Ministry of Forests and Soil Conservation
REDD-Forestry and Climate Change Cell

Development of a Measurement, Reporting and Verification (MRV) System for Emissions and Removals

Contract No.: FCPF/REDD/S/QCBS-7



MRV Full Cost Proposal Summary

April 2014

AGRICONSULTING S.p.A.

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REDD and Climate Change Cell

We would like to thank the whole REDD Cell Staff, in particular:
Mr. Resham Bahadur Dangi, Chief, REDD Cell;
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Dr. Narendra Chand, Policy and Program Planning officer, REDD Cell
who provided insight and expertise that greatly assisted the project

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Acronyms and Abbreviations

AFO:	Assistant Forest Officer
ANSAB:	Asia Network for Sustainable Agriculture and Bio resources
BAU :	Business as Usual Baseline
BZCFUGs:	Buffer Zone Community Forest User Groups
CBFM:	Community Based Forest Management
CBFMUGs:	Community Based Forest Management Users Groups
CCB:	Country Capacity Building
CF:	Community Forest
CFI:	Continuous Forest Inventory
CFOP:	Community Forest Operational Plan
CFUGs:	Community Forest User Groups
CoFM:	Collaborative Forest Management
COPs:	Conference of Parties
CSO:	Civil Society Organization
DBH:	Diameter at Breast Height
DBMS:	Database Management System
DDC:	District Development Committee
DFO:	District Forest Office/Officer
DFRS:	Department of Forests Research and Survey
DOF:	Department of Forests
ESMF:	Environmental and Social Management Framework
ESS:	Environmental and Social and Safeguards System (ESS)
FAO:	Food and Agricultural Organization of the United Nations
FAO FP	FAO Forestry Paper
FCPF:	Forest Carbon Partnership Facility
DSCO:	District Soil Conservation Officer
FECOFUN:	Federation of Community Forest Users Nepal
FGD:	Focus Group Discussion
FMU:	Forest Management Unit
FRA:	Forest Resources Assessment of Nepal Project
GHG:	Greenhouse Gas Emissions
GIS:	Geographic Information System
GLCN:	FAO/UNEP Global Land Cover Network
GPG:	International Panel on Climate Change: Good Practice Guidance
GPS:	Geographic Positioning System
ICIMOD:	International Centre for Integrated Mountain Development
IPs:	Indigenous Peoples
IPCC:	Intergovernmental Panel on Climate Change
LCCS:	Land Cover Classification System
LhFUGs:	Leasehold Forest User Groups
M and MRV:	Measurement and Monitoring, Reporting and Verification
MIS:	Management Information System

MRV:	Measuring, Reporting and Verifying
NAFIMS:	National Forestry Information Management System
NFCAG:	National Forest Carbon Action Group
NEFIN:	Nepal Federation of Indigenous Nationalities
NGO:	Non-Government Organization
NORAD:	Norwegian Agency for Development Cooperation
PSP:	Permanent Sample Plots
REDD:	Reducing emissions from deforestation and forest degradation
REDD+:	The REDD"+" is more than just avoided deforestation. It is tied to measurable and verifiable reduction of emissions from deforestation and forest degradation as well as sustainable management of forests, conservation of forest carbon stocks and enhancement of carbon stock
RL/REL:	Reference Emission Level
R-PP:	Readiness Preparation Proposal
SLMS:	Satellite Land Monitoring System
UNFCC:	United Nations Framework Convention on Climate Change
WISDOM:	Wood fuel Integrated Supply and Demand Overview Mapping
WWF:	World Wildlife Fund

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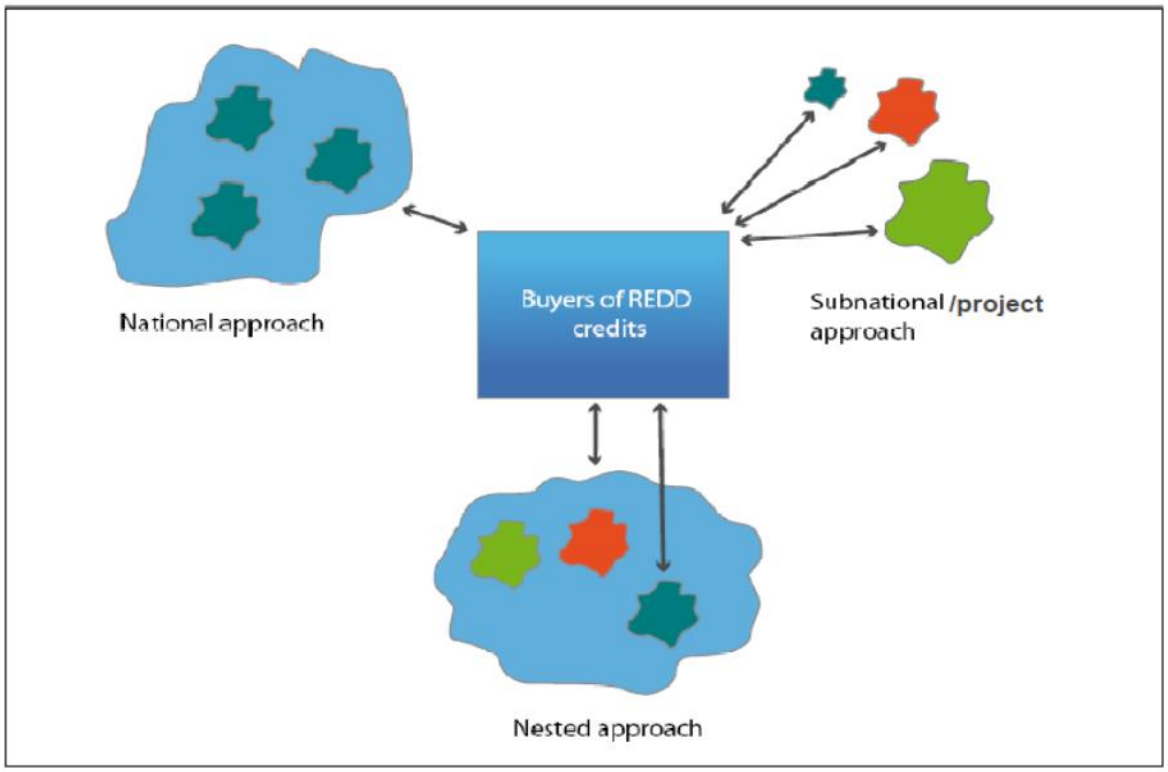
1. Introduction

1.1 Background

Nepal's national REDD+ strategy needs to build on the many community based forest management (CBFM) mechanisms being practiced since over three decades now. Over one third of Nepal's forests are under one or the other CBFM regime which clarifies the potential role of communities in Nepal's REDD+ implementation. CBFM and particularly the community forestry (CF) user groups have evolved as robust institutions with institutional arrangements and accumulated experiences of forest management planning and implementation. With realization of forest user groups' stake and potential role in REDD+, Nepal's R-PP has already justified the need of a hybrid (nested) approach which will enable the country to go for early participation in REDD+ at sub-national/local level while engaging in continuous improvement of its MRV institution and capacity for MRV system strengthening.

