures on the utilisation of the NFMS

Utilisation of NFMS	Current situation	Challenges and countermeasures
1. Linkage system between the District Offices and HQs	・ The limited IT officers have become capable to manage the core technology of the linkage system (Internet Map server setting by the ArcGIS Online) by the training. ・ The operation to correct the firebreak line data, which is actually a problem, has been initiated. ・ As described in the Table 4-2 "Possible application field of the system", there are various needs in the various fields for the linkage system.	・ No proper license of the ArcGIS Online, which is the core of the linkage system. ・ Actually, the prototype system was developed by the trial license ・ **Countermeasures:** According to the Enterprise License Agreement between the Government of Botswana and the ESRI, the proper license shall be obtained urgently. ・ After obtaining the proper license, DFRR can transfer the system by using the Manual (Module 3)
2. Use of the NFI data for FRA/GHG reporting	・ The DFRR can estimate the AGB / BGB which is the necessary information for FRA, by using the developed program code and the NFI data ・ The DFRR has become capable to collect the NFI data and the quality of the data was improved through the QAQC activities and the training	・ The programming skills shall be enhanced, in order to have the ability to solve themselves when the problem arise in a calculation process of dealing with enormous number of the data which will be collected by the NFI in the future. ・ **Countermeasures**: Skill upgrading by using the Manual (Module 4) ・ Improving the collaboration with FAO and/or UNFCCC, in order to promote the information sharing, generated by the NFMS. ・ **Countermeasures**: Place or nominate the Focal Point who is in charge of those international agencies

Utilisation of NFMS	Current situation	Challenges and countermeasures
3. Fire management	・ DFRR can update the information on the maintenance of the fire-break GIS data. The updated information can be shared between the central and district offices (it is useful for the fire-break planning and the field check) ・ DFRR can calculate the daily fire danger index (FDI) by using the meteorological data. The product can be communicated to the public when it is analysed by using adequate data which is actually no enough. ・ Potential fire risk map (fire zone map), asset map and the burnt area polygon can be generated by the DFRR ・ Above mentioned products can be generated even by the District by using free GIS software. Actually, no GIS software is equipped in the District Office of the DFRR.	・ The maintenance of the fire-break is carried out by the contractors and those maintenance information are not consolidated ・ **Countermeasures**: Appoint the officer in charge of the consolidation of the fire-break maintenance information ・ No adequate meteorological information. ・ **Countermeasures**: Enhance the relationship with the Department of Meteorological Services (DMS) and improve the data input system from each weather station. ・ The data for the potential fire risk map shall be evaluated by the experts ・ The asset map shall be generated by the officer in the Districts who is familiar with the field. ・ Improvement of communication infrastructure at the District office is necessary since the speed of the internet becomes a barrier.
4. CBNRM	・ One example of the utilisation of the NFMS to the CBNRM was presented and its methodology was transferred to the DFRR through the O-J-T. ・ Tree species identification was not possible even by using the high resolution satellite images although the tree cover map can be generated.	・ As described in 4.5.3, the limited officers have enough skills on the thematic mapping, and it is necessary to share those skills among the offices by using the manuals developed. ・ It is necessary for the DFRR to share this good practice to the stakeholders that the thematic map generated from the NFMS can be utilised and efficient for the management of the CBO, through the opportunities such as the Tree Planting Day every year and the other events proactively.
5. Knowledge Sharing	・ Inquiries for the BFDM2015 are increasing. Both hard and soft copy of the BFDM 2015 can be purchased at the Survey and Mapping. ・ Knowledge sharing on the NFMS is promoted by the DFRR though the various opportunities as mentioned in the Table 4-15 in this chapter. ・ Knowledge and experiences has been shared through the SADC-JICA Forest Project.	・ No opportunities for the DFRR to make a regular report or announcement on the forest information which can be generated from the NFMS. Therefore, every time, the stakeholders need to make inquiries to DFRR and the contact point in the DFRR is not clear. ・ **Countermeasures**: Establish promptly the NFMS implementation structure and publish the periodicals on the forest information, such as Forest Status Report (See Chapter 5 Conclusion and Recommendation). Or, it is necessary to collaborate with the Central Statistics Office (CSO) and the forest information generated by the NFMS shall be included in the national statistics document.

Source: DFRR-JICA NFMS Botswana Project

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

As a result of the examination of the National Forest Monitoring Plan, the following conclusions were derived through the NFMS Project:

1. The National Forest Monitoring Plan corresponds to the policy and the national development goal established by the Government of Botswana. Therefore, promoting the National Forest Monitoring System can contribute to the sustainable use of forest resources and it has high validity. It can also help to take responsibilities for international community including UN Framework Convention on Climate Change (UNFCCC) and the implementation of NFMS has very high validity.
2. The National Forest Monitoring Plan uses a combination of remote sensing with a ground-based inventory (forest inventory) and the forest distribution maps is developed by using forest remote-sensing technologies.
3. The methodology of the National Forest Inventory was discussed, developed and the training for capacity development was conducted. As a result, the DFRR acquired enough ability to conduct a forest inventory survey. In addition, the survey method was summarised in a technical manual (Module 1).
4. In order to conduct the National Forest Inventory (NFI) survey, 640 PSUs will be set in the forest across the country and the interval of the NFI is five years (DFRR has started already the NFI and will complete the first cycle by the end of FY 2020).
5. Land-cover classification was defined for the development of the Botswana Forest Distribution Map: 1.Riparian Forest, 2.Typical Forest, 3.Woodland, 4.Shrub/bush, 5.Grass land / Forbs / Savanna, 6.Marsh, 7.Desert / Sand Dune, 8.Bareland / Built up, 9.Water body / Pan
6. Regarding the definition of forest, it followed the Forest Policy 2011. This definition is the same as the definition defined by FAO. However, “Forest” which is the average tree height is 8 m or less and the monolayer structure is classified as “Woodland”. Therefore, in the Botswana Forest Distribution Map, three classes of "1. Riparian Forest", "2. Typical Forest", and "3.Woodland" correspond to "forest".
7. The National Forest Distribution Map (BFDM) 2015 which will be a benchmark for continuing forest monitoring has been developed and publicised in June 2016. According to the BFDM 2015, the forest area in Botswana is 157,279 km^2 and the forest cover rate is 27.1%.

Table 5-1 Result of BFDM (Botswana Forest Distribution Map) 2015

Class	Area (km^2)	%
Riparian Forest	1,552	0.3
Typical Forest	36,517	6.3
Woodland	119,210	20.6
Total ”Forest”	***157,279***	***27.1***
Bush/Shrubland	264,906	45.7
Savanna/Grassland	120,134	20.7
Bare ground	8,905	1.5
Desert/Sand dunes	7,008	1.2
Marsh/Wetland	7,661	1.3
Waterbody/Pan	13,875	2.4
Total	579,768	100

Source: BFDM 2015, DFRR-JICA NFMS Botswana Project

8. A series of the capacity development training regarding to the forest distribution map development by using remote-sensing technologies was conducted and the technical manuals were developed. As the DFRR has acquired the capacity, the forest distribution maps shall be updated based on their knowledges obtained through the project and using the technical manuals. (Module 2).

9. Regarding the forest remote-sensing technology, its application to the fire management was shown as a practical example for utilising the technology other than the Forest Distribution Map developing. The capacity development training on the following thematic maps was conducted, and the technical manual on those fire management related theme map was also created (Module 5).

   - Fire danger information
   - Fire zoning map
   - Asset map
   - Burnt scar
   - Biomass change

10. Forest GIS database was built in the DFRR and it will be managed by DFRR. The database stores various types of the data which can contribute to sustainable forest management. By using the database, it is possible to input and analyse the collected forest inventory data, developing the Forest Distribution Map and various theme maps, and analyse the satellite image.

11. For the Forest GIS database, Operation Manual and System Administrator Manual were developed. Furthermore, considering the sustainability of the database, the Practice Manual which can be utilised as a training material was made. (Module 3) However, similar to the situation of forest remote-sensing, a person in charge of the GIS lab is absent and where the responsibility of the lab remains unclear (Also see the recommendations).

12. It is important that the Forest GIS database shall be updated continuously and the stored data shall be kept fresh. In order to realise that, it is not important only the information generated by the central office but also the data from the district office. Therefore, the way to the information sharing in cooperate with the district office was indicated. (See Recommendation).

13. The training for the NFI data utilisation was conducted on the premise of reporting to the Global Forest Resource Assessment (FRA), FAO. In order to provide the data for it, both of forest area information derived from the Forest Distribution Map and the ground-based survey data are necessary. Therefore, the NFMS can be utilised as a tool to provide those essential information and data. By introducing the NFMS, the DFFR has a capacity to report the result to FRA by using the country's own data even the data is partial. In addition, the DFRR has a capacity to estimate the above-ground and underground biomass as well. So, it is now possible to make some contributions to the GHG national communications in the area of LULUCF, which has not been done enough so far. The tools are compiled in the technical manual and stored in the forest GIS database (Module 4). The following table shows the results of the NFI data analysis generated by the training (these results were preliminary generated using the data accumulated at the time of training which equivalent 27% of the total PSUs target).

Table 5-2 Result of BFDM (Botswana Forest Distribution Map) 2015

TOPIC/Variable in FRA	FRA Reporting year			Preliminary results obtained by the Training*
	2005	2010	2015	
3.1 Total forest growing stock	770	735	725	394
3.2 Total other wooded land growing stock	n.a.	n.a.	n.a.	n.a.
3.5 Above-ground biomass	893	881	868	749
3.6 Below-ground biomass	500	493	485	210
3.8 Carbon in AGB	420	414	407	352
3.9 Carbon in BGB	235	232	229	99

Source: BFDM 2015, DFRR-JICA NFMS Botswana Project

14. An example of CBNRM activity using NFMS as a tool was shown in order to contribute the sustainable forest management, and then O-J-T was conducted for capacity development on related issues for the DFRR officers and the members of the target Trust. In addition, the method used in the example, the knowledge and recommendations obtained during the training were compiled in the Good Practice Manual (Module 6).

15. By analysing the results of the NFI at the interval of five years and the information of BFDM which will be updated in every five years, the DFRR can generate the Forest Status Report on a regular basis. The Forest Status Report shall include not only the information generated from the NFMS alone but all the activities of the DFRR, thus a draft table of contents was proposed as following table.

Table 5-3 Tentative contents of the Botswana Forest Status Report

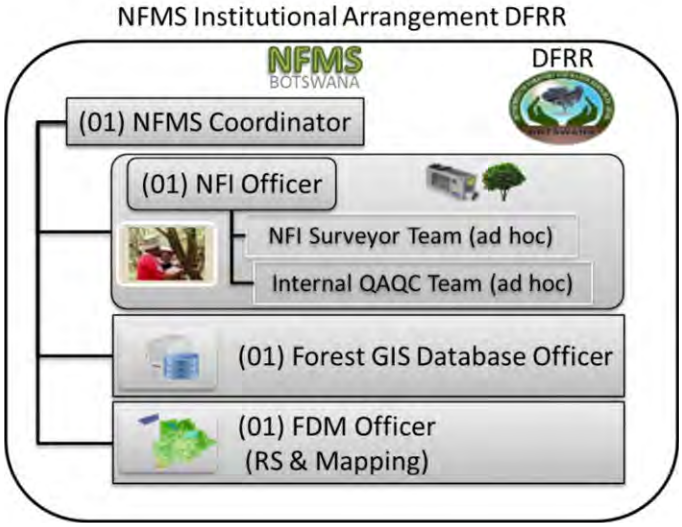
Chapter	Contents
1	**Introduction**
2	**Area of forest, woodland, other land-covers and their changes** Forest information obtained from the analysis of the BFDMs shall be described in this chapter. The information on area of the Forest, Woodland and other land-cover classes for national and district level, and the analysis on land-use change shall be described.
3	**Forest Resources and economic valuation**
3.1	Estimation of woody biomass (forest and woodland stock volume) by using the combination of the results of the NFI and the BFDM
3.2	Economic valuation of NTFP
4	**Forest and Fire** Burnt area history and trends
5	**Forest and Tourism**
6	**Community-Based Natural Resource Management with regard to forestry**
7	**Forestry and Policy**
8	**Recommendations**

Source: DFRR-JICA NFMS Botswana Project

5.2 Recommendations

5.2.1 Institutional arrangement in the DFRR

As mentioned in the former section, the institutional arrangements in the DFRR shall be realised as soon as possible to secure the sustainability of the NFMS because currently, it is not unclear who the person in charge is. So, it is recommended that the officers in charge shall be appointed or recruited as needed, as soon as possible and the tasks and responsibilities of each component shall be clearly assigned to each officer. Then, it is recommended that the collaboration mechanisms with other ministries and institutions are well established through the establishment of such implementation systems in the department. The DFRR shall add the necessary work items in the PDP (Performance Development Plan) by considering the TORs for each officer as mentioned in the Chapter 3, 3.10.



