



Course 8

Text-only version

National forest inventory results: Reporting and dissemination

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This course covers national forest inventory (NFI) reporting in detail and establishes the importance of reporting in the context of REDD+ actions.

Who is this course for?

The course is targeted mainly for those who are involved in reporting of NFI data, but can be taken by anyone with an interest in the subject. Specifically, this course targets:

1. Forest technicians responsible for implementing their country's NFIs
2. Forest data analysis practitioners
3. National forest monitoring teams
4. Students and researchers, as curriculum material in forestry schools and academic courses
5. Youth and new generations of foresters

Course structure

There are four lessons in this course.

Lesson 1: Reporting and dissemination

This lesson explains the basics of NFI reporting, and emphasizes the need for optimizing collaborative mechanisms for more effective reporting. It also explains the five principles of NFI reporting.

Lesson 2: The NFI report and supporting documents

This lesson outlines the purpose, structure and content of an NFI final report. It also discusses the additional documents that are prepared on a variety of aspects during an NFI, but are not always included in the final report.

Lesson 3: REDD+ results reporting (and role of NFIs)


This lesson discusses the modalities for measurement, reporting and verification (MRV) for REDD+ in the context of the UNFCCC. It also highlights the importance of transparent, consistent, accurate and complete data for REDD+ reporting and offers an overview of the REDD+ standards within and outside of the UNFCCC for results-based payments.

Lesson 4: Data transparency—open data and data sharing

This lesson delves into the principles behind open data and the possible solutions to share NFI data for optimal benefits.

About the series

This course concludes a series of eight self-paced courses covering various aspects of an NFI. Here's a look at the complete series.

Course	You will learn about
Course 1: Why a national forest inventory?	Goals and purpose of an NFI, and how NFIs inform policy- and decision-making in the forest sector.
Course 2: Preparing for a national forest inventory	The planning and work required to set up an efficient NFI or a National Forest Monitoring System (NFMS).
Course 3: Introduction to sampling	General aspects of sampling in forest inventories.
Course 4: Introduction to fieldwork	Considerations for fieldwork, plot-level variables and tree-level measurements.
Course 5: Data management in a national forest inventory	Information gathering and data management for NFIs.
Course 6: Quality assurance and quality control in a national forest inventory	QA and QC procedures in forest inventory data collection and management.
Course 7: Elements in data analysis	Typical approaches/calculations in data analyses and related topics.
 Course 8: National forest inventory results: Reporting and dissemination	(You are currently studying this course)

Lesson 1: Introduction to data analysis

Lesson introduction

NFI reports are the most visible output of the entire NFI process; therefore, precision and reporting style are key to the information therein eventually being understood and disseminated. This lesson will discuss the basics of NFI information reporting.

Learning objectives

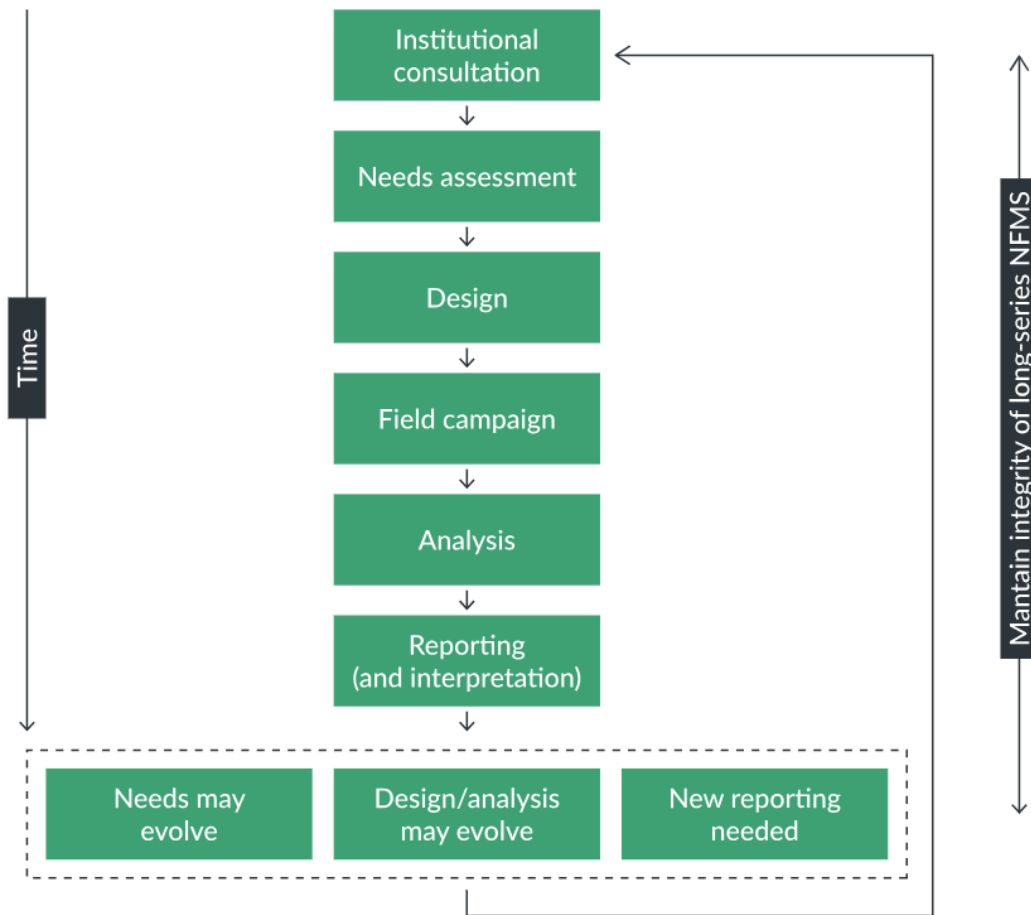
At the end of this lesson, you will be able to:

1. Evaluate the importance of reporting in the NFI process.
2. Describe the key considerations of reporting.
3. Describe the five principles of reporting.

Reporting: Closing the circle of NFIs

'Knowledge is power' is an old adage that renders especially relevant in the context of forest information. As you went through these courses, you may have noticed that we repeatedly describe NFI as a process. And although this course presents NFI as having a beginning and an end—with defined stages from planning to reporting—countries should plan to link each NFI to the next inventory cycle, as part of a wider monitoring programme and a long-term sustainable National Forest Monitoring System which seeks to improve with each new cycle.

Reporting often plays a critical role in this feedback loop and continual process of improvement over time. Incremental improvements are facilitated through an adaptive monitoring approach which links all previous and future NFI steps.



Coordination (or alignment) between these steps is particularly relevant to reporting and disseminating results, as well as eventual uptake. The reporting and interpretation of NFI results is linked to each of the steps we have gone through in the NFI courses and can be optimized by strengthening the following mechanisms:

Institutional alignment: Lack of coordination between different institutions happens more often than one expects. Even though they are all interested in the results of an NFI, they control different information release activities, and can often be reluctant to share these across institutions.

Conversely, high quality information will inform the institutional arrangements and the share of stakeholders involved in the decision process while avoiding duplication of activities through consistent communication. In the end, a proper institutional coordination will increase the dissemination of NFI reporting and has the potential to ultimately benefit forest policy creation and financing.

