



## Measurement, reporting and verification for REDD+

### Objectives, capacities and institutions

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- Participation in REDD+ requires much more emphasis on measuring, reporting and verifying (MRV) than has been the case in most national forest monitoring to date.
- Roadmaps to build and sustain capacity for measuring, reporting and verifying national REDD+ implementation according to national and Intergovernmental Panel on Climate Change (IPCC) requirements and principles must be effective, efficient and equitable.
- Without clear links between REDD+ MRV and policy from the outset, REDD+ compensation schemes that are based on results will be ineffective.

### Introduction

A cornerstone of any national REDD+ scheme is a reliable, credible system of measuring, reporting and verifying (MRV) changes in forest carbon stocks. A recent review shows that very few countries have even the minimum capacity (Box 7.1) needed for measuring and monitoring. Most developing countries

also have a long way to go before they will be ready to fully participate in an international system that provides compensation for REDD+ actions based on results.

### **Box 7.1. National capacities for MRV in non-Annex I countries**

In a recent study (Herold 2009), information from global information sources was analysed to assess the current national monitoring capabilities of 99 tropical non-Annex I countries. The assessment emphasised that most countries have limited ability to provide complete and accurate estimates of greenhouse gas (GHG) emissions and forest loss. Less than 20% of the countries have submitted a complete GHG inventory, and only 3 out of the 99 countries currently have capacities considered to be very good for both monitoring forest area change and for forest inventories. The current capacity gap can be defined as the difference between what is required and what currently exists for countries to measure and verify the success of REDD+ implementation actions using the IPCC Good Practice Guidelines (see Figure 7.1). Capacity gaps are largest in countries:

- that have limited experience in estimating and reporting national GHG inventories, and in applying IPCC Good Practice Guidelines and that have limited engagement in the UNFCCC REDD process so far;
- with weak existing capabilities to continuously measure forest area changes and changes in forest carbon stocks as part of a national forest monitoring system (reporting carbon stock changes on the IPCC Tier 2 level is considered a minimum requirement);
- that face specific challenges for REDD+ implementation that may not be relevant in all countries (e.g., they have high current deforestation rates, significant emissions from forest degradation and fires, or their soil carbon stocks are currently not measured regularly) and require significant investment to enable them to observe more IPCC key categories and move toward Tier 3 level measurements; and
- where data sources for REDD+ monitoring are limited (e.g., satellite data such as Landsat, SPOT, CBERS may be limited due to lack of receiving stations, persistent cloud cover, seasonality, topography or inadequate data access infrastructure).

Capacity building activities should consider different entry points and aim for a minimum level of monitoring capacity in interested countries within the next few years.