Source: DFRR-JICA NFMS Botswana Project

Figure 5-1 NFMS Implementation System

5.2.2 Transportation

The most difficult part of the National Forest Inventory (NFI) is to secure the transportation for the surveyor team. The teams had to traverse within a short period of time and all permanent sample units (PSU) are going to be distributed randomly throughout the national territory and some plots are:

- located in areas where it is not easy to reach and at times even bush-crushing with vehicles is not possible,
- found on hilltops or thickly vegetated areas, then there is no access by vehicle
- while others are too far to reach and without access routes

Under normal condition, one surveyor team uses two vehicles and consists of four or five surveyors and the two drivers. So, one team is formed by six to seven members in total. Then, when we organize two teams, four vehicles shall be required at the same period to conduct the NFI. In the same manner, eight vehicles shall be prepared to formulate four teams at the same time.

Moreover, the vehicles will be used in the very difficult terrain conditions, bush, rough gravel road, sandy road, rugged rocky road, water pool, marshy area and gullies etc. Therefore, there is a high risk of over-heating, puncture or any other damages. So, only the vehicles which can be used in all-terrain condition and which are well maintained, can serve for the NFI operation. Also, the vehicles shall equipped bush guard to protect the motor. Currently, the two vehicles provided by JICA have equipped the bush guard, the spare tires, the tires repair kits, and the jerry cans.

For the smooth implementation of the NFI, a certain number of the vehicles shall be secured. In the beginning stage of the first NFI cycle, the NFMS Project covers the cost of hiring a car to fill the lack of reliable transport provided by the Government. Although, currently, the DFRR covers the all of cost for the NFI implementation without the external financial support, the NFI team faces a difficulty to secure transportation for the NFI every time at the planning stage and sometime the timing competes with firefighting. So, the Government of Botswana shall attempt to remedy the situation in order to realise smooth NFI operation and it would be more prudent to commit at least four pick-up trucks to the project fleet and ensure these vehicles are available when needed, in adding the replacing the decrepit and unreliable vehicles.

Actually, two Toyota Land-Cruisers were procured by the Project and served exclusively for the Project's operations. **It is strongly recommended that, at least, those two vehicles procured by the Project shall be used exclusively for the NFMS purposes continuously even after the end of the Project**.

5.2.3 Ensuring Surveyor Safety and efficient implementation of NFI through the mutual agreement with relevant departments and/or institutions

As described in the chapter 3.10, the implementation system of the NFMS, ensuring surveyor (staff of the DFRR) safety is the most important and universalistic issue to secure the sustainability of the NFMS, even the DFRR has already dealt with this issue. In this regards, the **DFRR shall make some official permanent agreement or memorandum on how to secure the safety of the surveyors with relevant department and agency such as the Department of Wildlife and National Parks (DWNP) and Botswana Defence Force (BDF)** etc and it can improve the efficiency of the survey. The DFRR shall start drafting it.

So, currently, every time the NFI is implemented, the administration works for securing surveyor safety and transportation were increased. In that sense, it is recommended that DFRR makes some agreement with relevant government authorities in order to reduce those administration works and to secure surveyor safety. Then the DFRR can commit the smooth implementation of the NFI and improve the efficiency of the NFI. This improvement of the efficiency may have a positive impact on the quality of the NFI results.

5.2.4 Administrative/Financial Constraints

The on-going the first cycle of the forest inventory is being undertaken under a very tight budget. It has been very difficult to cover all the targeted points due to overtime limitations. Since the tasks and the overtime will be imposed on the NFI surveyor, so that the adequate field survey equipment and the

necessary allowances shall be secured and provided by the Government of Botswana as same as until now.

The financial constraints of the DFRR that have lately limited the scope of the work must be seriously addressed as this may negatively on the scale, sustainability and quality of the data being collected.

5.2.5 Updating of the NFDM in future

(1) Challenges on the updating FDMs

The Botswana Forest Distribution Map (BFDM) at the year of 2015 has been produced as one of the most important output by the Project. For the national forest monitoring in future, we can only know the forest area changes when comparing the updated BFDM in future and the BFDM 2015 as a bench mark map. Therefore, DFRR shall update it in the future even after the Project based on the knowledge and skills acquired by the lecture and the O-J-T training.

As for the Detailed Forest Distribution Map (DFDM), when the needs for the high resolution satellite imagery analysis arises in DFRR, the satellite and the sensor used, such as SAR and the processing methodology adopted, will differ according to the objective. In that case, DFRR will have to deal with it based on the knowledges and skills acquired by the Project through the training materials and manuals developed by the Project. The institutional arrangement is needed as mentioned in 5.1 in order to realise the continuous activities in this regard. Although it is possible to implement outsourcing the updating work, allocating one officer who prepares the TOR and manage the quality of the work and the product is necessary.

(2) Licenses of remote sensing software (ENVI and eCognition)

For the remote sensing software introduced by the Project such as ENVI and eCognition, the maintenance service is provided annually and the user can get the latest product and technical support. The license fee for the 1st year is included in the purchasing cost which covered by the JICA but the DFRR should cover the cost in the future. The situation of the remote sensing software licences, donated by JICA, is shown as in following table. The maintenance term has already expired.

Table 5-4 Situation of license for remote sensing software

Software	Maintenance Unit fee	Maintenance fee (tax included) (at 31 Jan 2016)	Initial fee (tax included)	Expired Date and Service provider
ENVI Single Use Node locked License (2 license)	BWP 12,700	BWP 25,400	BWP 65,600	Expired data: 30 Oct 2014 Contact: GIMS BOTSWANA (PTY) LTD P.O.BOX AD 816, ADD, Gaborone, Tel: 267-390744 Fax:267-3973086 Email: info@gimsbw.co.bw sales@gimsbw.co.bw support@gimsbw.co.bw
ENVI Atmospheric Correction Module Single use Node locked License (2 license)	BWP 6,600	BWP 13,200	BWP 27,000	
ENVI Orthorectification Module, Single Use Node locked license (2 license)	BWP 22,700	BWP 45,400	BWP 100,800	
ENVI Floating Licence	BWP 16,700	BWP 33,400	BWP 84,900	
ENVI Atmospheric Correction Module, Floating License	BWP 6,600	BWP 13,200	BWP 27,000	
ENVI Orthorectification Module, Floating License	BWP 22,700	BWP 44,500	BWP 100,800	
eCognition		¥1,200,000* (BWP 115,163**) * Update rate: Over 18 month from expire date ** JICA Rate Feb2016 (BWP1 = JPY10.42)	¥2,390,000 (BWP229,367**)	Expired data: 31 July 2014 Contact: Infoserve INC. Sotokanda 6-2-8, Chiyoda, Tokyo, Japan Tel: +81-3-3833-8201 Fax:+81-3-3833-8203 E-mail: product_info@infoserve.co.jp

Source: DFRR-JICA NFMS Botswana Project

5.2.6 Improve the ICT environment of the district office including GIS hard and software

"Practice makes perfect", this is a proverbial phrase often used in almost any field. GIS database also needs enough practice to master it. DFRR Headquarters has a GIS laboratory room equipped with enough hardware and software for keeping trainees' GIS knowledge and skills. When it comes to the district offices, it is different story and the software and hardware environments are not enough. The environment of the district offices seems not suitable for keeping them due to the lack of hardware and software for continuous training. It is highly recommended to introduce at least one license of ArcMap Basic and the hardware environment where it can properly be running. The following table shows the system requirements to be recommended for keeping trainees' GIS database skills. (Note: There is "Enterprise license agreement" between Botswana Government and ESRI, GIS software vendor of ArcMap.)

Table 5-5 GIS System requirements

Items	Recommended specifications	Remarks
Hardware		
CPU	2.2 GHz	HHT/Multi core recommended
Platform	x86 / x64	
Memory/RAM	2GB (minimum)	
Display	24bit colour	
Monitor resolution	96dpi 1024*768 (minimum)	
Swap domain	more than 500MB	
Internal HDD	more than 2.8GB	
Video Graphics	more than 64MB RAM Recommended 256MB or more	NVIDIA/ATI/Intel chip supported
Software		
OS	Windows 7 Ultimate/Professional	32bit / 64bit
	Windows 10 Home/Pro/Enterprise	32bit / 64bit
GIS	ArcMap Basic (Minimum)	1 node lock license

Source: DFRR-JICA NFMS Botswana Project

5.2.7 Toward efficiency improvement of the NFI

The result of the past NFI said that the mean survey number of PSU per day per team is 0.6 PSU/day/team. This number includes the weekend and travel day. For example, when we plan to survey 40 PSU with four teams, it is necessary to plan for 17 days survey period (40 PSU / 4 teams / 0.6 = 16.67).

The mean survey time taken for one PSU after arrival at the survey point is within about two hours although it depends on the density of the forest. In fact, one team is able to survey only one PSU by day and it becomes 0.6 PSU/day/team when travel time is included.

The cost of the NFI will be reduced when the survey time can be shortened. Moreover, longer survey time and period may negatively affect the quality of the survey results. Therefore, improving the efficiency of the forest inventory survey is indispensable in order to continue the NFI sustainably for a long time.

To improve the efficiency, there are three options as mentioned below.

1) Improvement of surveyor's skill level by continuous capacity development
2) Improvement of administration affairs in NFI by establishing cooperation agreement among related agency or department (See also the Recommendation 3.5)
3) Improvement by introducing the latest forest survey technology

Regarding 3) Improvement by introducing the latest survey technology, various technologies such as utilisation of UAV and laser measurement equipment have already come to the practical stage and it is recommended that DFRR develops the capacity development system as soon as possible in order to update and improve their technical capacity, while paying attention to the international trends, in cooperation with research institute such as the Department of Survey & Mapping, University of Botswana (UB), Botswana University of Agriculture and Natural Resources (BUAN) and Botswana International University of Science & Technology (BIUST).

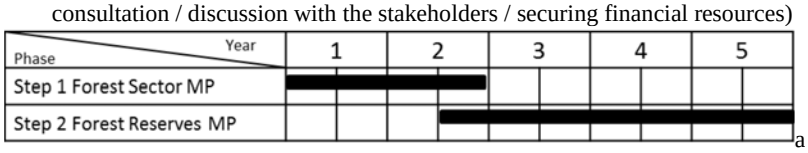
5.2.8 Necessity of Master Plan

In Chapter 2, the justification of the National Forest Monitoring Plan was confirmed by reviewing the Forest Policy 2011 and NDPs. After the Forest Policy 2011, there is no concrete plan or master plan in the forest sector has been developed on how to conserve, utilise and manage forest resources in the country. The situation that the national level master plan is lacking is the same as for the forest reserves. Therefore, as a next step, it is recommended to develop the national level forest sector master plan and the forest reserve management master plan, in line with the target in the NDP 11 and Vision 2036, by using the outcomes developed.