A nested approach is a flexible mechanism. It allows countries to start REDD+ efforts through sub-national activities and gradually move to a national approach, or for the coexistence of the two approaches in a system where REDD credits are generated by projects and governments, thus maximizing the potential of both approaches.



1.2 Description of the present assignment

The World Bank's Forest Carbon Partnership Facility (FCPF) is assisting Nepal with support to develop and apply strategies to address the drivers of deforestation and forest degradation.

Some of the key technical elements of REDD+ readiness work, namely, designing a Monitoring, Reporting and Verification (MRV) System (the present assignment), developing a Strategic Economic and Social Assessment Tool for REDD+ safeguards and developing a Reference Scenario are already on-going.

In this context, with Nepal moving ahead in the readiness phase, it needs to establish the organizational capacity to efficiently and sustainably operate a national forest carbon MRV program.

A reliable, credible system of measuring, reporting and verifying (MRV) changes in forest carbon stocks is a cornerstone of any national REDD+ scheme and MRV is a crucial part of a performance based REDD+ mechanism.

According to the country's R-PP , integrating the MRV system to include national, regional/district and management unit levels will enable accounting for REDD+ contributions at all levels thus allowing for equitable benefit sharing based on actual performance.

In this context the present assignment was aimed at:

- ✓ To assist the Nepal REDD Programme in the development of a comprehensive and detailed proposal for the continuous collection, analysis and verification of national data on forest-related carbon emissions and sequestration for implementation as part of REDD+ in Nepal.

Expected outputs were as follows:

- document the design and early implementation of an eventually coherent operational system of measuring and reporting changes in deforestation and/or forest degradation, and forest carbon conservation and carbon stock enhancement activities in Nepal;
- demonstrate the MRV system's capability to monitor the specific REDD+ activities as prioritised in Nepal's REDD+ strategy; the system must also enable the tracking of reversals of emissions reduction (i.e. non-permanence) and displacements of emissions (i.e. leakage);
- detail the MRV system's resolution, coverage and accuracy, and the carbon pools included; present an action plan to develop a fully operational system over time, including the required institutional arrangements and the existing vs. required capacities.
- present a 'Learning Plan for MRV' for capacity building that defines the remaining requirements for the implementation of the capacity building for MRV in terms of additional training activities, hardware and software.

Implementation of the MRV Project and output produced

The MRV Project had duration of 9 months, from June 2013 to March 2014. During this period the following working papers have been produced:

Working Paper Number	Title	Brief description
1	MRV Geographic Information System Data catalogue	Describes the spatial and statistical information collected and organized by the MRV Project.
2	Methodological approach of the MRV Project to REDD+ activities at local (CBFMUs) level	Methodological approach for MRV at sub-national and local level
3	Analysis of Institutional Structure for MRV System within Nepal's National REDD+, present Architecture	Analysis of Institutions related to MRV and REDD+ mechanisms.
4	MRV IT GIS Platform	Technical description of the prototype MRV IT GIS platform developed.
5	Case Study on Measurement and MRV Capacity Requirements of Communities, Local Forest Authorities and Other Stakeholders	Findings and recommendations from a case study on MRV implementation in two pilot local Communities.
6	WISDOM Nepal and contribution to MRV	Woodfuel Integrated Supply and Demand Overview Mapping for the whole Nepal. Includes fuelwood supply and demand balance, and its implications for forest degradation risk.
7	Remote Sensing for MRV: Activity Data Monitoring	Describes the proposed approach for monitoring activity data at National and Sub-National level, using Remote Sensing.
8	Nepal's MRV System Management Architecture: Structure, Functions, Human Resources and Capacities	Describes the proposed institutional architecture the future management of MRV.
9	IT platform user manual	Provides a user manual for operating the IT platform containing the prototype of the MRV System
10	MRV Full Costs Proposal	Summarizes the findings of the MRV proposal, including technical, institutional and financial requirements.
11	MRV Full Costs Proposal – Summary (this document)	Provides a synthesis of the full costs proposal

Scope of this document is to present a synthesis of the full cost proposal for an MRV implementation at national and sub-national level in Nepal.

Given the complexity of the tasks, for each element a dedicated working paper has been prepared, where the technical and institutional aspects are described in detail. What we present here is just a synthesis of our findings and results. Please refer to the 10 Working Papers in the list above for more details.
In this document, our findings and recommendations are organized in the following logical sections.

1. The MRV at National level
   - Institutional aspects
   - Technical aspects
   - Learning plan for the MRV
   - Estimated costs for the MRV at National level

2. The MRV at Sub-national level
   - The role of the Community Based Forest Management Users Groups
   - Institutional aspects
   - Technical aspects
   - Estimated costs for implementation of MRV at Sub-national level

3. Overall synthesis of MRV costs

2. The MRV at National level

2.1 Institutional aspects

2.1.1 Proposed Framework of National REDD+ Institutional Architecture

In order to ensure effective, efficient and transparent governance of measurement, monitoring and management of data under MRV system, the R-PP has envisioned that DFRS – the national MRV implementing agency, under the overall guidance of the Apex Body will be responsible for:

a) Periodic execution of forest assessments for deforestation and degradation monitoring;
b) Designing, maintaining and operating the National Forest Information Management System (NAFIMS);
c) Coordinating the collection of sub-national level information;
d) Disseminating NAFIMS deliverables through web portal;
e) Providing technical guidance and institutional/capacity support to the parallel institutional setups at sub-national/district/local community levels.

The sub-national, district and/or local government level MRV institutional setups will act as the implementing entities to implement the decisions taken by respective sub-national/District Forest Coordination Committees (DFCCs). These sub-national/district and/or local level entities will have a REDD Cell (as a new section) within the Regional Directorate and DFO structure.

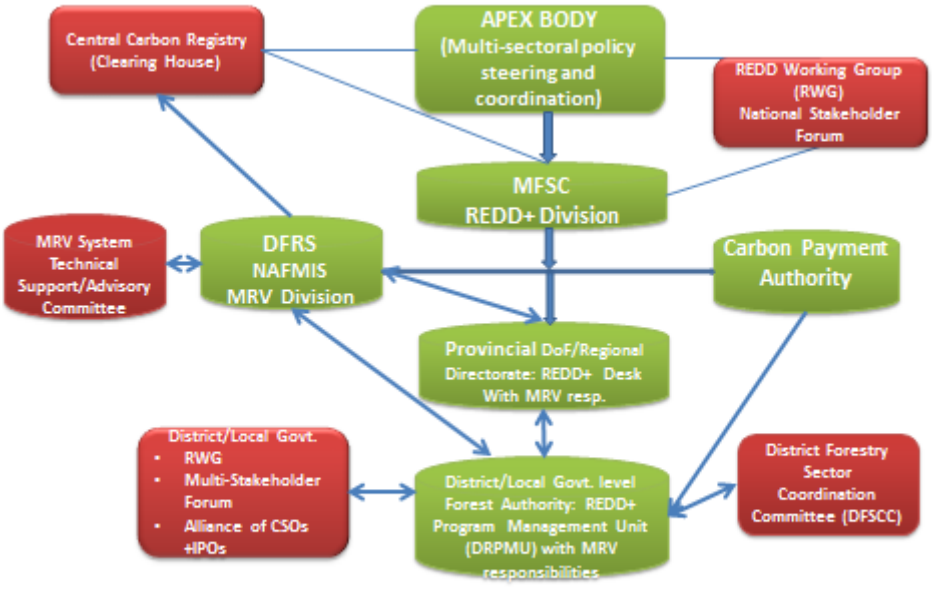
The REDD+ architecture proposed above, provides an institutional structure for MRV system. MRV will be one cabinet of a larger box of the national forest information management system (NAFIMS). FRA has developed Open Source Forest Information System (OSFIS). This system in its current stage manages the inventory data, spatial data sets and also has a standard platform for data dissemination. The OSFIS, however may not be considered as a full Management Information System as the system is primarily designed for the ongoing inventory only. It needs to be upgraded to enable continuous monitoring of the permanent sample plots with advance UIs and modules and database structure. The FRA project (2010/ 2014) is expected to deliver a national forest survey and