Tying up with the needs assessment: This is the core link. The evaluation of information needs at the beginning of the process has the aim to determine which information (indicators, variables,

relationships) needs to be reported.

On the other hand, a review of the reported information will inform on the success of the NFI in answering the questions posed at the needs assessment phase and will guide the objectives and needs for the next cycle.

Scalability of NFI design: The quality of the forest information reported will indicate the efficacy of the NFI design and will also help to scale the NFI design across levels, from subnational to international. The design—strictly following the information needs—will at the same time frame the scope of what level of reporting precision is feasible.

Improved fieldwork: The use of modern technologies and adequate capacity development and quality control in the field aim to minimize errors and has obvious consequences on the quality of the reported information. In turn, reporting and particularly the interpretation of results will in the long run help evaluate whether the field campaign needs updates.

Enhanced data management and analysis: Reporting requirements, while obviously dependent on the analysis, also drive the analysis and interpretation, and contribute to integrate data sources and methods during estimation. The step-by-step analysis is often the starting point and basis for the description of results and methods in the reporting stage.



Reality check

Reporting: get the right scale!

Too often policy makers across the world demand that reports offer estimates at resolutions that, understandably, match those typically used for implementation according to the subnational decision executive or management structures.

For example, decentralized forest offices scattered across the country often need to make decisions at provincial or district level, to account for the particularities of the forests and socio-economic circumstances therein present. And too often they face the answer that the reported estimates cannot be disaggregated to these small scales because they lack the confidence necessary for accuracy and precision. This may happen when a lack of communication exists between the

information needs assessment and the design (which sets the sampling intensity conditional on budget availability) phases.

Basics of aligning reporting with information needs

As you just saw, the link between the Information Needs Assessment (INA) and reporting is the most relevant link in an NFI. During NFI reporting, the analysis, results (and their formats) should follow previously stated specific information needs by stakeholders, because this is a core input that will be used for forest policy formulation and implementation.

The reports should include a detailed examination of technical experiences gained through the implementation cycle of an NFI, based on stakeholder expectations. Lessons learned from the reports, properly formulated, will improve performances at all planning and implementation levels occurring in the next iteration of an adaptive NFI cycle.

Because the stakeholders need to understand the information, the reporting will include the coverage of variables, results format, and an appraisal of what the obtained figures may signify. Specific sections (for example, on socioeconomic elements) might be beneficial for summarizing concerns like forest use.

Overall, reporting should:

- ① deliver scientifically sound results to stakeholders;
- ② publish the methodology, including assumptions and existing gaps; and
- ③ report information on uncertainties related to both accuracy and precision.

Reporting may come in several forms, depending on the audience and purposes of the reporting. They may reflect core (main) or detailed results, methodologies, inventory costs, policy briefs, infographics and general public messages. Although the purpose, structure and content of NFI reports is discussed in detail as part of the following lesson, there are some common considerations in developing reports:

Format

Reports should be self-contained. Although they should contain references for those readers aiming to learn more details, they should allow them to grasp the results without further external consultation of sources. Summaries for policy-makers might be advisable in parallel to main reports. The manner in which information is used will also influence the format in which it is

	presented, such as statistics, digital data, graphs, or maps.
Preliminary content	Before providing numerical findings for all domains of interest, reports should describe the NFI's strategic aims, political context, scientific rationale, and detailed description of methods, including QA/QC procedures.
Key messages	Key topics are put forward to simplify reporting, particularly for policy-makers. The report should be able to communicate the implications of the results through key messages that are relevant and meaningful for those who drive related policy processes.
Compliance	Consistent and reliable reporting statistics should comply with both national and international obligations. In the particular context of international reporting a special emphasis, present in REDD+ and Global Forest Resource Assessment processes, goes onto the reporting of trends -i.e., changes - in forest resource availability. National NFI reports, on the other hand, tend to focus more on static pictures of forest information. Nevertheless, when available, and if statistically comparable, the results of an NFI can be compared with historical data to provide estimates for changes.
Scope	Multipurpose NFI will yield a broad range of information including conservation and biodiversity variables as well as carbon offset accounting along with more traditional information related to socio-economical aspects of forest, such as timber and non-timber forest products.
Audience	Some documents or reports are aimed at policymakers and decision-makers. Research institutes, meanwhile, may be interested in NFI data and would benefit from an online database with standard reporting tools built in. The general public is normally addressed through summarized reports.
Aggregation level	Reporting from NFIs naturally aggregates data at the domain of interest, and often at scales that ensure a certain level of precision. Data must be aggregated and condensed depending on the scales of interest of decision-makers, and their information needs. Typical aggregations may show tables such as commercial volume per ha in a certain type of forest and region, or

	stocking rates for the most important commercial species by diameter class.
Uncertainties	<p>Reports, traditionally those drafted for national policies, often lack information on the reliability of their estimates. This absence is nowadays untenable, because policies are (or at least should be) chosen on the basis of risk and risk can only be ascertained through an honest assessment of uncertainties. It is recommended that any system output be supplemented by information about its reliability. Hence, predictions that are not accompanied by uncertainty information are of limited use in policy or decision-making. Yet, uncertainty must be explained in accessible terms while avoiding compromising the quality of the results. In fact, the contrary is true: if there is no information about uncertainty, one may wonder why and question the quality of the results.</p> <p>Essentially, NFI planners need to quantify uncertainty, because this is the "currency" in sampling and guides the NFI process, following the adaptive monitoring cycle, towards better designs ... it is all about reducing errors!</p>

Communication and dissemination

Dissemination will generally cover interested parties not previously identified as stakeholders and will raise awareness through shared information across different media: TV and radio, Internet, scientific papers, newspapers, educational materials, etc. Communication is reciprocal, and tracking users' response to shared information, together with their participation, will contribute to shaping future NFIs.



Quick tips!

Capacity building is extremely important in countries not only afterwards, but also during the process of an NFI. Communication and outreach of capacity development activities contribute to build institutional and social support for acquiring forest information. Web platforms can help in the task. Remember that general dissemination encourages dialogue—governed always by evidence-based, transparent, and validated information.

The five reporting principles

It is always a good idea, no matter the scale of reporting used, to follow the five principles for reporting outlined by the [PCC Good Practice Guidance](#). In no particular order, these are: **consistency**, **comparability**, **transparency**, **accuracy** and **completeness**.

Principle 1: Accuracy

Accuracy is a measure of how exact an estimate is. Estimates should be correct in the sense that they are systematically neither over nor under the true value—often unknown—to the best of our ability, and that uncertainties are minimized to the greatest extent possible. Appropriate procedures should be employed to promote the quality of the inventory, and reporting should aim to provide the detailed methods employed (e.g., through the use of unbiased estimators and a proper design) and justify them, quantitatively or qualitatively.

Principle 2: Comparability

Comparability means that the estimates presented in inventories by Parties should be similar among Parties. Parties shall utilize the procedures and formats agreed upon in international mechanisms for estimating and reporting inventories for this purpose.

This, in principle, seems to be only applicable for international reporting bodies. However, recent booms in overall data availability and the need to often compare estimates among neighbouring countries have called for the need to harmonize methodologies and reporting.