In order to discuss how to monitor the forest resources and how to conserve, utilise and manage them in the future, the scientific-based decision making is required and the National Forest Monitoring Plan is the most suitable tool for it. Therefore, it is recommended that the DFRR makes maximum use of the developed outcomes, not only for the forest sector but also in policy making and/or planning in the energy sector, fire management and CBNRM etc.

In fact, the necessity of the superior plan in the sector is recognised by the DFRR, and the Government of Botswana has requested a technical cooperation regarding the forest sector master plan to the Government of Japan. The following table shows the outlines of the request.

Table 5-6 Outlines of the new project's request

Item	Contents
Project Title	National Forest Master Plan and (Forest Reserves Master Plan Development) in view of diversifying the sources of economic growth in the Republic of Botswana
Background	In the latest National Development Plan (NDP11), "**Developing Diversified Sources of Economic Growth**" is set as the most important priority area and identified the Tourism sector as one of the priority economic sector which can realise the diversifying the sources of economic growth and poverty alleviation of the country. The development and growth of the tourism sector can be formed through the sustainable use of the forest and woodland where are the habitat of the wildlife and its status shall be monitored constantly. In this regard, the discussion for opening up the Forest Reserves to the tourism sector is now underway and the "Guidelines for Utilisation of Forest Reserves for Ecotourism Activities" were developed for DFRR under the support of the UNDP on July 2016. Moreover, the "**Sustainable Use of Natural Resources"** is set as one of the priority areas and the NDP 11 aims at the economic growth through the sustainable use of the natural resources. Consequently, development of the national forest sector master plan that provides a strategic direction and guidance on how to manage the forest resources in the country is necessary and also it is needed that the development of the forest reserve management plan in line with the national level master plan and NDP 11. On the other hand, the forest monitoring tools have been installed in the DFRR, which is responsible for forest administration, by the "National Forest Monitoring System" project supported by JICA, which was implemented from June 2013 to December 2017. Utilisation of those tools is expected in order to realise the sustainable use of natural resources.
Overall goal	"To optimize the contribution of the forest sector to the long-term socio-economic development of Botswana by ensuring equitable and sustainable flow of benefits to all segments of the population now and in the future".
Project purpose	To define strategic direction for sustainable management and improvement of the productivity of Botswana's forests, and to develop the forest reserves master plan for further enhance their contribution to local livelihoods, and national socio—economic development.
Expected Outputs	Output 1 Strategic Direction for National Forest and Range Resources Master Plan is defined. Output 2 Forest resources of the country and FRs are assessed Output 3 Tourism resources of FRs are assessed Output 4 Forest Reserve Management Master Plan is developed
Duration	Five years. Step 1 Two years for strategic direction for Forest Sector Master Plan (FSMP) development Step 2 Three and a half years for Forest Reserves Master Plan (FRMP) development (overlapping with 0.5 year with the Step1 / 2.5 years for planning and 1 year for consultation / discussion with the stakeholders / securing financial resources)  a
Counterpart agency	Department of Forestry and Range Resources

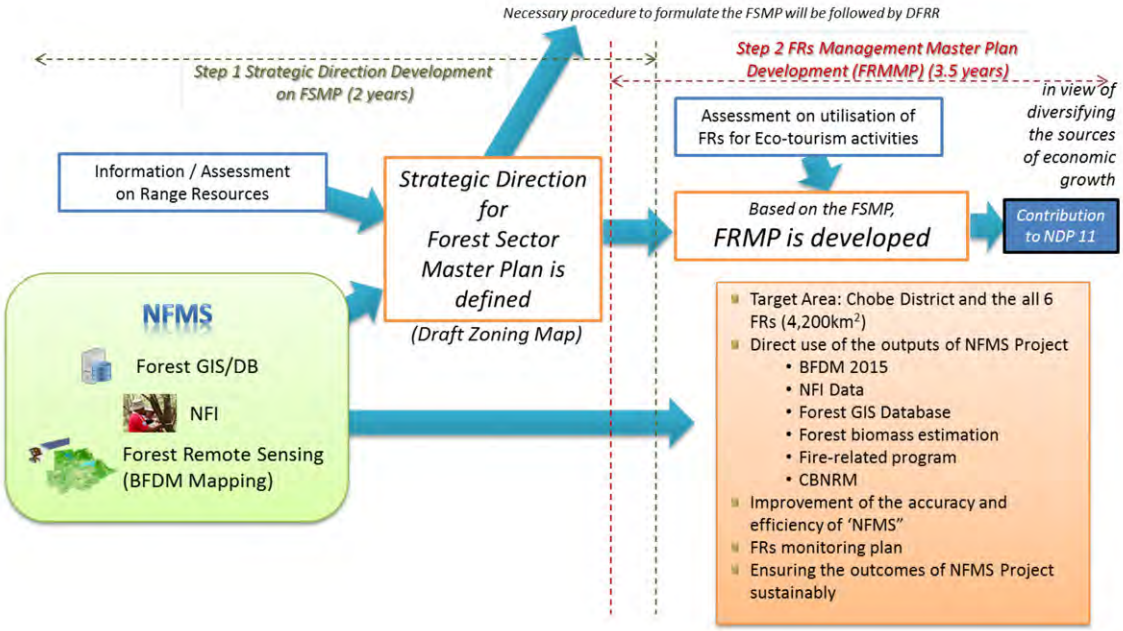


Figure 5-2 National Forest Master Plan and (Forest Reserves Master Plan Development) in view of diversifying the sources of economic growth in the Republic of Botswana

MINISTRY OF ENVIRONMENT, NATURAL RESOURCES CONSERVATION AND TOURISM
DEPARTMENT OF FORESTRY AND RANGE RESOURCES

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF BOTSWANA
THE PROJECT FOR ENHANCING NATIONAL FOREST MONITORING SYSTEM FOR THE PROMOTION OF SUSTAINABLE NATURAL RESOURCE MANAGEMENT

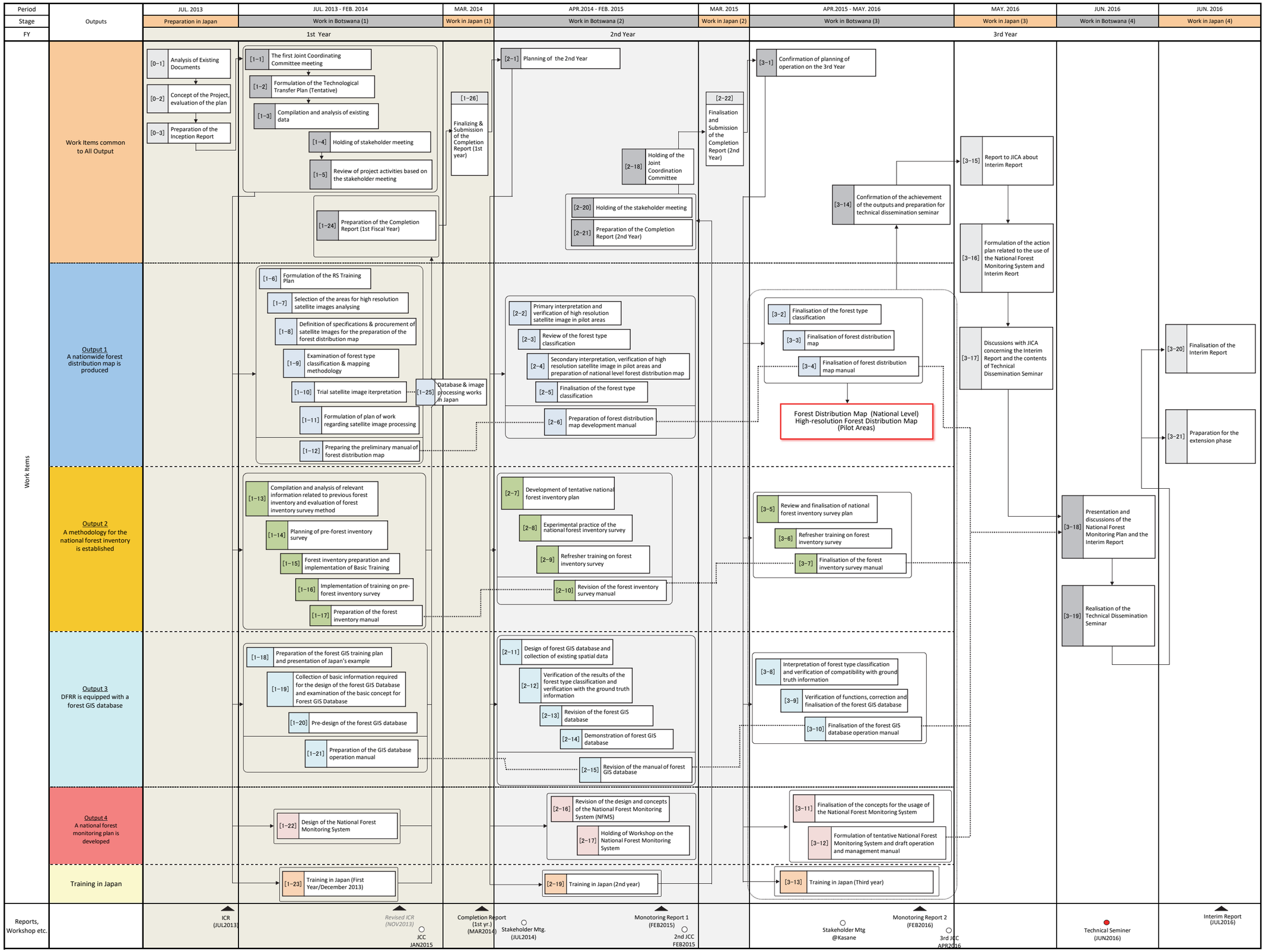
PROJECT COMPLETION REPORT

DECEMBER 2017

APPENDICES

Appendix-1

Worklfow of the Project (July-2013 – June 2016)



ICR: Inception Report、RS:Remote Sensing
JCC：Joint Coordinating Committee, TWG：Technical Working Group

Appendix-2

Plan of Operation for the Extension Phase (July 2016 – December 2017)

