Capacity development in national forest monitoring

Experiences and progress for REDD+

Edited by
Brice Mora, Martin Herold, Veronique De Sy,
Arief Wijaya, Louis Verchot and Jim Penman

GOFC-GOLD
Global Observation of Forest Cover and Land Dynamics
Land Cover
Project Office

CIFOR

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Abbreviations

BAU	Business as usual
CIGA	Centro de Investigaciones en Geografia Ambiental
COP	Conference of the Parties
DBH	Diameter at Breast Height
DIAS	Digital Image Analysis System
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
FCMS	Forest Carbon Monitoring System
FCPF	Forest Carbon Partnership Facility
FCPF	Forest Carbon Partnership Facility
FDS	Field Data System
FIB	Financial Incentives Benchmark
FIPI	Forest Inventory and Planning Institute
FORMIS	Forest Information and Monitoring System
FRA	Forest Resources Assessment
FRM	Forest Resources [change] Monitoring
FSI	Forest Survey of India
GEO	Group on Earth Observations
GFC	Guyana Forestry Commission
GFOI	Global Forest Observation Initiative
GHG	Greenhouse gas
GIS	Geographic Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GOFC-GOLD	Global Observation for Forest Cover and Land Dynamics
GPS	Global Positioning System
ICFRE	Indian Council of Forestry Research and Education
IDB	Inter-American Development Bank
IFL	Intact forest landscapes
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization

JCN	Joint Concept Note
LCDS	Low carbon development strategy
LoI	Letter of Intent
LULUCF	Land use, Land-use Change and Forestry
MoU	Memorandum of Understanding
MRV	Monitoring, reporting and verification
NFI	National Forest Inventory
NFIM	National Forest Inventory and Monitoring
NFMS	National Forest Monitoring System
NGO	Non-governmental Organization
NICFI	The Government of Norway's International Climate and Forest Initiative
OBIT	One Billion Indonesian Trees for the World
P&Ps	Policies and Pogrammes
PDF	Probability Density Function
PES	Payments for Environmental Services
PFES	Payments for Forest Environmental Services
PIS	Pre-Investment Survey of Forest Resources
QA/QC	Quality assurance/ Quality control
REDD+	Reducing Emissions from Deforestation and Forest Degradation
REDDES	REDD & Enhancing Environmental Services in tropical forests
REL/RL	Reference emission level/ Reference level
RME	Reliable Minimum Estimate
R-PIN	Readiness Plan Idea Note
RPlan	Readiness Plan
R-PP	Readiness Preparation Proposal
SBSTA	Subsidiary Body for Scientific and Technological Advice
SDN	Spatial Data Networking
SFEs	State Forest Enterprises
SIS	Safeguards Information System
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

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Summary

The GOFC-GOLD Land Cover Office (gofcgold.wur.nl) and the CIFOR Global Comparative Study on REDD+ (forestsclimatechange.org) held a workshop on 'Stepwise approaches for national forest monitoring and REDD+ MRV capacity development' (gofcgold.wur.nl/sites/CIFOR_workshop.php) in Wageningen, The Netherlands, on 3–5 September 2012. This joint publication is a synthesis of this experts' workshop, published with the aim of presenting, discussing and analysing experiences from national forest monitoring readiness and capacity-development activities for REDD+.

Most developing countries have substantial capacity gaps in national forest monitoring relative to the IPCC 'good practice' requirements of transparency, consistency, completeness, comparability and accuracy. Capacity-development programmes need to take this into account.

Several success factors for continuous improvement in national forest monitoring were extracted from developing country experiences. Particularly noted as essential are stable institutional arrangements with a strong mandate for the lead coordinating agency and clearly defined roles and responsibilities for the other stakeholders and sectors involved. Another important element is the availability of technical and institutional capacities in a stable and long-term setting. Where possible, countries should build on existing institutional forest monitoring frameworks and technical capacities to develop REDD+ monitoring.

Continuous improvement cycles and learning-by-doing have been common practice in many developing countries; however, they require sustained financial resources, as well as continued investment in education and related research and development. While improving capacities, moving to incentives based on national-level reporting on emission reductions can help catalyse progress. Interim performance indicators and a focus on simple methods for reference levels and reference emission levels may also be helpful.

A national forest monitoring system comprises the institutional and consultative arrangements that enable a country to estimate its greenhouse gas emissions and removals from forests, including those due to REDD+ activities. In addition, a system should provide data for policy assessment, take advantage of the knowledge of local communities in monitoring, be linked to monitoring of other forest values such as biodiversity and

social conditions, and provide information on the success of policy implementation. A national forest monitoring system should provide information on *all* forestland, including land on which regrowth is taking place. In addition, drivers of forest change that are outside the forestry sector (e.g. arising from agriculture or fuelwood demand) should be considered because of their importance for the statistical design, implementation and, in particular, monitoring for REDD+ and its impacts.

The concept of stepwise progress and continuous improvements underpins the model applied by many countries in building a monitoring system. This concept recognises that it takes time to implement emissions and removals methodologies and to collect the required data consistently in space and time. A stepwise approach allowing for conservative accounting of emissions and removals estimates may therefore be useful.

National REDD+ MRV should use the most recently agreed or adopted IPCC methods. Current IPCC methodology is suitable for estimating emissions and removals associated with REDD+ activities, but does not address these activities systematically by name. Therefore, the IPCC should be encouraged to develop further useful methodological guidance. The process of planning and implementation of REDD+ MRV may lead to initial priorities for MRV capacity development being defined, based on 1) understanding of the national REDD+ strategies and policies that address the key activities and drivers of forest change nationally; 2) identification of high-priority areas in which to focus most of the detailed MRV activities as part of a stratified national approach; and 3) the evolution of national MRV capacity development as a process following a roadmap with simple, interim performance targets that can be defined as intermediate milestones.

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Chapter 1

Introduction

The GOFC-GOLD Land Cover Office[1] and the CIFOR Global Comparative Study on REDD+[2] held a workshop titled 'Stepwise approaches for national forest monitoring and REDD+ MRV capacity development' in Wageningen, The Netherlands, on 3–5 September 2012. Institutions represented at the meeting were:

1. intergovernmental institutions (World Bank, FAO, IPCC, UNFCCC, European Commission, ESA)
2. national forest monitoring experts (from Brazil, Guyana, India, Indonesia, Norway, Tanzania, Vietnam, Germany)
3. academic institutes (Wageningen University, Colegio de la Frontera Sur, CIGA)
4. other international experts active in REDD+ MRV capacity development (such as Winrock, GIZ).

The meeting was organised in the context of increasing demand for the development of national forest monitoring capacities for REDD+. International negotiations at the UNFCCC SBSTA on REDD+ are ongoing; indeed, some progress was made during the most recent SBSTA[3] in May 2012. The discussions have highlighted a series of issues that will be further discussed and possibly decided at the 18th Conference of the Parties (COP) in Doha in November/December 2012. Key issues on REDD+ MRV and national forest monitoring include:

1. Consideration of a stepwise approach to build on existing forest monitoring systems, to incorporate better data for pools and/or gases and to improve methodologies over time.

1 http://www.gofcgold.wur.nl/.
2 http://www.forestsclimatechange.org/.
3 http://unfccc.int/resource/docs/2012/sbsta/eng/l09r01.pdf.

2. The need to identify uncertainties and the possible use of conservativeness.
3. The possibility for technical assessment of reported data and reference levels for verification activities.

The aim of this expert meeting[4] was to generate a synthesis of the methodological advancements and recommendations for forest monitoring in the context of REDD+ MRV. The main objectives of the meeting were to:

1. Discuss and synthesise the recent UNFCCC REDD+ negotiations and related needs.
2. Present, discuss and synthesise experiences from REDD+ monitoring, reporting and verification (MRV) and national forest monitoring readiness and capacity-development activities.
3. Discuss a framework for stepwise approaches for improving national forest monitoring and REDD+ MRV capacity development, and other urgent REDD+ MRV issues.
4. Develop and consolidate ideas for a joint publication (i.e. journal paper, update of GOFC-GOLD Sourcebook, CIFOR policy brief) to be released at COP 18 in Doha.

The aim of this report is to summarise the main contributions and findings of the meeting. Part 1 presents country experiences in improving national forest monitoring, with contributions from Guyana, India, Indonesia, Vietnam and Mexico. Part 2 summarises experiences and lessons learned from donor organisations, namely the Government of Norway's International Forest and Climate Initiative and the World Bank's Forest Carbon Partnership Facility. In Part 3, we discuss some of the central – and at times controversial – issues for national forest monitoring and REDD+: conservativeness, benefit distribution and a stepwise framework for REDD+ reference levels. Workshop attendees were also surveyed to identify the success and enabling factors for continuous improvements in national forest monitoring (for REDD+) in non-Annex I countries; some findings are presented in Part 3. This report will be presented in a side meeting at COP 18 in Doha, Qatar (26 November – 7 December 2012).

4 http://www.gofcgold.wur.nl/sites/CIFOR_workshop.php.

1 Country experiences in improving national forest monitoring

Chapter 2

Developing a monitoring, reporting and verification system for REDD+ in Guyana

Pradeepa Bholanath, Nasheta Dewnath and Jagdesh Singh

2.1 Guyana's involvement in REDD+

Guyana's forest area is estimated at 18.39 million ha – covering approximately 85% of the country –with more than 5GtCO_2 in aboveground biomass. The Government of Guyana has embarked on a national programme that aims to protect and maintain its forests to help reduce global carbon emissions and, at the same time, to attract resources to foster growth and development along a low carbon emissions path. Guyana is committed to contributing to efforts to address deforestation and forest degradation, estimated to account for approximately 18% of global emissions and thus the second most important source of carbon dioxide emissions worldwide.

Guyana's involvement in REDD+ began in 2008 with the submission of its Readiness Plan Idea Note (R-PIN) to the Forest Carbon Partnership Facility (FCPF). Following the approval of the R-PIN, Guyana prepared and submitted a Readiness Plan (RPlan), later renamed the Readiness Preparation Proposal (R-PP).With the financial support of the FCPF, Guyana will be able to undertake a series of REDD+ readiness activities, designed to create the basis for Guyana to receive payments for reducing carbon emissions from deforestation and forest degradation and for supporting conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+). These activities include the execution of technical studies and social and environmental impact assessments, development of a monitoring, reporting and verification (MRV) system, development of pilot demonstration activities, the active involvement of forest-dependent communities and other national stakeholders, and the development of a roadmap for capacity building.

On 9 November 2009, the Governments of Guyana and Norway signed a Memorandum of Understanding (MoU) that set out how the two countries would work together to provide the world with a relevant, replicable model for how REDD-plus can align the development objectives of forest countries with the world's need to combat climate change. Norway committed to providing Guyana with up to US$250 million by 2015 if Guyana succeeds in keeping its deforestation and forest degradation rates below an agreed level. Accompanying the MoU was a Joint Concept Note that describes the mechanisms through which payments will be made and outlines Guyana's obligations, which are related to 1) indicators of enabling activities; 2) REDD+performance indicators; and 3) efforts to support the acceleration of REDD+ efforts in 2010.

To date, Guyana has made considerable progress with the technical work related to REDD+, particularly in the development and implementation of a national MRV system.

2.2 Progress in Guyana in building a national MRV system for REDD+

In 2009, Guyana developed a national framework for the implementation of an MRV system, using a consultative approach informed by international and local experts. This framework took the form of a roadmap that outlined steps to be conducted over a three-year period, leading to the implementation of a full MRV system. The aim of Guyana's MRV system is to establish a comprehensive national system for monitoring, reporting and verifying forest carbon emissions resulting from deforestation and forest degradation in the country.

Guyana began by identifying and examining the key areas that needed to be addressed at the national level. It sought to establish a framework built on accepted principles and procedures for estimating and reporting forest carbon emissions and removals at the national level, as specified in the 2003 IPCC Good Practice Guidance and 2006 IPCC Guidelines, for reporting at the international level.

Based on the roadmap for the MRV system, work began in 2010 in the areas of 'forest area change assessment' and 'forest carbon stock assessment and monitoring'.The Guyana Forestry Commission (GFC)carried out the main activities during this period in collaboration with international experts on REDD+, namely Winrock International, Poyry and Indufor.

The aim of these work areas was to determine the historical and current patterns of deforestation and their drivers. To date, Guyana has completed forest area change assessments for the periods 1990–2000; 2001–2005; 2006 to September 2009 (Benchmark); 1 October 2009 to 30 September 2010 (Year 1); and 1 October 2010 to 31 December 2011 (Year 2). The benchmark map, which provides a snapshot of the country's forest area as of 30 September 2009, was created for use as the baseline for future comparison. The subsequent assessments conducted for 2010 and 2011 map and report all conversion of forest to non-forest.

The use of appropriate satellite imagery is integral to the accuracy and completeness of the spatial assessment. For the Benchmark and Year 1 assessment period, 30 m Landsat imagery and Disaster Monitoring Constellation were used, although efforts were hampered by challenges related to persistent cloud cover. The total forested area at this point was estimated as 18.39 million ha (with an indicative accuracy of 97.1%); of this area, 15.5 million ha is administered by the State.

An issue that arose in the Year 2 reporting period was that Landsat 5 was in the process of being decommissioned and Landsat 7 was reported to be encountering problems (stripes).Consequently, higher-resolution 5 m images were taken of previously identified change areas. A total area of 12 million ha (56% of Guyana's land area) was assessed at this higher resolution. The improved resolution enabled better identification of change boundaries, drivers of change and areas of forest degradation. In particular, it was revealed that the mapping of forest degradation is more precise when using high-resolution imagery rather than medium-resolution imagery. Consequently, substantial progress was made in Year 2 in mapping forest degradation. The area degraded during that period, as measured by direct interpretation (based on a degradation study) of the 5 m Rapid Eye satellite imagery, was 5460 ha.

This shift in technology has two important implications. First, with the use of 5m resolution imagery, the **level of detailed scope** of the system is much more expansive. Although this may mean that more resources are needed for processing and analysing the data, the results generated are much more precise, especially in the case of high cloud cover. The second implication is related to cost. Whereas medium-resolution imagery is freely available, alternatives to Landsat 5, one of Guyana's main options for medium-resolution imagery, are limited. Consequently, the cost of using satellite imagery has risen, now classified as a medium-level cost. Nevertheless, it has been shown that, given the high cloud cover in Guyana, medium-resolution imagery is inadequate in terms of availability and applicability for deforestation and forest degradation mapping on an annual basis.

The results for both Years 1 and 2 were assessed for accuracy by independent experts at the University of Durham, UK. The results of the independent accuracy assessment were similar to the original estimates. The rate of change for Year 2 was calculated at 0.054% and the area of forest remaining at the end of Year 2 was estimated at 18.378 million ha. The University of Durham assessment put the accuracy of the mapping at 99.2%.

The results of the forest area assessment for Years 1 and 2 were also subject to independent third-party verification. In this way, independent third-party verification was integrated into Guyana's MRV system from the outset and hence was standardised as part of the development process. Consequently, at every stage of development, verification has been a standard part of the system. This process helped Guyana to identify gaps early and to develop a strong, robust system that can meet rigorous international standards; furthermore, the use of a phased approach has enabled those involved to learn from early lessons.

Mining, including the development of mining infrastructure, was found to be the major driver of forest area change in Guyana. Nearly all (96%) deforestation occurred in state forest areas, that is, areas owned and managed by the State. Furthermore, the temporal analysis of forest change since 1990 indicates that most of the change is clustered around existing road infrastructure and navigable rivers. This information provides a useful basis for planning an ongoing monitoring programme that focuses on forest change hotspots. The results of these assessments can be used to design REDD+ activities that will lead to forest cover being maintained, in conjunction with continued sustainable development and improved livelihoods for the Guyanese population.

At the same time as the forest area change assessments, work was also underway to develop a long-term, robust and scientifically sound national forest carbon monitoring system (FCMS). In this system, data generated during monitoring of Guyana's forest carbon stock will be linked to estimates of historical emissions calculated by the forest area change assessments. This will serve as the starting point for future work on developing reference levels for Guyana and estimating annual carbon emissions and removals.

A key outcome of the FCMS is the development of a national look-up table of emission factors that meets international standards. These include standards for levels of uncertainty of ground data and the development of QA/QC (quality assurance/control) procedures for all data collection and analyses. Other activities completed during the development of the FCMS included:

- The use of spatial analysis techniques to develop a forest carbon stratification map, which was then used to establish the sampling design and location of the sample plots needed to determine the emission factors for deforestation.
- An analysis of the main drivers of degradation and deforestation and identification of the best method for estimating carbon stock changes for each. Based on the analysis, the Stock Change method was selected for measuring deforestation and the Gain–Loss method was chosen for degradation.
- Ongoing training and capacity building for GFC staff in collecting field-based data used to determine emission factors. These emission factors will then be used, in conjunction with the activity data obtained from the remote sensing analyses, to generate estimates of CO_2 emissions.
- The determination of emission factors for Guyana in terms of the emissions and removals of CO_2 per unit of activity data. These factors were derived from data collected by GFC staff.
- The development of a long-term monitoring plan to be implemented as part of the MRV system.
- Ongoing capacity-building sessions to train GFC staff and other relevant stakeholders in the implementation of the FCMS.

A key consideration in developing the FCMS was the stratification of threats, as not all forests are under immediate threat of conversion. The advantages of such stratification

Table 2.1. Key reporting measures for Guyana

Driver	Historical period			Year 1 2009–2010	Year 2 2010–2011 (15 months)	
	1990–2000	2001–2005	2006–2009		Deforestation	Degradation
	Area (ha)					
Forestry (includes forestry infrastructure)	6 094	8 420	4 784	294	233	147
Agriculture	2 030	2 852	1 797	513	52	N/A
Mining (includes mining infrastructure)	10 843	21 438	12 624	9 384	9 175	5 287
Infrastructure	590	1 304	195	64	148	5
Fire (deforestation)	1 708	235		32	58	28
Amaila Falls development	–	–	–	–	225	–
Area change*	**21 267**	**34 249**	**19 400**	**10 287**	**9 891**	**5 467**
Total forest area at beginning of period	18 473 394	18 452 127	18 417 878	18 398 478	18 388 190	–
Total forest area at end of period	18 452 127	18 417 878	18 398 478	18 388 190	18 378 299	–
Rate of deforestation (%)	0.01%	0.04%	0.02%	0.056%	0.054%	–

*Numbers may not add exactly owing to rounding.

Source: GFC and Indufor (J. Singh, P. Bholanath and P. Watt), July 2012. Guyana REDD+ Monitoring Reporting and Verification System, Interim Measures Report, 1 October 2010 – 31 December 2011, Version 3.

are that: 1) measuring and monitoring can be conducted in those areas where land use change has already occurred and is most likely occur in the future; 2) sampling effort is reduced; 3) accuracy and precision in carbon stock estimates are maintained; and 4) resources can be allocated wisely.

The main results from this phase of the work are summarised in Tables 2.2 and 2.3.

Table 2.2. Emission factors in Guyana, by drivers

Stratum	Drivers	Emission factors	
		tC/ha	tCO_2/ha
More accessible	Forestry infrastructure	285.3	1046.2
	Agriculture	315.2	1155.6
	Mining (medium and large scale)	258.6	948.2
	Infrastructure	285.3	1046.2
	Fire, biomass burning	258.6	948.2
Less accessible	Forestry infrastructure	374.4	1372.9
	Agriculture	410.8	1506.4
	Mining (medium and large scale)	354.3	1299.0
	Infrastructure	381	1396.9
	Fire, biomass burning	354.3	1299.0

Source: Goslee, K., S. Brown and F. Casarim. 2012. Carbon impacts of land use and land use change in Guyana: emission factors. Reported submitted by Winrock International to the Guyana Forestry Commission.

Table 2.3. Carbon stocks in Guyana's forests, by carbon pools

Carbon pool	Carbon stocks (tC ha^{-1})	
	More accessible	Less accessible
Aboveground tree biomass	187.2	284.8
Belowground tree biomass	44.0	66.9
Saplings	1.2	1.3
Deadwood	11.9	14.8
Litter	5.6	5.6
Soil carbon (top 30 cm)	105.5	87.9
Total (without soil)	**249.7**	**373.3**
Total (with soil)	**355.2**	**461.2**

Source: Brown, S., N.L. Harris, F. Casarim and K. Goslee. 2012. Establishing a reference level for REDD+ in Guyana. Report submitted by Winrock International to the Guyana Forestry Commission.

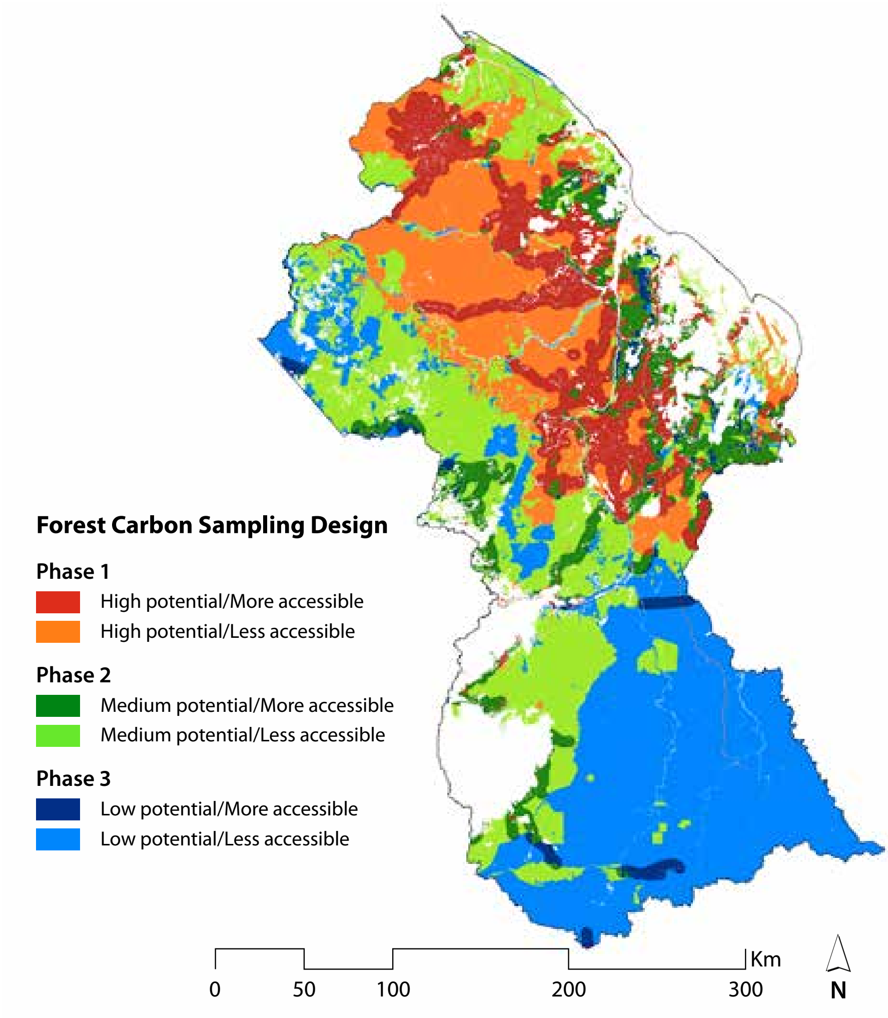

Figure 2.1. Map showing the forest carbon sampling design for Guyana's forests

Source: Goslee, K., S. Brown, F. Casarim, N. L. Harris, and S. Petrova. 2011. Sampling design and implementation plan for Guyana's REDD+ forest carbon monitoring system (FCMS). Report submitted by Winrock International to the Guyana Forestry Commission.

For the next step under the FCMS, the medium- and low-risk strata will be included in the field sampling and the above two tables will be updated.

2.3 Factors that improve capacity or hinder progress

Capacity building at the local level is integral to the successful implementation of REDD+ and the MRV system. This is an ongoing process targeting all levels of stakeholders involved in the implementation of REDD+ in Guyana. To date, a number of factors have contributed towards Guyana's success in improving capacity in the development of the national MRV system.