Principle 3: Completeness

More often used for international reporting of sinks and sources of greenhouse gases (*see Lesson 3 of this course*), completeness indicates that an inventory includes all possible estimates that are required by the stakeholders through the needs assessment and the design (for example, the information needs required by UNFCCC in the case of greenhouse gases GHGs).

Completeness also entails comprehensive geographic coverage depending on the objectives of the NFI.

Principle 4: Consistency

The term consistency refers to an inventory's internal consistency in all of its components with inventories from previous years. An inventory is consistent if the same procedures are utilized for the base year and all following years, as well as consistent definitions and data sets are utilized to produce

the estimates. It is important to demonstrate consistency—to the best of a reporter’s ability—particularly in those cases where the country has undertaken several NFIs.

Principle 5: Transparency

This implies that the assumptions and procedures used for an inventory should be fully described in order for consumers of the reported information to be able to replicate and analyze the inventory. The transparency of inventories is critical to the effectiveness of the communication and dissemination process. We will look at this in greater detail as part of Lesson 4 of this course.

Summary

Before we conclude, here are the key learning points of this lesson.

- Reporting plays a critical role in the iterative NFI process and contributes to building a robust National Forest Monitoring System (NFMS).
- Coordination between the steps of an NFI is particularly relevant to reporting and disseminating results, as well as eventual uptake.
- The link between the information needs assessment and reporting is the most relevant link in an NFI.
- NFI reports should include a detailed examination of technical experiences gained through the implementation cycle of an NFI, based on stakeholder expectations.
- Reporting may come in several forms, depending on the audience and purposes of the reporting.
- Capacity building is extremely important in countries not only afterward, but also during the process of an NFI.
- The five principles of reporting include consistency, comparability, transparency, accuracy and completeness.

Lesson 2: The NFI report and supporting documents

Lesson introduction

Documentation and reporting are two key processes that mark the conclusion of an NFI cycle. In order to ensure that an NFI can be repeated and managed over a long period of time, all relevant elements of the NFI cycle must be described in detail and in a transparent way. This body of knowledge is typically presented in a NFI final report and supporting documents detailing all relevant information, including design, implementation and results. This lesson explains the purpose, structure and content of an NFI final report, and also discusses the additional documents that are typically prepared on a variety of aspects, which are not included in the final report.

Learning objectives

At the end of this lesson, you will be able to:

1. Discuss the purpose and structure of an NFI final report.
2. Describe the topics typically covered in an NFI report.
3. Explain the additional documents and reports typically prepared at the end of an NFI.

Purpose of the NFI report

An NFI is a complex exercise involving many stakeholders, people and technical layers. In order to capitalize on the investment and ensure that useful lessons can be drawn from its implementation, transparent reporting is important. Documenting all the steps, both methodological and logistic, helps make the results understandable and credible, and allows for subsequent NFIs to be aligned and compatible. The NFI final report is typically the document that captures every step of the process along with providing a set of key results in response to the needs expressed at the outset of the NFI.

Ultimately, the aim of reporting is to:

- ① publish the methodology;
- ② inform about the results; and
- ③ inform on the estimated precision of the results (that is: presenting and discussing the sources of residual variability).

The ultimate value of the NFI (and the content of the final report) is measured by how well it delivers meaningful and required forest-related information in a timely and credible manner. This is particularly true for international processes that require precise estimates on forests. For example, REDD+ reporting requires transparency in methodological approaches.

Documentation, then, is a way of making your *modus operandi* transparent in order to reconstruct how the inventory was implemented and allow for replication

More and more, a portion of the information of a Final Report is presented through online data portals and possibly searchable databases. This approach is attractive and allows the user to easily navigate through the results and extract estimates of interest. This approach also allows for easy update of the content when new information is available.

Structure and content of the NFI report

An NFI final report is typically composed of at least three main sections:

- **CONTEXT:** In order to contextualize the NFI cycle, some ancillary information (e.g. an account of the history of previous NFIs should be reported, if available). The objective, scope and political mandate of the NFI should also be indicated as agreed at the outset of the process in order to make sure that the results answer the questions and the original information needs. Information on the institutional arrangements of the NFI system are also valuable particularly if, during the implementation, the system underwent review and improvements to ensure a more streamlined approach which could typically involve government agencies beyond the forestry department. Major stakeholders and partners involved in the implementation should also be acknowledged.
- **METHODOLOGY:** Throughout this course, individual lessons were dedicated to technical and methodological aspects such as sampling approach (**Course 3: Introduction to sampling**), field implementation (**Course 4: Introduction to fieldwork**), data management (**Course 5: NFI Data management**) and analysis (**Course 7: Elements in data analysis**), and QA/QA (**Course 6: Quality assurance and quality control in an NFI**). All technical steps are described in the NFI Manual, however it is useful to include in the final report, a section on the key methodological

approaches in order to make it easier for the reader to understand the alignment between methodology and results.

However, since technical details can be lengthy, they can also be published in separate reports (see section 3 of this lesson).

- ➔ **RESULTS:** The core section of the NFI report deals with Results and serves to communicate key findings to the stakeholders. Results could be presented in a variety of ways, but it is important that both content and format of the Results are in line with the information needs expressed by the stakeholders (see lesson 1 in this module). Results could be presented, for example, by thematic criteria, by the Sustainable Forest Management (SFM) elements, by the FAO FRA key topics or in a way that is most useful for the implementing agency or national government. See the example below.

THEMATIC CRITERIA	SFM ELEMENTS	FAO FRA KEY TOPICS
Forest extent and tree cover changes	Extent of forest resources	Forest extent and characteristics
Biological diversity and conservation	Forest biodiversity	Growing stock
Growing stock, biomass and carbon	Forest health and vitality	Biomass and carbon
Management and ownership	Productive functions of forest resources	Designation and management
Tree and forest disturbances	Socio-economic functions of forests	Ownership and management rights
Support for SFM	Legal, policy and institutional framework	Disturbances
		Policies and legislation
		Non-wood forest products
		Employment and education



Note

1. The government of Bangladesh conducted a multipurpose National Forest Inventory during 2015-2019 and presented the results according to thematic criteria. Consult their final report.
2. FAO hosts a [SFM tool box](#) compiling tools, case studies and other resources useful for the implementation of SFM.
3. Read more about [FAO's work on Global Forest Resources Assessments](#).

Regardless of the grouping, when presenting results to the reader, it is important to consider the key principles highlighted in Lesson 1 especially with regard to scale, units and precision.

In the next section of this lesson, we will look at the most common results reported as derived from the measurements of forest variables, including:

1. forest extent and tree cover;
2. biological diversity and conservation;
3. growing stock, biomass and carbon;
4. management and ownership; and
5. tree and forest disturbances.

Forest extent and tree cover

This is typically the most sought out information and it refers to the area and distribution of forest and other land classes. While area estimates can be obtained in a reliable way through a sample-based approach of in-situ field plots, the results are typically integrated and compared with spatially explicit, ex-situ satellite analysis.