Appendix-2 Plan of Operation for the extensio phase (July 2016 - December 2017)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		2016						2017											
Challenges and Key tasks		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Output 5.	**Developing NFMS**																		
1.1	Linkage with Regional Offices and other Ministries																		
1.1.1	Assess the capacity of the DFRR District offices in the pilot area		■	■	■	■	■												
1.1.2	Review the data storage specification to the central Forest GIS-DB			■															
1.1.3	Assess the needs for the contents to be delivered to the other ministries			■	■														
1.1.4	Review the deliver contents to the DFRR District offices and the other ministries						■	■											
1.1.5	Design and construct the WEB-based information sharing prototype system							■	■										
1.1.6	Customise the deliver contents in consideration of the internet conditions and register the data							■	■										
1.1.7	Implement the training on the operation of the WEB-based information sharing prototype system								■										
1.1.8	Develop the operation manual for the information sharing Web system								■	■							■	■	
1.2	Support to provide the data to the international mechanism such as FRA and/or GHG inventory																		
1.2.1	Assess the capacity and the needs of the focal person/organisation for the FRA and/or GHG inventory		■																
1.2.2	Implement the training on the reporting for the FRA and/or GHG inventory by use of the F-GIS-DB			■															
1.2.3	Implement the QAQC		■	■	■			■	■					■			■	■	
1.2.4	Conduct the training on the estimation of the AGB/BGB		■	■				■	■										
Output 6.	**Applying to Forest Fire Program**																		
2.1	Review the fire monitoring system in DFRR and confirm the availabilities of the fire related data		■																
2.2	Develop thematic maps on fire (Hazard map, fire break map, fire scar map etc.) according to data availability			■	■	■	■	■	■	■									
2.3	Develop the related manuals														■	■	■		
Output 7.	**Applying to CBNRM**																		
3.1	Collect and analyse the data about the legal framework, procedure and the stakeholders of the CBNRM		■																
3.2	Identify the CBNRM potential areas (pilot areas) through the existing data and discussion with the DFRR			■	■	■													
3.3	Collect and analyse the data on the CBNRM in the pilot area				■	■	■	■	■										
3.4	Develop thematic map in the pilot area by using the tool developed and existing data collected					■	■	■	■						■	■			
3.5	Develop the action plan in the pilot areas through the activities 7-1 to 7-4							■	■	■						■	■		
3.6	Develop the good practice manual of the regarding the CBNRM															■	■		
Output 8.	**[Linkage with JICA-SADC Project] - Sharing knowledge and experiences inside/outside Botswana in collaboration with SADC & developing partners**																		
5.1	Compile the knowledge and experience obtained in the Project		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
5.2	Identify appropriate knowledge and experience to be shared inside/outside Botswana		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
5.3	Hold seminars to share the knowledge and experiences inside / outside Botswana in collaboration with SADC and other Developing Partners.																	■	
Work in Japan (i)																			
J-i-1	Report to JICA about the work progress of the WORK IN BOTSWANA (I)																▲		
J-i-2	Formulation of the Draft Completion Report of the Project by reflecting the results obtained through the extensior phase																▲		
J-i-3	Discussions with JICA concerning the Draft Completion Report of the Project and the Contents of Final Technical Dissemination Seminar																▲		
J-i-4	Formulation of the presentation materials for the final Technical Dissemination Seminar																▲		
Work in botswana (ii)																			
B-ii-1	Presentation and discussions about the Draft Completion Report of the Project																	▲	
B-ii-2	Holding the final Technical Dissemination Seminar in collaboration with the DFRR/MEWT																	▲	
Work in Japan (ii)																			
J-ii-1	Prepare the answer to the comments on the draft Completion Report which are submitted by the DFRR in consultation with JICA																		▲
J-ii-2	Finalise the Project Completion Report with the necessary modification based on the comments submitted by the DFRR.																		▲
J-ii-3	Prepare the Technical Transfer Report and compile the results as an appendix of the Completion Report (final)																		▲
	Deliverables									△ Monitoring Report No.3								△ DFR	△ FR

Appendix-3

Certificate of Handover

CERTIFICATE OF HANDOVER

PROJECT TITLE: "THE PROJECT FOR ENHANCING NATIONAL FOREST MONITORING SYSTEM FOR THE PROMOTION OF SUSTAINABLE NATURAL RESOURCE MANAGEMENT"

This is to certify that the equipments in the attached list for above-mentioned project have been handed over properly as of *November 4, 2013* to *Department of Forestry Range Resources of Ministry of Environmental, Wildlife and Tourism*.

Gaborone,
November 4, 2013

THE PROJECT FOR ENHANCING NATIONAL FOREST MONITORING SYSTEM NFMS BOTSWANA

TEJIMA Shigeharu
Team Leader / Forest Resource Management
The Project for Enhancing National Forest Monitoring System for the Promotion of Sustainable Natural Resource Management
Japan International Cooperation Agency

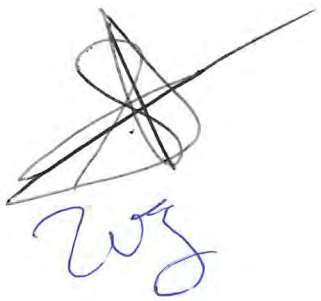
Dr. M Manthe Tsuaneng
Director
Department of Forestry Range Resources,
Ministry of Environment, Wildlife and Tourism

List of Equipment (1/2)

Reg. No.	Name of Item	Model	Name of Manufacturer	Quantity		Remarks
3-1-1	ENVI Single-user node-locked License	ENVI 5.0 SN	Exelis	2	Licenses	
3-1-2	ENVI Atmospheric Correction Module Single-user node-locked License	ENVI Atmospheric Correction Module SN	Exelis	2	Licenses	
3-1-3	ENVI Orthorectification Module Single-user node-locked License	ENVI Orthorectification Module SN	Exelis	2	Licenses	
3-2-1	ENVI Floating License	ENVI 5.0 FL	Exelis	1	License	
3-2-2	ENVI Atmospheric Correction Module Floating License	ENVI Atmospheric Correction Module FL	Exelis	1	License	
3-2-3	ENVI Orthorectification Module Floating License	ENVI Orthorectification Module FL	Exelis	1	License	
3-3	eCognition Developer	eCognition Developer Version 8.90	Nikon-Trimble	2	Licenses	
4-1	Desktop personal computers for RS/GIS	VOSTROS 470 i7-3770	Dell	4	sets	Including Monitor, Keyboard, Mouse, Cables, Office Software, and Anti-Virus Software
4-2	Notebook computers for RS/GIS	HP ProBook 470 i5-3230M	HP	3	sets	Including AC adapter, Office Software, and Anti-Virus Software
4-3	UPS for PC of RS/GIS	100VA Line Interactive UPS	MECER	4	units	
4-4	Network attached storage (NAS)	HDWDBACG0020, My Book Live	Western Digital	6	units	
4-6	A3 Color-page Printers	CE708SA, HP Color LaserJet5525DN	HP	1	sets	Including Printer Server (J8021A)
4-10	PDF software	Acrobat 11.0 Win APP License IE	Adobe	9	Licenses	Including DVD Install Media
5-1	Handheld GPS navigators	GPSMAP 62s	Garmin	5	sets	Including USB cable
5-2	Digital cameras	AW-110	Nikon	5	sets	Including Spare Battery, Carry Case, and Memory Card
5-3	Ultrasonic hypsometers	Vertex IV 360°	Haglof	4	sets	Including Transponder, L-form metal fittings, Monopod, and Carrying Case
5-4	Laser hypsometers	TruePulse360	Laser Technology	4	sets	Including Reflect for laser hypsometer, Tripod for laser hypsometer, Filter for laser hypsometer, Bracket for laser hypsometer, Screw for bracket, Eyecup for laser hypsometer, and Bracket for laser hypsometer
5-5	Hypsometers BLUME-LEISS	BL-6	Carl-leiss	4	sets	Including Carrying Bag
5-6	Clinometers	PM-5/360PC	SUUNTO	4	sets	Including Carrying Bag
5-7	Compass	MC-2G	SUUNTO	6	units	
5-8	Calipers	Mantax Blue 650 11-100-1103	Haglof	4	sets	Including Belt Holder
5-9	Digital calipers	CD-67-S15PS	Mitutoyo	4	sets	Including Case
5-10	Diameter tapes	D3M	Yamayo	4	units	
5-11	Measuring tapes	3X Million OTR100X	Yamayo	4	units	
5-12	Measuring rope	100-LN	Sekisui	4	units	
5-13	Ranging rod	No.102-2	Senshin	20	sets	Including Carrying Bag
5-14	Tree Tags	AlumiTag	FSI	6	sets	
5-17	Hatchets	-	-	5	units	
5-18	Marking tapes	VT-305, 10 tapes/bundle	Takeya Shoji	10	units	

List of Equipment (2/2)

Reg. No.	Name of Item	Model	Name of Manufacturer	Quantity		Remarks
6-1	Trail camera	SG560P-8M	BMC	8	sets	Including Security Box, Mounting Bracket, Security Lock, and SD Memory Card.
6-2	Waterproof binoculars	Monarch 10×36 DCF	Nikon	2	sets	Including Carrying Bag
6-3	Field scope with digital camera (Digiscope)	TSN-664	KOWA	1	sets	Including Eyepiece, Adapter, Digital Camera, Camera's Bracket, Coupler, Cable Release, Sighting device, LCD hood, SD Memory Card, Spare Battery for Camera, Tripod, Camera Platform, and Long Plate.
6-4	Single-lens reflex camera	D7100(J)	Nikon	1	sets	Including Spare Battery, 2 SD Memory Card, Telephoto Lens, Lens Protection Filter, Zoom Lens, and Carrying Bag.
6-5	Handheld digital thermo-hygrometer	Thermo-hygrometer "Ondotori RH" TR72Ui	T AND D	1	unit	
6-6	Data logger for thermometer and hygrometer	HOBO ProV2 2ch CO-U23-001	Oneset	1	set	Including USB Vase Station, HOBOware Pro Starter Kit, and Spare Battery.
6-7	Night vision scopes	NVSCP55	Sanko	1	unit	
6-8	Flashlights	P5 OPT-8405	LED LENSER	1	unit	
6-9	Sample bottles	Sample Bottles PS-15, 110bottles/carton	AS ONE Corporation	1	set	
6-10	Insect Nets	Extensible Metallic Rod 250cm, Net Flame 40cm, Net	Shiga Kontyu	1	set	
7-1	Multi-Function Printer (Scanning , Copying)	TASKALFA 5550ci MFP (012LC3NL)	Kyocera Mita	1	set	Including Accessories and Stabilizer
7-2	Projector	EB-X12XGA	Epson	1	set	Including Projector Screen and Laser Pointer
7-3	Notebook computers	HP ProBook 4540s	HP	1	set	Including AC Adapter, Office Software and Antivirus Software
7-4	Desktop personal computers	Dell Optilex 3010MT	Dell	1	set	Including Monitor, Keyboard, Mouse, Office Software, Antivirus Software, and UPS
8	Vehicles	Land Cruiser 76 series (Station Wagon)	TOYOTA	2	units	Including bush guard, roof lack, and 2 spare tires.



CERTIFICATE OF HANDOVER

PROJECT TITLE: "THE PROJECT FOR ENHANCING NATIONAL FOREST MONITORING SYSTEM FOR THE PROMOTION OF SUSTAINABLE NATURAL RESOURCE MANAGEMENT"

This is to certify that the equipment in the attached list for above-mentioned project have been handed over properly as of *September 29, 2014* to *Department of Forestry Range Resources of Ministry of Environmental, Wildlife and Tourism*.

Gaborone,
September 29, 2014

菅原 史緒

Sugawara Fumio
Assistant Forest Inventory

For TEJIMA Shigeharu
Team Leader / Forest Resource Management

The Project for Enhancing National Forest Monitoring System for the Promotion of Sustainable Natural Resource Management
Japan International Cooperation Agency

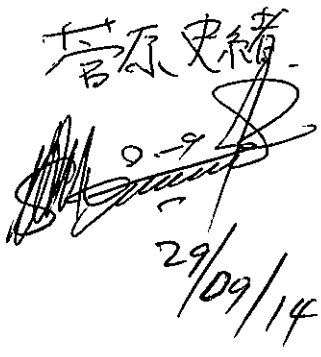
Sonny W. Mokgwathi
Acting Director

Department of Forestry Range Resources,
Ministry of Environment, Wildlife and Tourism

List of Equipment

Reg. No.	Name of Item	Model	Name of Manufacturer	Quantity		Remarks
4-1	PC Monitor for Desktop Personal Computer √	DELL S2240L	Dell	4	units	
4-12	Handheld Computer √	HP ElitePad 1000 G2 Tablet	HP	2	units	Including Tablet Pen, Pad Case, USB3 Adapter, microSD card
	GPS Receiver/Logger for Handheld Computer √	M-241	Holux	2	units	microSDHC Cards(×2)
	Rechargeable Battery Kit for Handheld Computer √	Eneloop KJ23MCC20	Panasonic	2	units	
	Car Inverter for Handheld Computer √	OWM-10	Owltech	2	units	
5-1	Handheld GPS navigator √	GPSMAP 62s	Garmin	2	unit	
	Vehicle Power Cable for Handheld GPS navigator √	010-10851-11	Garmin	7	units	
5-3	Ultrasonic hypsometer √	Vertex IV 360°	Haglof	3	units	Including L form metal fitting,
5-4	Laser hypsometer √	TruePulse360	Laser Technology	3	units	Including Reflect, Tripod, Fitter, Bracket, Screw, Eyecup
5-8	Caliper √	Mantax Blue 650 11-100-1103	Haglof	3	units	Including Belt holder
5-10	Diameter tapes 2m √	W606PM	Lufkins	7	units	
5-14	Measuring tapes 50m √	3X Million OTR50X	Yamayo	7	units	
5-14	Tree tag √	AlumiTag	Forest Supplier Inc	18	units	
6-1	Trail Camera √	SG560P-8M	BMC	16*	units	Including security box, direct tree mount, locking cable, SD memory card

*Remark: 17 trail cameras were purchased originally, but one was destroyed by wildlife during biodiversity survey in Khutse game reserve before the official handover.



