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FAO -voluntary guidelines on national forest monitoring and its possible effect on measuring, reporting and verification for REDD+

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Abstract - During the 23rd session of the FAO-Committee on Forestry (COFO 23) held in July 2016, the voluntary guidelines on national forest monitoring were approved. These guidelines were generated to support FAO member countries on the starting-up and the implementation of their national forest monitoring systems (NFMS). Under the United Nations Framework Convention on Climate Change (UNFCCC), the decision 1/CP.16 encouraged to developing country Parties to undertake actions for REDD+, and requested, *inter alia*: i) to develop a forest reference emission level and/of forest reference level (FREL/REL) as a baseline for the emission reductions report, and ii) a transparent and robust NFMS. This paper examines the technical assessments from UNFCCC of the FREL/REL submitted by six countries in relation to technical needs for the NFMS setting up. The analysis suggests the need to improve the procurement of ground-base data, to comply the quality of the estimations on forest emission changes, to complete the carbon stocks estimations, and to estimate the associated uncertainties. The strategic and technical planning of the NFMS is also needed, to be able to reach the acceptable preparation level for measuring, reporting and verification system of REDD+, and the FAO voluntary guidelines are a helpful tool for the step-wise approach development.

Diretrizes voluntárias da FAO para o monitoramento florestal nacional e seus possíveis efeitos nas ações de mensuração, relato e verificação no âmbito do REDD+

Resumo - Durante a 23^a Sessão do Comitê Florestal da FAO (COFO 23) ocorrida em julho de 2016, foram aprovadas as diretrizes voluntárias para monitoramento florestal nacional. Essas diretrizes foram desenvolvidas para dar suporte aos países membros da FAO no andamento e implementação de seu sistema nacional de monitoramento florestal (SNMF). No contexto da Convenção do Clima da ONU (UNFCCC), a decisão 1/CP.16 encorajou os países em desenvolvimento a implementarem ações visando REDD+, e requereu, *inter alia*: i) o desenvolvimento de um nível de referência para emissões florestais e/ou um nível de referência florestal (FREL/REL), como linha de base para os relatórios de redução de emissões, e ii) um SNMF transparente e robusto. Esse trabalho examina a análise técnica da Convenção do Clima dos FREL/REL submetidos por seis países em relação às necessidades técnicas para a implementação do SNMF. A análise sugere a conveniência do aprimoramento da obtenção dos dados básicos de campo para estabelecer a qualidade das estimativas das mudanças das emissões florestais, visando complementar as estimativas de estoque de carbono e para estimar as incertezas associadas. O planejamento estratégico e técnico do SNMF também é fundamental para se atingir os níveis de preparação aceitáveis para a mensuração, relato e verificação do sistema de REDD+ e as diretrizes voluntárias da FAO se mostram como uma ferramenta útil para a abordagem gradual de desenvolvimento.

Introduction

Since FAO was established, one of its core functions was to collect, analyze and disseminate information on agriculture, forestry and fisheries. FAO has been monitoring the world's forests at 5 to 10 year intervals since 1946. The Global Forest Resources Assessments (FRA) is now produced every five years in an attempt to provide a consistent approach to describing the world's forests and how they are changing. The FRA is based on two primary sources of data: i) country reports prepared by national correspondents, ii) global remote sensing analysis, conducted by FAO together with national focal points and regional partners. International expert workshops have been organized, where representatives of the countries have participated for the harmonization of concepts and procedures. Each member country prepares national reports based on FRA protocol agreed by countries, and applies the national information available. Even though these good efforts, in 2000 some analysis about the information sources on national reports found that 79 countries used information only based on expert consultation, 71 countries from remote sensors, and only 6 countries from national forest inventories (NFI) (Saket, 2002).