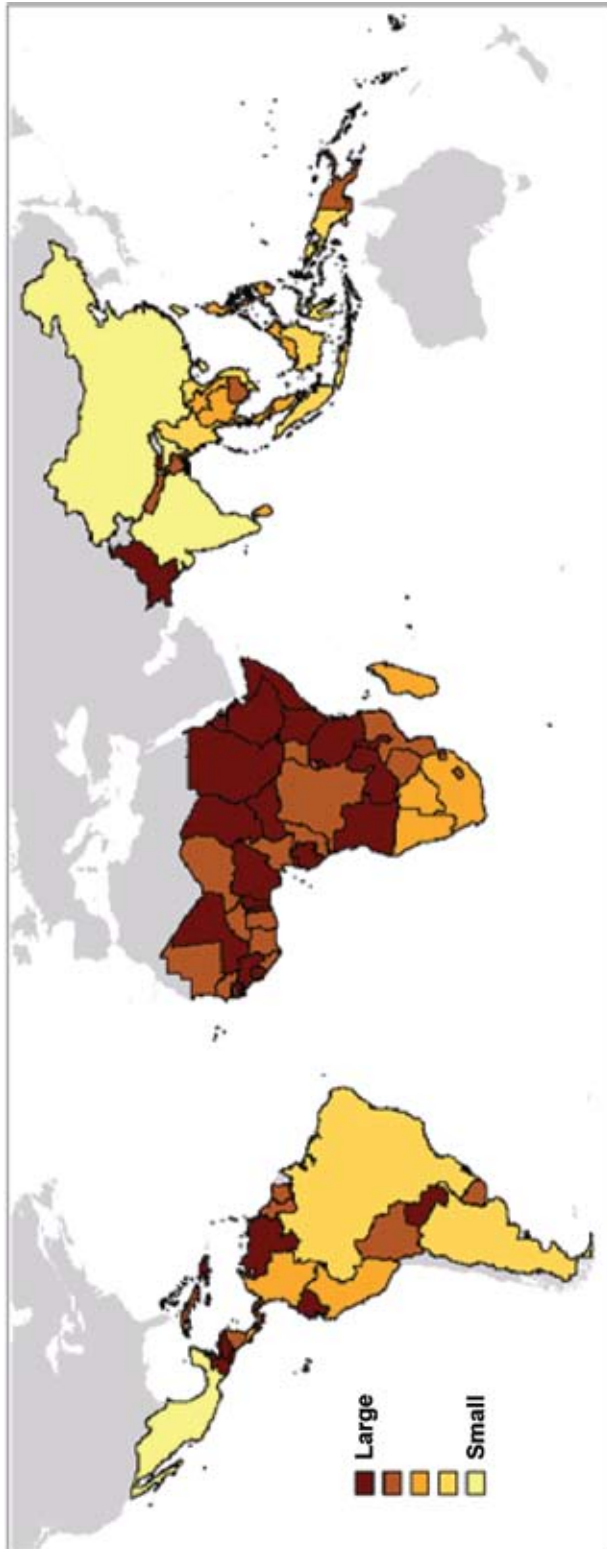


Figure 7.1. MRV capacity gap in 99 countries

MRV relates to both actions on the ground (i.e., that change forest carbon stocks) and REDD+ transactions (i.e., compensation and financial transactions or transfers). MRV of transactions is important for implementation, but is less significant in the readiness phase. MRV of actions is important in the readiness phase and for building capacity. National monitoring systems need to be established and use an appropriate combination of remote sensing and on-the-ground methods for forest carbon inventory. These monitoring systems would focus on estimating anthropogenic GHG emissions related to forests by source, removal by sinks, forest carbon stocks and changes in the area of forest. Each country will need to invest in a roadmap to establish an MRV system before participating in any REDD+ mechanism. This chapter sets out some of the steps in creating such a roadmap.

Policy should drive MRV and vice versa. Thus, a roadmap for developing an MRV system for REDD+ activities will need to take into account:

1. International requirements for MRV:
  - A roadmap should be guided by the principles and procedures for estimating and reporting carbon emissions and removals at the national level as set out in the IPCC Good Practice Guidelines and Guidance for reporting at the international level (IPCC 2003, 2006);
  - The particulars of the national REDD+ implementation strategy that has been selected, since different activities have different implications for MRV.
2. The existing national capacity for MRV:
  - A roadmap needs to be based on an assessment of the gap between the existing national forest monitoring system and the requirements of a REDD+ MRV system;
  - A roadmap needs to set out steps to put in place an effective, efficient and sustainable institutional and implementation framework for:
    - measuring and monitoring at different levels,
    - supporting national policies and REDD+ actions,
    - international reporting and verification,
    - linking MRV of actions and MRV of transactions.

This chapter highlights important issues with respect to international requirements, national capabilities and institutional settings. The specific issues and challenges in linking MRV and policy, interim performance indicators, and linking MRV at different scales are then discussed. The discussions assume that suitable methods for national forest carbon inventories are both available and can be applied. They also assume that the cost implications of initiatives

to fill the capacity gap and develop national MRV systems are understood (Angelsen 2008b; GOFC-GOLD 2009; UNFCCC 2009b).

## **International requirements: IPCC Good Practice Guidelines**

IPCC Good Practice Guidelines (GPG) require that two variables are measured and estimated in order to calculate (changes in) total forest carbon. The first variable – *forest area change* – needs to deliver spatially explicit trajectories of forest area change (deforestation and regrowth of forests) corresponding to Approach 3 of the IPCC guidelines (2003). Remote-sensing methods are considered to be appropriate for most developing countries to assess historical and future deforestation rates, i.e., forest area change (GOFC-GOLD 2009). For the second variable – *carbon stock change estimation or emission factors (carbon per hectare)* – the IPCC GPG provide different tiers with respect to the level of detail and accuracy required. While Tier 1 relies on global default data, Tier 2 requires national data (i.e., from forest carbon inventories). For Tier 3, detailed measurements of carbon stock changes need to be supplied for different carbon pools.