Appendix-4

List of Equipment

List of Equipment
DFRR-JICA NFMS Botswana Project

Category	No.	Item	Quantity	Place of Procurement	Procurement
1. Satellite Images	1-1	LANDSAT satellite images (FREE)	41 scenes (whole territory of Botswana)	Japan	Project (JICA HQ)
	1-2	High resolution satellite images (Rapid Eye)	6334 km^2 (Gaborone area)	Japan	Project (JICA HQ)
	1-3	High resolution satellite images (SPOT)	6504 km^2 (Francistown area)	Japan	Project (JICA HQ)
	1-4	PALSAR Mosaic Data	Gaborone area (3 tiles x 2007 & 2009)	Japan	Project (JICA HQ)
2. GIS Software	2-1-1	Arc GIS for Desktop Advance Concurrent Use	1	Botswana	MEWT
	2-1-2	ArcGIS 3D Analyst Concurrent Use	1	Botswana	MEWT
	2-1-3	ArcGIS Spatial Analyst Concurrent Use	1	Botswana	MEWT
	2-2-1	Arc GIS for Desktop Standard Single Use	1	Botswana	MEWT
	2-2-2	ArcGIS Spatial Analyst Single Use	1	Botswana	MEWT
	2-3-1	Arc GIS for Desktop Standard Concurrent Use	1	Botswana	MEWT
	2-3-2	ArcGIS Spatial Analyst Concurrent Use	1	Botswana	MEWT
	2-4	Arc GIS for Desktop Basic Single Use	3	Botswana	MEWT
3. RS Software	3-1-1	ENVI Single-user node-locked License	2	Botswana	JICA Botswana
	3-1-2	ENVI Atmospheric Correction Module Single-user node-locked License	2	Botswana	JICA Botswana
	3-1-3	ENVI Orthorectification Module Single-user node-locked License	2	Botswana	JICA Botswana
	3-2-1	ENVI Floating License	1	Botswana	JICA Botswana
	3-2-2	ENVI Atmospheric Correction Module Floating License	1	Botswana	JICA Botswana
	3-2-3	ENVI Orthorectification Module Floating	1	Botswana	JICA Botswana
	3-3	eCognition Developer	1	Japan	JICA Botswana
4. Hardware for GIS&RS	4-1	Desktop personal computers and additional monitor	4	Botswana	Project (JICA HQ)
	4-10	PDF software for view, create, manipulate, print and manage files in PDF	1 set (9 licences)	Botswana	Project (JICA HQ)
	4-11	Wireless broadband router	1	Botswana	Project (JICA HQ)
	4-2	Notebook computers	3	Botswana	Project (JICA HQ)
	4-3	UPS	7	Botswana	Project (JICA HQ)
	4-4	Network attached storage (NAS)	1 set (2TB x 6)	Botswana	Project (JICA HQ)
	4-6	A3 Colour Page Printers	1	Botswana	Project (JICA HQ)
5. Forest Inventory Sur	5-1	Handheld GPS navigators	5	Japan	Project (JICA HQ)
	5-2	Digital cameras	6	Botswana	Project (JICA HQ)
	5-3	Ultrasonic hypsometers (Vertex IV 360°	7	Japan	Project (JICA HQ)
	5-4	Laser hypsometers (TruPulse 360° Package)	7	Japan	Project (JICA HQ)
	5-5	Hypsometers BLUME-LEISS	4	Japan	Project (JICA HQ)
	5-6	Clinometers	4	Japan	Project (JICA HQ)
	5-7	Compass	6	Japan	Project (JICA HQ)
	5-8	Callipers	7	Japan	Project (JICA HQ)
	5-9	Digital callipers	4	Japan	Project (JICA HQ)
	5-10	Diameter tapes (synthetic fabric & steel)	11	Japan	Project (JICA HQ)
	5-11	Measuring tapes 50m	11	Japan	Project (JICA HQ)
	5-12	Measuring rope	4	Japan	Project (JICA HQ)
	5-13	Ranging rod	20	Japan	Project (JICA HQ)
	5-14	Tree Tags	24 sets	Japan	Project (JICA HQ)
	5-17	Hatchets	5	Botswana	Project (JICA HQ)
	5-18	Marking tapes	1 set	Japan	Project (JICA HQ)
6. Biodiversity	6-1	Trail camera	25	Japan	Project (JICA HQ)
	6-2	Waterproof binoculars	2	Japan	Project (JICA HQ)
	6-3	Field scope with digital camera (Digi-scope)	1 set	Japan	Project (JICA HQ)
	6-4	Single-lens reflex camera	1 set	Japan	Project (JICA HQ)
	6-5	Handheld digital thermo-hygrometer	1	Japan	Project (JICA HQ)
	6-6	Data logger for thermometer and hygrometer	1	Japan	Project (JICA HQ)
	6-7	Night vision scopes	1	Japan	Project (JICA HQ)
	6-8	Flashlights	1	Japan	Project (JICA HQ)
	6-9	Sample bottles	1 set	Japan	Project (JICA HQ)
	6-10	Insect Nets	1 set	Japan	Project (JICA HQ)
7. Project Management	7-1	Multi Function Printer (Scanning , Copying)	1	Botswana	Project (JICA HQ)
	7-2	Projector	1	Botswana	Project (JICA HQ)
	7-3	Notebook computers	1	Botswana	Project (JICA HQ)
	7-4	Desktop personal computers	1	Botswana	Project (JICA HQ)
8. Vehicles		Vehicles (02 Toyota Land Cruiser 76 SW)	2	Botswana	JICA Botswana

Appendix-5
CBNRM

Appendix-5-1 Action Plan of KyT to manage natural resource by using tree cover map and satellite imagery map

Appendix-5-2 Short list for the selection of CBNRM CBOs

Appendix-5-3 Long listed CBNRM CBOs

NFMS
BOTSWANA
JICA-DFRR/MEWT

THE PROJECT FOR ENHANCING NATIONAL FOREST MONITORING SYSTEM FOR THE PROMOTION OF SUSTAINABLE NATURAL RESOURCE MANAGEMENT

Action Plan of KyT to manage natural resource by using tree cover map and satellite imagery map

July 2017

Created by Department of Forestry and Range Resources, Ministry of Environment, Natural Resource Conservation and Tourism
and Japan International Cooperation Agency

1. Introduction

Kgetsi ya Tsie Women Resources Enterprise Community Trust (KyT) has been collecting Marula fruits and Gala la tshwene to make their product. But, according to the coordinator of KyT, Ms.Mmpi, the amount of these natural resource are decreasing. The reason is still unknown but, it is important for them to manage them sustainably.

The project for enhancing National Forest Monitoring System for the promotion of sustainable natural resource management (NFMS) has been implemented in Botswana since 2013, and some outputs of this project are already done, such as Botswana forest distribution map and establishing national forest inventory methodology.

Applying these outputs to the Community Based Natural Resource Management (CBNRM) activity is also one of the outputs of this project. KyT has been doing their CBNRM activity since 1997, and their achievements are abundant. Therefore, NFMS selected KyT as the pilot area of its' CBNRM activity. By implementing some survey, NFMS decided to create the wood cover map and satellite imagery map for KyT to manage natural resource in their area. The discussion and workshop were done on 15th November, 2016 and 16th February, 2017 for selecting the areas to create map for and to make the plan to manage natural resource by using the map.

2. Objective

The first objective of this action plan is to show how to manage natural resources in KyT area by using the tree cover maps and the satellite imagery maps based on the workshop done on 16th February, 2017.

The second objective is to show the activities of KyT. There are few resources to show their activities at present, and KyT sometimes face difficulty in explaining their activities to the visitors or people who are interested in KyT. Thus, this action plan can be a guide to show what they have done and are doing to outsiders. Also this action plan can be shared among members of KyT to know what they have done until now, because KyT is consisted of many villages and it is difficult for them to share information together among themselves.

In this action plan, first, it shows the activities of KyT. Second, it explains how to manage natural resources in KyT based on the content of the workshop.

3. The content of the activities of KyT

3-1. The Basic information in KyT area

Kgetsi Ya Tsie Women Resources Enterprise Community Trust (KyT) is located in Tswapong hill area and established in 1997. It is composed of 27 villages, and close to 832 members. The total population in 27 villages is close to 53000, and 75 % of the households of KyT members are female headed. Also KyT is composed of three regions, which is Central Region, North Region, and South Region.

Table 1 The population of three regions

KyT Region	MALE	FEMALE	TOTAL
Central Region (9 villages)	8,609	9,994	18,603
North Region (7 villages)	6,888	7,735	14,623
South Region (8 villages)	9,020	10,797	19,817
total	24,517	28,526	53,043

Source: Data provided by Central Statistics Office
Note: The population in the table represent only 3 out of 27 villages due to lack of statistics

The head office is in Lerala village (Central District), nearly 353km away from Gaborone, and about 45 minutes from Palapye by car. Except Tswapong hills, it " has mixed vegetation ranging from small bushed to dense savannah and mopane woodland[1]" and these area has mostly sandy-clay loams with slight surface crusting that are moderately fertile and suitable for crop farming[2]. Main ethnic group is Batswapong. The unemployment rate is 10.9% and south region is highest among three regions.

Table 2 The unemployment rate in the three regions

Region	Unemployment rate male	Unemployment rate female	total
Central Region	12.5%	6.6%	9.3%
North Region	11.1%	8.3%	9.5%
South Region	15.8%	12.2%	13.8%
Total (3 regions)	13.1%	9.0%	10.9%

Source: Central Statistics Office, 2011, Botswana
Note: The population in this table represents only 3 out of 27 villages due to lack of statistics.