inventory mechanism including:

- Forest cover mapping producing geographically referred information on the forest cover, its extent and quality;
- Development of a Forest Information System including development of a geographically bound Forest Information System (FIS) which is able to deliver thematic maps through the internet.

Once the FRA project has phased out, a major task of the DFRS will be to take over the OSFIS developed by FRA Nepal, integrate the MRV structure and maintain, manage and upgrade it through procurement of most relevant technology and capacity in a planned manner. The NAFIMS will need to be maintained, managed and updated based on GIS/remote sensing based periodic forest cover mapping and updating the FIS based on periodic field verification of data in permanent sample plots.

An institutional framework for MRV system under the NAFIMS is proposed in the flow chart below:



National REDD+ Architecture of Nepal

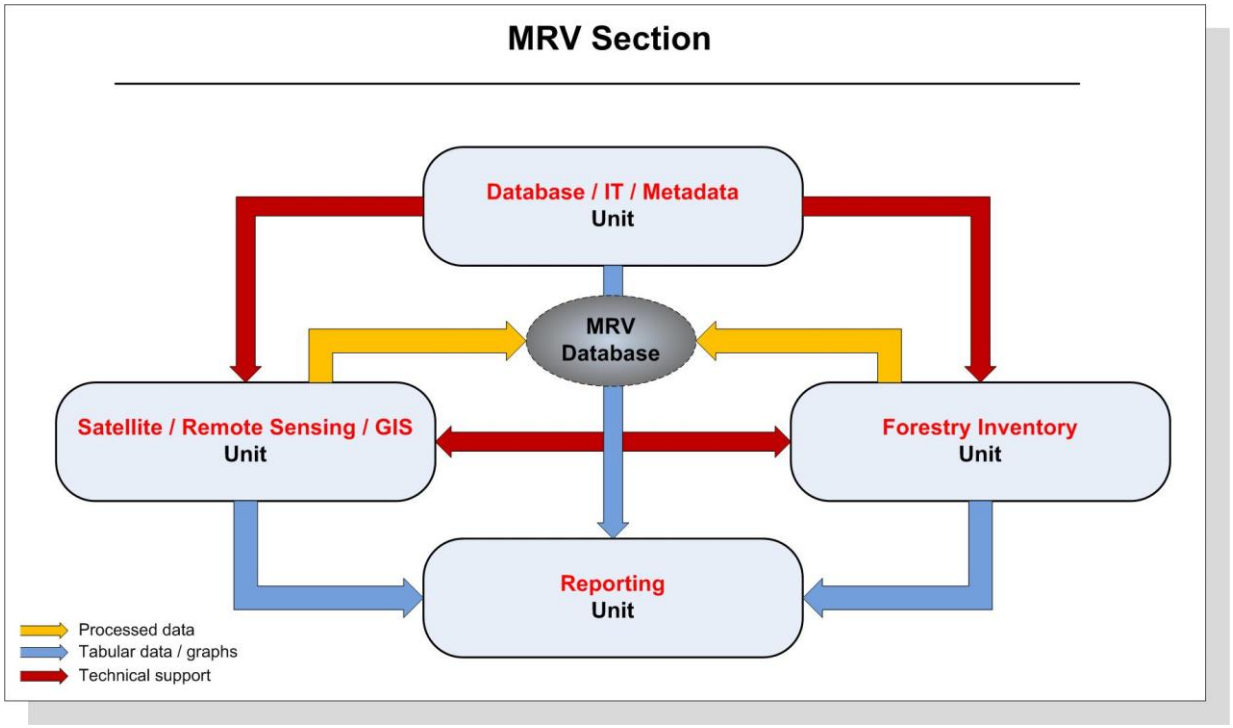
Proposed in line with R-PP

2.1.2 Key tasks for effective operationalization of MRV System.

Under the Survey Division (which is most likely to have NAFMIS and MRV operationalization, maintenance and management responsibilities) of DFRS, a MRV section will be responsible for organizing all MRV related functions from national to sub-national and to district/local levels and managing the MRV professionals. This section will be coordinated by a MRV coordinator who will have dual reporting responsibility – reporting to the divisional head in DFRS and also to the REDD division in the MoFSC. MRV section will manage and maintain the MRV system and also promote data dissemination about the project(s).

MRV section will require four independent but closely connected units, namely

1. Database/IT/Metadata Unit
2. Remote Sensing/GIS Unit
3. Forestry Inventory Unit
4. Reporting Unit.



The Database / IT / Unit (DBIT):

This is technically the core unit where 1 (one) System Administrator and 1 (one) DB Expert will work. Additionally, both professional should be on a part time basis (6 man \ months per year each) and their expertise should be shared with other units (e.g. FRA, NAFMIS).

The DB administrator will be responsible for managing and maintaining the MRV database structure (tables, relationships, keys) and assigning privileges and roles to different kind of users (public, editor, stakeholder, etc.), within the rules and protocols defined by the MRV Division.

The System Administrator manages and maintains the IT web platform interface, server system, OS, firewalls, web services, connections and software updates as well as the Web Content Management.

This DBIT unit provides support for graphs and tabular/aggregated data to Reporting Unit upon request.

2.5.3 The Remote Sensing / GIS Unit (RSGIS)

RSGIS Unit will be responsible for image processing and analysis to produce Land Use/Land Cover classification layers and perform GIS editing and analysis. It will ensure data integrity in MRV database. It will undertake change detection in different forestry classes and categories using multi-temporal satellite images, DEM and other ancillary data. Once LU/LC layers have been produced (and validated) they will be uploaded into the MRV database. The Unit is also responsible for REL and WISDOM data entry and spatial data integration in the MRV system and should be able to provide tabular data and graphs to Reporting Unit on request.
This unit will have 2 RS specialist, 2 RS technicians, 1 GIS specialist and 1 GIS technician and could also take advantage of technical support from the DBIT and FORINV Unit for specific tasks.