Five reporting principles underlie IPCC GPG: consistency, comparability, transparency, accuracy and completeness (UNFCCC 2009b). The data and estimates of many countries currently do not fully meet these reporting principles. These countries will only be able to develop MRV systems to meet these requirements over time. However, countries will need to prepare for an international review that will assess how they are working toward the requirements. The IPCC GPG call for all data, intermediate results and estimates to be acquired and analysed transparently, and made available to all actors and independent international review.

## **National capabilities and development pathways**

The United Nations Framework Convention on Climate Change (UNFCCC) discussions currently assume that any change in forest carbon stocks from direct or indirect human activities has an impact on climate and should be accounted for. Considering the variety of country circumstances (see Box 7.2), different emphases will have to be placed on the different processes affecting forest carbon (e.g., land use change causing deforestation versus selective logging or shifting cultivation) in both policy and MRV. The gap between the capacity to meet national and international REDD+ MRV requirements and current capacity (understood as the capacity gap, see Box 7.1) differs from country to country. Country-specific capacity development pathways will need to be based on individual requirements, as elaborated in the following sections.

## Box 7.2. Monitoring and establishing reference levels

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Setting reference levels for GHG emissions is among the more challenging issues in implementing REDD+ projects in developing countries. There is very little guidance in the agreed texts of the UNFCCC. The annex of decision 2/CP.13 suggests:

*Reductions in emissions or increases resulting from the demonstration activity should be based on historical emissions, taking into account national circumstances.*

Neither is there any agreement among experts about how to set a reference level. Santilli *et al.* (2005) suggested using a 5-year average and updating it every 3 years. Others have suggested using 10-year averages (e.g., the recent Brazil commitment to reduce emissions). Global Observation of Forest and Land Cover Dynamics (GOF-C-GOLD) recommends using forest cover values from 1990, 2000 and 2005, if better data are not available.

Baselines, or reference levels, can refer to two different things (Angelsen 2008a; Meridian Institute 2009a). First, they can refer to a business-as-usual (BAU) scenario, a prediction about what would happen without any REDD+ actions. Second, they can refer to a crediting baseline, which is similar to an emissions quota. The BAU baseline is the benchmark for measuring the effect of a REDD+ intervention, while the crediting baseline is the benchmark for rewarding a carbon rights holder. We use the term 'reference level' in the sense of crediting baseline. At the international level, reference levels can be seen as modified BAU baselines, which reflect 'common, but differentiated responsibilities'.

The overall reference level of a REDD+ country must be harmonised with the reference levels set for subnational activities, projects and forest owners. A combination of bottom-up and top-down approaches is needed. This harmonisation of reference levels across scales is a challenging task.

While setting reference levels involves political decisions, scientists can help predict deforestation. One approach to understanding the historical context of deforestation in a country might be to use the forest transition (FT) theory, as presented in Box 1.2. This concept, introduced by Mather (1992), has been used to describe a sequence where forest cover first declines and reaches a minimum before it slowly increases and eventually stabilises. The historical component in setting a reference level would consist of assessing the current position of a country or region within the FT curve, and modifying future predictions based on that.

The FT theory can also be combined with a land rent modelling approach (the von Thünen framework), constrained by land capability and other important factors (see Chapter 10). Using this combined approach, a country could assess a range of plausible future rates of deforestation and the future shape of the transition curve (Angelsen 2007).

A research project by CIFOR and its partners will combine the FT theory and von Thünen modelling approach. The research will not provide a single solution for estimating future emissions or allow objective estimates of appropriate reference levels. Rather, it will be a useful tool for assessing plausible future scenarios and for informing political decisions. Current proposals are for more or less straight-line projections from the recent past. This proposal provides for more sophisticated prediction of the future, although there is no guarantee that it is more realistic than current methods. However, it offers the opportunity for scenario analysis, long-term projections and the flexibility to update assumptions in the future as the REDD+ programme progresses.