With the aim of improving forestry statistics and for obtaining harmonized quality data from countries, FAO implemented the National Forest Monitoring and Assessment programme (NFMA). This programme assisted countries to generate information on their forest and tree resources at national level, necessary for policies development and strategic planning. Already earlier, in the years 60-70s, FAO supported the same initiatives. As a result, many countries implemented their first national forest inventory, although few countries continued this process. After the report of FRA 2000, several developed countries responded to the call to improve their national monitoring systems, also several developing countries started their processes with the support of FAO. After 10 years, the information improved significantly, since for FRA 2010, 84 countries reported with remote sensing data, 45 countries reported with forest inventory data and 22 countries with repeated forest inventories (FAO, 2010). Subsequently, for FRA 2015, MacDicken et al. (2015) reported that 82% of the global forest area was reported using information from a national forest inventory, and the sub regions of West and Central Africa, the Caribbean, East and Southern Africa, West and Central Asia and North Africa are the regions with the lowest percentage of forest area reported using NFI data (Figure 1).

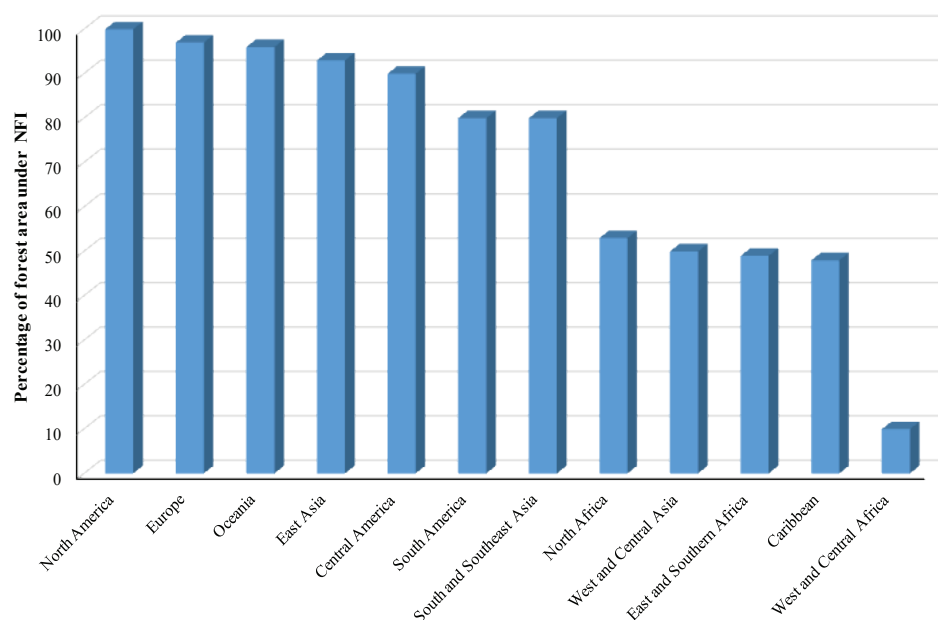


Figure 1: Percentage of forest area under NFI by sub regions. Source: McDicken et al. (2015).

With the establishment of the UN-REDD program in 2008, FAO increased its support to member countries,

with a strong emphasis on strengthening the capacities of countries in the readiness process to be able to meet

the principles, rules and procedures defined by the United Nations Framework Convention on Climate Change (UNFCCC) and to qualify for positive incentives for Reducing Emissions from Deforestation and Forest Degradation (REDD+). Within the UN-REDD Programme, FAO is the lead agency to support member countries in the preparation of two key elements for REDD+: the development of forest reference emission levels, forest reference levels (FREL/REL), and the setup and strengthening of their national forest monitoring system (NFMS). The principles and modalities for the FREL/REL were defined by a sequence of negotiations during the conferences of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) (2014a). These modalities are a general framework, hence each country has to work according to their capabilities to collect information in the country, as well as taken in consideration the specific institutional and national circumstances. These conditions have created a global challenge, so it has been necessary to gather with national and international scientists, to find the better solutions for the complex problems for FREL/REL definition of the five REDD+ activities: avoid deforestation, prevent degradation, enhancement of forest carbon stocks, sustainable forest management, and conservation of forest carbon stocks (United Nations Framework Convention on Climate Change, 2012). At the same time, countries must start building a transparent and robust NFMS (United Nations Framework Convention on Climate Change, 2012), which also should be multipurpose, have a landscape view, be permanent and sustainable to improve the quality of current information and other additional principles included in the FAO-voluntary guidelines on national forest monitoring (FAO, 2017). There are some preliminary assessments on capacity building to develop the FREL/REL and the NFMS, a case from Guyana is described by Bholanath et al. (2012), which albeit have made progress in building capacity to develop reference levels, they need to improve the NFMS, specially the data collection through a national forest inventory. These experiences confirm the importance in moving forward with a step-wise-approach, defined in decision 12/CP.17 (United Nations Framework Convention on Climate Change, 2012).