2.5.4 The Forestry Inventory Unit (FORINV)

FORINV will be responsible for undertaking forest inventories nationally and coordinating inventories at sub-national district/local governance unit level to estimate GHG emissions using very specific algorithms and models applied to local data collected at district/local governance unit level. Once GHG estimates have been produced (and validated) they will be loaded into the MRV database. It will require 2 Forestry Experts for the management of this unit.

The Unit could also take advantage of technical support from the RSGIS and DBIT Unit for specific tasks. Graphs and tabular/aggregated data should be provided to Reporting Unit upon requests.

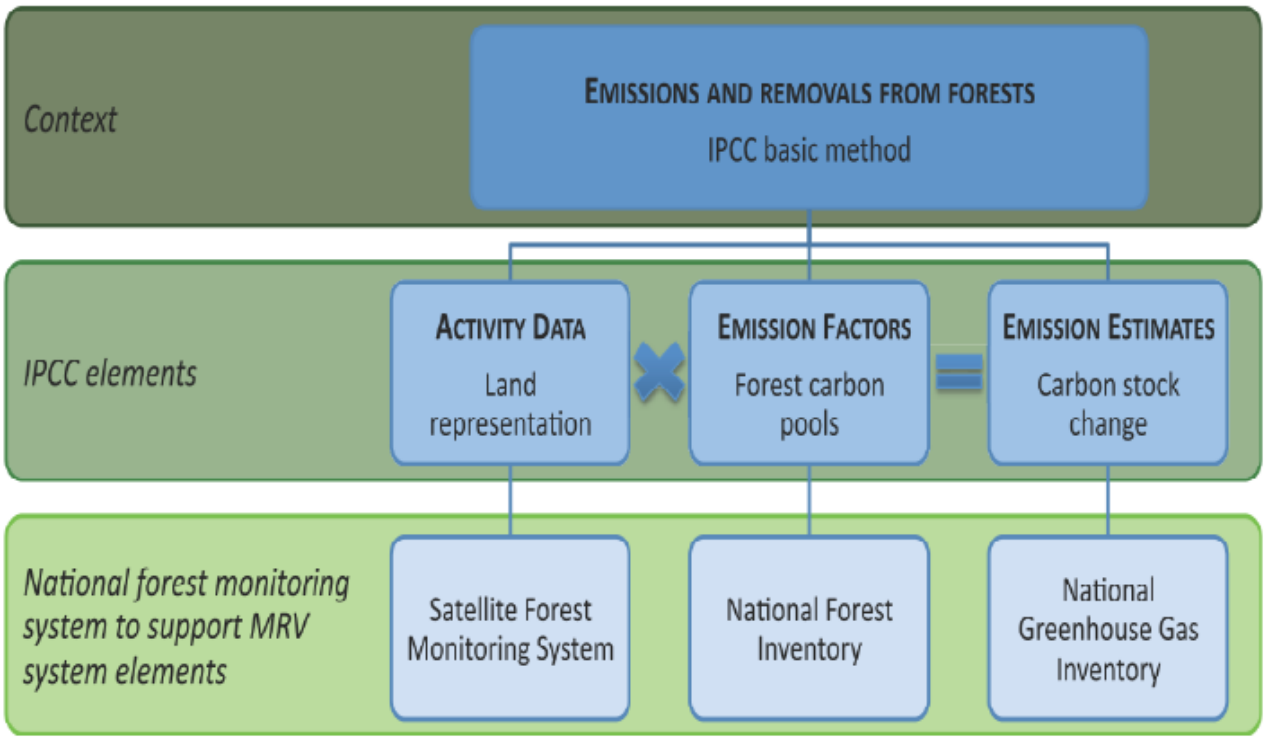
2.5.5 The Reporting Unit (REP)

This Unit provides periodic standard MRV reports (consistent with the reporting requirements outlined in the UNFCCC guidelines1) for dissemination of aggregated data and information, collecting the necessary info by the other three Units.
Reporting is a key element of MRV as it provides the means by which, the country's performance is assessed against its commitment or reference scenarios in future REDD+ mechanisms. Hence, it provides the basis for assigning incentives. Human resources needed to manage this Unit are 1 REDD-MRV expert.

[1] See the "MRV Manual", by FCMC (October 2013)

2.2 Technical aspects for the National MRV

The Measurement component of the MRV system consists of data, procedures, protocols and tools to monitor human activities and their impact on forests, providing quantitative estimations of human-induced carbon stock changes. The three pillars of this component are reported in the figure below.



2.2.1 Estimation of Activity Data

A national monitoring system provides the foundation for reporting and to verify that the all the forest-related or REDD+ activities at every level have a positive effect as regards human impact on forest carbon. To achieve this result the monitoring system (i.e. the MRV) must be capable to measure changes in forest area throughout all forests within a country's boundaries (the so-called wall-to-wall approach). Nationwide monitoring is needed to avoid displacement or leakage within a country where reduced deforestation could occur in one portion of the country but increase in another. Fundamental requirements of monitoring systems are that they measure changes throughout all forested area within the country, use consistent methodologies at repeated intervals (i.e. reporting time, which at the moment should be every two years) to obtain accurate results, and verify results with ground-based or very high resolution observations.

According to our analysis, the best methodology at national level can be synthesises as a temporally and spatially explicit national land cover change assessment and conversion between classes through a wall-to-wall mapping approach based on Landsat images classified with a limited number of classes using a hybrid approach that combines automated image segmentation with visual interpretation with a minimum mapping unit of 5 hectares, to be repeated at every reporting time (e.g. 2 years) and a with a specific protocol for the accuracy assessment.

The analysis will be carried out by the Remote Sensing/GIS unit of the MRV section at central level. The methodology also include the definition of a baseline map (probably related to 2010), that should be coordinated with the forest map produced by the FRA project and the result of REL project. A more general harmonization process should be planned with REL data once the results will be officially available and adopted by the REDD cell.

The first option among the available **data sources** for a national monitoring of forest cover and forest cover change is Landsat data (30 m resolution). Landsat has the advantage to be freely available for years 1990, 2000, 2005 and 2010, thus allowing a consistent data set that can be used also for the definition of historical trends. From 2013 on, Landsat 8 provides a complete coverage of the country every 2 weeks. Some pre-processing is needed to assemble a national mosaic, but no resources are needed for the data acquisition. The resolution permits to monitor forest cover changes with 1 to 5 ha Minimum Mapping Unit (MMU). Landsat is also the data source used by most national projects on forest monitoring. These data allow assessing changes of forest areas and producing a benchmark map of national forest area (to derive deforestation rates).
A possible alternative (or integration) to Landsat are Rapid Eye images (5 m resolution). These have been used by FRA project and a complete coverage for 2010 exists for Nepal. The acquisition of a complete coverage of the whole country for a single date is around 130,000 dollars. This would have a number of advantages:

1. better resolution;
2. data are provided with all the pre-processing steps performed;
3. data can be used for sub-national (e.g. local) level.