Figure 7.2 gives a conceptual representation of the range of actions that a country might include in a national REDD+ strategy, and shows the basic data requirements for each action. Countries may start with only a few REDD+ activities – those which are easiest to set up or most likely to achieve success. Some parts of the national forest area may be selected for interventions designed to reduce degradation and stimulate forest enhancement. Other parts may be targeted for reducing deforestation or conserving carbon. This means that a mosaic of approaches may emerge, as sketched for a hypothetical country in Figure 7.2. It is vital that the connection between MRV requirements and particular activities under REDD+ is understood, and that MRV and activities develop in parallel under the national REDD+ plan.

Each country will have to develop an MRV system to meet REDD+ requirements and, at the same time, select REDD+ actions that are feasible as regards MRV. We provide some general suggestions and guidance. Figure 7.3 shows the phases in preparing for REDD+ MRV. Countries can address the strategy development and readiness phase quite quickly if they have adequate data and capacity. However, some countries may first have to establish initial datasets to provide a basic understanding of the extent to which drivers of forest emissions are active and what their forest carbon impact is. They will also have to establish how policies can be defined and implemented to influence drivers and processes. Thus, MRV analysis and assessment is essential in the policy context, as is suggested in the term MARV (measurement, assessment, reporting and verification).

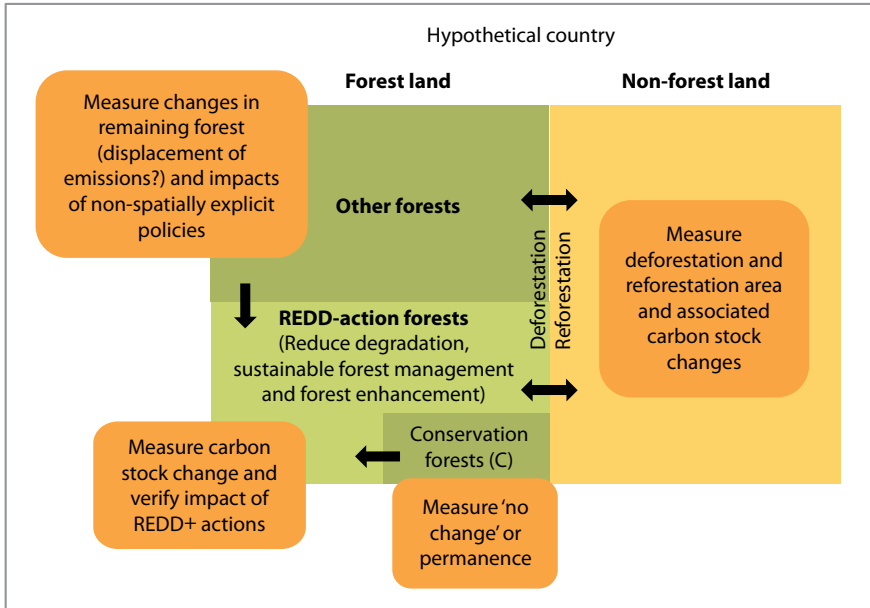


Figure 7.2. Different land types, their potential role in a national REDD+ programme, and the associated MRV tasks and objectives. Arrows indicate possible shifts in area which need to be monitored over time, while the orange boxes indicate what needs to be measured within each type.

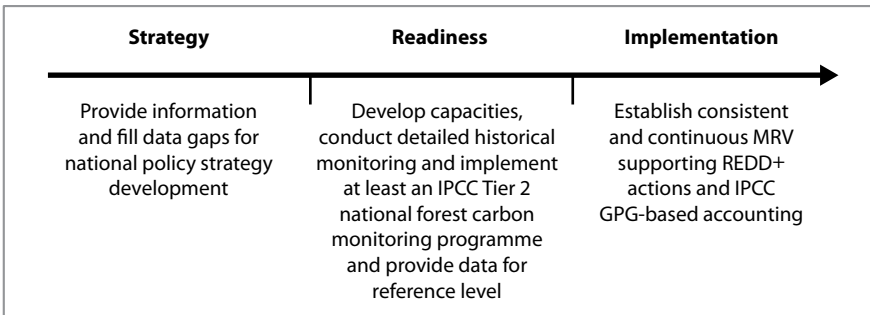


Figure 7.3. MRV objectives for different phases of REDD+ participation

### Institutional framework and capacity

As a country moves into the readiness phase, it must establish the organisational capacity to operate a national forest carbon MRV programme efficiently and sustainably. The requirements for a national institutional framework for MRV are:

- **Coordination:** a high-level national coordination and cooperation mechanism to link forest carbon MRV and national policy for REDD+, and specify and oversee roles, responsibilities and co-benefits, and other monitoring efforts (see also Chapter 5);



- **Measurement and monitoring:** protocols and technical units for acquiring and analysing the data related to forest carbon at national and subnational levels;
- **Reporting:** a unit responsible for collecting all relevant data in a central database, for national estimates and international reporting according to IPCC GPG, and uncertainty assessments and improvement plans; and
- **Verification:** an independent framework for verifying the long-term effectiveness of REDD+ actions at different levels and by different actors.

Different actors and sectors need to work together to make the monitoring system efficient in the long term. Sustainability is an important principle in setting up an institutional framework for MRV. As a minimum, a country should consider setting up the following institutions and clearly defining their roles and responsibilities:

- A national coordination and steering body or advisory board, including a national carbon registry;
- A central carbon monitoring, estimation, reporting and verification authority; and
- Forest carbon measurement and monitoring units.

The resources required for setting up and maintaining institutional capacities depend on several factors. Some countries may acquire, process and analyse most data through their own agencies or central units; others may decide to work with partners outside government (e.g., contractors, local communities or regional centres), or involve communities (see Chapter 8).

Any compensation for REDD+ actions should be tied to data on the positive impact of both actions and support in the long term. Any particular subnational activity will need to be assessed in terms of the amount of forest carbon preserved (measurement). This means that subnational data must be provided to the national system so that it can be included in national estimates and reports, and verified in terms of leakage (through systematic national monitoring) and permanence (long-term assessment of compliance). The institutional framework for MRV of transactions should be directly linked to the requirements for providing data, so that compensation transactions give incentives to all actors and reflect their different roles and responsibilities within the country. The national institutional infrastructure needs to provide the foundation for inclusive and effective national REDD+ MRV.

The criteria of effectiveness, efficiency and equity (3Es) are a tool to assess REDD+ outcomes (see Box 1.3), but can also guide the development of a national MRV infrastructure:

- **Effectiveness** implies that development of MRV should be driven by the development and implementation of a national REDD+ policy and activities;
- **Efficiency** implies transparent, consistent and cost-effective data collection and procedures. This means setting up an institutional MRV infrastructure, clear terms of reference, and establishing sustained capacity within the country to meet national and international REDD+ requirements and report forest carbon changes according to IPCC GPG;
- **Equity** implies integrating local measurements, national monitoring estimates, international requirements and independent reviews to ensure participation and transparency among all involved.

Policy development and implementation on the one hand, and MRV on the other, follow similar fundamental principles in terms of the 3Es.

### **Challenge 1: Linking MRV to policy**

International policies and MRV concepts focus on emissions and carbon impacts. However, national policy needs to focus on the drivers of forest emissions. National policies will need to target the key causes and processes that alter forest carbon on the ground. For an MRV roadmap, one needs an understanding of the active drivers and processes of forest emissions, sufficient data to assess their importance (carbon impact), and policies that will achieve REDD+ objectives (see Table 7.1).

This type of assessment will help develop priorities in terms of both national policy and monitoring requirements. Indeed, the decisions on national REDD+ strategies need to proceed in parallel with developing MRV procedures. One of the most fundamental questions is whether or not sufficient data are available to provide an understanding of the recent forest carbon impact of specific drivers and processes. If not, further studies may be needed in order to select actions which are likely to be successful in meeting REDD+ objectives. A REDD+ strategy and implementation activities should address the main drivers of change in forest carbon stocks. (Any given country most likely cannot start interventions immediately in all parts of its forest estate in any case.) This means that, initially, rather than defining MRV needs to fulfil all requirements, they can be defined in detail and accurately just for the drivers and processes causing most changes in forest carbon stocks. The IPCC GPG provide some flexibility in this respect as they focus on 'key categories'. Key categories are sources of emissions and removals that contribute substantially to the overall national inventory (in terms of absolute level or trends). Key categories, or pools, should be measured in more detail and with greater accuracy, and estimated using higher tiers (Tier 2 or 3).