The FAO support for monitoring and evaluation of forest resources is aimed at strengthening the long-term capacity, and is done through the development

of tools, practical and efficient methods, by training the national and regional experts, creating information exchange platforms, and by using direct execution on the concept of “learning by doing”. The process is not easy as demonstrated by the first experiences of the technical assistance from FAO, where little success in institutionalizing processes was achieved. However, there are successful stories to take in consideration, of which only two are mentioned here. In India, the federal government received support from FAO in 1965 for human capacity building on forest inventories, and for implementing their first national forest inventory aiming at improving wood production. At the end of the project the government continued the effort, and in 1981 the Forest Service of India started a permanent NFI with measurement cycles of 10 years. Later in 1986 it took up the challenge of including remote sensing monitoring at national level (Pandey, 2012). More recently, India has requested some additional support to FAO, in order to strengthening its work done for years, and is looking for an enhance on their NFMS. The case of Honduras started in 2005 with the establishment of the continuous national forest assessment with the support from FAO. In 2010 the new Forest Conservation Institute (ICF) was established, which was responsible for planning and implementing the second cycle in 2014-2015, with the financial support from the European Union. Based on the accumulated experience and the new information, the country is in the process of re-design the national forest inventory in order to better respond to present needs, with the priority of measuring changes in forest emissions. Additionally, it is expected that the new design will facilitate the institutionalization of the process, through the annual distribution of the sampling units and for integration into the annual operating plans that allow the measurement by government staff from sub-national offices of ICF.

The interest and efforts of many countries on setting up and implementing their NFMS was pointed out during the 21st Session of the Committee on Forestry (COFO 21) held in 2012, when countries recommended to the FAO “continue to support countries to strengthen their national forest information systems” and also requested “work in close collaboration with member countries and relevant organizations to prepare a set of voluntary guidelines on national forest monitoring, which takes into consideration the requirements for REDD+ reporting, and is in line with the principles and goals of the Forest Instrument” (FAO, 2016).

The objective of the guidelines is to support in creation and operation of the national forest monitoring system, including good practice principles, and a framework with guidelines, scientifically sound tools and practices adapted to national context (FAO, 2016). The guidelines are a technical reference for governmental agencies which are responsible on forest monitoring, in addition they serve for educational and research institutions, public and private sectors and civil society interested in forest issues. The construction process of the guidelines began in 2012. They are based on experience and lessons learned from FAO member countries, from past and present FAO projects, workshops and expert meetings held between 2012 and 2015. The first part of the document was validated in six forestry commissions and was approved in COFO 22 (FAO, 2014). The technical validation of the second part was performed by an online consultation, an expert meeting in 2015, and it was approved in COFO 23 (FAO, 2016).

The guidelines complement the existing tools for developing MRV systems for REDD+, as they provide the required elements for NFMS in order to be transparent, consistent and accurate as possible, according with the Houghton et al. (1997). Setting up and carrying out a NFMS is complex, therefore, proper planning and design is required, not only on scientific/technical aspects, but also in terms of the logistics and coordination of the support from the government and different stakeholders involved in the process (FAO, 2016).

As mentioned before, countries still have to overcome significant barriers to succeed in creating a well-functioning NFMS, to respond to the MRV requirements for REDD+. This paper analyzes the effects and general contributions of voluntary guidelines for national forest monitoring in the step-wise approach for the measurement, reporting and verification for REDD+.