Strong commitment and political will are proving important in efforts to improve capacity at all levels with regard to implementation of REDD+ and the development of the MRV system. With the launch of Guyana's Low Carbon Development Strategy (LCDS) and the subsequent MoU with Norway, Guyana's need to improve its capacity became evident. REDD+ forms one part of the LCDS, as the long-term mechanism through which the LCDS will be executed and monitored. The LCDS also calls for a performance-based mechanism to measure and monitor deforestation and forest degradation, thus requiring an MRV system to be developed and implemented. Capacity building at all levels remains important, to ensure not only success in the implementation of REDD+ and the MRV system, but also sustainability in this approach.

Guyana commenced work on the implementation of REDD+ in 2008. From the outset, roles and responsibilities were clearly defined. As the agency responsible for monitoring and managing Guyana's state forests, the GFC was tasked with implementing the key technical aspects of REDD+, including the development of the MRV system. REDD+ activities were designed to build on Guyana's previous efforts in terms of national forest monitoring and forest management. Among Guyana's systems are a national Log Tracking System, which provides chain of custody verification of timber products, and a system for forest management and annual planning based on guidelines. Initial work on forest carbon stock assessment had also already begun. The REDD+ plans stated that the GFC would be supported by the country's other natural resource management agencies, the private sector, civil society, academic and training institutions, and NGOs. The Office of Climate Change, which was later established, was to provide policy guidance. Thanks to the clarity regarding tasks and responsibilities, agencies have been able to effectively plan and implement activities relevant to their areas of work. In particular, the GFC was able to lay plans for the implementation of REDD+ and the MRV system in terms of capacity and resource requirements. A REDD Secretariat was subsequently established within the GFC to coordinate and implement technical activities related to REDD+ nationally, including work on the MRV system. The GFC directed resources with a focus on capacity building for key technical areas both for REDD Secretariat staff and for staff of other key departments supporting the work on REDD+ and the MRV system.

Given the importance of capacity building, a capacity gap assessment was conducted to evaluate Guyana's capacity to implement REDD+ and the MRV system and identify areas for improvement. In this assessment, current capacity, country-specific characteristics and requirements for REDD+ were analysed, with reference to international requirements (IPCC Guidance) and national needs (through an assessment of current forest change processes). All agencies involved in the implementation of REDD+ in Guyana were considered in this assessment. The results of the assessment were then used to inform the MRV system roadmap.

The capacity gap assessment identified seven key action areas:

1. Develop and implement a national mechanism and institutional framework.
2. Conduct a comprehensive forest area change assessment for a historical period.
3. Build carbon stock measurement capacities.
4. Develop MRV for a set of REDD+ demonstration activities.
5. Engage with the international community.
6. Create a sustained internal communication mechanism on MRV.
7. Conduct/support research on key issues.

Strengthening capacity within the GFC is an ongoing process that targets staff at all levels. Efforts are proving successful because the technical staff of the GFC and other agencies remain committed, learn quickly, are fully engaged and work hard in the field. Success is also attributable to their willingness to learn and to transfer their knowledge to other staff and relevant stakeholders.

The successful implementation of REDD+ and the MRV system requires a multi-stakeholder approach. Guyana has therefore established multi-stakeholder steering committees (including an MRV system steering committee), with representatives from government, the private sector, civil society, academia, women and youth groups, and other interest groups. This approach has extended the reach of capacity-building activities, as more groups are targeted and more knowledge is shared and exchanged. Furthermore, the natural resources agencies responsible for carrying out the activities have demonstrated ongoing cooperation and transparency, sharing with each other information, datasets, experiences and skills.

Since REDD+ activities in Guyana began, a key focal area has been the establishment of key partnerships not only at the national level, but also at regional and international levels. Through such partnerships, key technical agencies have been able to benefit from training, technical exchange and technology upgrades. Furthermore, the partnerships enable Guyana to share its own knowledge and experiences. The government has been working with a number of partners through both project-related and bilateral donors to secure support, both technical and financial, for building technical capacity and for further developing REDD+ and the MRV system. Of particular relevance in this regard is the MoU with Norway, which aims to foster a partnership related to climate change, biodiversity and sustainable, low-carbon development.

The GFC has also been seeking other avenues to increase the support of REDD+ activities. One opportunity identified was the International Tropical Timber Organization (ITTO) Thematic Programme on REDDES (REDD & Enhancing Environmental Services in tropical forests), which offers financial support for forest resources assessment at the national and community levels, thus enhancing planning and management in relation to deforestation and forest degradation. Other useful organisations are the Inter-American

Development Bank (IDB) through its Knowledge and Capacity Building Products and the Guiana Shield Facility, which was established as an outcome of the Guiana Shield Initiative Project and that aims to promote and support the conservation and sustainable development of the Guiana Shield ecoregion.

The government will continue to approach other possible donors, such as WWF, United Nations Development Programme (UNDP), FAO, IDB, Conservation International and KfW, and will seek technical support from agencies such as the Clinton Climate Initiative and Environmental Systems Research Institute - ESRI. Assistance may come in the form of technical inputs, for carrying out forest monitoring and planning work involving remote sensing analyses, and technical strengthening, particularly for the REDD Secretariat and the GFCso that the staff are able to effectively execute and manage the REDD+ programme.

Despite the considerable success in improving local capacity, some challenges have arisen also. A recurring challenge is that the optimal resources, both physical and human, are not always available in a timely manner. The implementation of REDD+ and the MRV system requires the use of improved, high-level technologies and skilled human resources to conduct activities at all levels. Guyana has sought to overcome its limitations through partnerships offering benefits in such areas as software upgrades and continued support to technical staff. The relevant agencies are also engaged in ongoing recruitment of staff to fill any gaps in the responsible technical departments.

Access to the remote areas of Guyana is another challenge for field data collection and ground truthing. Many remote areas within Guyana's forests are inaccessible by road, and reaching them by alternative routes may take days – or even weeks – with the accompanying high costs.

Many of the high-level technical and scientific skills needed for the technical aspects of REDD+ and the MRV system are not available locally, and must often be sourced from outside of the country – at greater cost. The aim is to shift away from this dependence on external resources by ensuring that the staff of the GFC and other relevant agencies continue learn from the experience and knowledge of these specialists.

The GFC has emphasised capacity building not only among its own staff, but also for staff of other agencies involved in REDD+ implementation and at the University of Guyana. Since work on the development of the MRV system began, a number of formal training sessions and workshops have been held. In addition, study tours and overseas training sessions that were organised were well attended by GFC staff. The GFC has been employing a learning-by-doing approach, whereby the commission's staff work directly with consultants in collecting and analysing data, conducting QA/QC procedures and analysing and interpreting statistics, among other tasks.

Another challenge with the MRV system is the need for regular analysis using satellite imagery, which, as noted above, is hampered by persistent cloud cover. Guyana has been working to overcome this through the use of several sensors, taking imagery early in the reporting period, using combi-tiles for the same areas and image mosaics.

Overall, despite the numerous challenges arising in the implementation of REDD+ and the MRV system, efforts to improve local capacity are continuing, not only among staff of government agencies, but also those in relevant non-government bodies.

2.4 Next steps for Guyana in the development of its MRV system: Learning from experience

In developing its national MRV system, Guyana has adopted a stepwise approach with the aim of improving on previous efforts in national forest monitoring and REDD+ MRV capacity building. At the same time, several imperative issues for MRV under REDD+ were integrated, with plans underway to address new areas.

As mentioned above, with its MRV system, Guyana will be able to calculate the amount of greenhouse gas emissions caused by deforestation and forest degradation and subsequent removals, as well as any changes in forest carbon levels as a result of REDD+ activities.

Early lessons were drawn from a pilot project for a community MRV model. The aim of this project was to transfer national-level results and approaches to the community level, in order to test the applicability of methods and to inform the REDD+ strategy. In doing so, the intention was then to bring new and refined approaches, results and methods back to the national MRV system.

The GFC's approach to developing the REDD+ MRV system allows for the stepwise development of local capacity while supporting the consolidation of separate elements of national forest monitoring into the MRV system. In the remainder of this chapter, we offer a first-person account of the process, highlighting the main lessons learned. In the initial stages of the process, our first task was to identify what data, skills and methods were already in place in the relevant natural resources agencies – and also to identify the gaps. We found that these natural resources agencies did already contain many of the elements necessary to commence work on key category analyses, such as land use and land management data and the capacity to use and analyse such information. This exercise was the starting point for building the system, with the aim of using, and therefore maximising, existing data, capacity, resources and established methods. A factor contributing to the success of this process was that open channels of communication were maintained with key stakeholders, even those who at the time were not identified as direct stakeholders.

During this initial analysis, the GFC was designated as the lead agency in the MRV system development process. Data, capacity and methods were then consolidated. This resulted in the aggregation of data on various land uses and management activities, including steps to develop a forest carbon map and examining, as part of this process, mining, agriculture, logging, infrastructure and other management activity data. At this stage, the definition of 'forest' for REDD+ for Guyana was agreed upon, guided by the Marrakech Accords.

At the outset, our objective was to analyse the historical trends as far back as the data would allow. We approached this from two interconnected perspectives: looking at spatial change based on drivers of deforestation and generating a forest carbon stratification map informed by the historical trends, while factoring in potential change variables for the future. We were able to conduct the historical assessment back to 1990, so long as the period from 1990 to September 2009 was considered in blocks of years:1990–2000, 2001–2005 and 2006–2009. For these three periods, we examined the complete national-scale coverage; we assessed area-specific changes, mapped new change areas in every period of assessment based on the previous period, and identified change areas based on the drivers of change. We found consistently throughout that trends were the same in terms of the drivers of change, with variations only in the magnitude of change attributable to each driver.

This historical assessment then seamlessly led to two annual assessments in 2010 and 2011, which marked the piloting of annual reporting on gross deforestation and forest area assessment, by drivers, at the national scale. Concurrently, the data derived from the analysis of historical data were used to inform the development of a forest carbon stratification assessment (with a map), which formed the basis of the FCMS. These initial activities proved to be the necessary technical starting points for the development of the national MRV system. We needed to carry out these activities to establish a comprehensive analysis, temporally and at a national scale, for a full national forest monitoring assessment for the REDD+ MRV system; that is, to establish at the start and end of every period the extent of forest and non-forest, to determine the causes of changes from forest to non-forest and to clarify this spatially for each period and then progressively build on each layer. This involved analysing data on land use, land management and drivers of deforestation, as well as other relevant data sources. Our early lesson in this respect was that tracking spatial changes, although necessary, was not sufficient by itself; it was necessary to complement the spatial aspects with a robust FCMS if Guyana-specific emission factors were to be developed in order to provide information on forest carbon emissions and removals due to human activity.

The next step, therefore, was to build the FCMS. This process involved using the results and methods of the forest area assessment, completing a forest carbon stratification map, building a sample design framework for the system, generating a complete report on emission factors based on the completion of Phase 1 of the system implementation and generating an initial report on the historical assessment of forest carbon monitoring using Guyana-specific emission factors. In particular, we found this last step to be a necessary follow-on from the forest area assessment because it meant we could transfer the spatial results to reporting on forest carbon emissions and removals. Our experience at this stage highlighted the usefulness of the stepwise approach, in which we identified systematically the features of the system that needed to be developed, and where each stage progressively built on the previous stage, with future steps already identified.

To verify the soundness of our approach, we opened the system up to independent third-party verification throughout the process. To date, two independent verifications of the forest area assessment approach, methods and results have been completed. We solicited a review of the sampling design framework for forest carbon monitoring by the IPCC and REDD+ experts, and have continually sought inputs from international partners. We have found this to be a good way to monitor our progress, the robustness of our methods and compliance with international best practice.

During this progressive development of the system, we have found that appropriate documentation is the key to keeping track of progress, planning for next steps, developing a system that is easily verifiable/auditable and, overall, creating an effective process. To this end, starting with the comprehensive MRV system roadmap, forest area change assessment approaches were documented, the forest carbon stratification and sampling design were developed and several standard operating procedures were drafted.

Although the foundation for the MRV system is forest area and forest carbon monitoring, in Guyana we have sought, albeit in a preliminary way, to establish historical reference levels, explore ecosystem services within the MRV system, pilot a community MRV model, integrate our results into IPCC national reporting tables and examine existing system compatibility with a Tier 3 model. Guyana is aware that Tier 3 requires that: higher-order methods are used, driven by high-resolution activity data that are disaggregated at the subnational level, which provide estimates of greater certainty than lower tiers; comprehensive field sampling repeated at regular time intervals and/or GIS-based systems are included; landuse and management activity data that integrate several types of monitoring are used; and the models used undergo quality checks, audits and validations that are thoroughly documented.

Already, efforts to align our current Tier 2 system with a Tier 3 system include shifting from medium-resolution imagery to high-resolution imagery on a GIS-based system, conducting disaggregated analysis at the subnational level, employing methods to reduce uncertainty surrounding emission factors, conducting comprehensive field sampling informed by a long-term monitoring plan that will address repeated measurements at strategic intervals, integrating land use and management activity data, and introducing third-party verification as a permanent element.

During the next 18 months, we will of course continue work on the reference level and projections of future emission levels, as well as on integrating reporting on forest carbon emissions and removals within the IPCC framework. We also plan to expand our efforts to include new areas of REDD+, such as exploring non-carbon ecosystem services and their possible incorporation into the MRV system and conducting more detailed studies on forest degradation and its drivers in Guyana; we will also look at other areas such as the implementation of readiness activities with FCPF support (some of these areas are outlined in the national roadmap). We also plan to expand the forest carbon monitoring system to other strata.

Areas to be examined include the development of a REDD+ policy for Guyana, expansion of REDD+ demonstration projects to other areas, opportunities to build on the experiences of the community MRV project, and the examination of MRV actions in greater detail for the longer term.

Overall, implementing an MRV system in Guyana has been a largely positive under taking. It has led to the development of a robust performance-based system for REDD+ financing, it has assisted in informed natural resources planning and management and it has instituted a multi-stakeholder approach to informing decision-making at national and local levels.

Guyana looks forward to taking the next steps, as we continue to build the system.

Chapter 3

National forest monitoring for REDD+ in India

Devendra Pandey

3.1 Forest monitoring at the local level

The Forest Survey of India (FSI) – an organisation under the Federal Ministry of Environment and Forests that is fully funded by the Indian government – has been responsible for the periodic monitoring of national forest resources in India since 1981. However, provincial governments (states) have been monitoring forests at the local and management unit levels for much longer than that. It is important to note that provincial governments own and manage most of India's forests under the federal government's major policy framework.

The practice of forest inventory was introduced at the local level in 1856 to estimate the growing stock to prepare management plans or working plans for the teak-dominated forests in the Pegu management unit (in Burma, now Myanmar). However, until 1884, progress was negligible because trained staff were scarce and the work involved in surveying, settlement and demarcation was immense. Recognition of the need for skilled workers led to the establishment of training institutions in India to build the capacity of field staff (Anon 1961). Subsequently, the forest inventory gradually expanded throughout various management units, and a substantial area of forest was covered by the working plans. The quality of the working plans also improved after 1919 when good-quality maps at a suitable scale became available from the Survey of India. It became possible to divide the management units into blocks and compartments and to make detailed stock maps. The working plans were generally valid for 10 years or, in some cases, 15 years.

Forest inventories at the management unit level are continuing even now because federal regulations state that tree harvesting can only take place with an approved working plan in place. Inventories are carried out not for the full area of a management unit but only for that part with generally mature forest crops that are to be harvested during the next 10–15 years. Management units are revisited for the forest inventory after the planning period is over. Different management units are inventoried in different timeframes; hence, estimates are not generated at the state or national level for any given timeframe (Pandey 2008). At present, there are about 790 management units in India (ICFRE 2011). During the past decade, inventory methods have been greatly modified with the introduction of modern tools such as geographic information systems (GIS) and remote sensing technology. In many management units, inventories now cover the entire forest area with low intensity of sampling. However, modern tools and methodologies are not applied uniformly in all states or in all of a state's management units. Although most states do have established information technology and GIS cells to support management unit–level forest inventories, the potential is not fully realised because of the shortage of adequately trained staff.

3.2 National forest monitoring

In 1965, an externally aided project, known as Pre-Investment Survey of Forest Resources (PIS), was launched with the support of the Food and Agriculture Organization (FAO) of the United Nations and the United Nations Development Programme (UNDP). This project laid the foundations for national forest monitoring in India. Under the project, some previously unexplored forest areas were inventoried as a step towards establishing wood-based industries. International experts and specialists in forest inventory selected by FAO worked with Indian counterparts in designing the forest inventory and planning the data collection, processing and analysis for large forest areas (much bigger than management units). Indian professionals and technicians were also trained abroad (mainly in Sweden) to build capacity in the use of the best available techniques, including use of aerial photographs for identifying forest areas and preparing thematic maps. Appreciating the quality of the output, the federal government continued the forest inventories even after the project was terminated in 1968. Finally, in 1981, PIS was reorganised into the FSI. The government made plans to begin a National Forest Inventory (NFI) to monitor forest resources and land use change on a 10-year cycle, but the project was stalled because human resources were not increased to meet the additional needs under the new NFI mandate. In 1986, FSI took on the additional responsibility of monitoring the country's forest cover using remote sensing imagery. By that time, about three-quarters of the country's forests had been inventoried (during the previous 20 years) and thematic maps using aerial photographs of the selected forest areas had been prepared, but no reliable estimates of the national growing stock could be generated.

FSI published the first report on India's national forest cover at a 1:1 000 000 scale in 1987 through the 'State of the Forest Report' by visually interpreting the remote sensing imagery. Since then, India's forest cover has been monitored at two-year intervals using a wall-to-wall approach that involves assessing the area of the forest cover and any changes to it. To date, forest cover monitoring has been carried out 12 times. The past 27 years have seen substantial technological and methodological improvements in forest cover monitoring, particularly in relation to interpretational techniques, mapping scale and accuracy assessment. Monitoring is now done using digital interpretation of satellite imagery of 23 m resolution and a mapping scale of 1:50 000. The minimum mappable area is 1 ha. About 4000 sample points are verified to assess the accuracy. Forest cover is classified into three classes of canopy density: very dense (more than 70%), moderately dense (40–70%) and open forests (10-40% canopy density) (FSI 2011). FSI used Landsat imagery until the fourth assessment in 1993; since then, imagery from Indian satellites IRS 1A/1B, IRS 1C/ID and IRS P6 has mostly been used.

In addition to periodic monitoring, FSI initiated a special study in 2005 to map the various types of forest in India based on Champion and Seth's (1968) classification system. This project used climate, soil and forest cover maps and extensive ground verification data (of about 15 000 locations) and was completed in 2009. Layers of the different forest types broken down into canopy density classes are available (www.fsi.org.in). The results are now being used to support REDD+ activities.

In 2001, FSI modified the forest inventory design to make the NFI operational, generate national estimates and meet changing information needs. Some new parameters required under the United Nations Framework Convention on Climate Change (UNFCCC), such as the estimation of soil organic matter, were included, and a two-stage sampling design was adopted. In the first stage, the country is divided into 14 homogeneous physiographical zones based on climate and vegetation, where civil districts form the sampling unit. A sample of 10% of the districts (about 60) is then randomly selected from across all the zones, in proportion to their size, for use in the forest inventory, which is to be completed in two years. This period coincides with forest cover monitoring by satellite imagery. In the second stage, selected districts are divided into grids of latitude and longitude to form the sampling units. Sample plots are laid out in each grid to conduct field inventory using a systematic sampling design. After completing an inventory of 60 districts in two years, a new set of 60 districts is selected and the process is repeated (FSI 2010). Parameters of national forests, such as growing stock and species distribution, began to be estimated after the first two cycles. The results of the third cycle of the NFI were added to improve the estimates. Since the fourth cycle, about one-third of the sample plots in the first cycle have been visited for remeasurement.

In 2008, FSI launched a new biomass study to measure those components of forest biomass that are not measured by NFI, as required under REDD+. This study was completed in 2009. The study followed two approaches. First, the biomass of herbs, shrubs, climbers, dead wood and litter was measured by revisiting about 100 sample plots in each physiographical zone inventoried during 2007–2008. Second, 20 to 30 trees of each species were selected in each zone, in a range of diameter classes above 10 cm, and the branches and leaves were cut according to a sample design; a similar number of young trees with a diameter of less than 10 cm were cut flush to the ground. The biomass of the trees was then measured to generate biomass equations for: 1) the diameter of NFI trees vs the biomass of branches with a diameter of less than 5 cm, bole wood of less than 10 cm and leaves, as these components are not measured in the standard NFI; and 2) the collar diameter of small seedlings and saplings vs the total biomass of these small trees. Based on the data collected in this new biomass study, FSI developed new allometric equations (about 200) for small trees/seedlings (diameter < 10 cm) for various species. Similarly, new equations have been developed to estimate the biomass of branches and leaves of trees with a diameter of more than 10 cm. These equations supplement the existing allometric equations developed for the standard NFI. With the completion of biomass study, a new dimension was added to the NFI in 2010. Additional parameters needed to estimate the total carbon stock of the forests are now being measured in the sample plots of the NFI.

The new biomass study led to the estimation of the carbon stock in India's forests in 2009, following the Tier 2 approach of the IPCC guidelines (IPCC 2006). To estimate changes in the carbon stock for the purpose of REDD+, 'post-sampling stratification' is done. This involves laying the map of forest types over the forest cover map, which has three canopy density classes. Thus, forest cover is stratified by two variables (type and density). The sample plots in each stratum characterised by a specific forest type (T) and density (D) are analysed to give the average amount of carbon stock per ha of the stratum (e.g. T_1D_1). To estimate the change in carbon stock, only the area in each stratum is required; this is obtained by laying the map of forest types over subsequent assessments of forest cover. The history of the development of steps for national forest monitoring in India is summarised in Table 1.

Table 3.1. Stages of development of national forest monitoring in India

Year	Stage of development leading to present level of preparedness for REDD+ activities	Remarks
1965	Start of Pre-Investment Survey of Forest Resources (PIS), supported by FAO and UNDP, which put large-scale forest inventory on a statistically sound footing under the guidance of international experts.	The project ended in 1968 but PIS activity continued, funded by the Government of India. A training unit was created during the early 1970s to train technical staff.
1981	Forest Survey of India (FSI) was created with a broader mandate to conduct the NFI, maintain a national database of forest resources and train forestry personnel in the application of technologies used in forest inventory.	Human resources were not increased to meet the additional needs under the new NFI mandate but training for technical staff was strengthened.
1986	FSI's responsibilities were revised, and monitoring of forest cover and changes to it using remote sensing imagery and preparation of the biennial 'State of the Forest Report' became important activities.	Landsat MSS data of 80 m resolution were visually interpreted at a 1:1 000 000 scale.

Year	Stage of development leading to present level of preparedness for REDD+ activities	Remarks
1987	The first 'State of the Forest Report' of India, giving the area of forest cover, was published.	The second, third and fourth assessments (until 1993) used Landsat TM imagery of 30 m resolution at a 1:250 000 scale, visually interpreted.
1995	FSI switched to imagery from Indian satellites IRS-1B and then IRS 1C/1D. Digital interpretation was introduced in limited areas and gradually extended.	IRS-1B imagery had 36 m resolution and IRS 1C/1D had 23 m resolution. Assessment continued at a 1:250 000 scale.
2000	With the eighth assessment, digital interpretation became fully operational on all imagery from IRS 1C/1D and IRS P6, and visual interpretation was dispensed with.	The assessment scale became 1:50 000 with a minimum mappable area of 1 ha. Accuracy assessment was rationalised.
2001	The design of the forest inventory was modified to make the NFI operational and to collect new information to meet changing needs, including information required for climate change studies.	Two-stage sampling was applied and the country divided into homogeneous zones so that sample plots could be laid in all zones.
2005	A special study was launched to map various forest types found in India using GIS, climate, soil and forest cover maps with extensive ground verification; this study was completed in 2009.	India has 16 major forest types, from dry to moist and from tropical to temperate and alpine, as per Champion and Seth's (1968) classification.
2008	A new biomass study was launched in 2008 to measure missing components of forest biomass (not measured by the NFI) as required under REDD+; it was completed in 2009.	To collect data on biomass of small trees, branches, leaves, climbers, shrubs, litter and dead wood.
2009	The carbon stock of India's forests was estimated using country data following the IPCC Tier 2 approach.	IPCC default values were used only to estimate belowground biomass (root systems).
2010	New parameters (small trees, biomass of climbers/shrubs, litter and dead wood) were included in the NFI in order to measure all the carbon pools in the forests.	Biomass of small trees was determined using recently developed allometric equations.