**Table 7.1. Drivers and processes affecting forest carbon change, national REDD+ policy opportunities, and monitoring requirements and priorities**

<b>Processes and drivers that affect forest carbon stocks</b>	<b>Current data and monitoring capacities (examples)</b>	<b>Importance (carbon impact on national level)</b>	<b>Suggested activity to fill monitoring capacity and data gaps</b>	<b>REDD+ opportunities and policies to encourage or discourage process</b>
Forest conversion for expansion of agriculture	Sample-based national forest inventory for two points in time	Significant areas affected nationally and large carbon emissions per ha	Assessment by remote sensing of forest area change and forest carbon inventory data	Protect existing forests and use of non-forested land for agriculture
Selective logging in native forests and remaining forest	Harvest estimates and concession areas by companies and forestry department	Significant areas affected and low emissions per ha	Gather existing data on areas and harvests, convert to carbon emissions, long-term case studies	Shift toward low-impact logging and sustainable forest management
Clear fell and selective harvesting in forest plantations	Harvest estimates, concession areas and growth rates by companies and forestry department	Some areas nationally may act as C sinks or sources depending on previous land use and harvest cycles and intensity	Gather data at national level and evaluate data by remote sensing, convert existing estimates into carbon values	Encourage reforestation of non-forested land, low-impact harvesting and sustainable forest management

MRV indicated for the readiness phase (Figure 7.3) are to acquire historical data to meet requirements for at least IPCC Tier 2 national carbon monitoring, and to acquire data and information to establish a reference level (see Box 7.2). Monitoring historical and future changes in forest carbon should ideally be continuous and consistent. The historical assessment would be a one-time effort as part of the readiness phase. However, the type and quality of monitoring data available from previous years may be limited, in particular with respect to field data. Monitoring future changes can incorporate the specific requirements of REDD+.

Figure 7.4 provides some guidance on what MRV capacities may be needed. This assumes that Tier 2 monitoring of the aboveground vegetation carbon pool for forest area changes is the minimum requirement. The level of detail for the other components depends on a number of factors that are country specific. If some carbon stock changes are significant (key category), or if the REDD+ policy targets particular activities (i.e., shifting from conventional logging to sustainable forest management), it may be necessary to invest more in MRV capacities than would be required to meet minimum requirements.

## **Challenge 2: Early participation and interim performance**

Countries with weak capacities and limited data will need more time to reach full REDD+ readiness than countries with stronger capacity and better data. Since early action is important, we consider what countries could do in the absence of a fully developed MRV system. A useful concept that provides flexibility in dealing with uncertain or incomplete data in the REDD+ process is *conservativeness* (Grassi *et al.* 2008). Conservativeness was introduced in the Kyoto Protocol. In the REDD+ context, conservativeness may mean that, when completeness or accuracy of estimates cannot be achieved, the reduction in emissions or increases in carbon stocks should not be overestimated and the risk of overestimation should be minimised. As an MRV system is implemented and improves, the need for conservative estimates may be replaced by the use of ‘best estimates’ if independent assessments show they are correct.

A set of simple interim indicators, or verifiable proxies, could be used to assess the performance of REDD+ actions in cases of incomplete and uncertain data. These would provide justification and help set priorities for implementation of REDD+ actions in the short term. The indicators would be based on the principle of conservativeness, while encouraging development of more accurate MRV over time. Monitoring using satellite data, for example, is straightforward. Just the fact that a country systematically acquires satellite data covering all its territory would engender confidence that key activities (forest area change) are being captured and that activities could be verified at