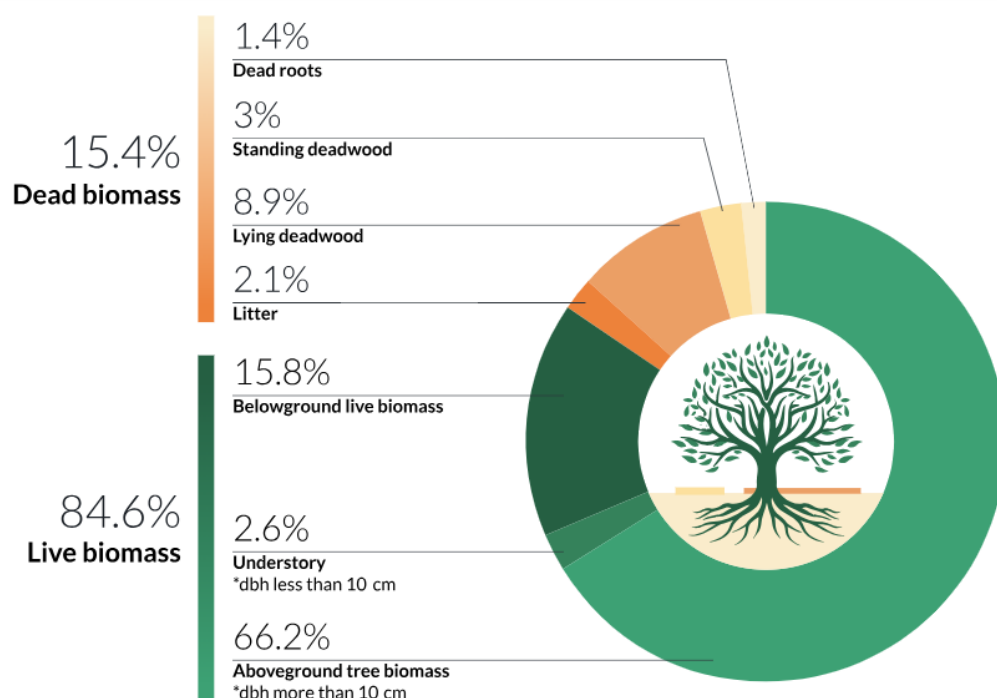
NFI reports typically include estimates of forest and tree cover. Forest cover is the aggregation of different forest and plantation classes that comply with the underlying forest definition, while tree cover is different, because trees can occur also outside of forest, particularly so in tropical landscapes.



Did you know?

For all reported figures on forest area and conditions, it is essential to explain the underlying forest definition that was adopted for the NFI project. While some countries stick to biophysical criteria or qualitative criteria, other countries sometimes use administrative criteria (e.g. forest land under a certain legislation).

Information on forest area and the way it changes over time is essential, among others, for measuring progress towards the SDGs. Area estimates are typically reported in terms of total area in hectares (ha) for each forest or land class. In some cases, national units (if different from hectares) are also reported, however for the sake of comparability, globally recognized units should be used for international reporting. If historical data are available (and statistically comparable) it is important to carry out an analysis of changes, to gain insights on the dynamics of land cover and use. In particular, recent reporting requirements by international mechanisms stress the importance to report change and identify trends and projections based on historical data.



It should also be noted that, particularly for area estimates (but also for other results), it is sometimes clearer to express the results in terms of proportions (percentages) rather than absolute values. In this way the tables or graph are usually more readable.

Most common results on Forest Extent and Tree cover	
Indicator	Unit
Area of Forest and other land classes	1 000 ha/relative %
Area and tree cover change	1 000 ha

Biological diversity and conservation

Forests are complex and dynamic ecosystems and a measure of their biodiversity is often indicative of their health and ability to provide habitat for both plant and animal species. Biological diversity is typically expressed in terms of number of tree species per land cover type, for example by listing the frequency of the top 10-20 species, sorted by total number of trees, and by total volume. This is referred to as species richness, which simply quantifies how many different species the dataset of interest contains. Information on whether species are endemic or introduced gives an indication of the human impact on the land. In addition, it is useful to report the occurrence of Endangered or Critically Endangered as per the IUCN’s Red List. Biological diversity is also expressed through Indices, the most common being the Shannon-Wiener Diversity Index and Simpson’s Dominance index.

Most common results on Biological diversity and conservation	
Indicator	Unit
Position, stem density, and size characteristics	species number, species-wise stems/ha (or plot)
Diversity indices	unitless
Status of native and introduced tree species	species names, species-wise stem/ha (or plot)
IUCN Red List tree and/or animal species	species-wise stem/ha (or plot)

Job Aids

The case of Papua New Guinea offers a good example of the integration of a methodology for biodiversity assessment and monitoring within the design of the planned NFI. Focused data collection included floral and faunal variables. Read more about the [NFI of Papua New Guinea](#)

Growing stock, biomass and carbon

Growing stock, the total volume of living trees in a forest provides information on existing wood resources and, when expressed as growing stock per unit area, it indicates how well or poorly stocked a forest is. Results on growing stock are useful to determine levels and distribution of growing stock by species and areas. Growing stock as well as merchantable timber volume, expressed as cubic meters per

hectare (m³/ha) are typically used to indicate the availability of resources for commercial extraction. Biomass expressed in tons per hectare (t/ha) is the corresponding estimate of dry woody matter, which can be converted to carbon equivalents.

Carbon stocks, also expressed as t/ha indicate the contribution of the country's trees and forest to the global terrestrial carbon cycle. As for many other variables, estimates of change over time are particularly useful.

Depending on the nature of the landscape in any given country, it is very likely that a significant proportion of trees grow outside of those areas classified as forest. This component is recorded as Trees outside the forest (TOF) and contributes to the overall estimates of stock, biomass and carbon.

Besides trees, estimates of dead wood biomass, soil organic carbon and other carbon pools are typically reported: the Intergovernmental Panel on Climate Change (IPCC) defines five carbon pools: Above ground biomass (AGB), Below ground biomass (BGB), Dead wood, Litter and Soil organic matter. Depending on the field methodology, if data has been collected, this type of information is increasingly becoming important in the context of climate change reporting.

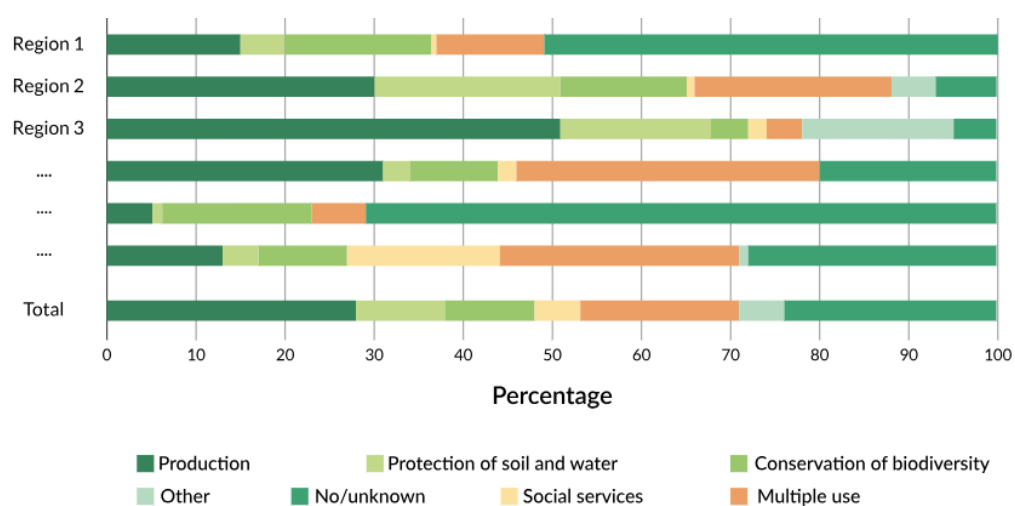
Most common results on Growing Stock, Biomass and Carbon	
Indicator	Unit
Growing stock: Number of trees, Basal area, Volume, merchantable Volume	Trees/ha, m ² /ha; m ³ /ha, million m ³
Biomass: AGB, BGB, total biomass (TB= AGB+BGB)	ton/ha, million tons
Carbon: AGC, BGC, total carbon (TC= AGC+BGC)	ton/ha, million tons