3.3 Capacity development: Strengths and weaknesses

FSI is dedicated to national forest monitoring and is the nodal agency for reporting to FAO on the country's forest resources. FSI has four zonal centres, each with a well-defined area, which mainly undertake field inventories; remote sensing and planning take place at headquarters. The training wing organises short-term (one to three weeks) courses on application of remote sensing, GIS, GPS and field inventory for professionals and technicians of state forest departments and FSI at the headquarters.

A sound scientific foundation for national forest monitoring in India was laid in 1965. The mostly young Indian professionals and technicians who were selected for the PIS project from among provincial government bodies were quite dedicated with the right aptitude. They took full advantage of the international experts in learning the scientific methods of conducting forest inventory, data collection, electronic data processing and interpretation of aerial photographs. In addition, they were trained in one of the best institutions in the world. Within three years, PIS had acquired an international reputation, and the Indian CEO of PIS at the time had an important role (Singh 2006). As PIS was to continue after the project ended in 1968, new young technicians recruited as permanent staff were attuned to the PIS work culture through in-house training by the experienced existing staff. This helped maintain continuity of the PIS work culture (e.g. precision in measurements, checking and verification of results), which has continued in FSI. As a result, FSI became a lead centre in the Asia-Pacific region, conducted regional training for professionals and offering support to FAO in its periodic Global Forest Resource Assessments.

FSI has kept pace with technological and methodological advances in computing, remote sensing and GIS during the past three decades and has been able to absorb applications of upgraded technology. For example, FSI is now equipped with state-of-the-art hardware and software for applying remote sensing technology.

With changing information needs, FSI changed its activities. As trees outside forests make a major contribution to timber production in India, such resources are now being simultaneously inventoried along with the NFI. New parameters have been added to the NFI to estimate forest carbon stocks. Remote sensing applications have been integrated with the NFI to monitor changes in the carbon stocks and greenhouse gas (GHG) inventory. FSI followed a Tier 1 approach for GHG inventory for the First National Communication submitted to the UNFCCC in 2004, whereas a Tier 2 approach was used in the Second National Communication in 2011. FSI plans to adopt a Tier-3 approach in the Third National Communication on GHG emissions, for which remeasurement of the NFI sample plots began in the fourth cycle.

However, FSI faces the challenge of dwindling human resources. The numbers of technicians – who are the real pillars of the organisation – have fallen over time. Given the volume of work for a country like India, the institution is too small. The result is that remeasurement of permanent plots is delayed, as is, therefore, the generation of information on changes in biomass and other parameters. There are not enough professionals to comprehensively analyse the vast amount of data held by FSI.

For REDD+ activities, information is lacking on the social and environmental value of forests. There has been no large-scale valuation of ecosystem services or how they support livelihoods, especially those of the poor. Furthermore, forest-dwelling communities' dependence on forest and their role in sustainable forest management and benefit-sharing mechanisms are not understood (Ravindranath *et al.* 2012).

3.4 Recommendations

India has a dedicated institution for monitoring forests, FSI, but it needs to be strengthened. India also needs to formulate a national strategy to implement REDD+, as required under the UNFCCC, with clearly defined mandates, roles and responsibilities.

Of great importance – and a great challenge – for implementing REDD+ is the establishment of a forest reference (emission) level (REL/RL). India has the advantage of a well-developed national forest monitoring system; it also has time series data on forest cover dating back more than 25 years and forest inventory data for most of the country's forests. It is possible to detect the locations of changes in forest accurately by analysing these data. Drivers of changes, whether deforestation and forest degradation or activities resulting in carbon stock enhancement, can also be identified to help set the REL.

In India, provincial governments (subnational units) are responsible for the protection and sustainable management of the forests. However, the level of protection and sustainable forest management varies from province to province. These governments will be the true beneficiaries of REDD+, and their involvement in REDD+ and monitoring, reporting and verification (MRV) is essential. FSI is already training forestry staff in provincial governments in forest inventory and using GIS. FSI's province-level forest cover and inventory data have to be analysed to set RELs at the subnational level.

For research on the value of forests' ecosystem services and forest-dwelling communities' dependence on forest and the livelihood support they provide, other institutions, such as the Indian Council of Forestry Research and Education (ICFRE), and provincial governments will have to be involved. For this purpose, it will be essential to develop guidelines and manuals for REDD+ MRV reporting on biodiversity and the social benefits of forests, as these are lacking at present.

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Chapter 4

Stepwise approaches to developing REDD+ MRV capacity in Indonesia

Ruandha Agung Sugardiman

4.1 From global agreement to national implementation

Policy approaches and positive incentives set out in the Cancun Agreement aim to provide encouragement to developing countries that are contributing to mitigation actions in the forestry sector by undertaking REDD+-related activities, defined as reducing emissions from deforestation, reducing emissions from forest degradation, conservation of forest carbon stocks; sustainable management of forests and enhancement of forest carbon stocks.

The Cancun Agreement also states that implementation of REDD+-related activities is to be measured domestically, reported, and then verified as making a contribution to global mitigation efforts. Implementation at national level involves developing 1) a national strategy or action plan; 2) a national reference emission level (REL) and/or a reference level (RL), which may be combined with subnational RELs/RLs depending on national circumstances (provisions contained in Decision 4/CP.15); 3) a robust and transparent national forest monitoring system for the monitoring and reporting of REDD+ activities; and 4) a system for providing information on REDD+ safeguards.

In Indonesia, the Directorate General of Forestry Planning, under the Ministry of Forestry, led the process for formulating the national REDD+ strategy, in collaboration with the UN-REDD Programme Indonesia. After a series of meetings and consultations with stakeholders at both national and subnational levels, the draft strategy was completed and published in November 2010. Following feedback from broader audiences, coordinated by the REDD+ Task Force in collaboration with the Presidential Delivery Unit, the revised draft was published in June 2012.

Indonesia is also in the process of preparing a system for providing information on REDD+ safeguards, called the REDD+ Safeguards Information System (SIS) Indonesia, led by the Ministry of Forestry. The draft is ready to be circulated for feedback among stakeholders at both national and subnational levels. Whereas the UNFCCC COP offers 'guidance' on the provision of further information safeguards, Indonesia is applying the principles of 'doing by learning' and 'learning by doing', for better and more sustainable results.

With regard to the measurement, reporting and verification of emission reductions, Indonesia uses the decision by SBSTA as a reference. The decision suggests employing a combination of remote sensing and ground-based forest carbon inventory approaches as a prerequisite to establishing a robust and transparent national forest monitoring system.

While the basic elements needed for monitoring greenhouse gas (GHG) emissions have been established and are being practised in activities related to forest inventory, implementation of reporting and verification requires the application of international standardised guidelines and the involvement of external independent bodies.[1] Indonesia's current forest monitoring processes can be developed into a robust and transparent system for monitoring and reporting REDD+ activities by strengthening capacity at national level and building capacity at subnational level. Further investments will be needed to build regulatory mechanisms for checks and balances, and mechanisms for coordination between and within government institutions.

4.2 Current state of Indonesia's forest monitoring system

Indonesia's monitoring system for forest resources was launched in 1986, when the Government of Indonesia began its National Forest Inventory (NFI) programme; FAO gave the Ministry of Forestry technical support for the four years to 1990. The NFI is now funded from the national budget. The NFI was originally designed to gather information on standing stock volumes for each type of forest, namely mangroves, peatlands, lowland forests and mountain forests. The information that it gathers on the distribution of forests, forest cover types and land use is essential for decision makers, forest planners and forest managers. The information is also very important for controlling forestry sector activities at both national and subnational levels.

The NFI has laid the foundation for the establishment of a system to monitor forest resources, which has four major components: forest resources (status) assessment, forest resources (change) monitoring, geographic information system (GIS) and users' involvement.

The NFI is operated by several enthusiastic divisions. The FRA (Forest Resources Assessment) division coordinates field inventories and ground-based measurement activities; it also operates the Field Data System (FDS) and is responsible for its integration

1 Guidelines for monitoring are mentioned in COP decisions (2/CP.13 and 4/CP.15); these may need additions but are probably sufficient to start developing monitoring systems. Guidelines and modalities for reporting and verification are still to be developed.

with the GIS. The DIAS (Digital Image Analysis System) division interprets and monitors changes in forest cover using multi-date satellite (imagery) data; it also prepares outputs that will serve as inputs for the FRM division. The FRM (Forest Resources [change] Monitoring) division, which has GIS capability, is responsible for national mapping and keeping maps up to date for the GIS database analysis; it is also responsible for modelling forest land use, including recalculating the extent of forest cover and its distribution. The SDN (Spatial Data Networking) division is responsible for providing standardised spatial data at the Ministry of Forestry to enable data sharing and data exchange that will be beneficial for broad audiences. This task includes providing benefits to the wider community, involving of a wide range of user groups and acting/facilitating as a node for spatial data networks at the national level. The NFI system is supported by dedicated staff at its Jakarta headquarters, with 17 regional offices across Indonesia.

Data on forests and relevant information need to be updated continually and systematically archived. They need to be made available to decision-makers in a timely manner, as well as to the public. From the first NFI in 1986 until 1996, the Ministry of Forestry undertook periodical nationwide forest resources monitoring and assessment.

Monitoring activities that were designed and established through the NFI programme were institutionalised as the main tasks and functions of the Directorate General of Forestry Planning at the Ministry of Forestry. The organisation has four divisions, namely Forest Inventory, Forest Monitoring, Mapping and Spatial Data Networking (Figure 4.1).

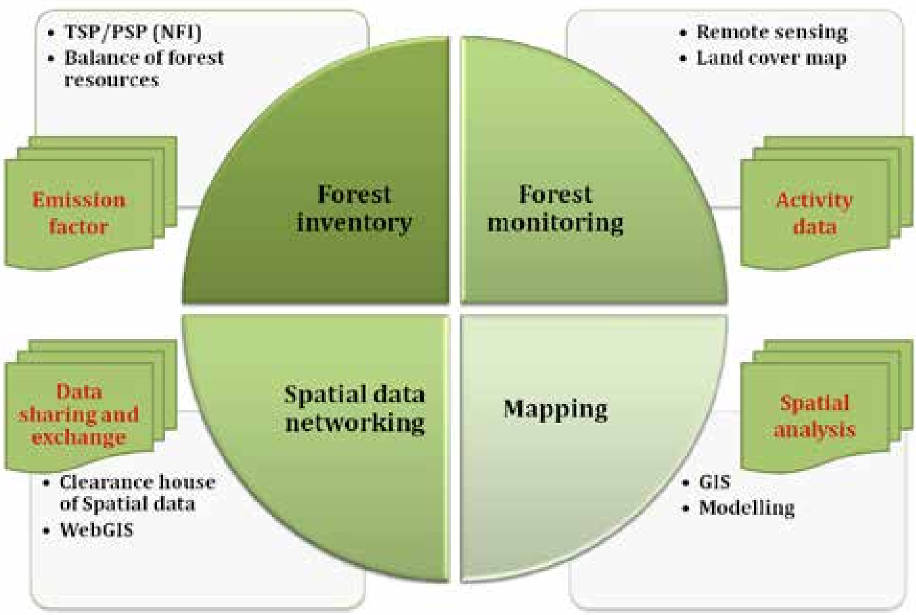


Figure 4.1. Directorate of Forest Resources Inventory and Monitoring, Directorate General of Forestry Planning, Ministry of Forestry, Indonesia (TSP = temporary sample plot; PSP = permanent sample plot; NFI = National Forest Inventory)

The present national forest inventory and forest monitoring systems provide a foundation for developing a national forest monitoring system (NFMS). The Forest Inventory and Forest Monitoring divisions of the Directorate will be able to produce activity data and determine emission factors. Supporting this capacity is the work of the Mapping division, which conducts spatial analysis using GIS and modelling. Then, the Spatial Data Networking division will support data sharing and data exchange, thus releasing information on forest resources and monitoring to the public.

Thanks to the establishment of the NFI, Indonesia does have some capacity to conduct REDD+ MRV at the national level, but this needs to be strengthened as part of the development of the NFMS. Such capacity is particularly important for measurement and monitoring; by contrast, international reporting to the UNFCCC is standardised and will be carried out by the focal point in each country, and verification takes place as part of an external independent verification process.

The creation of a national measurement and monitoring system is the main activity for REDD+ MRV. Indonesia has extensive experience in this area, but other initiatives related to measurement and monitoring currently at the field level need to be harmonised and synergised and then aggregated to the national level. Although there is no need to build a new system, strong leadership will be required to create clear mechanisms and procedures to facilitate the compilation and scaling-up of existing initiatives and ongoing activities into robust national capacity.

4.3 Current experiences

4.3.1 Forests in Indonesia and roles of the forest in global mitigation actions

Indonesia is located along the equator, stretching 5300 km from west to east and 1700 km from north to south. State forestland under the jurisdiction of the Ministry of Forestry covers approximately 72% of the country's total land area, that is, 136.2 million ha of the total 187.8 million ha.

Figure 4.2. Forest cover in Indonesia (Ministry of Forestry 2011)

Forests in Indonesia are categorised according to three main purposes: conservation, protection and production. As of October 2012, conservation forest accounted for 26 127 409 ha, protection forest for 32 211 210 ha and production forest for 77 832 508 ha.

Conservation forest consists of national parks, natural reserves and hunting forest. The aim of protection forest is to protect the hydrological integrity of an area. Production forest is separated further into limited production forest, permanent production forest and convertible production forest (for non-forestry uses), based on the biophysical condition of the forest area and the standing stock of (commercial) timber.

Given the wealth of natural resources embedded in the country's vast forest areas, the Ministry of Forestry has been tasked with managing the area responsibly, in accordance with national circumstances and with consideration of the country's need for development. As forest resources are essential for the sustainable existence of humanity and play an important role in stabilising the planet's climate, Indonesia has committed to conducting relevant activities to help in the efforts to reduce global emissions. This commitment is in line with Article 3 of the UNFCCC: 'parties should protect the climate system for the benefit of future and present generations of human kind on the basis of equity and in accordance with their common but differentiated responsibility and respective capabilities'. Indonesia's commitment is based on its willingness to contribute and act responsibly as a member of the global community.

4.3.2 National reference emission level/reference level

The reference emission level/reference level (REL/RL) serves as the baseline against which reductions in emissions are measured. The REL/RL is a function of forest area change, used in combination with the corresponding carbon stocks of the forests being deforested or degraded (IFCA 2008). It also includes reforestation and afforestation, such as the One Billion Indonesian Trees for the World (OBIT) programme. The REL/RL needs to be set at a certain level or period; for Indonesia, the baseline period is 2000–2006. Forest cover both inside and outside state forest areas is considered; within state forest areas, production forest that can be converted to non-forest uses is included.

Three approaches to setting the REL/RL have been established. First, under the historical approach, the REL/RL can be set by taking an average of past values over an agreed period. Second is the modelling approach, which makes calculations based on unplanned activities and land use planned for development goals during a specific timeframe. Third, a mixed approach measures emissions from unplanned activities against an REL/RL based on historical unplanned emissions, or an average of historical emissions. The mixed approach is the most appropriate for the Indonesian context. However, the approach encounters difficulties in making projections for deforestation rates, which require more than technical capacity. In establishing its REL/RL, Indonesia started with a historical approach using the available data. The results will be adjusted further using variables such as population density, economic growth, regional development and spatial planning.

4.3.3 Estimating emissions

Emissions are estimated or calculated in general using the following formula:
Emission estimate = Activity data × Emission factor

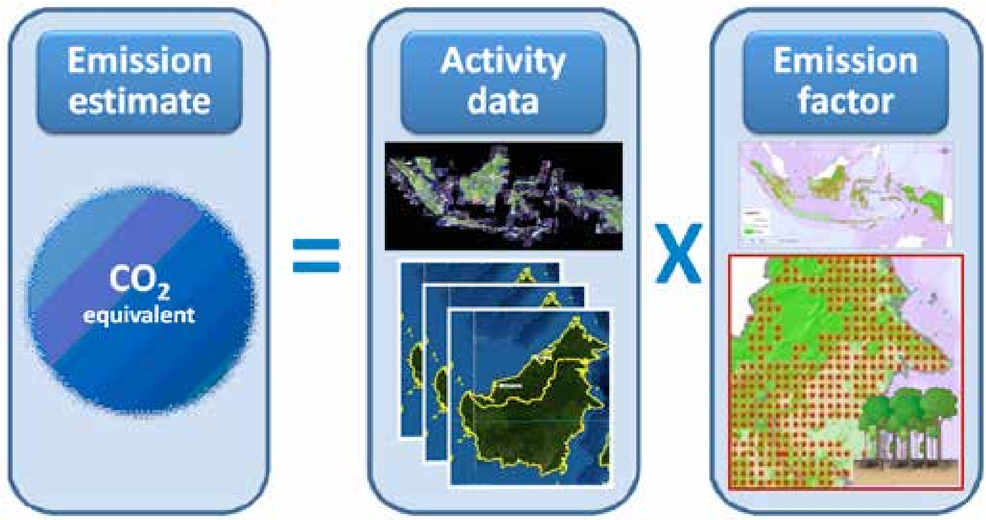


Figure 4.3. Formula for estimating emissions (Modified from Alberto Sandoval, Rosa Ramon – UNREDD general and MRV framework COP 2010)

The activity data reveal changes in land uses at certain locations and at certain periods as a result of human activity. Land use changes need to be monitored because they affect the land cover, which in turn influences the level of carbon stored. Monitoring takes into consideration the diverse factors that cause spatial changes, such as natural hazards (e.g. fires), conversion to other land uses, climate change and changes in management practices. Other factors include people's social and economic conditions and the availability of infrastructure.

Activity data provide essential information for mitigation actions, and indicate the opportunity costs available for land uses in a location. Factors that determine the amount of carbon being stored and the capacity of an area to sequester carbon include the types of vegetation and activities in the area. Having a diverse land use system provides a variety of options for income sources.

Land use changes are analysed by mapping the land use and land cover at two different points in time and then comparing them. After changes are identified, the extent of the change is calculated. From there, drivers of land use change, such as deforestation, can be identified and addressed, which are necessary steps for projecting future land cover changes that could generate further emissions. To track activity data or forest area change, Indonesia is considered capable of applying Approach 3 (Angelsen *et al.* 2012): an approach that involves spatially explicit tracking of land use conversions over time.

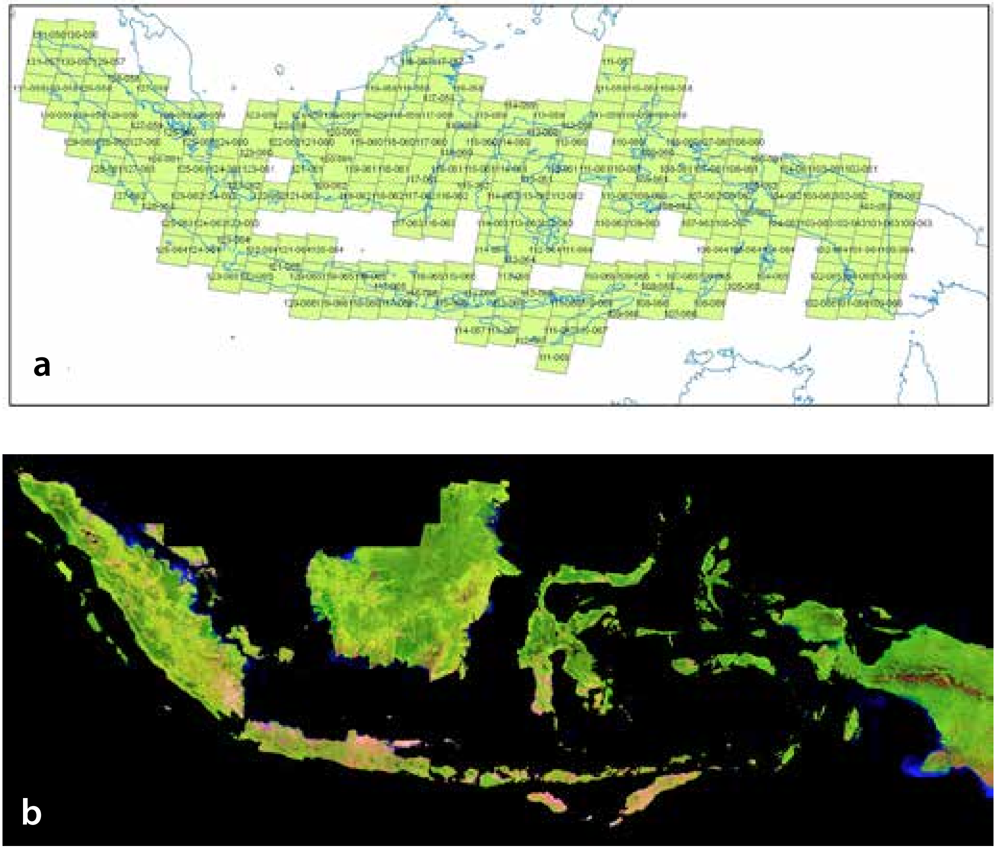


Figure 4.4. Landsat images for the whole of Indonesia (217 scenes): a. scenes (LAPAN, CSIRO 2011), b. Landsat image mosaic (Ministry of Forestry and South Dakota State University 2010)

Series data are available on land cover change for Indonesia. These data were obtained from Landsat 5 TM and Landsat 7 ETM+ (in each of 1990, 1996, 2000, 2003, 2006, 2009 and 2011).

The emission factor is a coefficient that quantifies GHG emissions or GHG absorption for each activity. It is used to determine the amount of carbon being lost and released into the atmosphere as a result of human activity, such as deforestation. In general, the emission factor is derived from emissions or absorptions calculated for the average data sample, for each activity and each time period. It is represented in tCO_2/ha. In the case of a change from primary to degraded forest, the emission factor is calculated as the change in carbon stocks from the initial period (pool) of the primary forest to the degraded forest (in tCO_2/ha). Based on this forest conversion process, the emission factor can generally can be distinguished from biomass component and emissions from the decomposition of soil carbon, both in mineral soil and in peatlands.

The emission factor can be obtained from the forest inventory or, more specifically, from an inventory of carbon stocks. It should be supported by the development of allometric equations to estimate the biomass and the biomass conversion and expansion factors. The inventory for the REDD+ carbon stock may combine remote sensing and field surveys.