Concepts related measuring, reporting and verification for REDD+

Based on the sequence of negotiations during the conferences of the Parties to the UNFCCC (United Nations Framework Convention on Climate Change, 2014a), a conceptual schema of the readiness for REDD+

and the MRV relation is shown in Figure 2. A summary of this process is described below:

- Develop a strategy or action plan for REDD+, which should identify the causes of deforestation and forest degradation, decide on actions to reduce emissions (avoided deforestation, prevent degradation, increasing forest carbon stocks, sustainable forest management and conservation of forest carbon stocks), define policies and measures to reduce emissions, and finally develop a financing plan (United Nations Framework Convention on Climate Change, 2011, 2014a).
- Develop the forest reference emission levels and reference emission levels (FREL/REL), where requested calculate the anthropogenic emissions of the five REDD+ actions, mentioned above, of the main carbon stocks, measured in tons of CO₂. Step-wise approach was recommended. An expert accredited team evaluates the methodologies, the transparency, and the robustness of the reference levels and recommends the improvements (United Nations Framework Convention on Climate Change, 2011, 2012).
- Building a national monitoring system, robust and transparent, about changes in anthropogenic emissions, by changes of forest to other land uses, changes in forest remaining forests, and by enhancements of carbon stock due to forest restoration. It has to be built on the basis of existing systems, to evaluate different types of forests, providing information on safeguards, considering national circumstances, be flexible for improvements, depending on the national capabilities (United Nations Framework Convention on Climate Change, 2011, 2014a).
- Build an information system of safeguards to support national strategies and provide information on how the safeguards are being addressed (Appendix I 1/CP.16) (United Nations Framework Convention on Climate Change, 2011). It should be built on existing systems, be transparent, flexible and accessible to all stakeholders (United Nations Framework Convention on Climate Change, 2010, 2012).

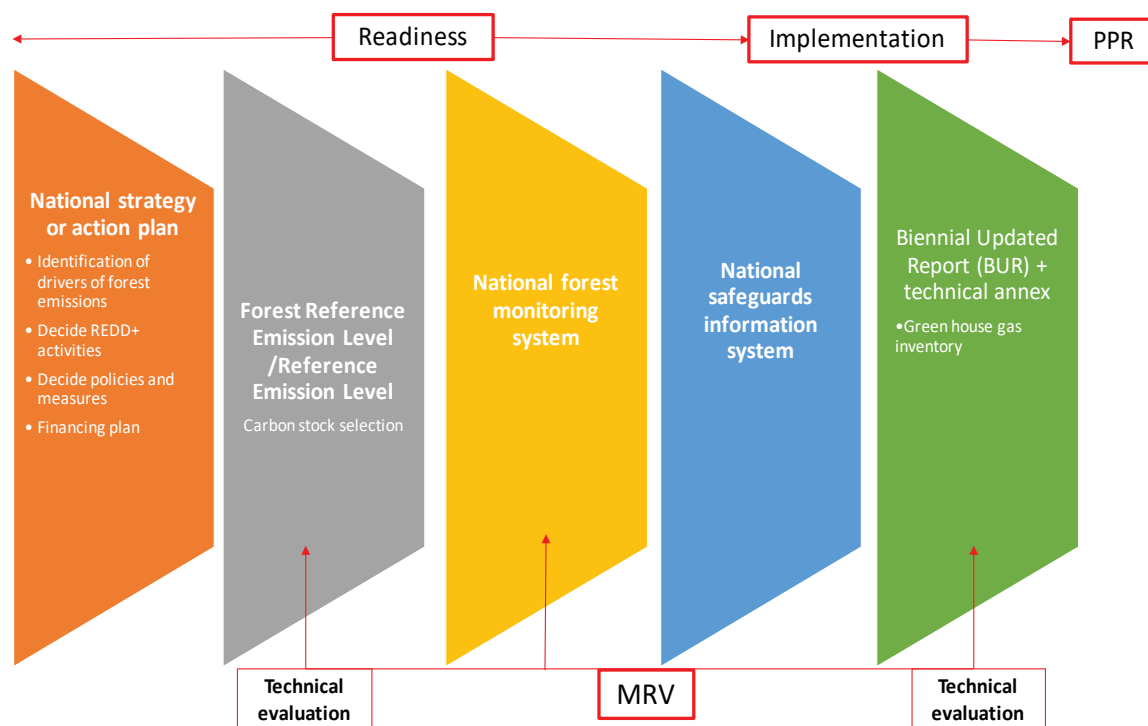


Figure 2. Summary of elements for the preparation and the process of measuring, reporting and verification (MRV) for REDD+.