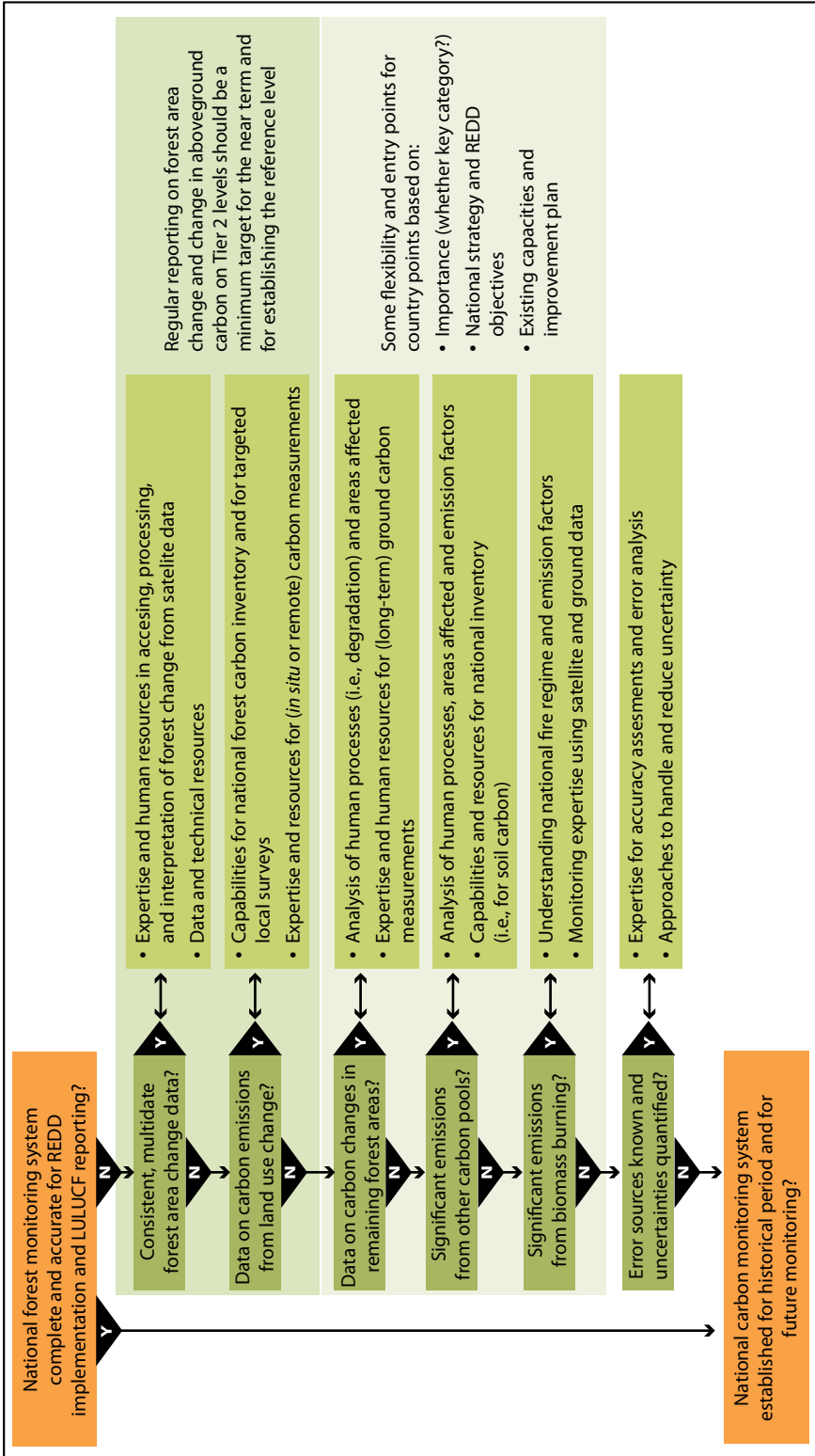


Figure 7.4. Flowchart showing key components of a national monitoring system and the capacities required (adapted and edited from UNFCCC 2009)

a later date. In this context, the data on area change may be most important. For some interim indicators, actual carbon data might not be needed initially. (This could be understood as a Tier 0 approach.) However, it is important to assume that all actors will use the best data available and internationally accepted methods, and will abide by the IPCC reporting principles of completeness, consistency, transparency, uncertainty and comparability. Independent international reviews of results are to be encouraged. Table 7.2 lists a set of suggested interim indicators and proxies that could be used to address a number of common processes affecting forest carbon at the national level. The idea would be to replace them as soon as performance can be measured, reported and verified according to IPCC GPG requirements.