[1] Motlhanka D.M.T. Nthoiwa G.P., 2012. *Ethnobotanical Survey of Medicinal Plants of Tswapong North, in Eastern Botswana: A Case of Plants from Mosweu and Seolwane Villages European Journal of Medicinal Plants3(1):10-24*

3-2. Detail of KyT Organisation

a. Mandate

KyT's mandate is to strengthen the local economy and livelihoods by gathering, processing, and marketing of veld products"[2]. The further goal is to empower women in Tswapong area socially and economically. According to the coordinator of KyT, working environment is not fully reserved for women in this area. Also it is difficult for them to raise their children while they work at the same time. Hence KyT pursues making a balance between those two. KyT also has the following long-term aims[2];

- Continue to develop the skills of KyT's members to run the trust themselves
- Ensure the long-term financial sustainability of the trust
- Improve the income-generating potential for KyT members
- Enhance the ability of members to play an active role in their own communities
- Manage and use the local natural resources in a sustainable manner

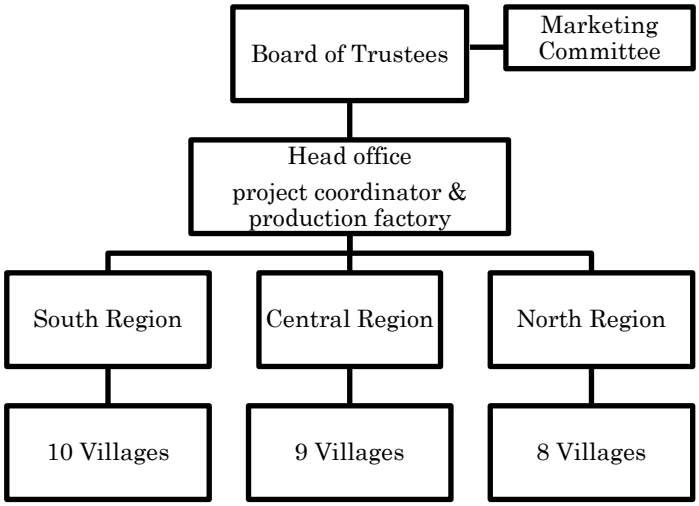
b. Structure of KyT

The board of trustees decides the policy of KyT. There are 10 boards of Trustees. Under the Board of Trustees, there is a project coordinator who usually works in a head office located in Lerala village. The head office is connected with the production factory and there are some oil expression machines to make Marula (*Sclerocarya birrea*) oil.

Marketing Committee advertises their products and activity. There are 3 members in this committee who sometimes go to some shops and supermarket outside of KyT and advertise themselves.

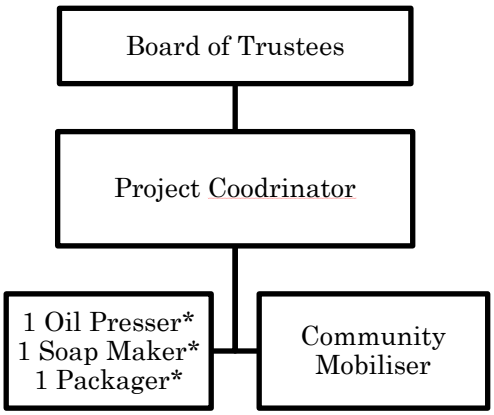
A project coordinator employs and instructs three part-timers intermittently for extracting Marula oil and making Marula soaps. There are community mobilizers who stay in each village and help the project coordinator when coordinator buys natural resources from villagers.

[2] Arntzen J., Buzwani B., Setlhogile T., Kgathi D.L., Motsholapheko. M. R. 2007. *Community-Based Resource Management, Rural Livelihoods, and Environmental Sustainability*, IUCN-South Africa Office and USAID Frame (Phase Three)



Source : Community-Based Resource Management, Rural Livelihoods, and Environmental Sustainability, Prepared for IUCN-South Africa Office and USAID Frame (Phase Three), March 2007and the interview

Figure 1 Structure of KyT



Note : * Part-time staff
Source : Community-Based Resource Management, Rural Livelihoods, and Environmental Sustainability, Prepared for IUCN-South Africa Office and USAID Frame (Phase Three), March 2007and the interview

Figure 2 Structure of the staff in KyT

A project coordinator also makes a lecture about social entrepreneur, prevention of HIV, and gender base violence in local primary school, high school, and college because trust considers economic and social independence of women and socially vulnerable people.

Table 3 The lecture of Project Coordinator

Place of lecture	Content of Lecture	Frequency
Moeng College,	Sexually Transmitted Disease, Gender Based Violence Entrepreneurship	1 / year
Lerala junior high school	Sexually Transmitted Disease, Gender Based Violence Entrepreneurship	2 / year
Primary school in Lerala	Sexually Transmitted Disease, Gender Based Violence	2 / month

Source: DFRR-JICA NFMS Botswana Project

c. The activity of KyT

Kyt's main activity is buying natural resources from members and selling products to the customers.

Table 4 Plants collected in the activity

	Setswana name	Scientific name	Main purpose	part to use	collection season
1	Marula	Sclerocarya birrea	Food	Fruit	March and April
2	Gala la tshwene	Myrothamnus flabellifolius	Medicinal	Leaf and stalk	all season
3	Monepenepe	Cassia abbreviata	Medicinal	Bark and root	all season

Source: DFRR-JICA NFMS Botswana Project

Photo 1 Marula tree and fruit in Lerala village

KyT members pick up the ripe fruits of Marula from the ground in season, February. After they harvest the fruits, they peel the skin followed by taking it inside out, squeezing the pulp, and getting the fruit juice. Approximately 20L (litre) of Marula juice can be produced from 80L of Marula fruits collected. The juice eventually turns into what they call "Beer" after fermented, which they sell to other villagers or customers. According to the consultant's survey, the seller sets the price of beer arbitrarily whose price ranges from BWP 0.50 to 4.00 in 750 ml.

After the pulps are squeezed, kernels are desiccated by sun drying, preserved until August, and cracked, after which white oil is extracted. The white oil is retailed to KyT

at about BWP 30 per kg. However, some members are encouraged to sell the oil in neighbouring towns such as Mahalapye, Palapye or even in South Africa, because of its high retailed price of about BWP 210 per kg. It is reported that some people earned more than BWP 1000 through the out-of-town business. There are lodges in Sherwood adjacent to the boundary between South Africa and Botswana, and the lodge staffs were reported to purchase the white oil at more than BWP 100 per kg in the past. The oil is popular in Botswana being used for a variety of dishes such as beef stew as a good seasoning.

Photo 2 Kyt member is squeezing Marula fruits

Photo 3 Marula fruits, juice, peeled fruit, peel of fruits (from left)

As the Marula beer or white oil generates such income, it is treated as valuable financial resource for KyT members. One women member S.G. indicated that Mopane worm also becomes an important income source for the members, as the worm sometime occurs in copious amounts. On the other hand, the annual production from Marula is reported to be stable with a certain amount being harvested every year. In that sense, Marula is considered to be more valuable than Mopane in supporting their livelihood.

Gala la tshwene (*Myrothamnus flabellifolius*) and Monepenepe (*Cassia abbreviata*) is used for medicinal purpose and sold to the customers without any processing.

Table 5 Amount of Marula oil exported to overseas

Year	Littre	Country
2003	800	France
2007	11	Germany
2007	11	UK
2009	150	US

Source: DFRR-JICA NFMS Botswana Project

Table 6 The price of products

Commodity	Unit	Price
Marula oil (normal)	1 L.	BWP 300
Marula oil (extra virgin)	1 L.	BWP 450
Marula soap	1 soap	BWP 10
Marula jam*	-	-

Note: * Marula jam was not sold in 2016.
Source: DFRR-JICA NFMS Botswana Project

A project Coordinator uses a public bus to go to each village and buy natural resources from members. In the season of Marula collection, she visits one village twice a month.

d. The revenue of KyT

The revenue of KyT has recently been low. There is less than BWP 2000 in their bank account as of November 2016. The table below shows the sales of veld products from August until October 2016. According to the project coordinator, expenditure exceeds income in this season.

Table 7 Sales of veld products from August until October 2016

Month-Year	Sales (BWP)	Breakdown
Aug-2016	504	Marula oil and Gala la tshwene
Sep- 2016	300	Marula oil
Oct-2016	270	Gala la tshwene
Total	1074	-

Source: DFRR-JICA NFMS Botswana Project

e. The history of KyT

KyT activities started in 1997. At that time, buying and selling Mopane worm were the main activity. But because Mopane worm has offensive odour when preserved, they stopped this activity and instead embarked on buying and selling Marula and other medicinal plants such as Gala la tshwene. At the same time in 1999, Micro-lending activity was started. The purpose of micro-lending activities is to make women members become more independent socially and economically by managing their own businesses. KyT provides BWP 500 to applicants with 2.5% interest. The applicants can use the money for their businesses such as running and managing their own grocery stores. If they can pay back the money, KyT provides additional BWP 750 at the second time, and BWP 1500 at the third. The project coordinator sometimes gave advice to members about their business. Because many members could not pay back the money, this activity was terminated in 2010.

Table 8 Major events in KyT

Year	Major events
1997	KyT was established and activities started with Mopane worm
1999	・Trust was legally registered in Deeds of Registry ・Micro-lending activity started ・Buying and selling Gala la tshwene, Monepenepe, Marula, and Marula jam were started
2001	Selling Marula oil, Marula soap were started
2002	The factory in Lerala village was established
2007	The lecture by project coordinator started

Source: DFRR-JICA NFMS Botswana Project

f. External funding and cooperation to KyT

Table 9 List of donorOrganisations to KyT

1	ADF	7	NEF
2	BHC	8	American Embassy
3	CFDP	9	UNDP
4	WAD	10	RESLIM
5	Labour Dept	11	PCI
6	GERICS(SASSCAL)	12	HPI

Note: ADF: African Development Foundation, BHC: British High Commission, CFDP: EU-Community Forestry Development Programme, WAD: Women's Affairs Department, GERICS (SASSCAL): The Climate Service Center Germany (Southern African Science Service Centre for Climate , Change and Adaptive Land Management), NEF: National Environmental Fund, UNDP: United Nations Development Program, RESLIM: USAID's Resilience in the Limpopo River Basin program, PCI: Project Concern International, HPI: Health Policy Initiative

Source: DFRR-JICA NFMS Botswana Project

Over 12 Organisations and program donated to KyT. ADF and Labour Dept started their donation from 1998. The latest donation will be done by NEF from 2017 until 2018.

g. Collaboration with University of Botswana

University of Botswana (UB) implements the projects on monitoring natural resources in KyT. There are two parts in this project, one is monitoring the natural resources including Marula and Mopane trees by using GPS, and the other is capacity building of the young local people to be able to get IT skill to manage monitoring data. They already started capacity building on September, 2016. The monitoring started in January 2017. There was a discussion between the consultants and UB staffs about utilizing the thematic map and the satellite imagery map created in the project for UB's project, and the map data are going to be handed by the beginning of March. Also UB staff participated in the discussions on selecting areas to buy satellite imagery for, which contributed to creating better maps for KyT members.

4. The action plan for managing natural resource in KyT

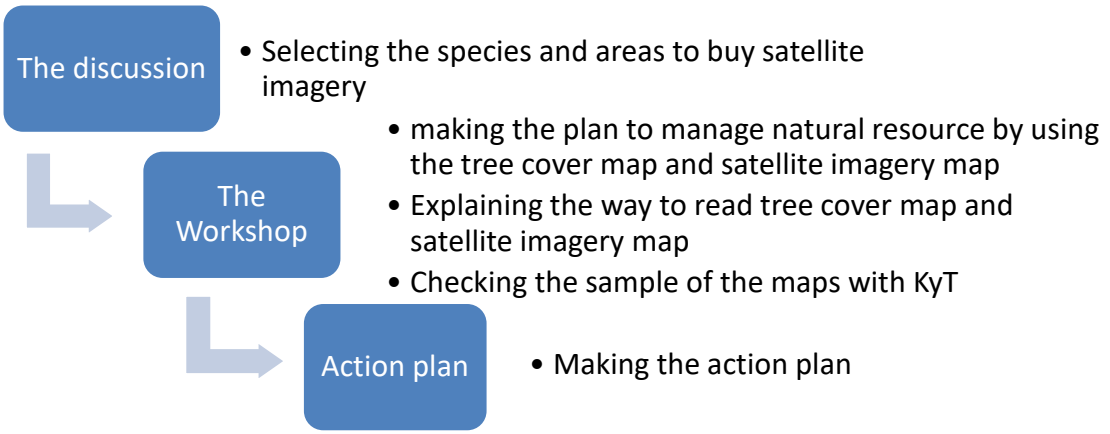


Figure 3 The step before making the action plan

To make the action plan was created, the discussion and the workshop were held. Figure 3 shows the step.