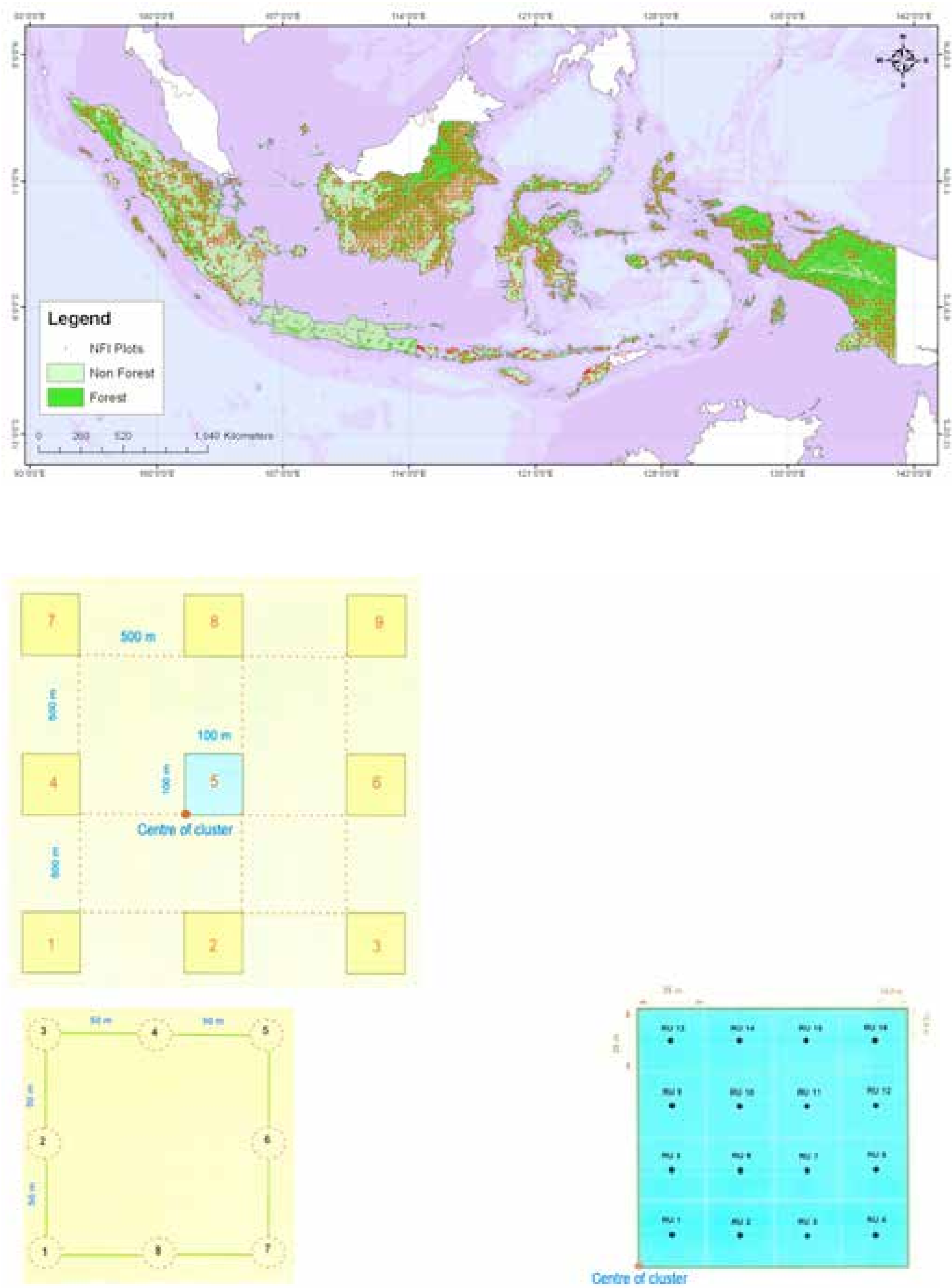
The emission factor is specific to local conditions, such as soil fertility and tree species. Therefore, in addition to conducting a carbon stock inventory, other data are needed for the allometric equations and for calculating the conversion factor/expansion factor. Extensive data must be collected to define the value of the emission factor, with data collected for each specific ecoregion.

Regular assessment by the NFI has produced information on the status of forest stands, forest stock, forest growth and forest diversity for areas across Indonesia. About 3000 permanent plots, measuring 20 km × 20 km, have been established, systematically distributed across Indonesia. Such regular assessment can result in unnecessary measurements (e.g. where several plots represent a single land cover class), which results in inefficiency, but other types of land cover may not be captured within that plot size. Further land cover stratification is therefore needed to enrich the representativeness of certain locations. The current NFI is being redesigned by increasing the density of grid plots, with the introduction in some provinces of plots with dimensions of 10 km × 10 km. In addition, some of the sample plots have been re-enumerated.

Although the NFI was not designed for the purpose of inventorying carbon stocks, the permanent sample plots serve as good sources of data for estimating changes in forest carbon stocks above ground, particularly inside state forests. However, these NFI plots will require improvements if they are to be used for reporting emissions at a Tier 2 level or higher. Improvements need to be directed towards making it possible to obtain data on changes in forest carbon stocks for all five carbon pools (aboveground biomass, belowground biomass, litter, dead wood and soil organic carbon) with low uncertainty. Technical aspects also need to be further improved to obtain data on the emission factor, to reduce uncertainty for the five carbon pools. The plots can potentially be used to measure gains and losses in carbon stocks in a data series. At present, changes in the carbon stock are calculated by comparing the values at two time points. Emission factors could be derived from measurements of permanent sample plots and temporary sample plots from the NFI for the following periods:

1. 1990–1996 (2735 cluster plots)
2. 1996–2000 (1145 cluster plots)
3. 2000–2006 (485 cluster plots)
4. 2006–2014 (>3000 cluster plots)

In 2011, the Ministry of Forestry, in collaboration with UN-REDD Programme Indonesia, began redesigning the NFI. The revised version will include measurements of carbon parameters and will extend the focus beyond measurement of commercial timber. The inventory will include all five carbon pools (i.e. not only aboveground biomass, but other pools also).



A tract Temporary Sample Plot (TSP) contents 8 Sub Plot. Measurement using sampling point (BAF 4)

Permanent Sample Plot (PSP) Only on tract 5 size 100 m x 100 m with 16 sub-plot

Figure 4.5. Distribution of cluster plots in a 20 x 20 km² grid (Ministry of Forestry 1996)

By changing how it determines the emission factor, Indonesia may reach Tier 2 or Tier 3, which require the use of country-specific data, forest biomass recorded at finer scales and actual inventories with repeated measures (Angelsen *et al.* 2012).

4.3.4 Land cover mapping to monitor forest carbon stocks

Through its current forestry activities, the Directorate General of Forestry Planning may be able to use land cover data for forest carbon monitoring through the process shown in Figure 4.6.

Following this kind of procedure, areas of Indonesia could be clustered into categories based on historical emissions or deforestation activity, and forest cover.

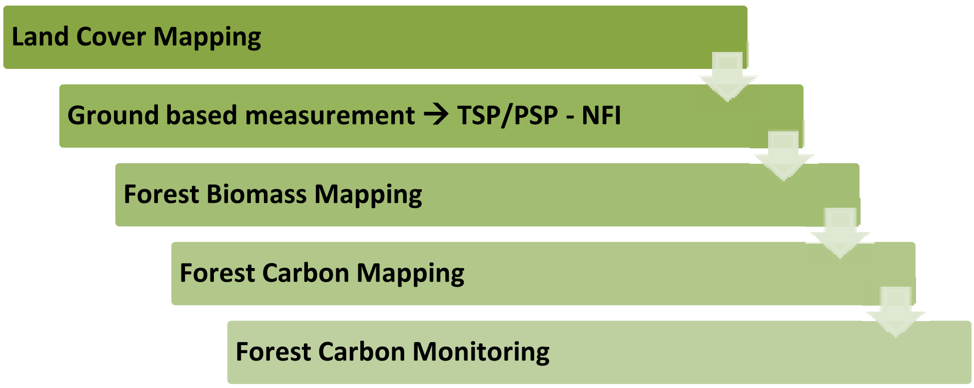


Figure 4.6. Process for using land cover mapping data for forest carbon monitoring
(TSP = temporary sample plot; PSP = permanent sample plot; NFI = National Forest Inventory)

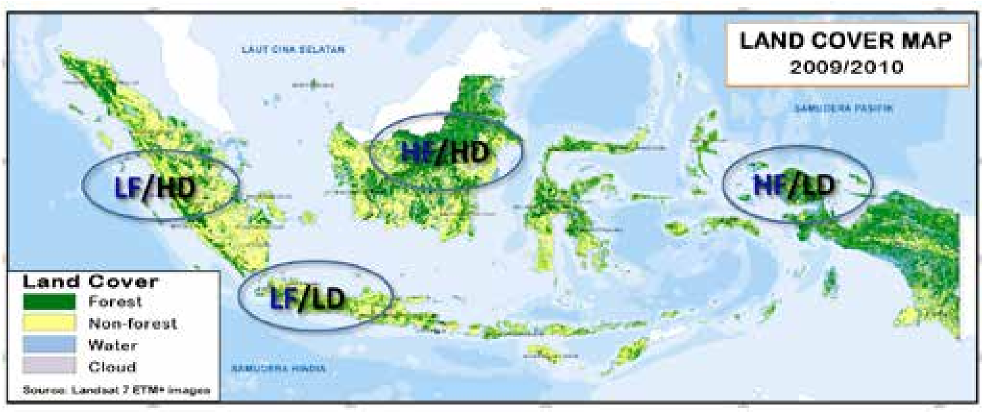


Figure 4.7. Clusters by forest cover and deforestation rate: (L)ow – (H)igh, (F)orest – (D)eforestation (Ministry of Forestry 2009)

As shown in Figure 4.7, Indonesia could be categorised into four regions in terms of forest cover and deforestation rate. The western region, Sumatra, is characterised by low forest cover and a high rate of deforestation. The lower middle region, Java, is characterised by low forest cover with low deforestation, and Kalimantan, to the north, exhibits high forest cover and a high deforestation rate. In the eastern part of the country, the Papua region is characterised by high forest cover and a low rate of deforestation. The national REL/RL must take into account that each main area is at a different point on the forest transition curve, and so must be based on assessments of historical emissions in a particular region and the extent of development at the subnational level. Such categorisation is important for policy measures within a development strategy that features activities that affect mitigation efforts and are considered as being for the national circumstances.

4.3.5 REDD+ strategy

Indonesia's REDD+ strategy considers the country's geography as an archipelago comprising seven big islands that differ in terms of their forest cover and deforestation rate, as well as the ethnicity of their populations. Also of relevance to the strategy is that the country is governed in a hierarchical system, with governments at the national, provincial and district levels. Indonesia is taking a national approach to REDD+ with subnational implementation; agencies at the subnational level will adapt the national REDD+ strategy by tailoring it to the specific situations and characteristics of the region.

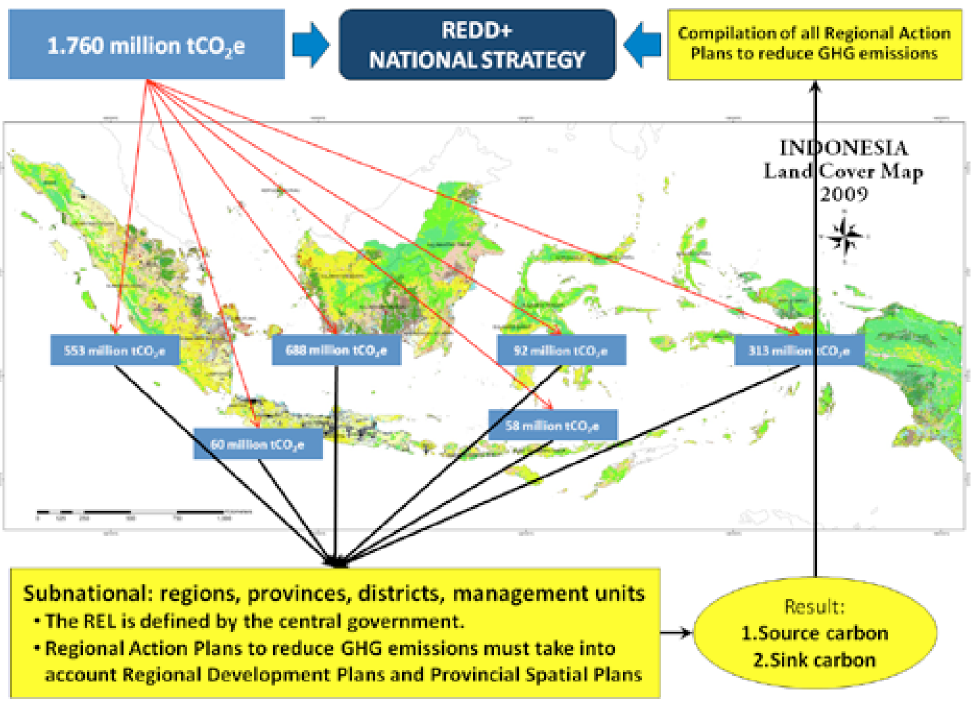


Figure 4.8. National consultation processes for the national REDD+ strategy
(Ministry of Forestry 2009)

These geographical, social and political characteristics were identified as key considerations when establishing a national MRV system in Indonesia. Consequently, national-level measurement and monitoring systems, namely the NFI and NFMS, need to be spatially explicit and provide coverage of the whole country. Indonesia will then be able to monitor changes at the national and subnational levels.

In setting emissions estimates, Indonesia is encouraging communication and consultation processes among stakeholders at both national and subnational levels. The results are compiled and then circulated for feedback at the subnational level, which may be a region (main islands), province, district or even a national park or forest management unit.

Using local data and specific field information to verify the figure set at the national level will increase the accuracy of central estimates of local or regional emissions. Furthermore, aggregating the emissions estimated at subnational levels will increase the accuracy of estimates at national level, thus reducing any uncertainty.

4.4 Concluding remarks

Indonesia's Ministry of Forestry has been able to maintain custodianship by defining and clarifying the responsible parties and to prevent the duplication and redundancy of work that lead to the inefficient use of time and resources. The development of an independent working system run by dedicated teams has contributed to the successful establishment of an NFMS. However, Indonesia's sheer size is a challenge, as is the ongoing need for skilled staff.

The effectiveness of the established system for monitoring forest resources in Indonesia provides a strong basis for the country to implement REDD+. Indonesia has made a consistent commitment to REDD+, as reflected in two Presidential regulations (or *Perpres*). The Presidential regulation on National Planning Action on GHGs (Perpres 61/2011 on RAN GRK) serves as a guideline for ministries and state institutions to conduct planning, implementation and monitoring, and for evaluating national plans related to emissions. It also regulates the participation of business entities in planning and implementation for emission reductions.

The second relevant Presidential regulation (Perpres 71/2011) guides the implementation of the GHG inventory. This regulation aims to produce two types of information. The first type is used for updating emission reports and trends in emissions and absorptions, including carbon stocks at the national, provincial or local level. The second type of information concerns national achievements in reducing GHG emissions through mitigation activities. Finally – and most importantly for REDD+ implementation – is the introduction of policies (or interventions) that target the drivers of deforestation, rather than merely considering carbon (biomass), that is, working towards actively reducing emissions rather than only monitoring (Lotsch 2012).

4.5 Acknowledgements

The author thanks the Directorate General of Forestry Planning at the Ministry of Forestry for providing me with the opportunity to contribute to this CIFOR publication. As a result, the extensive experience of the Directorate General of Forestry Planning can be shared among a broader audience, not only domestically but also internationally. Thanks also go to CIFOR and GOFC/GOLD, which patiently waited for my contribution at the last minute, and to a reviewer for helpful comments.

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Chapter 5

Development of a national forest monitoring system for REDD+ in Vietnam

Manh Cuong Pham

5.1 Implementation of the national forest monitoring programme and the need for improvement

Until 1990, forest monitoring in Vietnam was conducted only at subnational level, particularly for State Forest Enterprises (SFEs), by using a combination of aerial photographs and field surveys. The first cycle of the National Forest Inventory and Monitoring (NFIM) programme was formally implemented in 1991; the 1994 Law on Forest Protection and Development required that the programme be conducted every five years. As of 2010, the Forest Inventory and Planning Institute (FIPI) had completed four cycles of the NFIM. Although all NFIM cycles used a combination of remote sensing data and field surveys, the types of imagery, number of ground sample plots and scale of the resultant forest maps differed between cycles. Two types of sample plots were used in all NFIM cycles: semi-permanent sample plots and permanent sample plots.

Semi-permanent sample plots are designed for the collection of information on forest types, forest species composition, average timber volume of each forest type (through diameter at breast height [DBH] and tree height), status of regeneration, and types and volume of non-timber forest products. Some socio-economic data were also gathered. The plots, each measuring 1000 m × 1000 m (100 ha), are systematically selected from across the entire country. The objective of collecting the forest information at a certain point in time does not require that the sample plots used in different NFIM cycles be in the same location; that is why they are called semi-permanent plots. The number of semi-permanent sample plots changed from one cycle to another, depending on forest changes, the type of remote sensing data used and the availability of government funding. Before conducting a new NFIM cycle, FIPI uses the latest forest cover maps and/or remote sensing data to identify areas that have experienced forest changes; sample plots where forests have been cleared or converted to other land uses are then removed from the analysis. At each location, a nested (two-staged) sample plot approach is applied. The forest parameters are collected from 40 secondary plots, which are located along the L-shaped transect running from the centre of the sample plot to the north and east. Each secondary plot measures 25 m × 20 m (500 m^2); therefore, the total area of semi-permanent sample plots is 2 ha (40 plots × 500 m^2).

Permanent sample plots are designed to collect all information for studying the forest structure, yield and growth, and other forest ecological characteristics. These plots are representative of all ecological regions in Vietnam. The permanent sample plots stayed the same for all four cycles.

- **First cycle (1991–1995):** A combination of Landsat TM imagery for wall-to-wall forest cover mapping and 2800 sample plots (1000 m × 1000 m) systematically selected from across the entire country was used. Forest cover maps of eight agro-ecological regions (fully covering the entire country) at a scale of 1:250 000 were produced.
- **Second cycle (1996–2000):** SPOT images at a spatial resolution of 20 m × 20 m were used to make forest cover maps of all provinces at a scale of 1:100 000. The number of sample plots was increased from 2800 to 3800. Forest cover maps and field measurement data were generated in hardcopy.
- **Third cycle (2001–2005):** Landsat ETM+ imagery was applied. The number of sample plots was increased to 4200. Forest cover maps of all provinces were established at a scale of 1:100 000. In addition, some very-high-resolution satellite images (SPOT 5, IKONOS, QuickBird) were procured to make forest maps at a scale of 1:10 000 as well as forest management plans for SFEs to cover an area of about 200 000 ha. Electronic versions of most forest cover maps and field measurement data were available.
- **Fourth cycle (2006–2010):** SPOT 5 images, mostly at a spatial resolution of 2.5 m × 2.5 m were used to make forest cover maps, at the following scales: district level: 1:25 000-1:50 000; province level: 1:100 000. In total, 2100 semi-permanent plots were measured.

Each NFIM cycle generated the following key outputs:

- Forest cover maps of each province and agro-ecological region (with forest maps of Vietnam for 1990, 2000 and 2010 attached)
- Analysis of forest changes
- A report on the structure of key natural forest types for each of the eight agro-ecological regions
- Thematic reports on forest wildlife, forest diseases and insects, non-timber forest products, socio-economic conditions, forest growth, etc.

As of 2012, all forest cover maps generated during the four NFIM cycles had been harmonised using a common classification system, map scale (1:100 000) and projection

(VN-2000, similar to UTM WGS84). Furthermore, field measurement data from sample plots are digitally inputted. It was found, however, that the reliability of the forest cover maps produced during cycles 1–3 was compromised by several shortcomings, including a lack of accurate topographical maps, a lack of cloud-free and good-quality satellite images, inadequate image interpretation skills and errors incurred during the transfer of data from transparent paper to paper maps. Therefore, historical forest cover maps need to be validated and improved. However, data validation and improvement are time-consuming and costly, and are still underway. Although the historical NFIM data can be used to estimate the carbon stock of aboveground living biomass, they are not sufficient to produce reliable figures on the carbon stock of all carbon pools. In addition, no study has been carried out to analyse whether or not the number of sample plots and the sampling design are scientifically and economically appropriate.

Recognising the limitations of NFIM in its current form, the Government of Vietnam has made plans to redesign the NFIM so that it can serve multiple purposes, including payments for forest environmental services (PFES), REDD+ and biodiversity compensation policies. To date, it has invested US$2.5 million to pilot the proposed improved methods. The government also wants to encourage the effective participation of relevant local stakeholders, particularly local forest managers, in forest monitoring activities. Under the new plans, central technical agencies are responsible for providing classified forest maps and carrying out professional forest inventories, and local forest managers are responsible for verifying the forest types and areas under their managed territories. A new output of the NFIM will be the forest management profile of every owner/manager, to contain key information such as the name of the forest manager and the types of forest and areas the manager is responsible for (similar to a forest land registration document). The revised NFIM is expected to be implemented in 2013–2015. Lessons learned from this cycle will be used to make improvements to the next cycle.

During 2013–2015, a combination of very-high-resolution satellite images (e.g. SPOT 5 at a spatial resolution of 2.5 m × 2.5 m) and field surveys will be applied to produce forest cover maps for all communes[1] at a scale of 1:10 000. Data for use in estimating carbon stocks and changes will also be collected. In addition, allometric equations for key natural forest types and major forest plantation species will be developed with the support of international partners. All data are expected to be managed by the national Forest Information and Monitoring System (FORMIS), which is now under development with support of Finland (funding of about US$10 million in two phases).

It is further expected that some medium- to high-resolution satellite images (e.g. RapidEye, DMCii, DEIMOS) will be used to detect major forest changes between years 1 and 5 of each NFIM cycle.

1 A commune is the smallest administrative unit in Vietnam. It consists of several villages.

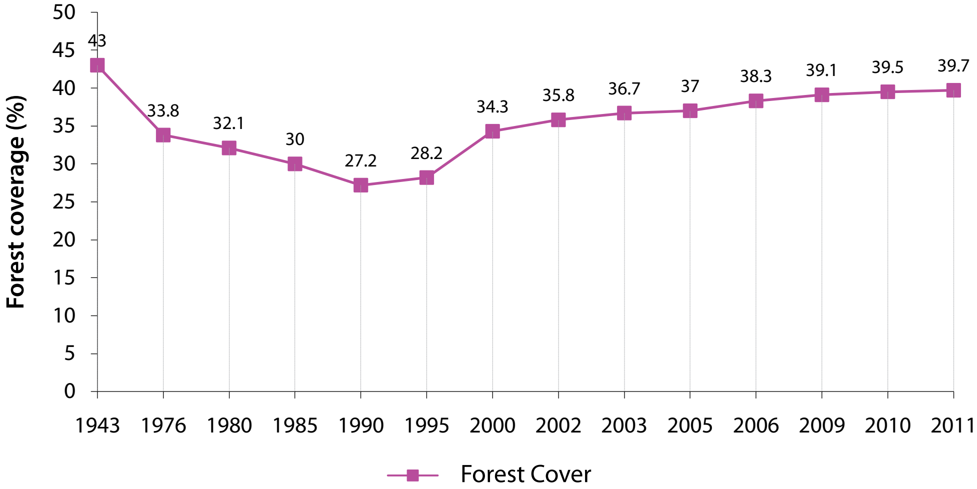

Figure 5.1. Evolution of forest cover in Vietnam between 1943 and 2011

As Figure 5.1 shows, forest cover in Vietnam shrank considerably from 43% of the country's total land area in 1943 to 27.2% in 1990. It then increased year on year to 39.7% in 2011. Although some point to this as evidence of the forest transition theory, others argue that the forest cover changes in Vietnam are largely the result of government policies and of substantial investment in forest protection and development.

5.2 Experience in building national forest monitoring capacity

NFIM is complicated, time-consuming and costly. For effective national forest monitoring that can provide reliable and timely data for policy formulation, forest management and future REDD+ implementation, national capacity building is essential. In Vietnam, capacity for forest monitoring has been built up using a 'learning-by-doing' approach. Of greatest importance in this regard is that Vietnam should take the lead in conducting national forest monitoring activities, with the technical support of international experts; this approach will lead to effective and sustainable enhancements of the nation's capacity. Nevertheless, experience in Vietnam shows that international experts have played important roles in introducing new and advanced technologies, in training national staff and in improving the existing design and methods.

Vietnam's technical staff are now very well trained as a result of the implementation of monitoring activities at SFEs and subnational levels. The essential capacity was continually improved from cycle 1 to cycle 4. At the same time, it is widely recognised that it is very important to train young professionals at universities and vocational schools. These professionals will then be able to gain practical experience and learn how to use modern technologies in forest monitoring.

Of course, financial resources are very important for capacity building. In most cases, hands-on training is funded out of the government budget; however, postgraduate training and advanced training rely on international support.

5.3 Further need for capacity building for REDD+ monitoring, reporting and verification (MRV)

It is important to note that most (if not all) key data for REDD+ MRV will come from NFIM. REDD+ has not been formally accepted as a mitigation mechanism under any international legally binding agreement, and international negotiations are proceeding very slowly. All international REDD+ initiatives are still in the phase of capacity building. Furthermore, no clear and detailed methodologies are available. Verification activities are not mentioned in any UNFCCC COP decision. Therefore, in Vietnam, national forest monitoring capacities are being strengthened not because of REDD+ but because the government wants a transparent and robust NFIM in order to produce more reliable and timely data. However, REDD+ MRV requirements may further strengthen carbon-related monitoring capacity (measurement, estimation), which remains quite weak at present.

5.4 Factors contributing to success in improving capacity

- The establishment of a clear mandate and legal support for NFIM has been very important in building national forest monitoring capacity. No agency or person would be interested in learning forest monitoring if there were no potential for employment. Indeed, capacity is lacking in countries without a national forest monitoring programme.
- Substantial investment in the NFIM during the past four decades has contributed to building the nation's capacity, as it has led to an increase in the number of people with the necessary skills.
- Courses on forest monitoring at national universities have graduated enough trained staff to supply the NFIM, FIPI and other forestry agencies.
- Technical capacity for forest monitoring has been improved through internationally supported projects in which remote sensing, GIS and GPS technologies have been applied and through training both in and outside the country, particularly postgraduate training.