The MRV process must start from setting up the NERF/NRF, since the methodology developed to define the NERF/NRF should be as similar as possible of the one used for the measurement and reporting. After the implementation of policies and measures, countries will present reports on emission reductions, according to the procedures defined in 14/CP.19 (United Nations Framework Convention on Climate Change, 2014c). The measurement is performed by the NFMS, which must provide data for the development of the greenhouse gas inventory (GHG-I) of agriculture, forests and land use change sector (AFOLU) or land use, land use changes and forestry (LULUCF).

The GHG-I is the basis for national communications to the UNFCCC, and biennial update reports (BUR). REDD+ reports should be submitted within a technical annex through the biennial update report. Validation or evaluation will be conducted by a technical team of accredited experts who will analyze the consistency between the methodologies of reference levels and the results of the implementation of the policy and measures (United Nations Framework Convention on Climate Change, 2014b).

The voluntary guidelines on national forest monitoring

The FAO Voluntary guidelines on national forest monitoring (FAO, 2017) includes that the objectives of a NFMS must be comprehensive. In other words, it should support the evaluation and adjustment of policies related to forestry, inform the progress to the citizens and stakeholders, prepare reports for international commitments, and provide baseline data for measuring the sustainable forest management. In addition, it highlights three important concepts:

1. The *national forest inventory* is commonly used to describe the technical process of data compilation and analysis of forest resources from a multitude of data sources, including field inventories and remote sensing, to estimate relevant forest characteristics at points in time.
2. The *national forest monitoring* is a much more comprehensive process that includes the assessment, evaluation, interpretation and reporting of data and the derivation of information, usually from repeated inventories,

that allows for the monitoring of change and trends over time.

3. The *national forest monitoring system* comprises the people, institutions and resources that implement national forest monitoring at the country level in collaboration with other stakeholders. Generally, a NFMS is led by a governing body responsible for its conceptualization, planning and execution within a clear and well-defined mandate, based on the principles and elements introduced in the FAO voluntary guidelines on national forest monitoring.

The collection of data and information on the three dimensions provide the necessary elements to ensure sustainable forest management as expressed by its seven thematic elements (FAO, 2010): extent of forest resources; forest biological diversity; forest health and vitality; productive functions of forest resources; protective functions of forest resources; socio-economic functions of forests; legal, policy and institutional framework (Morales-Hidalgo et al., 2014).

The voluntary guidelines on forest monitoring consist of 15 principles, organized into 5 groups (table 1) and 15 guidelines grouped in three classes elements (table 2).

Table 1. Principles of the voluntary guidelines on national forest monitoring.

Governance principles	Principle 1: Country ownership and responsibility
	Principle 2: Legal and policy basis
	Principle 3: Landscape view
	Principle 4: Institutionalization of NFM
	Principle 5: Research infrastructure and capacity building
Scope principles	Principle 6: Participatory discussion process
	Principle 7: Satisfaction of national information needs
Design principles	Principle 8: Integration of and consistency with existing information sources
	Principle 9: Flexible approach
	Principle 10: Multi-purpose approach
	Principle 11: Feasibility including cost-efficiency
Data principles	Principle 12: A well-defined data and information-sharing policy
Overall principles	Principle 13: Credibility through transparency and quality

Source: FAO (2017).

The guidelines include a detailed description of each principle. Each item has a description and basic components. The various elements and the overall

relationship detailed between NFMS and data collection cycles are presented in Figure 3.