4-1. The discussion

Before the tree cover map and satellite imagery map were created, the discussions for selecting the areas to create the tree cover map and satellite image were held with the community members. The discussions were held on 15th November at KyT head office in Lerala village. The main content of the discussion were 1.The species of the natural resources to manage, 2. The areas to manage this natural resource. The participants list of these discussions is below.

Table 10 Participant list of the discussion

NAME	Affiliation	Position
Mooketsi Osekilwe	Lerala Village	Kgosi
Sebopelo Boitumelo	Lerala Village	Kgosi
Phodiso Koobonye	Lerala Village	Kgosi
Masego Mmipi	Kgetsi Ya Tsie HQ	Coordinator
Reuben Sebego	University of Botswana (Gaborone)	Lecturer
Onalenna Manene	DFRR (Gaborone)	Forest Officer
Tomoko Furuta	JICA Consultant Team	Forest Remote Sensing 3
Hiroshi Sasakawa	JICA Consultant Team	Forest Remote Sensing 2
Mulalu Mulalu	UB (Gaborone)	Lecturer
Bonana Kelebetse	Seolwane Village	Chairperson of Botalaote Centre (one satellite centre of KyT)
Mmakale Puoeng	Sefhare	Community Mobliser
Tebagano Kesebonye	Chadibe	Board member of KYT
Rechan Mathare	Lerala	Board member of KYT
Moipoledi Mathare	Lerala	Board member of KYT
Ezekiel Lekhutile	Serowe DFRR	Soil Surveyor
Kenaope Tantsidi	Lesenepole	Chairperson of KYT
Reo Watanabe	JICA Consultant Team	CBNRM / Facilitator of the meeting

a.The species of the natural resources to manage

The result of the discussion about the species, 12 important species are proposed in terms of their livelihood by the participants of the discussion. From 12 species, 5 species are selected as highly important species to be protected, which is Marula (*Sclerocarya birrea*), Gala la tshwene (*Myrothamnus flabellifolius*), Mosata (*Orthanthera jasminiflora*), Monepenepe (*Cassia abbreviata*), and Mopane (*Colophospermum mopane*) by the participants.

Table 11 The list of plants suggested in the discussion

	Setswana name	Scientific name	Main purpose	Part to use	Collection season
1	Marula*	*Sclerocarya birrea*	Food	Kernel and pulp	March and April
2	Gala la tshwene*	*Myrothamnus flabellifolius*	Medicinal	leaf and stalk	All season
3	Mosata*	*Orthanthera jasminiflora*	Food	Fruit and root	February
4	Monepenepe*	*Cassia abbreviata*	Medicinal	Bark and root	All season
5	Motlopi	*Bosicia albitrunca*	Food	Fruit	January and February
6	Mopane*	*Colophospermum mopane*	Food (Mopane worm)	Mopane worm	December and April
7	Motsikiri	*Motshikiri spp.*	for roof and broom	Everything except root	July until September
8	Mogwana	*Grewia bicolor*	food	Fruit	January and February

	Setswana name	Scientific name	Main purpose	Part to use	Collection season
9	Mmupudu	*Mimusops zeyheri*	food	Fruit	October and September
10	Mmilo	*Vangueria infausta*	food	Fruit	January and February
11	Moretlwa	*Grewia flava*	food	Fruit	December and January
12	Moretologa	*Ximenia americana*	food	Fruit	December and January

*means the plants are considered highly important among others in terms of the activity of KyT and communities' livelihood.

b. The area to manage selected natural resource

5 areas where the 5 plants chosen before grow wild were selected by the participants. These areas are shown in the next page.

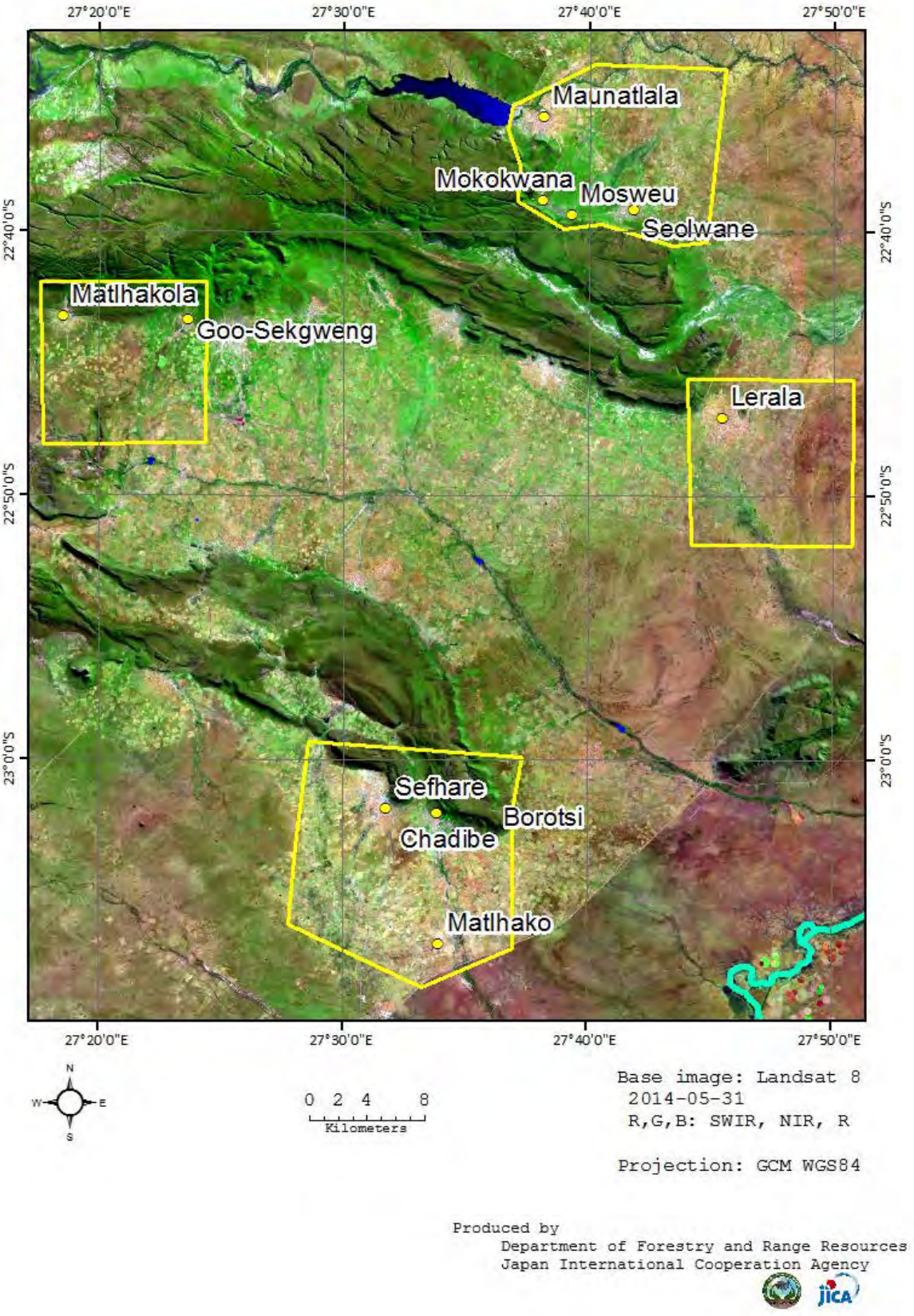


Figure 4 The map of selected area

Photo 4 Discussion for selecting the area to manage natural resource

4.2 The workshop

The objective of this workshop was 1. To make the plan to manage natural resource by using the tree cover map and satellite imagery map, 2. To explain how to read tree cover map and satellite imagery map, and 3. To check the sample of the maps with KyT members and JICA members to improve the maps. The workshop was held on 16th February, 2017 at KyT head office, in Lerala village. The participant list of this workshop is as below.

Table 12 Participant list of the workshop

NO	NAME	VILLAGE or ORGANISATION	POSITION
1	Odiitse Malekane	Matlhakola	Community mobiliser
2	Golayamang Lechaina	Moshopha	Community mobiliser
3	Tebagano Kesebonye	Chadibe	Vice Chairperson of KyT
4	Bonana Kelebetse	Seolwane	Chairperson in Seolwane group
5	Kesegofetse Kabelo	Mokokwana	Community mobiliser
6	Basuti Obonetse	Mosweu	Board member
7	Rachel Matlhare	Lerala	Chairperson in Lerala group
8	Kediegile Keeteletswe	Mosweu	Community mobiliser
9	Sarah Bosupeng	Lesenepole	Community mobiliser
10	Sophia Maila	Matlhako	Community mobiliser
11	Kenaope Tantsidi	Lesenepole	Board Chairperson of KyT
12	Onalenna Manene	Gaborone - DFRR	FRROI
13	Phetogo Selelo	Gaborone - DFRR	AFRRO
14	Agnes Ditau	Sefhare	Board Secretary of KyT
15	Mmakalo Puoeng	Sefhare	Community mobiliser
16	Namasiku Mufwanrala	Serowe	PFRROII

NO	NAME	VILLAGE or ORGANISATION	POSITION
17	Masego Mmipi	KyT Office	KyT Coordinator
18	Edward Kegaisang	Gaborone - JICA Forest	Driver of NFMS Project
19	Frige G. Seipholog o	Gaborone - JICA Forest	Driver of NFMS Project
20	Bathusi Mokganedi	Serowe	Driver DFRR
21	Reo Watanabe	Gaborone - JICA Forest	CBNRM (NFMS Project)
22	Furuta Tomoko	Gaborone - JICA Forest	FRS (NFMS Project)

※FRROI: Forest and Range Resources Officer I
AFRRO: Assistant Forest and Range Resources Officer
PFRROII: Principal Forest and Range Resources Officer II
CBNRM: Community Based Natural Resources Management
FRS: Forest Remote Sensing

In the workshop, the participants were divided into 4 groups and had a discussion about how to manage natural resources in KyT area (Lerala area, Sefhare area, Mokokwana and Maunatala Area, Mathakola Area) with the maps. These areas were selected based on the high number of participants. 5 topics were discussed in the workshop; (1) What kind of natural resources should be managed, (2) Where to be managed, (3) Who should manage, (4) How to be managed, and (5) When to be managed. The result of this workshop was adopted into the action plan to manage natural resource in KyT.

Photo 5 JICA member explaining about the satellite imagery

Photo 6 Participants are discussing in the workshop

Photo 7 After the workshop

4.3 The suggestion from JICA consultants how to use the maps

(1) How to use tree cover map

a. For making management plan of the trees

By using the tree cover map, the KyT can make a plan to manage trees because the map can help to overlook the place of the trees and share this knowledge among members.

b. For revising the map by adding GIS data

Additional GIS data can be added to the tree cover map (data version) by implementing inventories or every tree measurement by University of Botswana. The GIS data of the map has each trees data, so the new information such as the amount of production of fruits, the usage by community, the land property information can be added by additional inventory. Imputing these additional data can contribute to managing trees.

(2) How to use satellite imagery map

a. For making management plan of natural resources

The satellite imageries were used as the map to be able to grasp the distribution of the natural resources in the management area visually and share the information among KyT members.

b. For Ecotourism activity

JICA consultants found that there are some people who want to start ecotourism in the area of KyT. The satellite imagery map can be utilized for discussing about the land use for ecotourism with stakeholders. Also, there is a high possibility that an organisation has to be registered as a Trust to implement ecotourism. So the map can be used for showing the activity area of a Trust when they make a management plan.

c. For applying to donors

KyT had received funds from almost 12 donors. The consultant suggested to KyT using the maps for introducing the KyT area when they need to explain about their activities in the document applying to donors.

d. For clarifying land boundaries

The JICA consultant found that the recognition of the land boundaries among villagers in some areas of KyT is different. Then the JICA consultant suggested to KyT using the

satellite imageries for clarifying land boundaries and reconciling the recognition among them. Also the JICA consultant suggested to KyT villagers can propose their land boundaries to Land Board by using the imagery.