Management and ownership

A key set of results is the one about the management and ownership of forest and lands. This helps to answer questions such as 'Who owns the land? Who has rights to access the land? How is it managed?' Data can be collected on what is the main intended purpose for which a forest is managed and used. As per FAO FRA definitions, six broad management objectives are identified. National relevant categories can also be added.

Objective	Definition	Unit
Production	the management objective is the production of timber, fibre, bioenergy and/or non-wood forest products	1 000 ha/relative %
Protection of soil and water	the management objective is the protection of soil and water	
Conservation of biodiversity	the management objective is biodiversity conservation. This category includes but is not limited to areas designated for biodiversity conservation in protected areas	
Social services	the management objective is the provision of social services such as recreation, tourism, education, research and the conservation of cultural or spiritual sites	
Multiple use	the management objective is a combination of several purposes, none of which is significantly more important than another	

If available, proportion of forest under certification schemes can also be very insightful



In addition, information on the ownership of forests is crucial for governments in formulating effective

forest policies. A first rough classification is between Public vs. Private land ownership. More details can be added to indicate whether a forest area is under the ownership of the Forestry department or other government agencies. Information on forests and land area directly owned by community-based organizations is also important and can often have relevance to socio-economic and livelihood development analysis. A variety of other categories could be listed according to the institutional and political setup in each country.

Most common results on Management and Ownership	
Indicator	Unit
Tree and forest management types	1 000 ha/%
Trees and forest by ownership class	1 000 ha/%
Tree and forest product collection by ownership type	1 000 ha/%

Trees and forest disturbances

Forests are subject to many disturbances that can adversely affect their health and vitality, reduce their capacity to provide a full range of goods and services, and cause tree mortality. An NFI can offer the opportunity to gather data on anthropogenic or natural impacts on forest health.

If an NFI is combined with a socio-economic and household survey, additional information can be gathered directly from the forest dwellers. Information regarding forest area affected by fire can be collected in the field, as well as impact of extreme weather events (e.g. storms, draught) and agents directly impacting trees' health such as insects or disease. Information gathered directly from people living in the forest is particularly useful as it can also provide insights on key drivers of forest degradation and historical trends.

Supporting documents of an NFI

As we saw in previous sections of this lesson, the amount of information that is typically included in an NFI Final Report is significant and could be overwhelming. For this reason, a better approach is to keep a

stand-alone comprehensive NFI Report and complement it with additional and supporting documents aimed at explaining, or reporting on, other elements of the NFI cycle. An example is the [Bangladesh NFI](#). While there is no single approach to do this, as different contexts require different modalities, key supporting documents could fall into one of the following categories:

Technical documents	<p>Technical documents provide further specifications and in-depth reports on technical approaches and methodologies. These are aimed at technical staff as well as academic or research organizations to allow them to gain knowledge on the NFI methodology. Technical documents include a manual for data collection in the field, with a full list of variables and parameters definitions (you have seen samples of field manuals earlier in this lesson). In case of data collection on variables beyond the typical biophysical area, separate manuals can be compiled for data collection of soil organic carbon, range inventory, biodiversity indicators, bird and insect inventory. If data collection is carried out via electronic tablets, detailed instructions for system set-up, data entry in the field and management of data flow can also be combined in ad-hoc manual (see Course 5: NFI Data management).</p> <p>The overall methodological approach of the NFMS, of which the NFI is a component, is another useful document and typically includes a manual on the estimation procedures of indicators and variables of the NFI as well as the list of programming scripts utilized during data analysis.</p>
Policy briefs	<p>The ultimate objective of an NFI is to answer questions that were raised at the outset of the process. It is therefore crucial to be able to communicate clearly the findings of the NFI and present the results in an impactful manner in order to contribute to the dialogue at the policy level. Politicians typically don't have time to read full reports so short and focused briefs are more likely to have an impact. Few key messages supported by simple and readable graphs are often the best approach. Briefs of this nature can include biophysical results as well as a report on socio-economic indicators to highlight livelihood elements and gain insights on the human-forest interaction and co-dependency.</p>
Thematic reports	<p>The modern approach to an NFI is multipurpose, meaning that through the NFI</p>

process, which can be lengthy and expensive, the goal is to collect as much information as possible from field measurements. As a result, the full set of data has the potential to provide insights on a variety of themes, according to the angle of the analysis. Political leaders, but also academic institutions and civil society are interested in thematic reports without necessarily having to learn the fine details of the NFI. Data analysis and results can be “sliced” according to a specific area of interest and ad-hoc reports can be made public. Examples include briefs to contribute to the Climate Change dialogue, a presentation of the results according to the SDGs, a focus on reserved forest areas for conservation, biodiversity, as well as a report focused on the human spectrum, the impact of human on the forest and the impact of a degraded or over exploited forest on the livelihood of forest dependent people.

Communication materials

Communication should be approached as an on-going process throughout the entire implementation of an NFI, from the definition of goals to the publication of results. The importance of communication will be explained in more details in Lesson 3, however it is useful to highlight a few key concepts. Communication material should be prepared with the target audience in mind: format, language and content need to be drafted accordingly. All layers of the civil society could be reached, from young students, in the context of awareness campaigns for a sustainable use of the forest, to academic institutions, to promote data and results utilization and encourage further analysis, to the political level, to ensure that NFI results play a role in the political agenda.

Finally, and particularly at national level, a strong presence in the news helps to keep the momentum and raise the attention to the importance of the NFI: newspapers articles, web-stories, press releases and webinars, are all suitable means to reach a wider audience.

Raw data

An NFI produces a vast range of quantitative and qualitative data through an extensive field data collection. A database is set up containing the full set of raw (unprocessed) data. However, due to time and resources constraints, only a portion of the data is typically analyzed to produce results for the final

NFI report.

As a consequence, it is common that a large part of the dataset remains untapped. Nevertheless, it is crucial to safekeep all the data and encourage its utilization, possibly through studies outside of the NFI and by different stakeholders. Academic institutions, for example, are always interested in raw data to conduct scientific studies, the same goes for NGOs or independent research organizations. While this further utilization by external parties should be encouraged and facilitated, a word of caution is due. Clear data-sharing agreements should be drafted to ensure proper utilization and privacy. Tree- and plot-level field data can contain sensible information which should not be released.