On the other side, Rapid Eye also implies some disadvantages:

1. they are not free;
2. no long time series is available for historical analysis;
3. remote sensing data analyses become more difficult and more expensive with smaller Minimum Mapping Units (MMU), i.e. more detailed MMU's increase mapping efforts and usually decrease change mapping accuracy and the largely increase the processing time.

The two data sets can be integrated, for example using Landsat data for the national assessment and Rapid Eye to validate the result and to closely monitor hotspot of deforestation or areas directly affected by REDD+ related management measures.

The **classification method** recommended for MRV Nepal is a hybrid approach combining automated digital segmentation with visual interpretation and validation of the resulting spatial objects.

2.2.2 The MRV proposal for a Continuous Forest Inventory

The experience of FRA Nepal constitutes a major landmark for forest inventories in Nepal. FRA Nepal has developed a modern technique of forest inventory, using appropriate scientific methods and a statistically sound approach. So it is natural to implement a CFI based on the same approach and methods used by FRA Nepal.

In particular the same sample plot design should be implemented with 4 concentric plots for tree measurement and sub-plots to assess the status of seedlings, saplings, shrubs and herbs other than

trees. Homogeneity in the field measurements is essential for assuring comparability of the results, which is an essential pre-requisite for MRV.

Sampling intensity

For the Continuous Forest Inventory design in the context of MRV it is proposed to revisit 1'000 FRA Nepal field plots over a cycle of 5 years i.e. to measure 200 plots in the field every year. The number of 1,000 PSP is somehow arbitrary. The main reasons for proposing 1,000 PSP was based on the following considerations:

The number of plots in a forest inventory is generally based on the following principles:

- The level of precision required, and
- The variance of the variables to be estimated.

In our case the minimum desired level of precision is ± 10% at 95% probability. However the overall variance of key variables (like for instance Total Aboveground Biomass), is not yet known, as it should be calculated by FRA Nepal inventory, which is not yet completed. In the absence of a complete variance estimate, some proxies were used, as follows:

1. The experience of FRA Nepal has shown that field work in Nepal is difficult, due to terrain conditions and poor accessibility. For this reason the number of 1'000 plots seems a good compromise between the required statistical precision and a realistic annual work load for the field crews.

2. Regarding the statistical precision of the results, the NFI of 1994 achieved a precision of ±6% for the Hilly Area (including Siwaliks, Mid-hills and Mid-Mountains) with 600 plots, which is compatible with the proposed sampling design.

3. Finally, the proposed sampling intensity can be compared with the present CFI on-going in India. The extent of forests of India is estimated at around 69 Million ha (Forest Survey of India). The CFI of India is measuring a total of 8'000 PSP. So one plot is established per 8'625 ha of forests.

4. In the case of Nepal it is proposed to measure both forests and other wooded land (mainly shrubs). The reason being that in a perspective of Carbon stock monitoring the transition from forests to shrubs (or vice versa) must be fully accounted in the Carbon balance and related emissions. So field data for estimating Carbon stocks are necessary for other wooded land as well. Assuming an extent of forests + other wooded land of around 6 Million ha for Nepal, each of the 1,000 plots will represent 6'000 hectares of wooded land, which is more intense than the design used in India.

Implementation

As discussed earlier, the present proposal suggests the establishment of 1'000 PSP on a cycle of five years, with 200 different sample plot re-measured every year. The decision of which of the FRA plots will be re-measured in the MRV CFI design is difficult to formulate now. Only when the final results of FRA are available a sound judgment of which plots are more representative can be made.

Additional criteria for the PSP selection could be to sample with greater intensity the areas that are more subject to deforestation, if reliable REL data are available. In this case a Probability Proportional to Size could be adopted. To help in the PSP selection process also the results of the WISDOM model, highlighting area likely to be subject to anthropic pressure for fuel wood demand could be used.

In our proposal we suggest that the field work should be carried out by 10 crews. Using these calculations the number of man/month needed for one field crew to measure the required number of sample plots is annually of 17 man/crew. With the deployment of 2 crew per each Development Region (Total of ten field crews), the annual time to be spent in the field for each annual CFI campaign would be of around two months per year.

After the completion and validation of the field work the results will be integrated in the MRV database where the number of observations will continuously grow over time, thus gradually improving the precision of the results.

This information will form the basis for the estimation of emission factors, which will be coupled with activity data to produce a National GHG inventory.

Besides the data on Carbon emissions the CFI will also produce auxiliary information useful for forest management and forest and land use planning, such as: tree growth and yield, forest degradation or forest enhancement, status of regeneration, etc., which can be later integrated in the NAFMIS.

2.3 Learning plan for the MRV

At National level we propose that the MRV implementation will be carried out by the Central MRV Section to the created within DFRS as a new structure, with the following roles and responsibilities:

MRV section will require one Coordination unit and four independent but closely connected units, namely:

1. Database/IT/ Unit
2. Remote Sensing/GIS Unit
3. Forest Inventory Unit
4. Reporting Unit.

For each unit the MRV Project proposal has clearly identified the benchmarks professional skills that are defined as follows:

Coordination Unit
Expert: MRV Coordinator
Quantity: 1
Role:

- Submits data and reports to REDD Cell.
- Coordinates activity from DFO to central MRV Section.

Expertise / Skills

- Knowledge of MRV REDD+ Guidelines
- Ability to manage and coordinate experts

Job duration: Full time

Database/IT/ Unit

Expert: DB Expert
Quantity: 1
Role: DB administrator manages and maintains MRV database structure (tables, relationships, keys) and assign privileges and roles to different kind of users (public, editor, stakeholder, etc.), according to what REDD Cell defined.
Expertise / Skills

- PostgreSQL / PostGIS
- DBMS performance
- SQL
- Stored Procedures

Job duration: Part time (six man/months per year)

Expert: IT Platform Expert / System Administrator
Quantity: 1
Role: Manages and maintains the IT web platform interface, connections and software updates.
Expertise / Skills

- Linux System installation and upgrade management
- Linux based web server platform (Apache http, Tomcat)
- Object Oriented Programming
- Java
- CMS (liferay, alfresco, wordpress, plone, zoomla, etc.)
- Web applications (GeoServer, GeoNetwork, NFMS)
- Portlet
- Single Sign On
- Object Oriented Programming
- Junit
- Web content management

Job duration: Part time (six man/months per year)

Remote Sensing/GIS Unit

Expert: Remote Sensing specialist
Quantity: 2
Role:
Together with GIS expert they are responsible for land cover and land cover change assessment, spatial data integration in the MRV system at national and sub-national level.
Expertise / Skills

- Remote Sensing software
- Image pre-processing
- Visual interpretation
- Supervised and unsupervised classification
- Image segmentation
- Accuracy assessment
- Knowledge of the Forestry Sector
- GIS

- Spatial modelling

Job duration: Full time

Expert: Remote Sensing technician
Quantity: 2
Role:
They give technical support to RS specialists in the image classification and land cover change assessment
Expertise / Skills

- Remote Sensing software
- Image pre-processing
- Visual interpretation
- Supervised and unsupervised classification
- Image segmentation
- Accuracy assessment
- Basic of GIS

Job duration: Full time

Expert: GIS specialist
Quantity: 1
Role:

- Together with RS experts he is responsible for data collection and harmonization, entry and spatial data integration in the MRV system.
- Manages GIS data in desktop environment doing geometric and attribute edits, spatial analysis, preparing legends and symbology, providing static maps for printing.
- Manages and maintains the Metadata Catalogue: updates of metadata in OGC standard format, manages and tunes the GeoNetwork platform to keep Metadata Catalogue updated and consistent.
- Uploads and updates spatial data in the MRV central database, connected to GeoServer and GeoNetwork platforms

Expertise / Skills

- GIS advanced level
- Vector editing
- Spatial analysis
- Attribute editing
- Create map layouts
- Open Geospatial Consortium metadata standards
- XML
- GeoNetwork and GeoNetwork platform

Job duration: Full time

Expert: GIS technician
Quantity: 1
Role: He/she will support the GIS analyst for the technical work related to spatial analysis and modelling, spatial data editing and map composition
Expertise / Skills

- GIS
- Vector editing
- Spatial analysis

- Attribute editing
- Create map layouts

Job duration: Full time

Forest Inventory Unit

Expert: Forestry Experts
Quantity: 2
Role:
Forest Inventory design, coordination of field work and data processing for estimating emission factors and GHG emissions both at national and sub-national level.
Expertise / Skills

- Sampling design
- Forest inventory
- Forest mensuration
- Statistical analysis
- Reporting

Job duration: Full time

Reporting Unit

Expert: MRV - REDD+ Expert
Quantity: 1
Role:
Provides periodic standard MRV reports (consistent with the reporting requirements outlined in the UNFCCC guidelines) for dissemination of aggregated data and information.
Expertise / Skills

- REDD /MRV Guidelines and methodology
- Biometry
- Statistics
- Quality Control

Job duration: Full time

According to this plan a total of 12 Experts are needed to efficiently run the proposed MRV System at National level, whose Terms of Reference and related skills are detailed above. It is now up to the DFRS to evaluate which of the expertise and skills are already available in-house, especially after the completion of FRA Nepal Project, which skills still need to be developed through on the job training by skilled experts (National or International, depending on the expertise required and available) and which skills are not likely to be available and should be better outsourced. In our vision, there are two high technical positions which are not likely to be available within DFRS, namely the DB Expert and the IT Expert. In this case the solution to outsource these two posts could be the most convenient, keeping in mind that these two Experts are needed on a part time basis and their salaries could be shared with other DB / IT activities within DFRS. In this respect the possible synergies with existing Project are elaborated in the next Section of this document.

The problem of training professional Experts and then retaining them once they have acquired skills that can be better remunerated by the private sector is common to all developing countries, and has

no easy solution. Performance based incentives or outsourcing of services are two possible alternatives, however these are political decision to be taken by MFSC and are outside the scope of this consultancy.

However, since the decision whether to outsource the services or to rely on improved institutional capacities have implication on the costs, two scenarios are elaborated in the costs section, one based on outsourcing and one based on existing institutional resources.

In all cases, given the complexity related to the functional implementation of an MRV System, a technical assistance component is foreseen. Ideally the technical assistance should be stronger during the early implementation phase of the MRV, and should gradually decrease over time, when national capacity has been built.

2.4 Estimated costs for the MRV at National level

Given the complexity of implementing an MRV System at national level, different alternatives can be undertaken depending on financial, technical and institutional constraints. In our case to the extent possible for each activity a minimum and maximum cost have been calculated and described in this section.

The costs calculated for the MRV implementation at National level include:

1. Institutionalization of the MRV Section
2. Activity data (Remote Sensing and GIS)
3. Emission factors (the Continuous Forest Inventory)
4. Special study on biomass equations

The costs have been calculated for the initial MRV operational period of five years.

Estimated costs for the MRV implementation at national level

(Unit: US$)

Activity / Sub-activity	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
	min	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
Institutionalisation of the MRV Section											(1)	(2)
Coordination Unit	3,600	10,800	3,600	10,800	3,600	10,800	3,600	10,800	3,600	10,800	18,000	54,000
IT and DB Unit	3,000	9,000	3,000	9,000	3,000	9,000	3,000	9,000	3,000	9,000	15,000	45,000
Remote Sensing and GIS Unit	17,400	52,200	17,400	52,200	17,400	52,200	17,400	52,200	17,400	52,200	87,000	261,000
Forest Inventory Unit	6,000	18,000	6,000	18,000	6,000	18,000	6,000	18,000	6,000	18,000	30,000	90,000
Reporting Unit	3,000	9,000	3,000	9,000	3,000	9,000	3,000	9,000	3,000	9,000	15,000	45,000
Equipment and running costs	24,000	24,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	72,000	72,000
Sub-total Institutionalisation of the MRV Section	57,000	123,000	45,000	111,000	45,000	111,000	45,000	111,000	45,000	111,000	**237,000**	**567,000**
Activity data (Remote Sensing and GIS)											(3)	(4)
Image procurement	10,000	65,000	10,000	65,000	10,000	65,000	10,000	65,000	10,000	65,000	50,000	325,000
Field verification	10,000	50,000	10,000	50,000	10,000	50,000	10,000	50,000	10,000	50,000	50,000	250,000
Sub-total Activity data (Remote Sensing nag GIS)	20,000	115,000	20,000	115,000	20,000	115,000	20,000	115,000	20,000	115,000	**100,000**	**575,000**
Emission factors (the Continuous Forest Inventory)												
Field work	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	1,500,000	1,500,000
Equipment / vehicles (5)	500,000	500,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	700,000	700,000
Quality control of field work on 7% of field plots	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	105,000	105,000
Sub-total Emission factors (the Continuous Forest Inventory)	821,000	821,000	371,000	371,000	371,000	371,000	371,000	371,000	371,000	371,000	**2,305,000**	**2,305,000**
Technical Assistance	270,000	270,000	270,000	270,000	180,000	180,000	180,000	180,000	180,000	180,000	(6) **1,080,000**	**1,080,000**

Activity	Sub-activity	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
		min	max	min	max	min	max	min	max	min	max	min	max
Special study on biomass equations		0	250,000	0	250,000	0	0	0	0	0	0	(7) **0**	**500,000**
Grand total for MRV at National level		**1,168,000**	**1,579,000**	**706,000**	**1,117,000**	**706,000**	**1,117,000**	**706,000**	**1,117,000**	**706,000**	**1,117,000**	**3,722,000**	**5,027,000**

Notes:

(1) The minimum costs for institutionalisation of the MRV Section are based on GoN Salary schedules.
(2) The maximum costs for institutionalisation of the MRV Section are based on expected fees for performance based incentives or outsourcing of the services.
(3) The minimum costs for RS implementation are based on acquisition of LANDSAT imageries (30 meters resolution).
(4) The maximum costs for RS implementation are based on acquisition of Rapid Eye imageries (6.5 meters resolution).
(5) The costs for equipment and vehicles are expected to be undertaken in first year. For the following years only maintenance costs are foreseen.
(6) Technical assistance (TA) needs will depend on the capacity reached by national actors. At this stage TA needs are budgeted assuming 6 m/m for 3 international experts for on the job training in the field of DB/IT, RS and Forest Inventory for the first two years and 2 m/m for the successive years.
(7) The budget for the special study on biomass equations is based on a binary option i.e.0. Minimum: no study, 1. Maximum: full study.