4.4 The action plan

Based on the result of the workshop, the action plan was created. To implement the plan, the wood cover map and the satellite imagery map can be referred to detect the place and share the area among members to manage the resource. The detail plan of each area is written below.

Lerala Area

(1) What kind of natural resources should be managed

- Marula (*Sclerocarya birrea*)
- Mophane (*Colophospermum mopane*)
- Motlopi (*Bosicia albitrunca*)
- Moretlwa (*Grewia flava*)

(2) Where to be managed

- Thakadiawa forest
- Lephaneng
- Mmabahumi
- Nakatsakgokong
- Mmakgabo
- Molapong
- Pakame
- Sekgarapaneng
- Sesulelwa
- Lotsane, and members' own field

(3) Who should manage

- Conservation Committee
- KyT members
- Village leaders
- DFRR staff

(4) How to be managed

- Make a permit system to go inside of the specific area of bush. The permit to be issued by relevant authority.
- Make guidelines on natural resource management and utilization.
- Planting tree every year
- Make botanical Gardens

(5) When to be managed

- Seasonally according to season for each plant species selected for management.

Sefhare Area

(1) What kind of natural resources should be managed

- Marula (*Sclerocarya birrea*)
- Gala la tshwene (*Myrothamnus flabellifolius*)
- Mosata (*Orthanthera jasminiflora*)
- Motopi (*Bosicia albitrunca*)

(2) Where to be managed

- Marula (*Sclerocarya birrea*) →Mathako
- Gala la tshwene (*Myrothamnus flabellifolius*) →Sefhare, Chadibe, Moshopha, and Borotsi
- Mosata (*Orthanthera jasminiflora*) →Moshopha
- Motopi (*Bosicia albitrunca*) →Sefare, Borotsi, Mathako, Chadibe, and Moshopha

(3) Who should manage

- KyT members
- Village leader (Kgosi)
- Village Development Committee (VDC)
- Farmers

(4) How to be managed

- Prohibit cutting plants, which are going to be managed.

(5) When to be managed

- The management will be started from March 2017.

Mokokwana and Maunatala Area

(1) What kind of natural resources should be managed

- Marula (*Sclerocarya birrea*)
- Gala la tshwene (*Myrothamnus flabellifolius*)
- Mosata (*Orthanthera jasminiflora*)
- Monepenepe (*Cassia abbreviata*)
- Mmupudu (*Mimusops zeyheri*)
- Mophane (*Colophospermum mopane*)

(2) Where to be managed

- Marula (*Sclerocarya birrea*) →*Mabanyana* (bush area) in Seolwane
- Gala la tshwene (*Myrothamnus flabellifolius*) →Metsimahibitshwane (hill area) in Mokokwana
- Mosata (*Stomatostemma monteiroae*) →Chebeng Hill (bush, hill, and forest area) in Mokokwana
- Monepenepe (*Cassia abbreviata*) →Mabalane Lands (bush area) in Mosweu
- Mmupudu (*Mimusops zeyheri*) →Makopong Dam (hill area) in Mokokwana
- Mophane (*Colophospermum mopane*)
  →Setshoumane Lands (bush area) in Mokwana, Mosweu, and Mabalane

(3) Who should manage

- KyT members
- Conservation Committee
- DFRR staff

(4) How to be managed

- Prohibit cutting plants, which are going to be managed.
- Cut dead trees not alive trees when people collect trees.
- Leave the roots when people harvest plants such as Gala la tschwene.

(5) When to be managed

- Marula (*Sclerocarya birrea*) →From January to March
- Gala la tshwene (*Myrothamnus flabellifolius*) →September or whole year
- Mosata (*Orthanthera jasminiflora*) →From March to May
- Monepenepe (*Cassia abbreviata*) →From August to September
- Mophane (*Colophospermum mopane*) →April and December

Matlhakola Area

(1) What kind of natural resources should be managed

- Mosata (*Orthanthera jasminiflora*)
- Marula (*Sclerocarya birrea*)
- Moretlwa (*Grewia flava*)
- Motlopi (*Bosicia albitrunca*)

(2) Where to be managed

- Mosata (*Stomatostemma monteiroae*) →Top of the hill in Matlhakola
- Marula (*Sclerocarya birrea*) →Surrounding area of Matlhakola
- Moretlwa (*Grewia flava*) →Surrounding area of Matlhakola
- Motlopi (*Bosicia albitrunca*) →Surrounding of the fields and inside of Mathakola village

(3) Who should manage

- Village Development Committee (VDC)
- Kgosi
- People who use natural resources

(4) How to be managed

1. Check the exact location where the plants, which are going to be managed grow
2. Research the growing environment of these areas
3. Monitor these plants

(5) When to be managed

- Mosata (*Orthanthera jasminiflora*)→From October to March
- Marula (*Sclerocarya birrea*)→From October to March
- Moretlwa (*Grewia flava*)→October
- Motlopi (*Bosicia albitrunca*)→November and March

N.	Name of CBO	Village name	District	Main Activity	supporting organisation
1	Mapoka VDC	Mapoka	North East	Land Reclamation	DFRR, FCB
2	Nhlapkhwane Lingilila Environment Conservation Trust	Nhlapkhwane	North East	Land Reclamation	DFRR, FCB, EU, GEF
3	Kgetsi ya Tsie Women Resources Enterprise Community Trust	26 villages includeLerala	Central	Selling Marula nuts and Marula products	DFRR,UB,FCB,EU,NFTRC,BCA
4	Nthantlhe VDC	Nthantlhe	Southern	Land Reclamation	DFRR
5	Kawii Development Trust	Khwee	Central	Breeding & selling wildlife animals, Monitoring natural resources	DFRR
6	Matsheng Community Trust	Shadi-Shadi, Loologane, Sojwe, Boatlaname, Lephephe	Kweneng	Selling Marula nuts and oil	DFRR, UNDP, GIZ, FCB, US embassy
7	The Zone 4 life	Kanye	Southern	Bee-keeping	Consumer Fare

Note:

VDC Village Development Committees
DFRR Department of Forestry and Range Resources
FCB Forest Conservation Botswana
EU European Union
GEF Global Environment Facility
NFTRC National Food Technology Research Centre
BCA Botswana College of Agriculture

N.	Name	Year established	Place / Village	Activity
1	Bosele Lake Ngami Conservation Trust	unknown	Sehitwa, Bothatogo, Legothwana	Conservation of birds and special avifauna
2	Botlhale Jwa Phala Community Development Trust	unknown	Otse	Producing fuel briquettes from waste paper
3	Botlhale Jwa Phala Conservation Trust	unknown	Lerala	Unknown
4	Bukakhwe Cultural Conservation Trust	2002	Gudigwa, Seshora	Preserving the cultural heritage
5	Cgaecgae Tlhabololo Trust	1996	XaiXai, Xaa, Qubi, Maun	Ecotourism
6	Chobe Enclave Conservation Trust	1994	Kasane, Kachikau, Mabele, Parakarungu, Satau, Kavimba,	Ecotourism (mainly on wildlife)
7	D'kar/Kuru Community Trust	unknown	D'kar	education, community mobilisation and empowerment
8	Gaing-O Community Trust	1997	Mmatshumo, Lekhubu island	Ecotourism
9	Huiku Community Based Natural Resources Conservation Trust	1999	Groot Laagte, Qabo	Wildlife management
10	Kalepa Conservation Trust	1996	Kasane, Kazungula, Lesoma, Pandamantenga	Unknown
11	Kgetsi ya Tsie Women Resources Enterprise Community Trust	1997	Chadibe, Goo Mosweu, Goo-Tau, Lecheng, Lerala, Lesenepole, Majwaneng, Malaka, Manaledi, Mathakola, Matolwane, Maunatlala, Mhalapitsa, Moeng, Mokobeng, Mookane, Mokungwane, Moremi, Mosweu, Pilikwe, Ramokgonami, Ratholo, Sefhare, Sekgweng, Seleka, Seolwane,	Collecting and selling natural resources
12	Khawa Kopanelo Development Trust	2001	Khawa	Safari based tourism
13	Khwai Development Trust	2000	Khwai	Photographic tourism, management of campsite and lodge, thatching grass and craft marketing
14	Koinaphu Community Trust	1999	Tshabong, Kokotsha, Inalegolo, Phuduhudu	Safari based tourism
15	Mababe Zukutsham Community Trust	1998	Mababe	Photographic tourism, management of campsite and lodge
16	MAHUMO Community Trust	2008	Maake, Hunhukwe, Monong	Safari based tourism
17	Manyana Community Trust	2006	Manyana	Unknown
18	Mapanda Conservation Trust	2002	Lepokole	Unknown
19	Matsheng Community Development Trust	2006	Boatlaname, Leogolane, Lephephe, Shadushadi, Sojwe	Collecting and selling natural resources
20	Mekgatshi Conservation Trust	2001	Sekoma, Kokong, Mahotshwane, Keng,Khomkhwa, Kanaku, Kutuku,	unknown

N.	Name	Year established	Place / Village	Activity
			Mabutsane, Khakhea, Itholoke, Morwamosu	
21	Mmadinare Development Trust	2001	Mmadinare	Manage local natural resources
22	Mmamotshwane Conservation Trust	unknown	unknown	Ecotourism
23	Mokopi Community Trust	unknown	Mopipi	Produce land use and rangeland resource management plans
24	MOLEMA Trust	2001	Motlhabaneng, Lentswe le moriti, Mathathane	Develop economic opportunities for the villagers
25	Moremi Manonnye Conservation Trust	1999	Moremi village	Ecotourism
26	Mowana Trust		Mokokwana, Mosweu	Promotes economic development
27	Nata Bird Sanctuary Trust	1992	Nata, Sepako, Maposa, Mmanxotae	Conservation of birds and ecotourism
28	Ngande Community Trust	2002	Khumaga	Support appropriate land use, development and needs of the population within the Khumaga area
29	Nqwaa Khobee Xeya Trust	1998	Ukhwi, Ncaag, Ngwatle	Safari based tourism
30	Ngwao Boswa Women's Co-operative	unknown	Gumare	Production and marketing of mokolwane baskets, domestication of mokolwane tree, woodcarving
31	Okavango Community Trust	1995	Gudigwa, Beetsha, Eretsha, Gunotsoga, Seronga	Photographic tourism, boat Ferry between villages
32	Okavango Jakotsha Community Trust	1999	Jao, Ikoga, Etsha 1, Etsha 6, Etsha 13	Photographic tourism
33	Okavango Kopano Mokoro Community Trust	1997	Ditshiping, Quxau, Daonara, Boro, Xaxaba, Xharaxao	Photographic tourism, management of campsite and gate fees, management of mokoro packages, grass, reedsand fish marketing, making and selling crafts
34	Okavango Polers Trust	1998	Seronga, Etsha 13, Gunotsoga, Mokgatsha	Tourism, sale of crafts, campsite and Chalets
35	Pandamatenga Lesoma Kazungula Community Trust	1996	unknown	Ecotourism and some cultural issues
36	Qangwa Community Trust	2014	Qangwa, Magopa, Dobe, Qooshe	Eco-cultural tourism, campsites
37	Qhaa Qhing Trust	2001	Zutshwa	Safari based tourism
38	Sankuyo Tshwaragano Management Trust	1995	Sankuyo	Photographic tourism, management of campsite and lodge
39	Xhauxhwatubi Community Development Trust	2002	Phuduhudu	Photographic tourism
40	Xwiskurusa Community Trust	1996	East Hanahai, West Hanahai, Kacgae	Community tourism and craft sales
41	The Zone 4 life	unknown	Kanye	Bee-keeping