5.5 Challenges hindering efforts to strengthen national forest monitoring capacity

- Decision-makers at the central level and officials within local authorities do not understand the importance of forest monitoring. This lack of understanding has undermined the development and allocation of sufficient financial resources for the implementation of a robust and transparent national forest monitoring programme and for the strengthening of forest monitoring capacity.

- The insufficient allocation of financial resources for forest monitoring assignments means that only highly skilled and experienced staff can take part, which reduces opportunities for young staff to benefit from on-the-job training.

5.6 Recommendations on stepwise approaches for improving national forest monitoring and REDD+ MRV capacity development

1. A country must have a strong intention and clearly defined policy related to forest management and REDD+ preparation. A practical roadmap, or strategy, must then be developed. The country needs to define what it wants, how it will obtain it and who will do the work.
2. Developing a robust and transparent national forest monitoring system should be considered a priority of the government, or at least of the forestry sector. If this is the case, the government will allocate adequate financial resources for the programme implementation and encourage international support. It is for this reason that, in Vietnam, the national forest monitoring system is clearly included in the National Forest Protection and Development Plan and re-emphasised in the national REDD+ action programme, approved by the prime minister.
3. A country should have clear institutional arrangements for national forest monitoring, so that the tasks and responsibilities of the leading agency and supporting/participating agencies are clearly assigned, and collaboration mechanisms are well established.
4. Support from international development partners for the national forest monitoring system and REDD+ pilot projects is important. However, the country should lead the process; otherwise, partners will dilute the support to serve their own interests and perceptions, leading to conflicts of interest among partners and failure to develop a common strategy or system.
5. The participation of research institutes, universities and NGOs is important and will contribute substantially to the process.

Chapter 6

Step-wise approach to improving greenhouse gas inventories

The case of Mexico

Bernardus H.J. de Jong

6.1 Introduction

The UNFCCC recommends that non-Annex 1 countries submit national communications related to climate change. Greenhouse gas (GHG) inventories that apply the most recently accepted methodology are an essential part of each communication. Consequently, Mexico, as a non-Annex 1 country, has submitted four national communications, all of which include a summary of GHG inventories for all sectors. The country has also separately presented other publications or reports that set out in more detail the procedures and data applied in each inventory. Each communication reports emission estimates for a certain base year or period, depending on the sector (see Table 1 for the data used in each inventory).

In the land use, land-use change and forestry sector, two IPCC methodologies were used: the first three communications applied the IPCC 1996 guidelines, whereas the fourth communication used the IPCC 2003 guidelines to estimate emissions from two carbon pools: biomass and soil. Emissions from woody debris and litter were not considered in any of the inventories, as data were not available. A brief overview of the methodology and sources of information used in the four national GHG inventories in the LULUCF sector is presented in Table 6.1. In Figure 6.1, the results of the third and fourth inventories are compared, illustrating the differences in reporting GHG emissions between IPCC 1996 and IPCC 2003. The main differences between the two methodologies arise in relation to reporting emissions from land-use change and reporting fluxes in soil organic matter. In IPCC 1996, flux estimates derived from changes in forest, grasslands and abandoned land are required, whereas with IPCC 2003, GHG fluxes derived from changes between up to six land use classes are described: forest land, cropland, grassland, wetlands, settlements and other land. In IPCC 1996, the fluxes are calculated for changes in forest

Table 6.1. Synthesis of data used in Mexico's four national GHG inventories

Factors	National inventory			
	1st inventory	2nd inventory	3rd inventory	4th inventory
Year	1990	1996	1990-2002	1990-2006
IPCC guidelines used	IPCC 1994	IPCC 1996	IPCC 1996	IPCC 2003
Activity data				
Land-use change data	Land use statistics	Land use statistics	Two land use maps: 1993 and 2002	Three land use maps: 1993, 2002 and 2007
Level approach	**1**	**1**	**2**	**2–3**
Forest types	Five major forest classes	Four major forest classes[d]	Seven major forest classes	Ten major forest classes
Forest management	Statistics	Statistics	Statistics	Statistics
Emission factors				
Pools considered	Biomass + part soil	Biomass + soil	Biomass + soil	Biomass + soil
Biomass data	Literature	Literature	7000 inventory plots of 3000 m^2	25 000 inventory plots of 1600 m^2
Allometric equations above ground	n.a.	n.a.	Brown *et al*. 1989[b]; Brown 1997[c]	National database, complemented by derived generic equations
Allometric equations below ground	n.a.	n.a.	Cairns *et al*. 1997[d]	Cairns *et al*. 1997[d]
Tier biomass	**1**	**1**	**1–2**	**2–3**
Expansion factors	IPCC	IPCC	IPCC	Nationally derived
Soil carbon	Literature	Literature	Database of 4400 soil samples	Database of 25 000 soil samples
Tier soil	**1**	**1**	**2**	**2**
Uncertainty analysis	High-low estimates	No estimate	IPCC Tier 1, identifying major sources for activities and emission factors	IPCC Tier 1, identifying major sources for activities and emission factors

a Open forest excluded from the analysis.
b Brown *et al.* 1989.
c Brown 1997.
d Cairns *et al.* 1997.

and grassland to some other land use, whereas in IPCC 2003, fluxes are calculated based on changes from the original land use class to the current class for which they are reported. Soil organic carbon fluxes are treated separately in IPCC 1996, whereas in IPCC 2003, soil organic carbon is calculated and reported for each land-use change category.

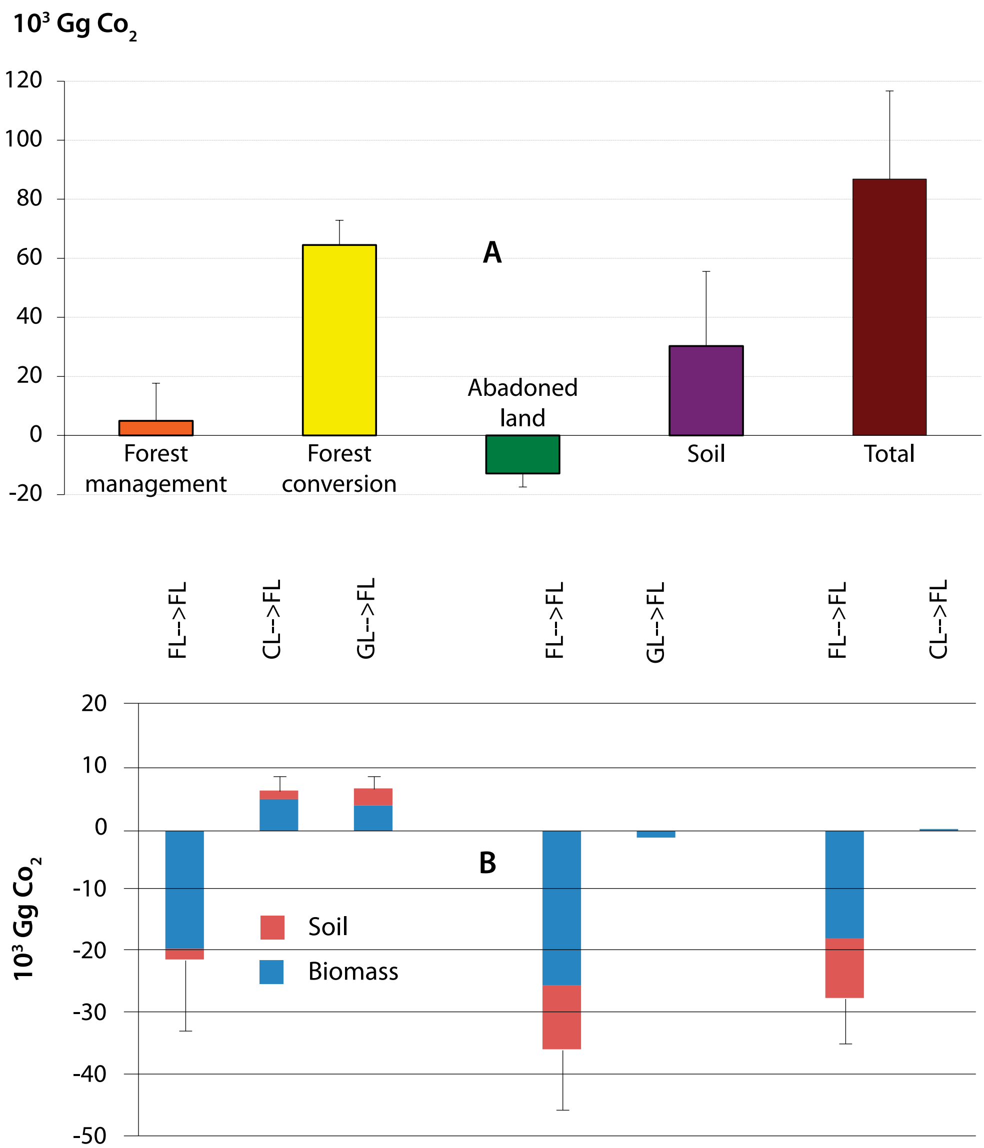

Figure 6.1. Differences in GHG reporting using IPCC 1996 (A) and IPCC 2003 (B). The base year for both reports is 2002. FL = Forestland; CL = Cropland; GL = Grassland (De Jong, Masera *et al.* n.d.; De Jong, Olguín *et al.* n.d.). Please note that fluxes to the atmosphere are reported positive in A and negative in B.

6.2 Availability of data that led to gradual improvements in the national GHG inventories

GHG inventories depend on reliable data, and data availability will determine the level of uncertainty in the estimates. Since the 1990s, Mexico has adopted a national policy of making data publicly available. This policy led to improvements in the third and fourth GHG inventories, for which both national forest inventory data and land use maps were made available for the GHG analysis. This in turn allowed for a more systematic analysis of the major sources of uncertainty in the data and also made it possible to identify the steps to be taken to improve the next generation of GHG inventories. Mexico's interest in REDD+ is one of the driving forces behind the need to produce good-quality data on emission factors and activity data. As such, it is one of the factors that influenced the decision to include the measurement of all carbon pools in the second round of remeasuring the permanent inventory plots, established between 2004 and 2007. Since 2009, dead woody debris, litter and soil organic carbon have been measured in all inventory plots (4500–5000 plots per year), using IPCC guidelines. This will allow Mexico to report emissions from all pools with Tier 2- or Tier 3-level information.

Factors that are currently slowing the process of improving the quality of data for GHG reporting include frequent changes of key governmental personnel due to changes within the Secretaries, and competing interests of government bodies. Whereas the National Institute of Ecology is responsible for GHG reporting, REDD+ and the implementation of forest-related policies are the mandate of the National Forest Commission. There is therefore a need for close collaboration between these institutes and other institutes that deal with land use–related policies and data acquisition, such as the Secretary of Agriculture, Animal Husbandry, Rural Development, Fisheries and Food and the National Institute of Statistics and Geography. Laws and regulations will also have to be adjusted. The recently passed law on climate change represents a step towards improving these relations and towards better defining the mandates of each institute in relation to climate change issues.

6.3 Future steps for further improvements

Continued improvements in data acquisition and management are required for GHG inventories and for future reporting of REDD+-related mitigation activities. As such, it is very important to develop institutional capacities that can integrate national forest inventory data collection methodologies and procedures into remote sensing requirements. On the other hand, as REDD+ will be implemented at the local scale but will require national reporting, there is a need for local data collection procedures that can be directly incorporated in and calibrated with the databases of the National Forest Inventory and associated with remote sensing analysis. As such, simplified monitoring procedures to be implemented in community-type MRV (monitoring, reporting and verification) are being developed, directly calibrated with the National Forest Inventory data plots and data collection procedures. For example, as many data points are available for the major forest types in Mexico, relations between biomass and basal area are statistically very robust and can be used as a basis for community monitoring (Figure 6.2), as basal area is a forest structure parameter that can be rapidly assessed with a relascope.

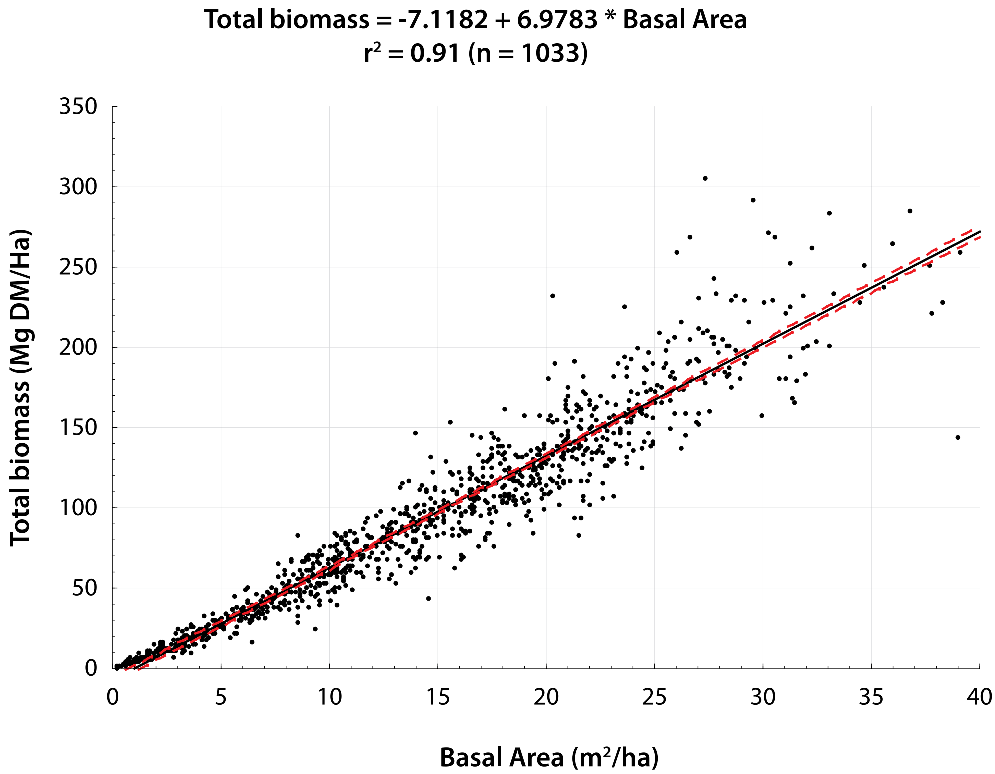

Figure 6.2. Linear relationship between basal area and total biomass in 1033 inventory plots, established in the state of Campeche (De Jong, unpublished)

6.4 Conclusions

- Mexico has established good national-level databases on carbon stocks in all pools. These are continually updated through remeasurements of 25 000 permanent plots.
- Standardised methodologies (at field and laboratory level) have contributed to reducing uncertainty in carbon inventories.
- Mexico now has data available to quantify carbon in all five forest carbon pools for all major ecosystems. However, land use dynamics are poorly quantified and there are long periods without information; this is the main limiting factor for flux estimates at national and subnational scales.
- Studies on carbon dynamics and carbon simulations are very scarce and have only

taken place at local scale. However, such studies will be required, particularly if Mexico adopts the REDD+ activities of 'sustainable management of forests' and 'stock enhancement'.

- Recent studies have been exploring the dynamics of carbon processes in the most important ecosystems.

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2 Experiences and lessons learned from donor organisations

Chapter 7

Measuring, reporting and verifying REDD+

Experiences from the Government of Norway's International Climate and Forest Initiative

Maarten van der Eynden

7.1 Introduction

The Government of Norway's International Climate and Forest Initiative (NICFI) was launched by Norwegian Prime Minister Jens Stoltenberg at the United Nations Framework Convention on Climate Change's (UNFCCC) 13th Conference of the Parties (COP) in Bali in 2007. Through NICFI, the Government of Norway aims to support efforts to slow, halt and eventually reduce greenhouse gas (GHG) emissions resulting from deforestation and forest degradation in developing countries (REDD+). As the world fights to avoid the dangers of climate change, REDD+ is gaining recognition as one of the most important, timely and cost-effective tools at our disposal.

Within its overall aim, NICFI has the following key objectives:

- To contribute to the inclusion of REDD+ under the UNFCCC.
- To contribute to early actions for measurable emission reductions from deforestation and forest degradation.
- To promote the conservation of primary forests, due to their particular importance as carbon stores and for their biological diversity.

As an overarching goal, all these efforts should promote sustainable development and the reduction of poverty. Norway sees REDD+ not simply as an issue of improved forest management, but as a fundamental development choice. The climate change mitigation potential will never be realised unless it offers a more attractive and viable development option than the destructive use of forests.

To achieve its objectives, Norway is pursuing four main tracks:

- Playing an active role in the international negotiations under the UNFCCC, seeking both to identify innovative solutions and to help create consensus around those solutions.
- Entering into large-scale partnerships with key forest countries to demonstrate that real action on a national level is possible and to encourage large-scale emission reductions even before a REDD+ mechanism is agreed upon under the UNFCCC.
- Contributing to the design and establishment of an integrated architecture of multilateral REDD+ initiatives to help ensure broad and early progress on REDD+.
- Financing NGOs, research institutes and civil society organisations to provide analyses, pilot projects and demonstrations supporting REDD+ negotiations and learning through field experiences.

Norway underlines the importance of payments for measurable, reliable and verifiable reporting of emission reductions on a national scale, but also stresses the need for governance measures and broad stakeholder involvement.

7.2 NICFI and measurement, reporting and verification (MRV)

A results-based REDD+ mechanism, whereby countries are paid in proportion to their reduction in emissions from deforestation and forest degradation, requires systems that measure performance in reducing forest-based emissions. Acknowledging the crucial importance of MRV, Norway emphasises capacity building and institutional strengthening related to monitoring and reporting as key priorities for support. Such capacity building and institutional strengthening are implemented both through bilateral agreements between Norway and several countries, and through multinational initiatives (e.g. UN-REDD and the Group on Earth Observations (GEO)).

There is an ongoing debate concerning what the scope of MRV for REDD+ should be. In this chapter, MRV of GHG emissions from the forestry sector (measured in tons of CO_2 equivalents) will be treated. In Norway's view, information regarding biodiversity, poverty reduction and other co-benefits is best treated in the safeguards information systems, also under the UNFCCC.

Given the wide variation in MRV capacity between the countries implementing REDD+, Norway has promoted a stepwise approach to MRV. In early stages, area change data and approximate values of forest carbon can be used to estimate emission reductions. Applying conservative carbon estimates ensures that results-based compensation can start without any overestimation of the results achieved. This approach also provides a clear incentive for countries to work to reduce the uncertainties of reported results, as this would eventually lead to a reduced 'uncertainty discount' when payments are calculated.

In the following sections, experiences from two of Norway's partner countries are presented, exemplifying how MRV is integrated into bilateral frameworks and illustrating Norway's approach to MRV development.

7.3 Guyana–Norway partnership

7.3.1 Background

The partnership between Guyana and Norway offers a working example of how to create incentives for countries with high forest cover and low deforestation rates. Guyana and Norway entered into a climate and forest partnership in November 2009. The agreement was structured so as to incentivise Guyana to maintain its deforestation at its current low levels (or to reduce it), with payments rapidly decreasing in response to rising deforestation rates. Provided that the agreed and expected results are achieved, Norwegian support for the years up to 2015 will add up to as much as USD 250 million.

A Joint Concept Note (JCN) set out the framework for taking the Guyana–Norway cooperation forward. The current version (dated March 2011) includes a description of several interim REDD+ performance indicators and an explanation of how these indicators will trigger compensation in relation to a reference level. This model has ensured that results-based compensation has started from an early stage, with the interim indicators to be revised as a more complete MRV system is developed. The development of the MRV system is guided by an MRV roadmap, which was developed through a broad stakeholder consultation process at the initiation of the partnership. The MRV roadmap is implemented by Guyana, with assistance from consultants who have capacity building as a key part of their Terms of Reference.

7.3.2 Interim performance indicators

Following are brief descriptions of the interim performance indicators.[1]

- Deforestation indicator:
  - *Gross deforestation* – Rate of conversion of forest area compared with the agreed reference level. Conversion of natural forests to tree plantations counts as deforestation with full carbon loss.

  Reporting is based on medium-resolution satellite imagery and *in situ* observations where necessary.

- Degradation indicators:
  - *Loss of intact forest landscapes* – The total area of intact forest landscapes (IFL) should remain constant. Any loss of IFL will be accounted as deforestation with full carbon loss. The IFL baseline map developed in the first reporting year is used to assess future changes.[2]

1 For full descriptions, please refer to the JCN (available at http://www.regjeringen.no/upload/MD/2011/vedlegg/klima/klima_skogprosjektet/Guyana/JointConceptNote_31mars2011.pdf).

2 An Intact Forest Landscape (IFL) is defined as a territory within today's global extent of forest cover that contains forest and non-forest ecosystems minimally influenced by human economic activity, with an area of at least 500 km^2 (50 000 ha) and a minimal width of 10 km (measured as the diameter of a circle that is entirely inscribed within the boundaries of the territory). (See www.intactforests.org).

Similar reporting methods as for forest change estimation are used.

- *Forest management (i.e. selective logging) activities in natural or semi-natural forests* – Increases in total extracted timber volume (compared with the mean volume extracted in 2003–2008) will be accounted as increased forest carbon emissions.

Data on extracted volumes are collected by the Guyana Forestry Commission. Independent forest monitoring will contribute to documenting the figures.

- *Carbon loss as an indirect effect of new infrastructure* – Unless a larger or smaller area or GHG emission impact can be documented through remote sensing or field observations, the area within a distance extending 500 m from new infrastructure will be accounted with a 50% annual carbon loss through forest degradation.

Medium-resolution satellite imagery is to be used to detect human infrastructure (e.g. small-scale mining), with targeted sampling of high-resolution satellite imagery for selected sites.

- *Emissions resulting from illegal logging activities* – Areas and processes of illegal logging should be monitored and documented to the greatest extent possible.

In the absence of hard data on volumes of illegally harvested wood, a default factor of 15% of the reported legally harvested volume will be used to reflect illegal logging.

- *Emissions resulting from anthropogenic forest fires* – The area of forest burnt each year should decrease compared with the current amount.

Coarse-resolution satellite data of active fires and burnt areas will be used in combination with the medium-resolution satellite data used for forest area changes to estimate the area burnt each year.

In addition to these indicators, a long-term goal is for the MRV system to include indicators related to emissions from subsistence forestry and land use, shifting cultivation and increased carbon sink capacity of non-forest and forest land.

Guyana has already made substantial progress in terms of measuring and reporting on the interim performance indicators; it is therefore expected that the JCN will be updated in the near future to incorporate these advances. In other words, the agreement is following the same stepwise approach as the development of Guyana's MRV system.

7.3.3 Reference level and compensation mechanism

The reference level was set so as to provide incentives to keep deforestation at low levels, while still allowing for limited deforestation required for Guyana's national development. The compensation mechanism is summarised in the box (Box 3 in the JCN).

Box 3. How will results based payments be calculated?

To calculate the results based payments due to Guyana based on the results in any given year, the following steps will be followed:

1. Subtracting Guyana's reported and verified deforestation rate from the agreed interim reference level of 0.275%;
2. Calculating the carbon emission reductions achieved through avoided deforestation (as compared to the agreed reference level) by applying an interim and conservatively set estimate of carbon loss of 100 tC/ha. This value will be replaced once a functional MRV system is in place. The interim carbon loss figure corresponds to 367 tCO_2/ha.
3. Subtracting from that number changes in emissions – on a ton-by-ton basis – from forest degradation as measured against agreed indicators, as specified in Table 2. In calculating the carbon effects of forest degradation, an interim and conservatively set carbon density of 400 tC/ha will be applied. Upon agreement under the UNFCCC on how to estimate and account for emissions from degradation, this approach will be adjusted accordingly;
4. The tons of "avoided emissions" is then multiplied with an interim carbon price of US$ 5/ton CO_2, as established in Brazil's Amazon Fund.
5. If the deforestation rate in a given rate exceeds 0.056, the payments will be gradually reduced as a proportion of the sum derived through step 1-4 above, or cease (if at or exceeding 0.1 per cent), as stipulated in section 3.1.3, box 2.