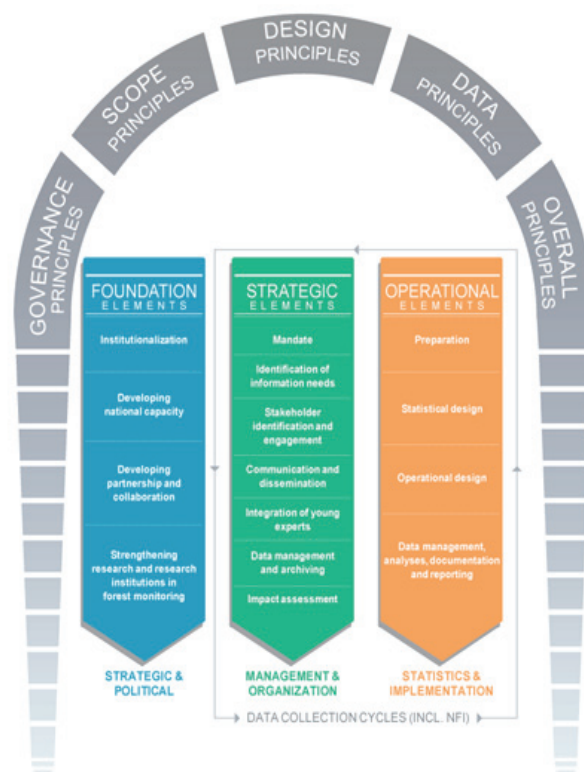


Figure 3. Core elements in a NFMS and the general relationship between NFMS and data collection cycles. Source: FAO (2017).

Each element describes the basic minimum requirements to be fulfilled, and the sum of elements ensures compliance with the 14 principles listed in the guidelines. Among those principles, the voluntary guidelines promote the strengthening of the ownership of countries, an interactive process with different stakeholders, a continuous information needs assessment, sufficient flexibility to accommodate changes, a landscape view and a multipurpose approach in order to provide added value to the information generated.

Analysis on MRV process and the related experiences on construct the national forest monitoring systems

The timeline of the MRV process according to the agreements of the parties of the UNFCCC is shown in figure 4. The process begins when countries start the preparation the FREL/REL. Then, the historic emissions/removals from each of the five REDD+ actions selected

should be calculated. The FREL/REL is developed using the most reliable information from each REDD+ activity, and is submitted to the UNFCCC. If necessary, the reference level update is recommended by the technical evaluation team, and the technical evaluation should be published. If the country has progressed on the implementation of policies and measures from the REDD+ strategy, the emission reductions should be measured and reported through the technical annex

of the BUR. The process ends with the publication of the technical assessment of emission reduction report. Almost three years' time (158 weeks) will be required until the country is ready for taking the last step, which consists of an agreement on the actions eligible for payment by results according to the market approaches that could be developed by the conference of the parties (United Nations Framework Convention on Climate Change, 2014b).

Table 2. Guidelines elements included in the Voluntary Guidelines on National Forest Monitoring.

Type Element	Guide element
Foundation elements	1. Institutionalization
	2. Developing national capacity
	3. Developing partnerships and collaboration
	4. Strengthening research and research institutions in forest monitoring
Strategic elements	5. Mandate
	6. Identification of information needs
	7. Stakeholder identification and engagement
	8. Communication and dissemination
	9. Integration of young experts
	10. Data management and archiving
Operational elements	11. Impact assessment
	12. Preparation
	13. Statistical design
	14. Operational design
Operational elements	15. Data management, data analyses, documentation and reporting

Source: FAO (2017).

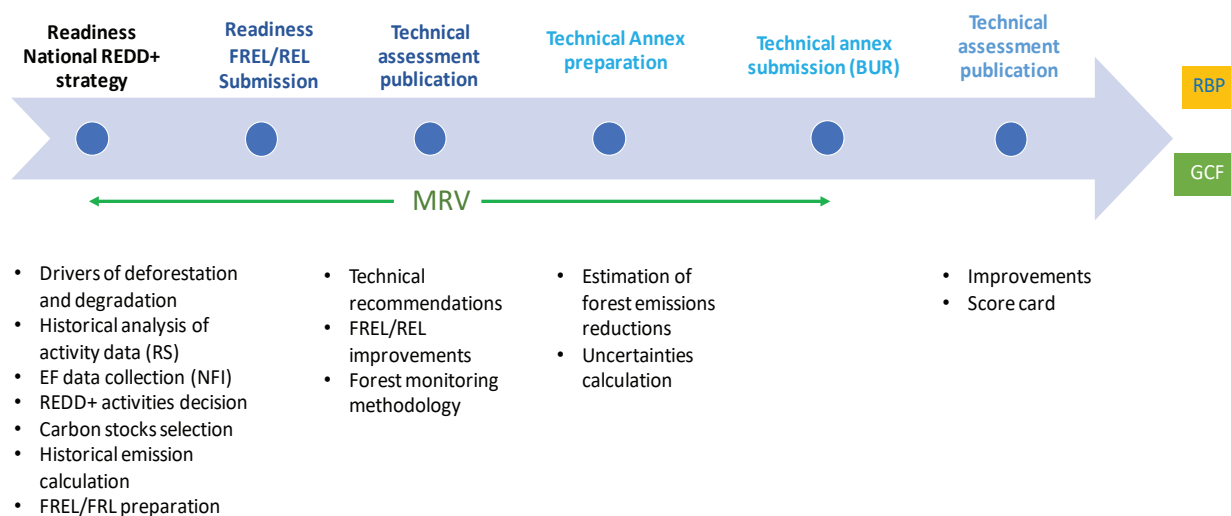


Figure 4. Timeline of measurement, reporting and verification for REDD+.