In addition, since tree and plot data are typically georeferenced, their release should be monitored and regulated because if the exact location of certain trees is made public, this may both attract poachers, and influence management in the permanent sample plot, thus causing a bias for subsequent data collection campaigns. One way around this is to slightly and randomly offset the geolocation of the plots in the data set to be released so to make it impossible (or much more difficult) to identify the exact location of a plot or a tree.

Summary

Before we conclude, here are the key learning points of this lesson.

- In order to capitalize on the investment into an NFI and ensure that useful lessons can be drawn from its implementation, transparent reporting is important.
- Documenting all the steps, both methodological and logistic, helps make the results understandable and credible, and allows for subsequent NFIs to be aligned and compatible.
- The final report of an NFI is typically composed of at least three main sections: context methodology and results.
- Forest extent and tree cover is typically the most sought out information and it refers to the area and distribution of forest and other land classes.
- It is good to produce a comprehensive and focused NFI report and complement it with additional and supporting documents.
- A large part of an NFI dataset remains untapped - it is still crucial to safekeep all the data and

encourage its utilization, possibly through studies outside of the NFI and by different stakeholders

Lesson 3: REDD+ Results reporting (and role of NFIS)

Lesson introduction

In this lesson, we will learn about the modalities for measurement, reporting and verification (MRV) for reducing emissions from deforestation and forest degradation (REDD+) in the context of the United Nations Framework Convention on Climate Change (UNFCCC).

NFIs provide robust forest resources information which is used for different national international reporting and documentation across countries. REDD+ reporting might be one important motivation for establishing NFIs in some countries. This lesson highlights the importance of transparent, consistent, accurate and complete data for REDD+ reporting. Also, it offers a general overview of the REDD+ standards within and outside of the UNFCCC for results-based payments. It addresses the data requirements needed to report on REDD+ and how data from NFI are crucial and related to this reporting process.

Learning objectives

At the end of this lesson, you will be able to:

1. Describe the MRV processes for REDD+ under the UNFCCC.
2. Describe REDD+ information requirements.
3. Identify the data requirements to quantify emissions and reductions for REDD+.
4. Discuss how NFI data can contribute to REDD+ reporting.
5. Provide an overview of the REDD+ standards for accessing results-based payments.

The Warsaw Framework for REDD+

Before knowing the REDD+ reporting process and how results-based payments (RBPs)/results-based finance (RBF) for results-based actions (RBAs) can be accessed, let's recall the Warsaw Framework for REDD+. The Warsaw Framework, which was adopted at the Conference of the Parties (COP) 19 held in Warsaw in 2013, established the structure for an international REDD+ mechanism. It presented the rules and methodological guidance for REDD+ design and implementation and provides the modalities for

measuring, reporting, and verifying (MRV) GHG emissions and removals as an essential tool for linking verified REDD+ results to results-based payments.

In the context of REDD+, results are defined as mitigation outcomes: GHG emission reductions and/or increase in forest cover and carbon stocks (sinks) measured against a benchmark (forest reference emission level and/or forest reference level) expressed in tons of carbon dioxide equivalents (to tons) per year ($\text{tCO}_2\text{eq year}^{-1}$).

7 COP decisions: A quick overview

The Warsaw Framework for REDD+ is a set of COP decisions in seven thematic areas namely:

- results-based finance ([Decision 9/CP.19](#)) ;
- coordination ([Decision 10/CP.19](#));
- national forest monitoring systems ([Decision 11/CP.19](#));
- safeguards ([Decision 12/CP.19](#));
- forest reference levels ([Decision 13/CP.19](#));
- measuring, reporting and verification (MRV) ([Decision 14/CP.19](#)); and
- drivers of deforestation and forest degradation ([Decision 15/CP.19](#)).

The phased approach for REDD+

Countries interested in REDD+ are required to progress through three phases. In this section, we will learn about the three phases of REDD+ and its finance sources.



Source: [Eligibility Requirements for REDD+ Standards and Financing May 2021](#)

REDD+ Readiness: Countries design national strategies and action plans with relevant stakeholders,

build their capacity for REDD+ implementation, work on policies and measures for REDD+ implementation and design demonstration activities.

REDD+ Implementation: National strategies and action plans proposed in Phase 1 (Readiness) are implemented and tested. This phase may include results-based demonstration activities and require additional capacity building, technology development and transfer. Subnational demonstration activities on an interim basis are allowed as countries scale up to national implementation. The process is well-documented and transparent.

REDD+ Results: Results-based REDD+ actions are implemented at the national level and results are fully measured, reported and verified. In the context of REDD+, reporting is the process of formal submission of results according to pre-established requirements and verification is the process of assessing the data and information submitted.

Finance: Finance for readiness and implementation is provided by several different institutions and it has evolved both within and outside of the UNFCCC. Public international funds flow through multilateral channels and can take several forms (e.g., grants etc.).

Examples of REDD+ finance include the [U N-REDD Programme](#), the World Bank's [Forest Carbon Partnership Facility](#) (both the Readiness and Carbon Funds), the [Green Climate Fund](#), the Forest Investment Programme, and others. Bilateral programmes are also an integral part of REDD + finance such as [N Norway's International Climate Forest Initiative](#) (NICFI), Germany's [International Climate Initiative \(ICI\)](#), [U K International Climate Fund](#) (ICF) etc.

Market and non-market payments: Market or non-market payments cut across a variety of different sources and financing entities either within the UNFCCC (e.g. Green Climate Fund) or outside the UNFCCC such as multilateral or bilateral arrangements, public or private donors.

Non-market-based finance consists of public donors that have agreed to retransfer emission reduction credits back to REDD+ countries. These credits will not be sold on the market but may be used for REDD+ countries Nationally Determined Contributions compliance. Examples of non-market mechanisms include the Green Climate Fund and the World Bank's Forest Carbon Partnership Facility Carbon Fund (FCPF Carbon Fund). The FCPF Carbon Fund includes both market and non-market finance from both public and private donors. In the market-based REDD+ transactions, an emission reduction title is transferred between seller and buyer. There are several schemes and contexts for this.



Examples

The FCPF Carbon Fund has signed payment agreements with several countries for emission reductions to be reported from 2020 onwards. Other market-based finance for REDD+ results include the [Architecture for REDD+ Transactions](#), [The REDD+ Environmental Excellence Standard \(ART/TREES\)](#), [Verra's Jurisdictional and Nested REDD+ \(Verra's JNR\)](#), [Verified Carbon Standard's project-scale REDD+ methodologies \(Verra's VCS\)](#), the [Lowering Emissions by Accelerating Forest finance \(LEAF\) initiative](#) and [CCORSIA](#).

Once the MRV process is finalized and all the relevant documentation regarding REDD+ results and the requirements for obtaining RBPs are available, these will be published in the [Lima REDD+ Information Hub](#). The Lima REDD+ hub aims to increase the transparency of information on REDD+ results-based actions.

You can see the [list of countries](#) that have reported results for their successful REDD+ implementation and the corresponding results-based payments.