The reference level of 0.275% is based on equal weighting of Guyana's mean 2000–2009 deforestation rate and the mean 2005–2009 deforestation rate in developing countries with deforestation. Note, however, that the payments will decrease substantially if the deforestation rate exceeds 0.056% (Guyana's deforestation rate in the first reporting period of the partnership) and come to a complete halt at 0.1% deforestation.

Compensation for results also depends on a thorough, independent third-party verification process. This process also involves input and suggestions on methods and performance indicators.

For further background and details about the reference level and the compensation mechanism, please refer to the JCN.

7.3.4 Current status

The reporting for the second year of the cooperation has just been independently verified, and Guyana's deforestation rate has been maintained at the very low rate of 0.054%. The uncertainties associated with such an analysis are, of course, potentially significant. Guyana is making rapid progress in several aspects of its MRV system development, including in reporting on uncertainties. The conservative approach to calculating the results-based payments in the interim phase is ensuring that Norway is not compensating 'hot air'.

Progress has been made on developing the MRV system, both in terms of better remote sensing data, and on developing emission factors for Guyana's forests. In order to reflect these developments, the JCN and related interim indicators are expected to be updated in the near future.

7.4 Indonesia–Norway partnership

7.4.1 Background

To support Indonesia in achieving its highly ambitious policy objectives, Norway entered into a climate and forest partnership with Indonesia in May 2010. Norway will support Indonesia with up to USD 1 billion over the coming years, provided that Indonesia delivers agreed results. Funds are initially devoted to preparation measures and activities, such as enacting a two-year moratorium on forest and peat concessions, developing a national REDD+ strategy, consulting stakeholders and establishing the necessary institutions.

The bulk of the USD 1 billion will be payments for independently verified emission reductions. This will initially be based on reductions in the pilot province of Central Kalimantan. As soon as practicable, Norway will pay Indonesia for independently verified emission reductions at a national scale.

The implementation of the cooperation is guided by a Letter of Intent[3] and a Joint Concept Note,[4] describing a set of outcomes that will qualify for disbursements.

7.4.2 MRV in the Letter of Intent and Joint Concept Note

The Letter of Intent (LoI) and Joint Concept Note (JCN) include the establishment of an independent MRV institution as a main component of the cooperation. From the JCN:

> Output 3: Establishing the initial design for an independent monitoring, reporting, and verification (MRV) institution that will set up a system for anthropogenic forest and peat related greenhouse gas emissions by sources and removals of sinks, forest carbon stocks, and natural forest, as specified in the LoI. The MRV institution will have the following mandates:
>
> a. Monitoring and providing reports on land and forest covers that include annual report and more frequent reports that function as an early warning system.

3 http://www.norway.or.id/Norway_in_Indonesia/Environment/Norway-and-Indonesia-in-partnership-to-reduce-emissions-from-deforestation/.

4 http://www.norway.or.id/Norway_in_Indonesia/Environment/Indonesia--Norway-Joint-Concept-Note-for-the-forest-and-climate-partnership/.

b. Providing all relevant and sound data to the public in accordance with Indonesian laws on public disclosure and right to information.
c. Authority to procure or to access any and all information it deems appropriate and necessary within its mandate from all official Indonesian entities as well as civil society and private sector sources and consolidate all relevant data namely activity data and emission factor data to monitor forest carbon emission.
d. Establish and further develop national capabilities to measure and monitor activities affecting forest carbon stocks.

Key Performance Indicators:

1. Existing MRV activities identified and initial assessment on data gaps for the purpose of MRV completed.
2. Mandate, organizational structure, member roles and terms of reference for members of the MRV institution developed following consultation with relevant multi-stakeholders.
3. A clear plan for establishing an independent MRV institution by 2011.

Furthermore, the documents include a timeframe for reaching reporting of GHG emissions and removals at the national scale. Compliance with IPCC guidance and guidelines and harmonisation with the evolving framework under the UNFCCC is also highlighted, as is the role of independent third-party verification of reported results when the cooperation reaches the results-based stage.

7.4.3 Current status

The cooperation has experienced some delays as some processes have required more time than expected. However, Indonesia is currently developing its MRV strategy for REDD+ through a broad consultation process, and this process has made considerable progress this year. This process has catalysed communication and cooperation between several institutions and organisations with MRV capacity in Indonesia.

7.5 Experiences and recommendations for MRV development

Based on these and other experiences, NICFI offers the following recommendations for developing MRV for REDD+:

- **Early action is key**

  In our experience, getting as soon as possible to a phase where payments are based on reporting of emission reductions is of key importance. This establishes the incentive structure from an early stage and catalyses progress on both MRV development and the broader REDD+ agenda. Moving as quickly as feasible to the national scale is another important issue, as this makes control of leakage possible.

  Where data on emission factors are lacking, a combination of remote sensing data and conservative estimates when calculating payments can provide a means of reporting and incentivising action from an early stage.

- **A thorough verification process is crucial**
  A thorough verification mechanism not only ensures credibility of the mechanism; it also provides welcome advice from an independent third party on methods and indicators. The verification can be tailored to suit any stage of MRV development, and is therefore not only relevant for 'advanced' stages of MRV.
- **Clear institutional setup is necessary**
  Clarifying mandates and promoting coordination between relevant institutions is necessary in order to ensure an efficient implementation of MRV. Several actors in a country might be involved in REDD+ MRV, but one institution should always have a clear coordinating mandate.
- **MRV development should be tied to a wider strategy to reduce GHG emissions**
  Different countries will have different MRV needs, and the development of the MRV system should therefore be closely aligned with the broader policy landscape. MRV is not done only to qualify for payments for emission reductions; it is also a potentially powerful decision-making tool, enabling countries to exercise better control and management of their forest resources.
- **Forest reference levels/reference emission levels should not be too complex**
  In Norway's experience, forest reference levels/reference emission levels (RLs/RELs) should be based mainly on historical data, and not be too complex – especially in situations where data are lacking. During the process of developing the MRV system, information on forest resources may potentially emerge, which can later inform future revisions/adjustments of the RLs/RELs.

Chapter 8

REDD+ readiness preparation under the Forest Carbon Partnership Facility

Alexander Lotsch

The Forest Carbon Partnership Facility[1] is a multilateral global initiative that supports REDD+ readiness preparation activities. Since its inception in 2008, the facility has promoted a collaborative partnership among countries, donors and observers that has provided a meaningful platform for exchanges on REDD+. The World Bank hosts and manages the facility and has been the principal implementing agency thus far. An important contribution of the FCPF has been the development of an operational framework[2] for readiness preparation activities that encompasses 1) national readiness organisation, 2) REDD+ strategy preparation, 3) reference levels and 4) monitoring systems for forests and safeguards.

The FCPF operates two funds. The Readiness Fund (since 2008) provides grant funding for REDD+ preparation and the Carbon Fund (since 2011) is designed for performance payments for the piloting of emission reductions programmes, which countries may implement after the initial REDD+ readiness preparation phase (Figure 8.1).

With the support of grants provided through the FCPF Readiness Fund, about 30 countries have formulated a national REDD+ readiness preparation proposal (R-PP) and had it assessed by the Participants Committee of the FCPF. About one-third of these countries have begun or are about to begin implementing the activities proposed in the R-PP. Countries generally also receive funding from other sources, because the estimated costs for readiness preparation often exceed the funding providing by the FCPF (the estimated budget for activities related to the development of reference levels

1 http://www.forestcarbonpartnership.org.
2 Forest Carbon Partnership Facility Annual Report 2012. Washington DC.

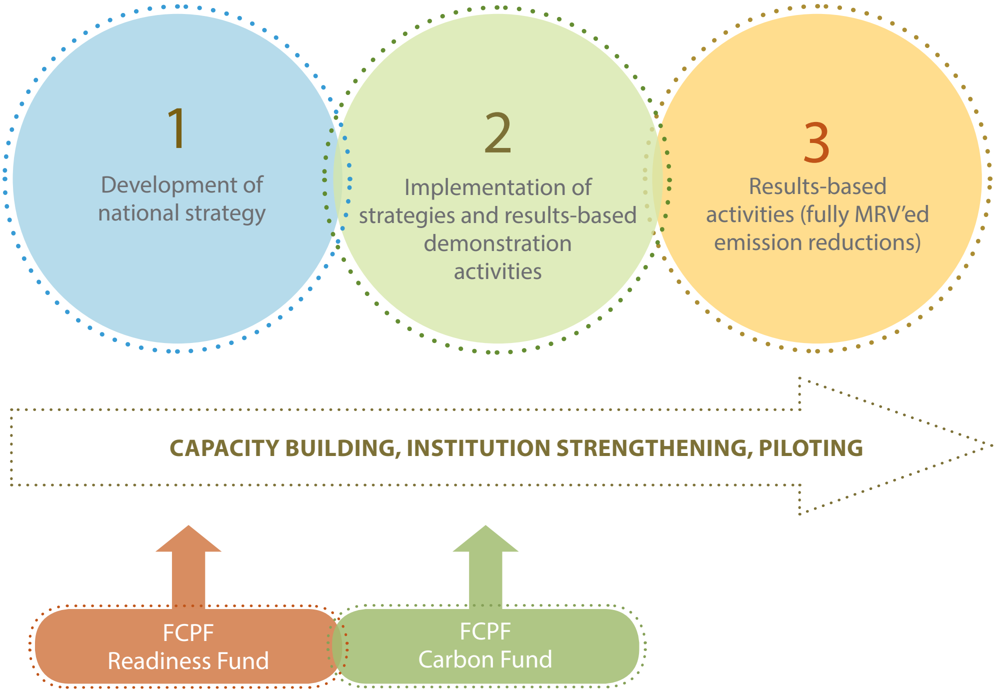

Figure 8.1. The three phases of REDD+ (per Cancun Agreements)

Source: Forest Carbon Partnership Facility Annual Report 2012

and monitoring, reporting and verification (MRV) systems often represents a substantial amount of the overall R-PP budget; see Table 8.1).

Activities under the Carbon Fund[3] have focused on the development of the procedural and legal aspects related to the development, submission and review of REDD countries' emission reductions programmes and the development of a methodological and pricing framework for performance-based transactions. The Participants Committee of the FCPF recently (June 2012) adopted a set of principles for the development of a methodological framework for carbon accounting of emission reductions programmes that are consistent with the UNFCCC guidance on REDD+.[4]

R-PPs provide the principal source of information on how REDD+ countries[5] propose to develop their forest monitoring systems and perform MRV for REDD+. Most REDD+ countries are still in the initial phase of implementation and only a few have actively started to develop national forest monitoring systems (it is important to note, however,

3 www.forestcarbonpartnership.org/fcp/node/277.
4 See: Resolution of the FCPF Participants Committee (PC/12/2012/3): Methodological Framework and Pricing Approach for the Carbon Fund of the FCPF; and Facility Management Team (FMT) Note2012-8: Recommendations of the Working Group on the Methodological and Pricing Approach for the Carbon Fund of the FCPF (www.forestcarbonpartnership.org).
5 http://www.forestcarbonpartnership.org/fcp/node/203.

Table 8.1. Estimated costs of readiness preparation activities

Readiness component	Readiness preparation costs (*in '000 USD*)			Share of budget (%)	
	Africa	Asia	Americas	Average	Maximum
Organise and consult	2286	1762	2380	21	45
REDD+ strategy	3889	3324	2715	32	60
Reference level	1319	1574	1306	13	34
Monitoring system	2572	5833	2811	32	77
Programme management	453	126	31	2	17
Total average R-PP budget	10518	12619	9244	–	–

Source: National readiness preparation proposals presented to the FCPF Participants Committee (as of June 2012)

that many countries are piloting and testing different approaches and technologies in the context of projects or initiatives at the subnational level, often with support from bilateral development partners or non-governmental organisations). Furthermore, although national R-PPs are assessed by the FCPF Participants Committee, MRV activities are not necessarily or exclusively funded by the FCPF; rather, they are often supported through other programmes or initiatives (although still within the framework of national readiness preparation).

The following experiences have emerged from the approaches proposed for forest monitoring and MRV in countries' R-PPs.

- Countries generally propose a combination of (national) inventory approaches and remote sensing to generate emission factors and activity data to support MRV. A systematic national forest inventory approach is often proposed if it is supported (or was previously programmed) by a development partner or has been operational in the country for some time.
- A wide variety of remote sensing approaches to support forest monitoring and MRV are being considered. The specific proposals are often informed by ongoing or recent forest mapping activities.
- A 'no regrets' approach that allows the forest monitoring system to serve a variety of purposes beyond providing information for REDD+ MRV tends to be preferred. This often makes the design and planning of forest monitoring activities more complex and requires a greater degree of coordination.
- A large number of REDD+ countries have little capacity in forest monitoring, especially in the implementation of remote sensing–based approaches. A recent country needs assessment[6] has stressed the need for support on virtually all aspects related to forest

6 UN-REDD Programme and Forest Carbon Partnership Facility (October 2012). Country Needs Assessment: a report on the REDD+ Readiness among UN-REDD Programme and Forest Carbon Partnership Facility Member Countries.

monitoring and MRV functions, particularly in Africa. The most common need is for guidance and specific expertise (and, to a lesser degree, for funding).

- Institutional arrangements for forest monitoring and MRV (e.g. the mandate of different government agencies to perform forest inventories and surveys, process satellite data or disseminate forest-related information) are often not clearly defined at the time a country develops its national R-PP. REDD+ countries also differ greatly in their pre-existing capacities, which will determine what can be achieved in the short-term during the initial readiness preparation phase and the investments that may be necessary in the long-term.
- Countries that have begun to implement forest monitoring activities often revise or update their proposals to reflect recent developments (e.g. in ongoing piloting activities), emerging guidance or technical proposals that are submitted by consulting services.
- There is generally little cost–benefit analysis that relates the costs of developing a forest monitoring system (data, field work, capacity building, etc.) to the benefits or financial revenues that may be expected from REDD+ in the future.

Following are some common challenges for many REDD+ countries.

- *Consistency between national strategy development and forest monitoring:* Generally, national REDD+ management has focused on consultations with key stakeholders and strategy development. Ongoing technical work (e.g. through piloting or technical collaboration with scientific initiatives) is not always well coordinated or integrated with the REDD+ strategy development at this stage. Countries are learning – in an iterative fashion – to achieve better consistency between 1) the diagnostics of forest cover change in the country (analysis of the drivers of deforestation and forest degradation), 2) the policy options that are prioritised as part of the national REDD+ strategy development, 3) the definition of reference levels for priority REDD+ activities and 4) the development of a forest monitoring system that is tailored to track the performance of specific REDD+ policies.
- *Guidance on methodologies and approaches:* There is a proliferation of technologies (e.g. application of different remote sensing data to map different forest properties), methodological approaches (e.g. different combinations of inventory, sampling, models), guidance material (e.g. ranging from community-based mapping approaches to good practices for mapping large geographical areas). This can lead to confusion and countries may receive inconsistent advice and unclear guidance.
- *Role of local communities:* Many REDD+ countries have created policies to engage local communities in the management of forests. A rich set of experiences[7] illustrates how communities can be enabled (e.g., through capacity building, monitoring protocols or handheld mapping devices) to play an active role in forest monitoring and generate location-specific information that is more difficult to track in a national system. Where appropriate, countries are exploring ways to effectively develop

7 http://www.forestcarbonpartnership.org/fcp/node/339.

participatory structures for forest monitoring and to efficiently integrate local efforts into the national forest monitoring design. An important related question is how to best link performance established through local monitoring to a benefit distribution system for REDD+.

- *Development of informed government policy for forest monitoring:* The development of a forest monitoring system is not a purely technical exercise; during the process of developing methods and data for forest monitoring, important policy-relevant decisions need to be made. These include, for instance, the definition of forest (which determines the extent of forest for REDD+ policies and has implications for the choice of methods and data for forest monitoring) or the desired accuracy of forest map products and emission estimates (which is linked both to the expected revenue from REDD+ performance payments and to costs, e.g. related to the required density of field sampling).

As these experiences and challenges suggest, national forest monitoring systems and capacities for REDD+ MRV need to be developed with a long-term perspective, and technical assistance and international collaboration need to be sustained over the long run. At the same time, it is critical to begin demonstrating REDD+ through activities at the subnational level (the scale that has the desired impact and environmental integrity envisaged for REDD+ under the UNFCCC) in the short-term to promote the necessary learning and development of methods and policy approaches for REDD+. Following are some important elements and insights for a stepwise approach to developing a forest monitoring system that have emerged during the early readiness preparation phase.

- *Promote a learning-by-doing approach:* Countries, especially those with low pre-existing capacity in forest monitoring, cannot realistically build all required capacities for REDD+ MRV in the initial readiness preparation phase. A collaborative approach – not only between the REDD+ countries and international experts, but also through meaningful south–south interactions among REDD+ countries – that harnesses and builds on existing capacities to advance early technical work can reveal strengths and weaknesses, and identify necessary actions to be taken.
- *Focus on no-regrets activities:* A forest monitoring system designed exclusively for REDD+ is unlikely to be cost effective. Many REDD+ countries lack the basic forest monitoring capacities to support, for example, the management of conservation or concession areas or the management of natural resources in general. Aligning initial MRV capacity-building activities with ongoing development priorities and investments creates traction for REDD+-related efforts.
- *Prioritise strategic options:* Most countries are still in the process of defining their national strategy for REDD+. These strategies set priorities for REDD+ (i.e. relative focus on each of the five REDD+ activities) and national REDD+ policies to be promoted in the short-term. By prioritising actions, MRV capacity building can also be more focused and manageable (e.g. if the policy focus in the short-term is on deforestation, MRV can initially focus on the relevant geographical areas and drivers).

- *Learn from subnational implementation:* Early and preliminary ideas that are emerging for emission reductions programmes (under the FCPF Carbon Fund, for instance) suggest that most countries are likely to pilot-test REDD+ performance payments at the subnational level and for a subset of REDD+ activities (i.e. addressing the drivers that are most relevant in a given geographical region). Developing an emission reductions programme entails a series of steps (principally, formulating initial programme ideas, making necessary investments, implementing policies that result in emission reductions, developing subnational reference levels and monitoring systems, establishing performance indicators) all of which provide important lessons for the desired and eventual national system.
- *Use initial mapping activities to inform strategy development:* The development of a national REDD+ strategy and a national forest monitoring system is an iterative process. The strategy development can be meaningfully informed by initial mapping initiatives that, for instance, reveal areas of rapid recent forest cover change or the dynamics of specific drivers (e.g. agricultural expansion).
- *Perform cost–benefit analysis:* Technical activities related to the development of reference levels and MRV are generally among the costliest subcomponents of national readiness preparation budgets. This partly reflects the need to build basic capacities, but costs are also related to field work and the procurement of data and professional services. A sound analysis of potential revenues and benefits from REDD+ and the investment required to achieve emission reductions can help in scoping and designing a forest monitoring system and MRV capacity-building activities during the initial readiness preparation phase.
- *Invest in defining institutional arrangements:* Effective REDD+ MRV will require the collaboration and interplay of a number of different government entities, as well as external technical support during the initial phase. MRV is a new function that will require time to become institutionalised. It is therefore critical to define clear mandates and roles early on to ensure longer-term sustainability.

3

Key issues for national forest monitoring and REDD+

Chapter 9

Implementing the conservativeness principle in accounting for REDD+ under the UNFCCC

Sandro Federici, Giacomo Grassi and Frédéric Achard

9.1 Introduction

Tropical countries vary widely in their technical and financial capacities and in their environmental conditions (Romijn *et al.* 2012). It is expected, therefore, that countries will employ a variety of methods for reporting their REDD+ activities under the UNFCCC (UNFCCC 2012a), which could lead to differences in data quality and accuracy of results. National circumstances may therefore lead to incompleteness of country-specific data or even errors in estimates when applying complex methods. As a consequence, some countries may not benefit from REDD+ performance-based payments because they will not be able to provide accurate and/or reliable estimates of forest biomass before deforestation occurs or, therefore, accurate[1] estimates of reduced emissions from reduced deforestation. Biases in estimates[2] can arise because of problems in collecting country-specific data or in applying correct methods. Resolving these problems requires time and resources.

9.2 Approaches for dealing with limitations in technical capacities

A few options for dealing with the issue of limitations in national technical capacities (i.e. for countries unable to provide accurate estimates of emission reductions) might be considered.

1 An accurate estimate means that, so far as can be judged, the estimate is systematically neither over nor under the true value and uncertainties are reduced so far as is practicable (IPCC, 2006). Uncertainty is the lack of knowledge of the true value of a variable that can be described as a probability density function (PDF) characterising the range and likelihood of possible values. Uncertainties stem from random and systematic errors; whereas random errors tend to cancel out at a high level of aggregation, such as the national estimate, systematic errors are to be avoided or quantified and removed.

2 A bias is a systematic error, whose magnitude in most cases is unknown. A systematic error is an inaccuracy that consistently occurs in the same direction.

One option is to exclude from REDD+ policy approaches and incentives countries that cannot produce accurate estimates. However, exclusion would greatly decrease the potential for these countries to raise resources to improve their monitoring and reporting capacities; furthermore, exclusion of some countries would likely result in the displacement of deforestation and forest degradation activities from those countries implementing REDD+ to the territories of the excluded countries.

Under the second option, low-capacity countries would be allowed to access REDD+ incentive schemes based on their potentially biased estimates, despite the high probability that an accounted ton of carbon is under- or overestimated. A ton of carbon that is accounted based on potentially biased estimates would not be comparable to a ton of carbon accounted by another country through an unbiased method.

Comparability is a basic principle to be followed for accounting quantities to be accepted under the UNFCCC for the allocation of financial incentives. Therefore, an approach is needed to ensure that technical and financial constraints associated with national circumstances do not prevent comparability of accounted quantities. Such an approach should not act as a barrier to a country's participation to REDD+, but rather should allow for emission reductions to be accounted as closely as possible to the reductions in net emissions achieved.[3] In this respect, the Reliable Minimum Estimate (RME) approach should be avoided because it determines in practice a threshold to be exceeded, that is, the difference between the opposite boundaries of uncertainties associated with actual emissions and reference emission levels (RELs); consequently, no or very limited reductions of emissions can be demonstrated and accounted (Grassi *et al.* 2008). Negotiations on REDD+ under the UNFCCC have already identified this issue: during the 36th session of the SBSTA, a conservative treatment of reported estimates was identified for the accounting phase to 'account for financial, technical, and/or technological constraints' (UNFCCC 2012b). Nevertheless, such a conservative approach has not yet been officially agreed under the UNFCCC. The conservative approach consists of allowing a country to calculate any emission reductions achieved in a conservative way, that is, in a way that ensures that, as far as can be judged, each accounted ton of carbon of reduced emissions does indeed contain (with a 95% confidence level) an actual ton of carbon (Grassi *et al.* 2008).

9.3 Implementation of the conservative approach

Under the Kyoto Protocol (UNFCCC, 2005), this issue was addressed by defining as 'conservative' an estimate prepared with a Tier 1 IPCC method and data while ensuring that, as far as can be judged, it is not a systematic overestimate of either the achieved reduction in emissions or accounted removals, and then applying it in accounting. When the Tier 1 estimate is judged to probably be over the true value, then a conservativeness

3 The reduction of emissions and enhancement of removals (tons of CO_2-equivalent is the metric) are calculated as the difference between actual emissions (and/or removals) and emissions (and/or removals) that occurred in the period to which the REL or reference level (RL) applies.