The construction of the FREL/REL is an important step, because it also involves the starting point for building the NFMS. At this stage, countries have developed some tasks of the operational elements suggested in the voluntary guidelines on national forestry monitoring, such as: i) the collection and analysis of available information on remote sensing and ground-based data, ii) generate methodologies for historical analysis of each REDD+ action selected, iii) decide carbon stocks to be reported (above ground biomass, below ground biomass, lying dead wood, litter and soil organic carbon), iv) decide the methodology for calculating the contents of carbon stocks in forests,

collect data and adjust the calculation methodologies with uncertainties, v) start the development of technological platforms for the dissemination of information and demonstrate transparency.

Until January 2016, fifteen countries had submitted their FREL/REL, of which six have received their technical evaluations. Based on a qualitative analysis, relevant issues recommended by the technical evaluation teams for the improvement of a future update of FREL/REL were identified (Table 3). The FREL/REL presented by the six countries, include one or two actions to reduce emissions: i) deforestation: Brazil, Colombia, Mexico; ii) deforestation and degradation: Ecuador; and, iii) sustainable forest management: Malaysia.

Table 3. Summary of issues that need improvement by the 6 countries that submitted their FREL/REL, as recommended by the technical evaluation teams from the UNFCCC.

Theme/Country	Brazil	Colombia	Ecuador	Guyana	Mexico	Malaysia
Activity data uncertainty	x	x	x	x	x	x
Inclusion of new carbon stocks*	x	x	x	x	x	x
Inclusion of non-C gases	x	x	x	x	x	x
Emission factors uncertainty	x	x	x	x		x
Inclusion of degradation	x	x	x	x	x	
Forest definition harmonization		x	x	x		x
Inclusion of regeneration	x	x				
Separate mature or primary forest from secondary forest	x		x			
Improve historic map production			x		x	
Information on deforestation						x

* Dead wood and litter, soil organic carbon (SOC), Ecuador: only COS.

Source: United Nations Framework Convention on Climate Change (2017).

In IPCC good practice (Penman et al., 2003) and as agreed by the parties (United Nations Framework Convention on Climate Change, 2010) it is recommended the combined use of remote sensing and ground-based data on national forest monitoring systems. However, in the experience of building the FREL/REL there is a trend of a very strong use of remote sensing, because it is the only resource available to analyze activity data, in other words, changes of historical deforestation, degradation or forest restoration. To meet this need, some countries are already taking in consideration the discussion on sampling techniques that can be applied to remote sensing and ground-base data.

Ground-base data is also essential for calculating the carbon content of different stocks by forest type. In five cases the available data allowed only the calculation of above ground and below ground biomass. Only Ecuador presented information on dead wood and litter. On the other side, only Mexico has used data from a completed national forest inventory. Brazil, Colombia and Guyana have used a compilation of data from different sources and methodologies to improve the robustness of information. They were recommended to continue their

efforts on the national forest inventory. The inclusion of non-carbon gases was a common recommendation for the six cases evaluated. Only Mexico has made a preliminary effort to calculate the non-carbon gases from forest fires.

The inclusion of degradation was another common recommendation for five of the countries, as only Ecuador included degradation. There is not only one way to monitor forest degradation, although several methods are based on statistical modelling using a combination of field-based and remote sensing data (Herold et al., 2011; FAO, 2011; Global Forest Observations Initiative, 2014). Other recommendations as the calculation of historical regeneration need further scientific research, better methods for the continuous collection of field data, and for the combined analysis with remote sensing. Due the two previous considerations, it is necessary to include degradation and regeneration issues in the national forest inventory designs.