Elements required to obtain results-based payments under the UNFCCC

In order to obtain and receive RBPs / RBFs for results-based actions, REDD+ actions should be fully measured, reported and verified and the following required elements should be in place and publicly available on the [UNFCCC Lima REDD+ information Hub](#)

The MRV process for REDD+

Decisions [12/CP.17](#) and [13/CP.19](#) invite countries to submit, voluntarily and in the context of results-based payments, proposed FREL/FRLs. Forest reference levels are a critical element of REDD+ for assessing a country's performance in implementing REDD+ activities and measuring emission reductions due to REDD+ actions and their elaboration is often directly dependent on the availability of NFI data. The information included in the FREL/FRLs should respect the principles of transparency, completeness, consistency, accuracy and should be guided by the most recent [IPCC guidelines](#) and guidance.

Read more about the [guidelines for submissions of information](#) on reference levels.

Scope of REDD+

The Cancun Agreements set out five REDD+ activities which can be considered as the ‘scope’ of REDD+:

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.

REDD+ activities are not defined in UNFCCC decisions. Countries instead define these according to the IPCC guidelines and according to their national circumstances.

In the context of seeking results-based payments/finance, countries may choose to implement one or more of the five REDD+ activities to reduce forest-related emissions and/or enhance forest-related removals, which should include all significant activities, forest carbon pools (above- ground, below-ground, soil, litter and dead wood) and greenhouse gases (CO₂, N₂O, CH₄)

The technical assessment (a review process undertaken by independent experts) of FREL/FRLs is a mandatory requirement and the basis of the MRV process. This is extremely important especially for countries seeking results-based payments, as the verification process is based on the consistency between the assessed FREL/FRLs and REDD+ results. The results of the technical assessment are published on the [U NFFCC REDD+ Web platform](#) together with the FREL/FRL submissions and any revised submissions resulting from the technical assessment. Once a technical assessment has been completed, countries can submit REDD+ results which are measured against the assessed FRELs/FRLs (in tCO₂eq year⁻¹). The REDD+ results are reported through a technical annex to the biennial update reports (BUR) and verified through the International Consultation and Analysis (ICA) process. The two land use, land use change, and forestry ([LULUCF](#)) experts responsible for the ICA process verify the extent to which:

- there is consistency in assessment methodologies, definitions, comprehensiveness and the information provided between the assessed reference level and the results of implementation

of REDD+ activities;

- the data (e.g. NFI data) and information (e.g., forest and other land use information) provided in the technical annex is transparent, consistent, complete (in the sense of allowing reconstruction) and accurate;
- the data and information are consistent with the guidelines for preparing the technical annex contained in the annex to [decision 14/CP.19](#); and
- the results are accurate, to the extent possible.

What data are needed to quantify emissions for REDD+?

REDD+ monitoring and reporting requires data that are transparent, consistent over time, accurate and complete. Countries use their national forest monitoring systems (NFMS) to collect, analyze and disseminate forest-related data and quantify historical emissions/removals of GHGs associated with REDD+ activities and measure REDD+ results.

A well-established and transparent NFMS should use a combination of remote sensing and ground-based forest-carbon inventory approaches. Combining measurements of forest area and area changes (**activity data**) with estimates of forest carbon stocks and carbon stock changes (**emission factors**) enables estimation of GHG emissions/removals for REDD+.



Examples

Read more about how [Papua New Guinea](#), [Bangladesh](#), [Chile](#), [Democratic Republic of the Congo](#) and [Ghana](#) established national forest monitoring systems (NFMS) that are able to provide more robust data for sustainable forest management and climate action.

How countries calculate activity data (or forest area changes) for REDD+ activities

To assess forest area and forest area changes, countries generally use the following methods:

1. **pixel counts (remote sensing classification alone):** areas are extracted directly from modeled wall-to-wall change maps;

2. **stratified area estimates (map and sample-based estimates):** areas from samples that are stratified using wall-to-wall maps including forest area changes in the map;
3. **systematic or random samples (sample-based estimates alone):** areas are extracted from samples only with either a systematic or random distribution and sometimes using a map for intensification; and
4. **continuous NFIs based on permanent samples** can also be potentially used under certain circumstances.

Read more about [Method used for FREL/FRL submissions, by country](#) (FAO 2018).

The IPCC and the [Global Forest Observations Initiative methods and guidance documentation](#) for forest monitoring support the use of sample-based methods compared to pixel counts for estimating activity data.

Countries are increasingly improving the quality and accuracy of their activity data. Let's review now the case of Mexico where deforestation area estimates were improved by replacing pixel counts with sample-based estimates.

How does NFI data contribute to REDD+?

NFI data is an important source of information for estimating carbon emissions/removals for REDD+ activities. NFIs provide data to estimate the associated emission/removal factors, namely above-ground and below-ground biomass.

Recently, several countries started to include the dead wood pool, and soil organic carbon and litter data in NFI, although estimating changes in these pools is challenging. Soil remains the least frequently reported carbon pool in the FREL/FRL submissions and changes of soil parameters are more static. NFI data coupled with other data sources (data from social surveys) can provide information on the drivers of deforestation and forest degradation. Besides, inclusion of socioeconomic factors in NFIs provides more clear understanding on how human interactions and dependencies are related with the drivers.

The degree to which NFIs can provide useful data for REDD+ depends on various factors including:

- the number and type of measurements collected;
- the objectives and requirements for NFI implementation and sampling design; and
- the population frame of interest within the geographic reporting unit. For example, if samples

are collected only from forested areas, then no emission factors for land converted to forest land (afforestation/reforestation) or forestland converted to other land (deforestation) can be estimated, as the pre/post carbon stocks are unknown.

Emission factors for afforestation/reforestation

To measure forest carbon stock changes in other land converted to forest land (afforestation/reforestation) many countries face challenges. The challenges are mostly associated with the delayed removal of carbon resulting from biomass growth in new forested areas. Estimating the biomass growth rates in new afforested/reforested areas can be done with NFIs or with growth models. However, many countries with NFIs prefer to use IPCC default biomass growth rates, as the available NFI data may not be representative.

Therefore, having a suitable and consistent sampling system should be taken into consideration. The representative age classes and/or multiple NFI cycles combined with satellite image based monitoring system are also very important.

Emission factors estimation for forest degradation

Measuring carbon stock changes in ‘forest remaining forest’ may require multiple forest inventories with consistent measurement approaches. Some countries use NFI data (e.g. stump counts) and multiple NFI cycles to estimate forest carbon stock changes.

For example, Viet Nam calculated forest degradation emissions as the difference between dense and open forest types and this was combined with data obtained from multiple NFI cycles to assess carbon stock declines in ‘forest remaining forest’ over repeated inventories.

Read more about how [Vietnam used multiple NFI cycles in REDD+ reporting](#).

REDD+ standards for results-based payments

In the context of results-based payments, standards are defined as any regulatory document, which describes mandatory rules and requirements for accounting GHG emission reductions from REDD+ activities. Standards regulate the eligibility of REDD+ projects or programs, define required methodologies and protocols, establish the criteria and a standardized approach for the measurement, reporting, verification and crediting of emission reductions and carbon removals from forests.

Let's explore now a few REDD+ standards that provide results-based payments for verified emission reductions for REDD+.