The financial plan for MRV implementation at national is expected to be between 3.7 and 4.9 Million US Dollars for a 5 year cycle and can be further summarized as follows:

(Unit: US$)

Activity	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
Proposed budget	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
Institutionalisation of the MRV Section	57,000	123,000	45,000	111,000	45,000	111,000	45,000	111,000	45,000	111,000	**237,000**	**567,000**
Activity data (Remote Sensing and GIS)	20,000	115,000	20,000	115,000	20,000	115,000	20,000	115,000	20,000	115,000	**100,000**	**575,000**
Emission factors (The Continuous Forest Inventory)	821,000	821,000	371,000	371,000	371,000	371,000	371,000	371,000	371,000	371,000	**2,305,000**	**2,305,000**
Technical Assistance	270,000	270,000	270,000	270,000	180,000	180,000	180,000	180,000	180,000	180,000	**1,080,000**	**1,080,000**
Special study on biomass equations	0	250,000	0	250,000	0	0	0	0	0	0	**0**	**500,000**
Grand total for MRV at National level	1,168,600	1,579,800	706,000	1,117,000	616,000	777,000	616,000	777,000	616,000	777,000	**3,722,000**	**5,027,000**

3. The MRV at Sub-national level

3.1 The role of Community Based Forest Management Units (CBFMU)

Nepal's R-PP envisages local level implementation of specific REDD+ activities wherever CBFMU areas exist. REDD+ initiatives and regular/periodic carbon monitoring will be undertaken by respective CBFMU communities with capacity and technical support from local forest authorities.

The present full cost proposal is also aimed at proposing a methodology for assisting in the devolution of management functions and responsibilities (including forest inventory) of large areas of forest to Community Based Forest Management User Groups, and the technical capacity development needs and potentials of CBFUGs as they relate to both forest carbon and more conventional forest inventory and management issues.

Over the last twenty five years, successive government programs, with significant donor assistance, have turned forests over to local communities (in the form of Community Based Forest Management User Groups (CBFMUG) for protection and management. Individually small in area, in total the community forestry subsector consists of some 19,000 CBFMUG and now accounts for around 25 percent of the total estimated forest area (mostly in Hill districts). CBFMUG management seems to be proving sustainable and generally socially sound and equitable. These internal governance challenges interplay with a large scope for improving the technical and commercial quality and profitability of CBFMUG forest management to form the basis for a second generation of community forestry development programming.

While not without limitations, rural communities have demonstrated a great propensity for internal cohesiveness, conflict resolution and stewardship that translate into effective, and sometimes highly effective, forest resource management. These aspects have been fully recognized during the field visits undertaken by the present project (see Working Paper N. 5 for more details).

In our vision, data collected will be transferred to sub-/national MRV system in a transparent manner, and the participating CBFMU communities will be compensated based on an appropriate crediting system established under the REDD+ strategy. An appropriate mechanism for ensuring environmental and social safeguards will be implemented side by side which will consider both environmental conservation, and distribution of carbon and non-carbon benefits ensuring forest dependent interest groups/communities impacted due to REDD+ are benefitted in an equitable manner.

The R-PP also plans to share the carbon monitoring role with local bodies e.g. village development committees (VDCs) in case of "government managed forests" and with buffer zone council and groups in case of forests in "protected areas". The R-PP aims at community based ground inventory for all carbon pools in the long run however emphasizes on above/below ground biomass at initial stages.

Implementation of MRV at CBFMU level

The development of an MRV system at CBFMU level is a challenging issue, both from the technical and the socio-economic view point. The purpose of this paper is to describe the various steps needed for its implementation.

The proposed approach will rely on three major actors, namely

1. The MRV team established at national level;
2. District Forest Officers and rangers in the districts and FMU levels;
3. CFUGs and other local forest managers in case of different community based forest management modalities.

The role of NGOs and civil society should also be taken into adequate consideration.

Schematically, the implementation of MRV at CBFM unit's level includes the following steps:

MRV Phases	Step	Responsible body	Output / Product
Preparation	Step 1: Preparation phase	FUGs / REDD Cell / MRV Section	A formal agreement between FUGs and the REDD cell / MRV on the establishment of REDD+ activities in given communities.
Measurement of activity data	Step 2: Delineation of project boundaries	FUGs / DFOs / MRV Section Jurisdictional boundary	A digital map with the boundaries of the project area.
	Step 3: Land use and land cover mapping	MRV Section/FUGs/Local forest officers	The baseline LULC map, and the changes that occurred in the recent past, prior to the project initiation.
	Step 4: Stratification of the project area	MRV Section / FUGs / Local forest officers	Project area stratification map
Measurement of emission factors	Step 5: Preparation for the field work and capacity building of local communities.	Local forests authorities / service providers/ NGOs	Local communities are trained for field work.
	Step 6: Pilot inventory for variance estimation	MRV Section / FUGs / local forest officers	Field sampling design established
	Step 7: Field work	FUGs, local forest authorities	Field inventory executed
	Step 8: Quality assurance and quality control	Local forest authorities	Validated field data
	Step 9: Data processing and estimation of emission factors and GHG	MRV Section	Estimation of GHG emissions (REL)

MRV Phases	Step	Responsible body	Output / Product
	emission		
Reporting	Step 10: Analysis of trends	MRV Section	Trends in carbon emission balance established
	Step 11: Detection of leakage	MRV Section and local forest officers	Quantification of leakage
	Step 12: Estimation of net (deducting leakage) carbon emissions	MRV Section	Net carbon emission balance established
	Step 13: Collating and presenting the information on GHG emissions/removals.	MRV Section	A report in a REDD+ standard and documented format.
Verification	Step 14: Verification	Independent authority	Certified net carbon emissions
Payments of carbon credits	Step 15: Payments of carbon credits	MRV Section and designated REDD+ authorities	Carbon transactions in place
Follow-up	Step 16: Follow-up	MRV Section / REDD Cell	Sustainable REDD mechanisms are in place

The procedures presented above for CBFMUs approach are valid for any sub-national unit in general in terms of methodological approach, however there will be differences in the actors involved, depending on the management regime of the forests, as follows:

Forest management regime	Preparation phase	Measurement of activity data	Measurement of emission factors	GHG emission estimates and reporting	Verification, Carbon credits payment and follow-up
Community forests	CFUGs / REDD Cell / MRV Section	MRV Section Support: CFUGs / DFOs	CFUGs Support: Local Forest Officers / MRV Section	MRV Section	Independent authority and Designated REDD+ authorities
Collaborative forests	CFUGs / REDD Cell / MRV Section	MRV Section Support: CFUGs / DFOs	CFUGs Support: Local Forest Officers / MRV Section	MRV Section	Independent authority and Designated REDD+ authorities
Government managed forests	Local Forest Officers / VDC / REDD Cell / MRV Section	MRV Section Support: VDC / DFOs	Local Forest Officers /VDC Support: MRV Section	MRV Section	Independent authority and Designated REDD+ authorities
Protected forests	National Park Officers / Buffer Zone Council /REDD Cell / MRV Section	MRV Section Support: National Park Officers / Buffer Zone Council	National Park Officers / Buffer Zone Council Support: MRV Section	MRV Section	Independent authority and Designated REDD+ authorities

3.2 Capacity building at CBFMU (Institutional, technical)

The MRV approach at sub-national level can be a good opportunity to strengthen the capability of existing CBFMUG to develop sustainable forest management programs on the basis of forest surveys, mapping and analysis.