The voluntary guidelines promote the data collection and management with the combination of different sources of information. Figure 5 outlines the information flow to be considered.

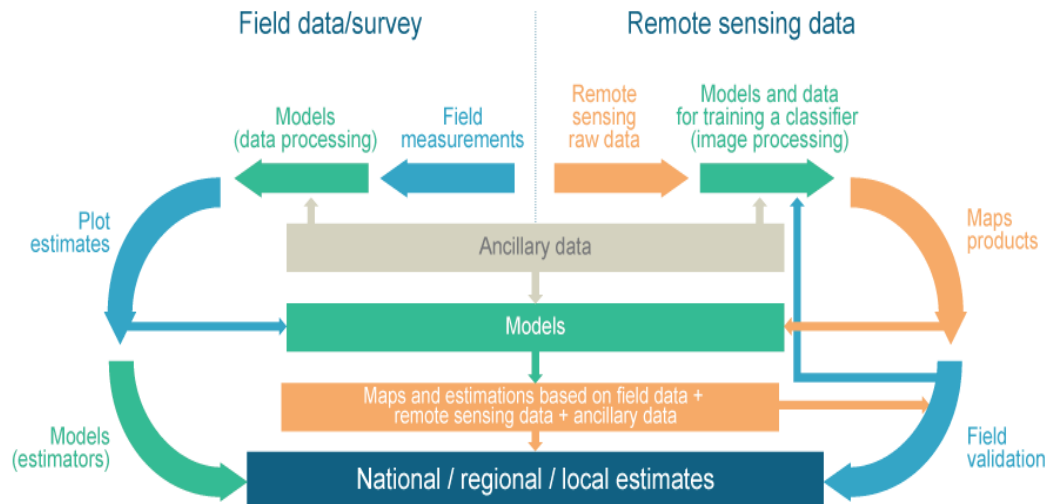


Figure 5. Major processing steps for data collection and analysis from field and remote-sensing sources, promoted in the voluntary guidelines on national forest monitoring. Source: FAO (2017).

Conclusions

Only when countries are ready to demonstrate emission reductions, they actually start the process of measuring, reporting and verification (MRV) and the

operation of the national forest monitoring systems (NFMS), as they must perform the measurement and calculation of emission reductions, using the same methodology developed for the forest reference emission level and/or forest reference level (FREL/REL).

To move forward with the recommendations from the technical evaluations on FREL/REL submitted to the United Nations Framework Convention on Climate Change (UNFCCC), during the setting up of the NFMS, countries need to consider a robust statistical design for the field data collection, to fulfill the information needs for the remote sensing analysis and the development of cartographic products.

Robust field-data collection also is needed for the estimation of emissions and removals of all carbon stocks, by changes in forest cover of different forest types and calculate the associated uncertainties. These improvements could be applied for a second cycle of MRV, where countries can upgrade their FREL/REL, and later improve their report of the emissions and removals.

It is confirmed that the construction of a forest monitoring system at the national level is a complex process and this exactly justified the development of voluntary guidelines for national forest monitoring. The use of these guidelines will facilitate this procedure from its strategic and political processes, to the technical planning with statistical robustness, and finally aiming to operationally feasible and sustainable monitoring system. It is recommended that countries review the principles and elements to assess their current processes and develop integral improvements.

The use of remote sensing sources combined with ground-based data for emissions and removals estimations of forest carbon is a guideline agreed by the parties of the United Nations Framework Convention on Climate Change (2010), but in practice the use of ground-based data has been underestimated, because a lack of wide-national information from forest inventories or historic data collection. This situation has generating a gap on capacity building of human resources in developing countries. It is recommended to integrate the remote sensing and forest inventory teams in countries to work together in the design and development of the NFMS.

Until now some countries have outsourced the NFMS development, as they still do not have enough capacities to develop it through governmental institutions. Other countries, however, have advanced with stronger steps for the construction of NFMS. It means that they have started with some tasks to fulfill the fundamental and strategic elements of the guidelines, such as: analyzing institutional mandates, identifying and formalization of the leading institution, identifying responsibilities to

collect and develop data analysis for FREL/REL, run participatory workshops for the definition on forests, deforestation and degradation, developing a work plan, among others.

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