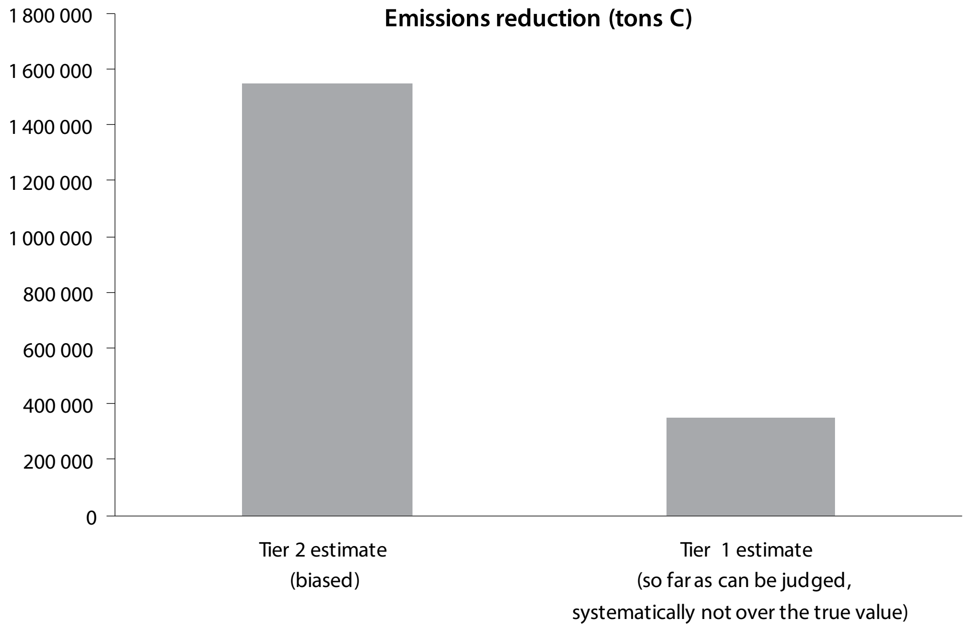

Figure 9.1. Example of Tier 1 and Tier 2 estimates

A country has reported a reduction in deforestation of 10 000 ha compared with the REL. By applying the aboveground biomass carbon-stock-change factor calculated for its rainforests at 155 tC ha^{-1} (Tier 2 estimate), the reduction in emissions is estimated at 1 550 000 tC. However, the reduction in deforestation occurred in an area of the country that only contains tropical shrublands, for which the IPCC default aboveground biomass factor is 35 tC ha^{-1}. Therefore, this Tier 2 estimate is considered biased and overestimating the true value. Assuming a complete loss of biomass with conversion to soybean, the Tier 1 estimate is calculated and applied to account for the aboveground biomass pool (350 000 tC).

factor[4] is applied so that the conservative estimate is the lower boundary of the 50% confidence interval of the Tier 1 estimate. The lower boundary of the 50% confidence interval (i.e. the 25th percentile) divides the lower portion of the PDF into two parts, which have the same probability of containing the true value. In the case of a probable overestimate, this lower boundary of the 50% confidence interval of the Tier 1 estimate is, as far as can be judged, neither systematically over nor under the true value. Thus, the most straightforward approach to dealing with limitations in technical capacities is to allow the application of, *mutatis mutandis*, the solution designed for the Kyoto Protocol, namely, to use the conservative accounted[5] quantity for each requested carbon pool.

Thus, it is proposed that low-capacity countries can participate in REDD+ by applying a procedure with two consecutive steps. First, they can use Tier 1 methods and data for

4 Conservativeness factors were designed under the assumption that the PDF of a Tier 1 estimate contains the true value. When an estimate is considered to be overestimating the true value, the true value is contained in the lower portion of the PDF.

5 Either a reduction of (net) emissions or an enhancement of net removals.

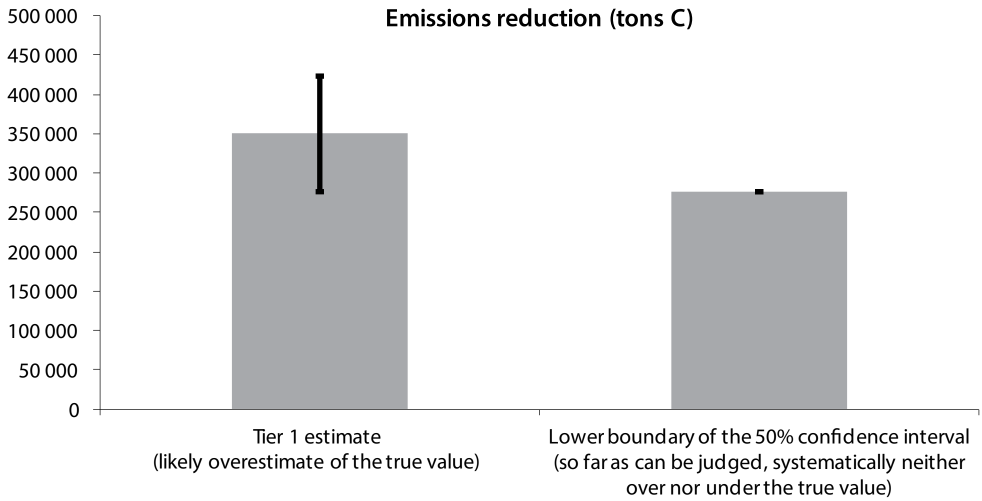

Figure 9.2. Example of calculation of a conservative estimate from a Tier-1 estimate

A country prepares a Tier 1 estimate (left; the bar marks the 50% confidence interval). However, from ancillary information, it is judged that the IPCC default factor is an overestimate of the true value for that specific country. Therefore, a revised value, the lower boundary of the 50% confidence interval of the Tier 1 estimate, is applied to account for the aboveground biomass pool.

accounting for reduced (net) emissions and/or enhanced net removals, in the absence of any better data, as far as it is demonstrated that the Tier 1 estimate is systematically not over the true value (see Figure 9.1). Second, if the country judges that the Tier 1-derived estimate is a probable overestimate of the true value, then a conservative estimate would be calculated as the lower boundary of the 50% confidence interval of the Tier 1 estimate[6] (see Figure 9.2) and used for the accounting phase.

9.4 Conclusion

In conclusion, REDD+ needs to be – and can be – accessible to the largest number of countries. In complement to other proposals (e.g. Bucki *et al.* 2012), the present proposal to adopt a conservative approach provides a few elements for an accounting procedure that would help to achieve such scope in the following ways:

1. By allowing those countries with limited capacities for forest monitoring to join REDD+, that is, broadening the participation in REDD+. Such countries would report emissions and removals by applying IPCC Tier 1 methods and IPCC default or national emissions/carbon-stock-change factors and regional or national activity data, or a mix of those.

6 Or, as under the Kyoto Protocol, applying conservativeness factors calculated on standard ranges of uncertainties associated with either reduced (net) emissions or enhanced net removals for different carbon pools.

2. By ensuring the comparability of accounted (net) emission reductions and/or net removals enhancement, while maintaining incentives for further increases in the accuracy of the estimates, i.e. for a move to higher tiers.

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Chapter 10

Expanding MRV for assessment of policy effectiveness and as a basis for benefit distribution

Margaret Skutsch and Arturo Balderas Torres

10.1 Introduction

A great deal has been written about measurement, reporting and verifying (MRV) in connection with REDD+ and the associated technical requirements for developing robust and reliable systems for assessing reductions in emissions and increases in carbon stock. There has also been some concern about monitoring the *co-benefits* of REDD+, such as the ecological co-benefits (Stickler *et al*. 2009) and social co-benefits (Richards and Panfil 2011), particularly since the issue of safeguards (biodiversity, indigenous rights, governance) was introduced into UNFCCC texts (e.g. UNFCCC 2009). There are, however, two other functions of monitoring associated with REDD+ that have received scant attention to date: the need for a country to be able to monitor the success of its own policies under REDD+, an issue raised recently by Wertz-Kanounnikoff and McNeill (2012), and the potential need to base rewards systems on performance.

10.2 Monitoring the effectiveness of internal policies and programmes

Monitoring the success (or failure) of public policies will be essential for governments that are struggling to promote REDD+ policies and that need feedback in order to decide where and how to invest. They need guidance, based on experience, on what works and what does not work, and what works most cost-effectively (where 'works' could be defined in terms of carbon impacts, but also, and more holistically, in terms of other social and environmental criteria). Monitoring REDD+ activities will therefore need to go beyond the sum of the data acquired by monitoring changes in carbon stocks, the level of co-benefits and the state of safeguards, although these data are obviously relevant. It needs to relate these data to the different REDD+ actions or interventions applied. It should also be noted that monitoring will be needed in relation to all five elements of

REDD+ (reduced deforestation, reduced degradation, forest enhancement, sustainable management of forests and conservation). However, at least as far as carbon-related achievements are concerned, these elements may be placed into two groups: reduced deforestation and forest conservation may be monitored in terms of area change, while reduced degradation, forest enhancement and sustainable management of forests may be measured in terms of change in forest density.

Compounding the difficulty of policy evaluation is the fact that multiple policies and programmes (P&Ps) may be in play simultaneously. First, there is the group of P&Ps that have no particular spatial focus, and that may or may not have direct costs; these include: amendments to forest laws; better enforcement of existing laws; training of forestry officers, guards and extension officers; attempts to harmonise policies between ministries; changes in agricultural and trade subsidies and taxes; awareness raising and related campaigns for forest conservation; and improved land use planning and zoning. Second, there are the P&Ps that are spatially specific and targeted to identifiable parcels of forest, landowners or communities. These include community forest management programmes, payments for environmental services (PES) schemes and individual subsidies to promote a particular type of land use; they may also include, for example, the creation of new protected areas and national parks. It may seem easier to find a relationship between performance and the type of P&P applied, when the location of the interventions is clearly defined; however, in reality, success is likely to vary greatly between different parcels of forest under the same programme, depending on the locally prevailing conditions. Of course, to some extent, these programmes may have been matched *ex ante* to local conditions based on an analysis of the drivers at the time that baselines were being constructed, but this does not eliminate the need for evaluation *ex post* to determine whether they were, in fact, effective.

A system of *nested MRV* would seem to offer the best hope of untangling some of the complexity and providing at least some useful information to national decision makers. In a nested system, data are gathered at a variety of geographical scales and integrated into a national database. In particular, the generation of data at the level at which the policies are in practice adopted or rejected could be vital to understanding what is happening. If individual parcels of forestland are registered as 'REDD forests', in the sense that they are eligible for some technical or financial assistance, grants or subsidies, the owners (individual or collective) could be required to carry out standard monitoring activities following a procedural guide or protocol, particularly with regard to impacts on carbon stock, through participatory forest survey. The much higher sampling density, in both space and time, would reduce statistical uncertainty in these areas (Figure 10.1). Forest owners or their technical assistants could, in principle, upload these data directly into a national forest monitoring system (NFMS), provided that it incorporates some kind of filter for quality control (e.g. to check that stocking rates and growth rates are within reasonable limits). Spot checking could also be instituted, given that the results of any local MRV efforts with regard to carbon will clearly be subject to top-down approval and integration into national carbon accounts. Assessment of impacts on biodiversity and social well-being, although more difficult to standardise, might also be incorporated into community surveys of this kind.

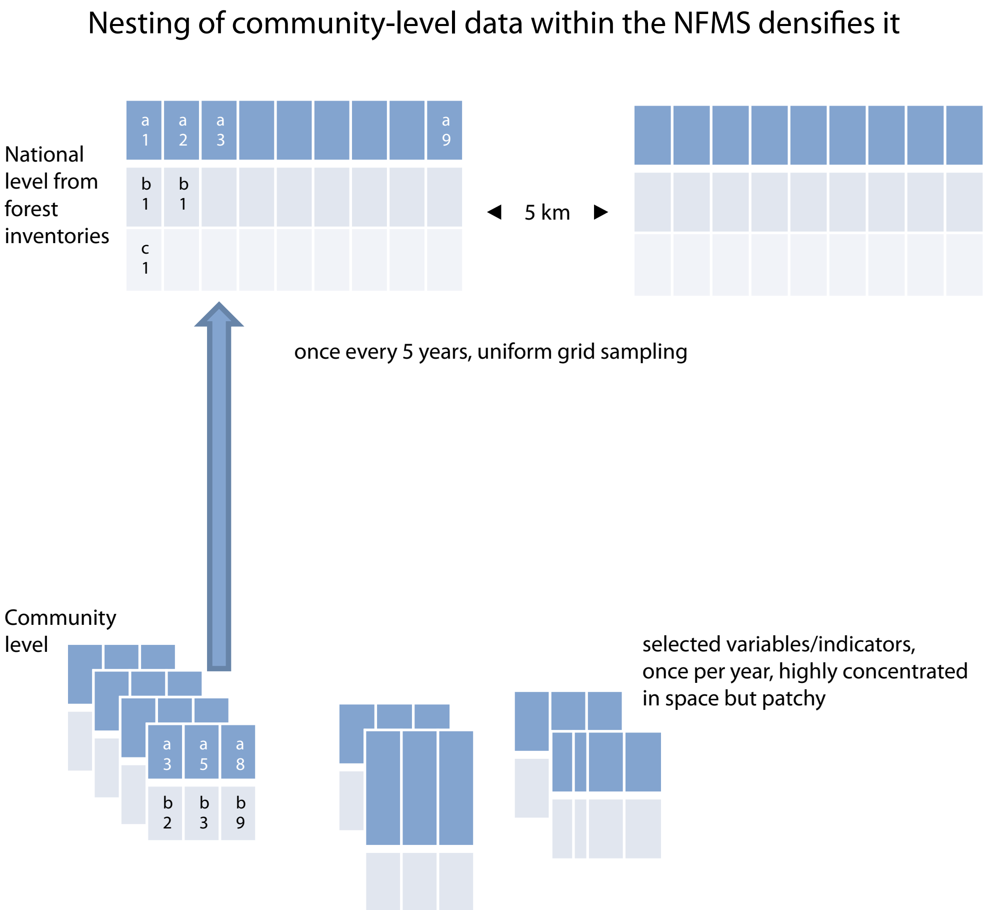

Figure 10.1. National inventory data, as represented in the NFMS, can be densified with data from community monitoring

10.3 MRV in connection with the distribution of rewards

REDD+ is intended to be a performance-based instrument: countries will be rewarded on the basis of their achievements in reducing emissions relative to an agreed national reference emission level (REL) or reference level (RL), or a subnational REL/RL in the short term. The idea has arisen in some quarters that each individual forest owner within a national REDD+ programme should be rewarded according to his or her performance within this programme, and there has been considerable discussion recently regarding 'rights to carbon' in this respect (Graham and Thorpe 2009; Karsenty *et al.* 2012; Mahanty *et al.* 2012; Skutsch *et al.* 2012). It quickly becomes evident that such a system is impossible. First, there could be many claimants besides the owners of the forest property, such as those who have facilitated the REDD+ process, and those whose actions lead to less deforestation and degradation even though they themselves have no forest (consider, for example, livestock owners who choose a more intensive system of fodder production, or charcoal producers who invest in energy-efficient kilns). Second, it is, in practice, impossible to assess the extent to which any one landowner has not deforested, but would have done in the absence of REDD+, given that almost all deforestation is unplanned (for detailed explanation of this point, see Balderas Torres and Skutsch 2012).

On the other hand, the principle that owners should be rewarded proportionally to their output is being advocated by organisations supporting indigenous and local community rights, by carbon dealers and by those who support the ideological principle that offering rewards for performance will result in increased performance. As we have suggested elsewhere (Balderas Torres and Skutsch 2012), a compromise solution may be to distinguish between performance in reducing deforestation and degradation and performance in enhancing carbon stocks on the property. Reduced deforestation and degradation can be measured at a broad geographical scale only, and therefore may be better attributed to a higher-level administrative unit. The financial rewards could later be distributed among participating forest owners on a flat-rate basis. By contrast, in the case of stock enhancement, increases can be physically measured on each individual site and thus attributed directly to the forest owners. This is in the context of the fact that instruments such as PES and community-based forest management are often more effective in promoting forest enhancement than in halting deforestation, and the scope for this is large. In Mexico, for example, 70–80% of all forest is, to a greater or lesser extent, degraded, meaning that there is plenty of 'room to grow' through stimulation of natural regeneration. A baseline in the form of a qualitative independent judgement that stocks were not increasing of their own accord before the project began would be required to ensure that the forest enhancement is additional.

An alternative approach would be to dissociate rewards from performance entirely, instead paying landowners and communities simply for monitoring. This would remove any incentive to exaggerate achievements, thus leading to improvements in the accuracy of the data; it would also avoid the dangers of the 'angels and sinners' dilemma inherent in any scheme that offers to pay those who have deforested in the past but not those who have always protected their forest. However, it might also remove an important stimulus in relation to instituting improvements in management. This is less likely to occur if the monitoring is considered to be an integral element in a set of forest management activities under a PES-type arrangement. The extra cost to the PES programme of paying for the monitoring activities would have to be weighed against the value of the greater certainty of the data, which would in turn increase the reliability of national estimates of carbon achievements, and thus the number of credits that the country could claim internationally.

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Chapter 11

Developing REDD+ reference levels

A data-driven, stepwise framework

Martin Herold, Veronique De Sy, Arild Angelsen and Louis Verchot

11.1 Introduction

Forest reference levels (RLs) and forest reference emission levels (RELs)[1] are most commonly used as a business as usual (BAU) baseline to assess a country's performance in implementing REDD+ (Meridian Institute 2011; UNFCCC 2011). RLs are needed to establish a reference point or benchmark against which actual emissions (and removals) are compared. The RL also serves as a benchmark for compensation or payments in a results-based REDD+ mechanism. This financial incentives benchmark (FIB) determines the emission levels after which a country, subnational unit or project should start being paid for their results. The way the FIB is set has implications for REDD+ transfers, and ultimately for environmental integrity (carbon effectiveness), cost efficiency and equity (benefit sharing).

One way to deal with limitations in the available data and uncertainties inherent in the REL/RL development process is to adopt a stepwise approach (Herold *et al.* 2012; UNFCCC 2011). This approach aims to better structure and deal with the variety of RL methods, the variability in data and their quality, uncertainties and country circumstances. Stepwise progress should help to stimulate broad country participation in estimating RLs and provide a starting point, even with limited data, from which to improve RL setting as countries progress through the REDD+ implementation phases and build capacity.

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1 The difference between reference level (RL) and reference emissions level (REL) is not always clear. The distinction is often made that REL refers to gross emissions from deforestation and forest degradation, while RL refers to deforestation and forest degradation, as well as other REDD+ activities related to enhancement of carbon stocks, sustainable management of forests and forest conservation. Here, we use RL as a general term, which encompasses RELs; much of the discussion here focuses on emissions (UNFCCC 2010).

11.2 Scoping a stepwise framework

The UNFCCC (2011) refers to stepwise progress in establishing REL/RLs, as indeed is the case with many aspects of REDD+ implementation. As countries move through their REDD+ implementation phases, they have to develop national, or as an interim measure subnational, forest RLs. The understanding, reliability and validity of data for RLs are bound to improve through that phased process. A stepwise approach to developing forest RLs provides a starting point for all country situations (Table 11.1), taking into account the variability in available data used to estimate future trends and the lack of capacity in many countries (Romijn *et al.* 2012).

Table 11.1. Some dimensions of a stepwise approach to developing forest reference levels (adapted from Herold *et al*. 2012)

	Step 1	Step 2	Step 3
Activity data/ area change	Possibly IPCC Approach 1 (national net change) but also Approach 2 (national gross changes) or 3 (national gross changes, spatially explicit data)	IPCC Approaches 2 or 3 (to estimate gross changes)	IPCC Approach 3 (spatially explicit data required)
Emission factors/ carbon stocks	IPCC Tier 1 (defaults) but also Tier 2 or 3 (national data) if available	Tier 2 or 3 (national data)	Tier 2 or 3 (national data)
Data on drivers and factors of forest change	No driver data available or used	Drivers at national level known with quantitative data for key drivers	Quantitative spatial assessment of drivers/ activities; spatial analysis of factors
Approaches as guidance for developing reference levels	Simple trend analysis/projection using national statistics, based on historical data	Country-appropriate methods for interpolation/ extrapolation using historical data and statistical approaches	Potential to use options such as spatially explicit modelling and other statistical methods for considering both drivers and other factors of forest change
Adjustments/ deviations from the historical trend	Simple rules (in technical terms)	Assumptions and evidence for adjustments to key drivers/activities	Analysis and modelling by drivers and activities
Uncertainty assessment	No robust uncertainty analysis possible; use of default uncertainties and/or conservative estimates	Modelling to accommodate uncertainties and testing using available data	Independent and quantitative uncertainty analysis possible, sensitivity analysis and verification using available data

Step 1 provides a potential starting point for countries to engage in RL setting and can be based on coarse national-level data only. It will be challenging for some countries to provide quantitative evidence for their deviation from the projected historical trend; they can therefore start with simple rules. All countries should be able to undertake a Step 1 approach with only modest effort using available data, even if those data are uncertain. Examples of a Step 1 methodology can be taken from the Brazilian Amazon Fund (a subnational approach) and Guyana (a national approach). The Amazon Fund REL is based on gross deforestation and a conservative estimate of aboveground carbon stocks of 100 tC/ha. The annual deforestation rates used in the calculation of emission reductions are compared with the average deforestation rates over 10-year periods, which are updated every five years (Amazon Fund 2009).

Step 2 progressively includes national data and circumstances quantitatively, that is, by undertaking evidence- or driver-based assessments to adjust historical rates, and by using better country data (e.g. Tier 2 for carbon stocks). However, at this stage, data on historical trends are likely to dominate estimates of future trends. This is exemplified in the results of regression analyses (Herold *et al.* 2012), where predictions were made based on subnational activity data.

Step 3 builds upon Step 2, using higher-quality data that give a wider choice of modelling methods. In particular, more spatially explicit activity data and driver-specific information support, for example, the use of more complex spatially explicit regression or simulation models, which should then lead to a more robust and forward-looking estimate.

The idea of the stepwise framework is to provide a pathway for reducing uncertainty and moving to higher steps over time, which will allow countries to develop more accurate forest RLs for assessing the impact of their policies and measures. With proper support, countries should be able to acquire data to develop forest RLs at higher steps fairly quickly and at a reasonable cost (UNFCCC 2009).

11.3 Linking uncertainty in stepwise RLs and FIBs

The reasons for setting the FIB differently from the BAU baseline are discussed in Herold *et al.* (2012). One key issue is that an FIB might be a BAU baseline adjusted to reflect uncertainty in the data and approaches to developing REL/RLs. In this context, the stepwise approach provides RL development options ranging from approaches based on simple and (likely) uncertain data (Step 1) to those using more complex data and a rigorous uncertainty analysis (Step 3). It is reasonable for higher levels of certainty to be rewarded by higher rates of payment. This incentive is important for encouraging countries to graduate to higher steps in order to develop higher-quality RLs. Step 1 RLs may, in many instances, be considered too uncertain to be used or accepted in a REDD+ payment scheme. The stepwise system has to take uncertainty into account for reasons of effectiveness and efficiency and for 'fair risk sharing' between the parties of the agreement. Several options have been proposed for dealing with uncertainty (summarised in Table 11.2).

Table 11.2. Options for dealing with uncertainty in setting RLs (Herold *et al*. 2012)

Option	Elaboration	Pros	Cons	Most applicable for
1. *Ex post* adjustment of RL	RL formula agreed *a priori*; final RL set when parameters (e.g. agricultural prices) are known	Predictable; adjustments made as more data become available	Hard to establish the formula	Steps 2 and 3
2. Corridor approach	Gradually increasing payments within an RL corridor	Flexible; payments also mimic marginal cost curve	Political acceptability	Steps 1–3
3. Uncertainty or conservativeness factor adjustment	Estimated difference between the outcome and RL multiplied by an uncertainty or conservativeness factor (<1), based on assessment of data quality	Reduced risk of overpayment and 'hot air' (unfounded claims); incentives to produce better data; somewhat accepted by UNFCCC; easy to implement	Makes REDD+ less attractive for countries with poor data	Steps 1–3
4. Renegotiation	Renegotiate RL during the course of implementation of a REDD+ agreement	Flexible, can incorporate unforeseen factors	Political game-playing	Steps 1 and 2
5. Insurance	Could design insurance contract–based approaches in Steps 1 and 2	Well-developed markets for insurance	Probably expensive; complex contract	Steps 2 and 3

One proposal is to allow an *ex post* adjustment of the RL, originally termed 'compensated successful efforts' (Combes Motel *et al*. 2009). Deforestation pressures in, for example, the Brazilian Amazon are closely linked to the profitability of cattle and soybean production; allowing the adjustment of RLs based on the prices of these commodities would better reflect the true BAU scenario and therefore allow better estimation of real emission reductions.

The corridor approach, proposed by Schlamadinger *et al.* (2005), recognises that any point estimate of the RL will be uncertain. A factor is therefore introduced where greater emission reductions get increasingly lower discount factors (i.e. higher price per tCO_2). This approach defines an interval (corridor) around the point estimate of the RL, with the discount factor increasing from 0 to 1 (zero to full payment) within this interval.