The component would finance CBFMUG training; provision to CBFMUG of basic survey equipment and tools.

Revision of existing guidelines for CBFMUG operational forest management planning and operations should constitute a natural follow-up to be implemented by a successive project.

Moreover, the CBFMUG approach presents the opportunity to couple the traditional and local knowledge on forest resources, and natural resources in general, with some modern techniques like advanced Remote Sensing, Database and GIS techniques to be applied to forest management in an innovative manner.

In the Section above we have outlined the necessary steps deemed necessary for implementation of MRV at CBFMU level.

The roles and functions of local CBFM practicing groups are emphasized in:

i) preparation phase (step 1);
ii) steps involved in activity data measurement phase (steps 2 – 4); and
iii) Two of six steps involved in emission factor measurement phase (steps 6 and 7) for implementation of field inventory.

More specifically, enabling the CBFM groups participate meaningfully in REDD+ requires them to acquire:

- Knowledge and awareness about the possible benefits and disadvantages and/or risks associated with establishing REDD+ activities;
- Knowledge and skills involved in delineating forest boundaries;
- Basic understanding of the land use map of CBFM area and ability to interpret the map to some level;
- Ability to understand the basic and specific parameters on which the forest area is stratified and the sample plots are located;
- Knowledge and skills of doing forest inventory and recording the data;

Key role and functions of the DFO and its field staff revolves around the facilitation of whole process involved in all phases of Table. They need to do social/institutional mobilization in close coordination with existing local and district level relevant CSOs and NGOs and at the same time be technically capable to train the CBFM groups on point 2) to 5) above.

DFO staff will also need to record, maintain and manage the measurement related data and communicate with the MRV team at district and sub-/national level MRV teams.

For the sake of synthesis the technical aspects of the MRV at sub-national level are not discussed in these documents. Instead they are treated in detail in the Full Cost proposal and in Working paper N.7.
For data processing and reporting, the MRV Team has implemented a prototype of data entry procedure and reporting, which includes internet based user's friendly computer applications for:

1. Standard Forms for data entry, and
2. Standard Reporting functions including volume, biomass and carbon stock calculations.

This functionality has been integrated in the MRV web portal as a prototype. This application, when finalized, will be run in DFOs Offices and will permit:

1. Immediate calculations of the inventory results at local level;
2. Automatic upload of newly collected inventory data into the central MRV database.

3.3 Estimated costs for MRV implementation at Sub-National level

As stated earlier, a global full cost proposal for the MRV at Sub-National level cannot be completely formulated because the likely area of application is not known *a priori* and in a way will be determined by the success of the REDD+ initiatives at local level.

What can be done at this stage is to try to determine the MRV total costs at SNU on a per area unit base.

Assuming that 10,000 hectares of forests is the minimum unit area for REDD+ viable implementation, the estimated costs will be assessed using 10,000 hectares as baseline for calculations.

According to the proposed institutional architecture, the responsibility of the SNU component of the MRV will be shared among the following actors, in order of importance:

Actors	Main tasks
CBFMU Members	• Verification and validation of satellite based map • Support to stratification of forest types based on local knowledge • Execution of field work
DFO's	• Creating Awareness on REDD and Seeking Free, Prior, Informed Consent (FPIC) for participation in REDD+ • Training of Community members • Supply of technical equipment • Technical supervision of the field work • Validation of the field measurements (at least 10% of the sampling plots should be revisited for quality control) • Data processing and • Reporting
Central MRV Section	• Land use and land cover mapping • Stratification of the project area • Data processing and estimation of emission factors and GHG emission • Analysis of trends • Detection of leakage • Collating and presenting the information on GHG emissions/removals

Assuming a minimum area unit of 10,000 ha of forests, a tentative assessment the costs related to field inventory at Sub-National level, is summarized as follows:

Actor	Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total
CBFMUg	Field work allowances	1,000	1,000	1,000	1,000	1,000	5,000
	Equipment	1,000	-	-	-	-	1,000
Sub-total CBFMUg		2,000	1,000	1,000	1,000	1,000	6,000
District Forest Office	Field work allowances	800	800	800	800	800	4,000
	Equipment	5,000	-	-	-	-	5,000
Sub-total District Forest Office		5,800	800	800	800	800	9,000
Grand Total		7,800	1,800	1,800	1,800	1,800	15,000

The calculations above are based on the following assumptions:

- On average 100 plots are established every 10,000 ha, i.e. one plot per 100 ha;
- Each plot will be measured in one day, meaning that 100 field inventory crew days are needed;
- If, for instance , 4 (four) field crews are deployed then 25 days per year are required for the field inventory work;
- The support of DFO includes awareness raising, local capacity building and quality control of the field measurements.

Finally an attempt is made here to provide a broad estimate of the MRV costs at National level. Since the total area to be covered is not known a priori, two scenarios have been elaborated, as a minimum and maximum approach, as follows:

a) Minimum scenario: the area under REDD+ at sub-national level is equal to the area to be covered by the on-going R-PIN proposal for the Terai Arc Landscape, covering approximately 1,000,000 ha of forests.
b) Maximum scenario: all CBFMUG of Nepal are involved. In this case the area involved is estimated at approximately 3,000,000 ha.

For each scenario the corresponding costs are estimated as follows:

MRV implementation at sub-national level	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
Scenarios	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Estimated costs	780,000	2,340,000	180,000	540,000	180,000	540,000	180,000	540,000	180,000	540,000	**1,500,000**	**4,500,000**

4. Overall synthesis of MRV costs

The following table presents a synthesis of the estimated costs for an MRV implementation in Nepal according to the proposed nested approach, comprising national and sub-national level, according to a minimum and maximum scenarios. The financial plan for total MRV implementation is expected to be between 5.2 and 9.5 Million US Dollars for a 5 year cycle.

Unit US$

Estimated MRV implementation costs	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
Scenarios	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
MRV at National level	1,168,000	1,579,000	706,000	1,117,000	616,000	770,000	616,000	770,000	616,000	770,000	**3,772,000**	**5,027,000**
MRV at Sub-national level	780,000	2,340,000	180,000	540,000	180,000	540,000	180,000	540,000	180,000	540,000	**1,500,000**	**4,500,000**
Grand Total	1,948,000	3,919,000	886,000	1,657,000	796,000	1,317,000	796,000	1,317,000	796,000	1,317,000	**5,222,000**	**9,527,000**