### **Challenge 3: National MRV and subnational implementation**

A national REDD+ strategy needs to encourage specific local actions. A national carbon monitoring system should provide data on these local actions, but also be flexible for more detailed, accurate measurement at these sites. More specifically, a national estimation and reporting system needs to incorporate measurement at the subnational scale driven by REDD+ related activities. This could be through a national stratification system that provides for all (subnational) REDD+ implementation activities to be measured with an appropriate degree of certainty. That is to say, with more precision and accuracy in REDD+ action areas and less detailed, systematic monitoring in the rest. A national stratification system could be based on forest carbon density and types of human activities (and thus REDD+ actions). Figure 7.2 shows different MRV objectives for different types of land. Such a system would help show the effectiveness of subnational activities by accounting for national leakage and, to some extent, for additionality. It would also provide a framework for continuous monitoring to verify permanence. The national mechanism should further provide entry points for existing pilot projects that are already receiving some kind of carbon credits that contribute to national targets. An example of subnational monitoring linked to a national system is provided in Chapter 8.

### **Final remarks**

This chapter is intended to improve understanding of the links between MRV, national REDD+ plans and existing capacities. The development of an MRV system should accommodate specific country needs; be based on national and international IPCC principles requirements; and meet the criteria of effectiveness, efficiency and equity.

**Table 7.2. Interim indicators for assessing the performance of national REDD+ activities in the absence of a fully developed MRV system**

REDD+ objective	Justification	Interim performance indicator
No deforestation	Emissions from the loss of forests cause the largest per unit losses of terrestrial carbon.	Total area under current forest cover (as defined by the Marrakech accords) shall not decrease as monitored by satellite data.
Conservation of intact forests	Degradation of intact forest through human activities will produce a net loss of carbon and is often the precursor to further processes causing long-term decreases in carbon stocks.	The total area of intact forests within the country should remain constant as monitored by satellite data.
No increase in emissions from forest management (i.e., selective logging) activities	Forest management should work toward sustainable forest use with a net zero or positive carbon balance in the long term.	All areas under forest management should be monitored and activities documented as far as practicable using existing capacities (e.g., concessions, harvest estimates or satellite data where appropriate and useful). Observed changes in forest management activities should spur estimations of forest carbon impacts.
No increase in emissions resulting from anthropogenic forest fires	Forest fires result in direct emissions of several greenhouse gases.	Area of forest burnt each year should decrease compared to current amount, verifiable by satellite data.
Encourage increasing carbon sink capacities of non-forest and forest land	All changes from non-forest to forest land (i.e., through plantations, land use change) or within forest land (sustainable forest management, enrichment planting) increase the sequestration of atmospheric carbon.	Not considered relevant in the interim period before a proper MRV system is in place, but any dedicated activities should be documented as far as practicable.

MRV is of fundamental importance for REDD+ implementation and, in many environments, needs to have a much higher priority than national forest monitoring has had in the past. Currently, developing solid MRV systems is the key to participation in REDD+ and there are strong incentives for many countries to do so. A set of readiness funding mechanisms and capacity development activities are taking shape to support countries in this process.

It is also important to recognise that a basic set of forest data and information (and thus monitoring capacity) is required to underpin the development of national policy. A good understanding of the drivers and processes responsible for forest carbon changes, and their long-term effects, is fundamental for determining policies and actions to encourage or discourage them. Additionally, a consolidated national REDD+ implementation plan helps to pinpoint areas where detail and accuracy are needed and thus set priorities for MRV.

Developing an MRV system is a process. Many countries do not have even a minimum capacity for MRV. The priority for these countries is to develop a roadmap for establishing a sustainable MRV system and to get started. A first step could be to set up an interim system that would gradually lead to a fully developed MRV system. This would allow, and be an incentive for, countries to take early action. The step-by-step approach encourages continuous improvement toward more accurate monitoring that, ultimately, will allow full compensation for REDD+ actions based on results. Without clear links between MRV and policy from the outset, any national plan to achieve compensation for REDD+ actions based on results will be ineffective.