Another approach is to use uncertainty or conservative adjustments. In this context, an adjustment to the RL could reflect the degree of uncertainty, such that countries with the poorest data would apply a multiplicative discount based on the degree of uncertainty, for example in the form of a lower price per tCO_2. This approach addresses one of the problems of uncertainty, namely the risk of overpayment and unjustified REDD+ credits. The use of conservative assumptions is reflected in the recent UNFCCC decision (UNFCCC 2011) concerning the possibility of omitting non-significant carbon pools or specific REDD+ activities in developing RLs. Thus, this approach is, at least in principle, already used by the UNFCCC; it currently provides the simplest and most suitable option to account for uncertain RLs in payment schemes (Grassi *et al.* 2008) and allows participation in REDD+ while better inventory systems are being developed.

Other options for dealing with uncertainty are contract renegotiation or insurance, but these have not been explored in the context of REDD+ RLs. The question of insurance in relation to permanence is discussed by Dutschke (2008); options reviewed there are relevant to RLs as well.

Included in Table 11.2 is the applicability of the various adjustments to particular steps. Given that many countries will start with a Step 1 or 2 approach, conservative adjustment currently provides the simplest solution. Regular renegotiations may also be an option, but are vulnerable to political bias. The corridor approach, which has several attractive features, can be considered an elaborated variant of the conservative adjustment approach (with progressive adjustments).

11.4 Concluding remarks

Establishing forest RLs for developing countries is among the most urgent and challenging tasks in REDD+. A stepwise approach to developing forest RLs can help to overcome the challenges of lack of data, uncertainty and competing interests, and could encourage wider participation by countries in REDD+. It is a data-driven approach; as such, the availability of more and higher-quality data will increase the robustness of the RLs over time. While Step 1 methods are simple and may generate results with a high level of uncertainty, Step 1 does allow countries to at least initiate RL activities and provides a benchmark for assessing trends and interim performance. Step 2 allows greater incorporation of national circumstances and links RLs to known drivers of deforestation and degradation as a means of adjusting historical land use change rates. Step 3 develops this approach further, with more spatially disaggregated data and a more explicit analysis of drivers and factors. Step 3 could be implemented, for example, through the use of spatial simulation models that also allow a more forward-looking modelling component.

The stepwise approach, by nature, will result in RLs of varying levels of uncertainty, and this should be taken into account in any payment scheme. Where uncertainty varies (between countries, for example), an FIB that modifies the BAU baseline provides a means of rewarding efforts to reduce uncertainties and move to higher-step RLs over time. There are several approaches for dealing with RL uncertainty; the conservative adjustment factor currently provides the most suitable option. This approach is, at least in principle, already being discussed and considered by the UNFCCC (Grassi *et al.* 2008; UNFCCC 2011).

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4 Summary and recommendations

Chapter 12

Summary and recommendations for continuous improvements in national forest monitoring and measuring, reporting and verification of REDD+ activities

Martin Herold, Jim Penman and Veronique De Sy

12.1 Introduction and background

Reporting of REDD+ activities[1] requires national forest monitoring systems (NFMSs)[2] that use an appropriate combination of remote sensing and ground-based and national inventory approaches for estimating anthropogenic forest-related greenhouse gas (GHG) emissions by sources, removals by sinks, forest carbon stocks and forest area changes. Such systems provide the foundation for estimating, reporting and verifying the effect of all forest-related or REDD+ activities on forest carbon (Herold and Skutsch 2011).

Many countries already have some form of national forest monitoring in place, but the existing capacity gaps relative to the likely requirements to participate fully in REDD+ are substantial and vary according to countries' circumstances (Romijn *et al.* 2012). When the current capacity gaps are expressed in relation to the net change in forest area (using FAO Forest Resources Assessment data for 2005–2010; Figure 12.1), countries with a very small capacity gap show a net increase in total forest area of 2 513 000 ha over the period, whereas countries with larger capacity gaps have a net loss of total forest area of 82 991 000 ha. Most capacity gaps are in countries with a net loss of forests, and significant global deforestation occurs in countries with very low capacities.

Given that REDD+ aims to be a results-based mechanism, it is essential to bridge the current capacity gaps through capacity-building initiatives. Capacity building should result in sustainable national REDD+ monitoring systems that are able to report on

1 The five REDD+ activities are: 1) reducing emissions from deforestation; 2) reducing emissions from forest degradation; 3) conservation of forest carbon stocks; 4) sustainable management of forests; and 5) enhancement of forest carbon stocks.

2 With, if appropriate, subnational monitoring and reporting as an interim measure.

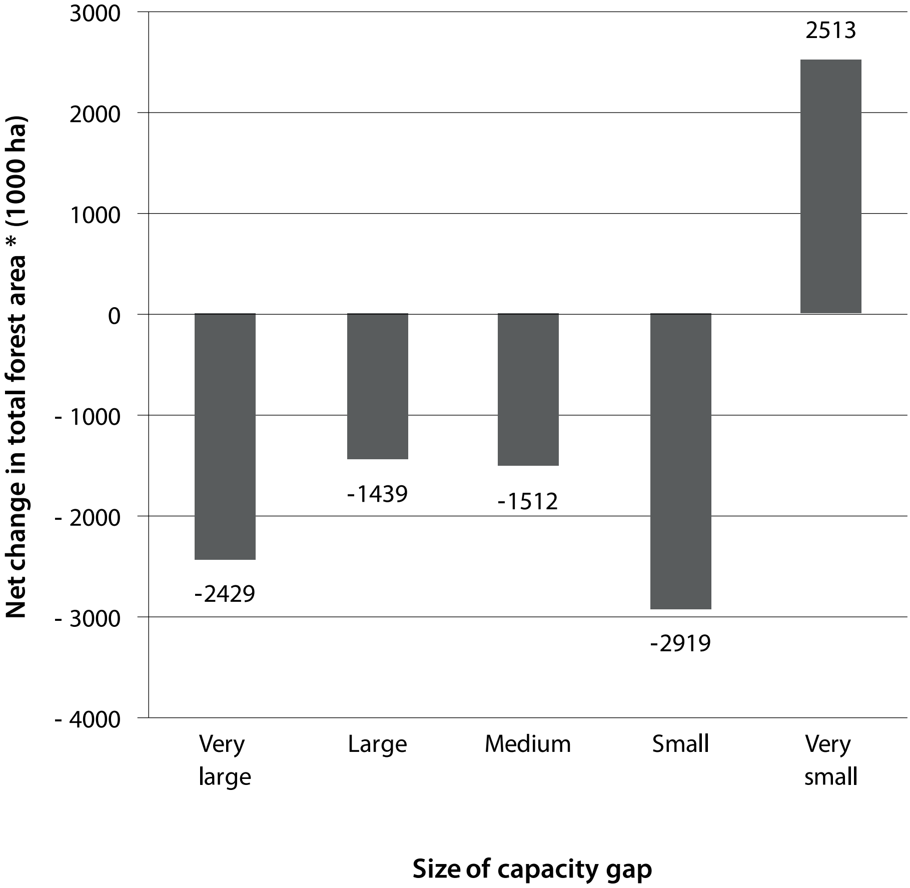

Figure 12.1. Capacity gaps in relation to the net change in total forest area between 2005 and 2010 (based on FAO Forest Resources Assessment forest area statistics), summarised for all countries that fall into each capacity gap category (adapted from Romijn *et al.* 2012)

carbon stocks and changes in compliance with IPCC reporting requirements, including the five principles of consistency, transparency, comparability, completeness and accuracy (IPCC 2006). The most common gaps in monitoring capacities can be summarised as follows, using these reporting principles (Romijn *et al.* 2012).

- Consistency: In many countries, carbon estimates are based either on single-date measurements or on the integration of heterogeneous data sources (FAO 2006, 2010), rather than on the use of a systematic and consistent measurement and monitoring approach.
- Transparency: Lack of transparency arises because estimates, whether based on expert opinion, independent assessments or model estimations, often lack adequate descriptions of the information sources used (FAO 2006, 2010).

- Comparability: Few developing countries have experience in using the IPCC 2003 Good Practice Guidelines or the IPCC 2006 Guidelines in the context of monitoring land use and land use change and estimating GHG emissions (FAO 2006, 2010; UNFCCC 2008). It is necessary to use common methodologies and guidance to produce comparable results.
- Completeness: Many countries lack suitable data for measuring and monitoring changes in forest area and carbon stocks. Carbon stock data for aboveground and belowground biomass are often based on estimates or conversions using IPCC default (Tier 1) data, and very few countries are able to provide information on all five carbon pools or estimates from biomass burning (FAO 2006, 2010; UNFCCC 2008). Reporting on other GHGs such as N_2O or CH_4 is also often based on Tier 1 defaults or not performed at all.
- Accuracy: Information on sources and levels of uncertainty of the estimates provided by countries is limited, as is information on approaches for analysing, reducing and dealing with these in international reporting (FAO 2006, 2010).

With most developing countries having medium to very large capacity gaps, capacity-building activities need to take into account countries' different starting points and national circumstances. Activities should work towards achieving a level of monitoring capacity that can be used to report on forest carbon stocks and emissions to the UNFCCC and then further developed over time, as is recognised in the concept of a stepwise approach.

12.2 Success factors for stepwise progress for national forest monitoring

During the workshop[3] that led to this report, attendees were surveyed to identify the success or enabling factors for continuous improvements in national forest monitoring (for REDD+) in non-Annex I countries (Figure 12.2). The results indicate the importance of clear and stable institutional arrangements (including national coordination for MRV), consistent political support and continued improvement of technical capacities. The availability of staff with sufficient and relevant technical and institutional capacities, in a stable and long-term setting, is another important element. Other aspects identified were continued investment in higher-level education and related research and development; sustained financial resources; and cooperation with international organisations/experts and between sectors.

The importance of the factors identified in Figure 2 is reflected in the countries' experiences with stepwise improvements, as presented in this report. A recurring observation in all the country examples is that it is essential to have a good institutional framework, with a strong mandate for the leading agency and clearly defined roles and responsibilities

3 For more information see http://www.gofcgold.wur.nl/sites/CIFOR_workshop.php.

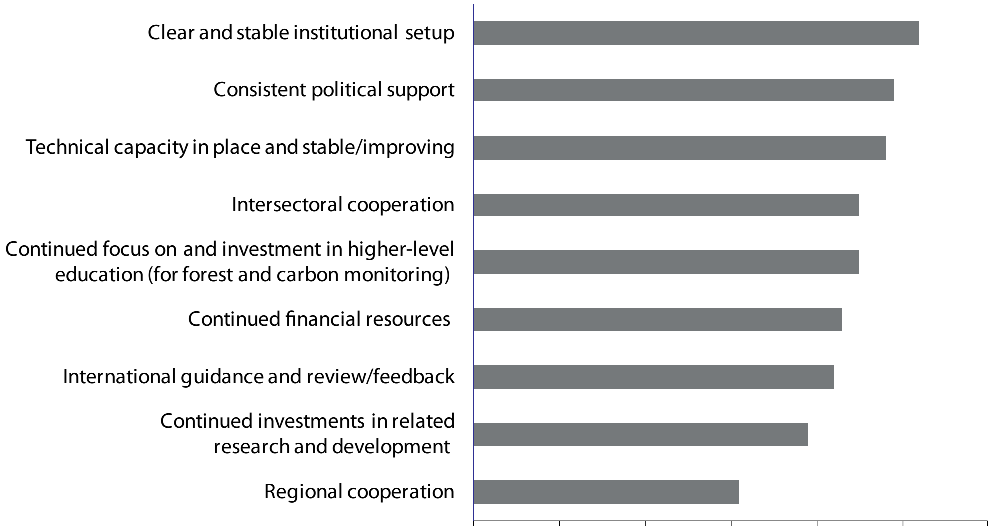

Figure 12.2. Success factors for continuous improvements in national forest monitoring

for participating agencies and other stakeholders. Countries that can build on existing institutional forest monitoring frameworks and technical capacities have a good starting point for REDD+ MRV.

An NFMS needs cycles of continuous improvement so that it can adapt to new technologies (e.g. remote sensing) or to changing needs for information on forests (including for REDD+). Sustained investment in forest-related research, development and education helps countries to improve their methodologies and data and to refine their systems according to their specific circumstances. For example, India[4] has undertaken additional studies to map various forest types and to assess missing forest biomass components, and Mexico has improved its GHG inventories by adopting a national policy to make data publicly available, thereby allowing a more systematic analysis of the major sources of uncertainty and thus helping to identify the necessary steps for improving the next generation of GHG inventories.

The experience from Vietnam reveals several important factors for success: capacity building via a learning-by-doing approach, with technical support from international experts and organisations; incorporation of training programmes for young professionals at national universities; and political support. Vietnam emphasised that countries themselves should lead – that is, retain ownership of – the development of an NFMS as part of a clear and sustainable strategy.

Guyana provides an example for countries starting with limited forest monitoring capacities. The development of a REDD+ MRV roadmap has triggered progressive

4 The examples given are drawn from presentations made at the Wageningen workshop.

improvements in forest monitoring capacities. The roadmap has helped Guyana to assess the available data and its technical and institutional capacity gaps and to use the findings to set priorities for developing its NFMS. Through this approach, the country has been able to formulate progressive steps and targeted capacity building, which can lead to rapid and substantial progress.

From a donor's perspective, Norway highlighted that moving early to a phase where payments are based on national-level reporting of emission reductions can help catalyse progress. In the Guyana–Norway agreement, interim performance indicators are used for this purpose. Norway further identified as key success factors a thorough verification process, clear institutional set-up, a focus on simple methods for RL/RELs and tying the MRV development to the broader context of national development and forest resource management.

The experiences and challenges emerging from the World Bank FCPF initiative show that the development of NFMSs and capacities for REDD+ MRV needs to be approached with a long-term perspective; it requires investment in defining and setting up institutional arrangements and sustained efforts directed towards technical capacity building and international collaboration. The FCPF also advocates a learning-by-doing approach and suggests that countries prioritise their strategic options by linking them to national strategies and policy priorities for REDD+. Iterative improvements should be made to the system by using available data and mapping activities to inform strategy development. Furthermore, countries should focus on 'no-regrets' activities (that is, a multipurpose forest monitoring system), learn from subnational implementation and perform cost–benefit analyses to help scope and design their forest monitoring system.

12.3 Recommendations for REDD+ international negotiations

12.3.1 National forest monitoring systems

An NFMS consists of the institutional and consultative arrangements that enable countries to estimate their GHG emissions and removals from forests, including those related to REDD+ activities. Countries may develop new systems for this purpose, or, where possible, may take advantage of existing national forest monitoring and inventory systems previously established to conduct forest resources assessments. In the latter case, the sampling strategies are likely to need to be adapted for measuring and monitoring forest changes and associated carbon emissions. An NFMS should: provide data for policy assessment; take advantage of the knowledge possessed by local communities for monitoring; be linked to monitoring of other forest values, such as biodiversity; and provide information on the success of policy implementation.

Parties to the UNFCCC have agreed that NFMSs should measure GHG emissions and removals using the most recent IPCC Guidelines adopted or encouraged by the COP. For developing countries, this means the 2003 Good Practice Guidance (IPCC 2003) rather than the 2006 Guidelines (IPCC 2006), although use of the latter may be encouraged as a scientific supplement to the 2003 Good Practice Guidance. UNFCCC negotiations may request further work from the IPCC specifically addressing REDD+ activities; such work will likely draw on both the 2003 Good Practice Guidance and the 2006 Guidelines. Existing documents such as the GOFC-GOLD REDD+ Sourcebook[5] provide REDD+ countries with a useful starting point in their efforts to improve national forest monitoring in accordance with the IPCC Good Practice Guidance.

An NFMS should provide information on all forestland, including land on which regrowth is taking place. The information provided by the NFMS should not only enable estimation of emissions and removals associated with REDD+ activities, but also aim to go beyond this. For example, information on wider social and environmental forest values would be of use in policy development and reporting to other multilateral environmental agreements, such as the Convention on Biological Diversity. An NFMS may also be of use in consultations with local communities, and may help local communities to participate in forest measurement. An NFMS should enable the assessment of changes in natural forests linked to the agreement made in UNFCCC COP 17 that REDD+ activities should not incentivise conversion of natural forests.

An NFMS requires clear institutional arrangements – which may not yet exist in many countries. Different actors and sectors need to work together to make the monitoring system efficient in the long term, as part of the implementation of REDD+. As many drivers of forest change are outside the forestry sector (e.g. arising from agriculture or fuelwood demand), other sectors also have a role in the statistical design, implementation and, in particular, the monitoring for REDD+ and its impacts (Kissinger *et al.* 2012). Institutional sustainability should be an important principle in setting up a framework, which commonly requires, at a minimum, a national coordination and steering mechanism, centralised monitoring, estimation and reporting infrastructure, and a mechanism for coordinating national and subnational forest measurement and monitoring stakeholders. In addition, good integration with research and higher-education institutions may be important for ensuring long-term sustainability in capacity development and for supporting progress for continuous improvements to the national monitoring system.

In the absence of national coverage, an NFMS may be developed from subnational monitoring as an interim step. In this case, as was recognised at UNFCCC COP 17 in Cancun, countries should be capable of estimating the leakage effects associated with REDD+ activities outside the area covered by the NFMS. In practice, this may be facilitated by establishing some form of national monitoring using remote sensing, perhaps linked to detection of impact indicators such as infrastructure development. Subnational estimation may continue to be useful within national coverage, to achieve stratification by forest ecosystem, to provide information to state or regional administrations and to facilitate entity-level engagement with REDD+.

The IPCC principles of transparency, consistency, completeness, comparability and accuracy are the usual requirements to be met if emissions and removals estimates are

5 For more information, see http://www.gofcgold.wur.nl/redd/index.php.

to comply with the IPCC definition of 'good practice'. Comparability between NFMSs may be delivered at different stages of development, provided the systems are being developed with common underlying principles. Conservative estimates may be used to increase comparability of emissions and removals estimates themselves.

Where forest inventories or other forest monitoring systems already exist, it makes sense to use them in developing an NFMS for REDD+ activities. For example, existing forest monitoring capacities should be used and forest inventories may have useful information on biomass carbon densities and its changes over time. However, depending on country circumstances, inventories designed for forest resources assessment may not be well suited to estimating deforestation and degradation, because estimating change events is more challenging than measuring the size of the resource overall. In such cases, the sampling design may need to be supplemented. Furthermore, existing forest inventories may not have sufficient information on all the relevant carbon pools; default assumptions, perhaps combined with conservative assumptions, followed by additional sampling, may be needed to provide the additional information. The requirements for national systems will depend on the REDD+ implementation phase; they are likely to be most demanding for Phase 3 – fully MRV'd results-based actions with a mandatory national system.

An NFMS may use the default (Tier 1) information provided in the IPCC guidelines on the size of carbon pools and related uncertainties to help guide the allocation of resources for estimating emissions and removals. Furthermore, systems may integrate uncertainty assessment into sampling strategies and procedures. Uncertainty estimates may be relevant for implementing conservative approaches.

Systems for providing information on how safeguards are being addressed and respected may be considered part of national REDD+ monitoring and implementation efforts and, as agreed in Durban, summary information on safeguards should be provided in national communications, or via other communication channels agreed by the COP. It may be cost-efficient to include this as an integral function of the NFMS, especially as it is likely to be of use in national forest policy development and monitoring.

12.3.2 Measurement, reporting and verification

For measurement, reporting and verification (MRV), the most recently agreed or adopted IPCC methods should be used, as decided by the UNFCCC COP. The current IPCC methodology is suitable for estimating emissions and removals associated with REDD+ activities, but does not address these activities systematically by name. A further request to the IPCC to develop REDD+-specific guidelines therefore seems logical. This work could take between 18 months and two years to complete and would need scheduling within IPCC's inventory programme. Consistency and continuity between emissions and removals estimates and reference levels is likely to be a matter of concern. The IPCC should be able to provide methodological advice on how to achieve this, without straying into prescriptive policy recommendations.

Requirements in terms of emissions, removals, stock changes and areas for the various activities may be best decided after the IPCC completes this work. The general terms for transparency, completeness, consistency, comparability and accuracy, however, would remain. Comparability of data does not necessarily require strict comparability of national systems, especially if conservativeness is accepted as a way to make estimates more comparable. Participation in results-based incentive schemes linked to commitments does require some level of comparability. Demonstration of consistency between emissions and removals estimates and reference levels is likely to be an important requirement.

Inclusion of all forests and the establishment of comparable information on them are additional steps towards a future climate change agreement that includes wall-to-wall carbon losses and gains from all land use in all countries and climate zones – a much more effective approach in the long run. Until then, early actions will need to deal with partial MRV systems and data, and make the best use of existing activities, including those conducted at the subnational or local level.

The concept of stepwise progress and continuous improvements underpins the model applied by many countries in building a monitoring system. This concept recognises that it takes time to implement emissions and removals methodologies and to collect the required data consistently in space and time. The usefulness of data for policy analysis will increase over time as time series accumulate, improving countries' capacity to understand the effectiveness of policy interventions. Uncertainties are likely to be greater initially, and may differ markedly from country to country depending on the data already available. A stepwise approach allowing for conservative accounting of emissions and removals estimates may therefore be useful. Conservativeness may mean, for example, omission of pools that are not sources, or accounting at a conservative percentile rather than at the central estimate. The agreements under the Kyoto Protocol provide precedents for both these approaches.

As part of the planning and implementation of national REDD+ MRV, initial priorities for MRV capacity development may be defined, based on 1) understanding of the national REDD+ strategies and policies that address the key activities and drivers of forest change nationally; 2) identification of high-priority areas in which to focus most of the detailed MRV activities as part of a stratified national approach; and 3) evolution of national MRV capacity development as a process following a roadmap with simple, interim performance targets that can be defined as intermediate milestones.

Satellite and other remotely sensed data will be very useful for tracking forest-related activities and alteration in trends in forest change as a result of REDD+ implementation. Remotely sensed data are, however, unlikely to be sufficient: ground-based data are also needed for reference and to provide robust measurements of emission and removal factors. GOFC-GOLD provides useful background material on the use of remotely sensed data and the GEO GFOI initiative is developing guidance for use by countries and data providers in the context of IPCC methods.

International verification by means of a review process is a likely requirement for participation in results-based schemes linked to adherence to commitments under a future climate treaty. It is likely to cover emissions and removals estimates, as well as consistency with estimates of reference levels. Additional guidance will need to be developed for agreement by the COP. International verification may help with the implementation of conservative estimation under a stepwise approach.

The international review could also be extended to cover NFMSs, consultation, safeguards and wider forest values. If based on the principle of a facilitative and non-confrontational approach, review of these aspects could be very valuable for increasing policy effectiveness (and hence the likelihood of success in achieving emission reductions or removals enhancement) and sharing experiences.

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This publication contains preliminary or advance research results, significant to tropical forest issues, that need to be published in a timely manner. They are produced to inform and promote discussion. Their content has been internally reviewed but has not undergone the lengthier process of external peer review.

The development of a system for forest monitoring and measurement, reporting and verification (MRV) is an on-going priority – and challenge – for REDD+ countries. Although many countries already have some form of national forest monitoring in place, the existing capacity often falls short of the level required to participate fully in REDD+. In this context, a group of experts from around the world met in September 2012 to share their experiences and to discuss some of the central – and at times controversial – issues for national forest monitoring readiness and REDD+.

This joint publication of the CIFOR Global Comparative Study on REDD and the GOFC-GOLD Land Cover Office synthesises the main outcomes of that meeting.

Through the experiences and analyses of five REDD+ countries, two donor organisations and several researchers and negotiators, the papers gathered examine:

- success factors for building capacity and implementing national forest monitoring
- stepwise approaches for bridging capacity gaps through continuous improvement
- key components and attributes of an effective national forest monitoring system
- data and technology needed for forest monitoring
- the conservativeness principle, benefit distribution, and a framework for REDD+ reference levels (stepwise approach)
- assessment of current and required methodological guidance.

By publishing these papers for a wider audience, this collection aims to help all those invested in the success of REDD+ to learn from others' experiences.

This joint publication of the CIFOR Global Comparative Study on REDD and the GOFC-GOLD Land Cover Office synthesises the main outcomes of that meeting. More information can be found at www.gofcgold.wur.nl.

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