Forest Carbon Partnership Facility	The FCPF is a multilateral pay-for-performance carbon fund, with a total investment capital of 1.3 billion USD across its Readiness and Carbon Funds. The Carbon Fund is focused on REDD+ implementation and set up to pilot payments for emission reductions under a contract known by Emission Reduction Payment Agreement (ERPA). The World Bank has signed ERPAs with fourteen countries. The FCPF Carbon Fund includes both market and non-market finance from both public and private donors. Around 95 percent of the total FCPF contributions come from public donors and cannot be used for market purposes while 5 percent of the contribution consists of public, private and non-profit donors.
Architecture for REDD+ Transactions	This is a global voluntary carbon program (architecture) to register, verify and issue high-quality REDD+ emissions reduction credits to countries and jurisdictions to attract REDD+ finance at scale. It was the first jurisdictional crediting standard for REDD+ developed and published after the adoption of the Paris Agreement. It was launched in 2018 and since then seven jurisdictions from three continents have started the registration process. For more details on the standards, visit Chapter 5 of Sandker et al. (2022) .
Verra's Jurisdictional and Nested REDD+ (Verra's JNR)	The JNR framework serves as a comprehensive carbon accounting and crediting platform for governments to guide development of their REDD+ programs. It helps to nest REDD+ projects and subnational jurisdictions within these programs. JNR was specifically designed to facilitate private investment in REDD+ at multiple scales, and is therefore well-aligned with the Paris Agreement's objectives of engaging the private sector, while linking to national efforts, as well as providing emission reductions to emerging compliance and voluntary markets. The most recent update to this standard, JNR Version 4 , was released in April 2021. Verified Carbon Standard's project-scale REDD+ methodologies (Verra's VCS): Verra was founded in 2005 by

environmental and business leaders who saw the need for greater quality assurance in voluntary carbon markets. The VCS Program is the world's most widely used voluntary GHG program.

Summary

Before we conclude, here are the key learning points of this lesson.

- NFIs provide robust forest resources information which is used for different national international reporting and documentation across countries.
- REDD+ reporting might be one important motivation for establishing NFIs in some countries.
- The Warsaw Framework established the structure for an international REDD+ mechanism, presented the rules and methodological guidance for REDD + design and implementation and provided the modalities for the MRV of GHG emissions and removals as an essential tool for linking verified REDD+ results to results-based payments.
- Countries interested in REDD+ are required to progress through three phases: readiness, implementation and results.
- REDD+ monitoring and reporting requires data that are transparent, consistent over time, accurate and complete.

Lesson 4: Data transparency open data and data sharing

Lesson introduction

Open access to data is revolutionizing science and policy alike. Forest data transparency in NFIs is fundamental if we aim to increase the value of information and the role that forests play in climate change action and forest policies around the world. This lesson will delve into the principles behind open data and the possible solutions to share NFI data for greater benefit.

Learning objectives

At the end of this lesson, you will be able to:

1. Explain why open forest data is important.
2. Review the principles of open data repositories.
3. Define the concept of metadata.
4. Appraise the public nature of NFIs and the need for compromises in open data policies.

How data and transparency are interlinked

Before we dive into the issues regarding open data, it is important to distinguish concepts to avoid confusion. Forest data usually arrive in several formats and depend on how they were collected and how they are presented. But what do we mean by data?

The type of data NFI technicians typically receive are either **sampling data** (i.e., coming from probabilistic sampling) or **census data** (from all elements in a population). Depending on the detail—or scale—in which they are presented, they can be detailed individually-based data (i.e. at tree level), aggregated at the sampling unit level, or aggregated at larger scales (i.e. province, region, forest type, etc.).

The release of data to the public at large is generally defined as “opening the data”. This leads us to the next question: “What is openness vs. transparency?”

Opening forest data involves the liberation of information about what the government or institution knows, for instance: sampling plot data, land tenure data or satellite information.

Transparency, meanwhile, is more **about how the government/institutions works** (so-called

governance) or what they do with that information.

As such, it is then easy to see that a government or institution can in fact openly release a lot of data without being transparent. To be transparent, therefore, a good practice is to make all information available to give evidence of credibility and meaningfulness both to broad audiences.

Principles of open forest data and transparency

The [Voluntary Guidelines on National Forest Monitoring \(VGNFM\)](#) provide guidance on transparency and open data in the forestry sector through two basic principles applicable to NFI data:

- **Credibility through transparency and quality:** As mentioned in **Course 1: Why a National Forest Inventory (NFI)?**, the results of an NFI must be scientifically defensible; therefore, each methodological and organizational step must be transparently documented and justified. The information products generated by the NFI must allow any user to understand the data design, collection and analysis processes in order to understand the quality and credibility of the reported results.
- **A well-defined data and information sharing policy:** To inform policy-making and decision-making, as well as to promote further research, forest data and complementary documentation must be disseminated as widely as possible with varying levels of detail. It is therefore necessary to establish a clear data exchange policy to which national and international users can refer. The implementation of a long-term data exchange policy also means that long-term data storage and management is seen as a priority and is legally ensured.

Open NFI data: Why?

Through the courses of this series, we have insisted on the need to capitalize on data to maximize the use of information for monitoring natural resources, appropriate planning and policy interventions, evaluation of their impacts, as well as the advancement of science through novel research. Within this general framework, many disciplines have in the last years pointed to the need to share data (usually aggregated at large scales) in order to expand knowledge to the public while providing transparency.

The case of forest data is particularly important. Indeed, **transparency is one of the key concepts of the**

Paris Agreement and a prerequisite for **accessing performance-based payments in the context of Reducing Emissions from Deforestation and Forest Degradation (REDD+)** and other results-based, climate-focused payment schemes. Although major advances have come from international climate change forums, the collection, analysis and dissemination of accurate and transparent data are essential for wider international reporting of forest information.

The large amount of NFIs developed across the world in the last decade came not only out of a sudden funding availability from climate finance mechanisms such as REDD+, but also from the need to develop more transparent NFMS and the interest in encouraging scientific approaches in their planning, implementation and analysis. Greater transparency of countries' forest-sector data and information has resulted in improved national decision-making. For example, the Swiss NFI established a data storage and analysis system ([NAFIDAS](#)) that, combined with open public access to a comprehensive [a comprehensive set of tables and interactive maps on forest statistics](#) offered increased transparency while triggering the production of decision-making support systems.

Besides governments, increasing information access has raised in citizens the need for assurance and transparency so they can act as individuals and communities, and to advocate for data-driven policy development. Once data is made available, they can be combined to allow us to have a much better understanding of nature.



Examples

How data provides insights

A [recent study](#) combined open datasets from two repositories to conclude that global tree richness is approximately 14 percent higher than previously thought.

An [earlier study](#) made use of an open data repository on forest inventory data from hundreds of thousands of field plots to determine that tree biodiversity loss also leads to a loss of commercial forest productivity. These new insights can inform conservation as well as evolutionary science and can highlight a need to re-assess biodiversity values and forest management strategies.

Open access data repositories

Open access refers to freely available, digital, online information. It can be either gratis if free of charge, while some copyright and licensing restrictions may still apply; or free if free of charge and free of most copyright and licensing restrictions. While 'free' implies that the information does not cost anything to access, remember that it still involves a cost to release it! To follow the internationally recognized principles of open access and data management (*FAIR, see below*), data must be available to all users and not be hindered by any financial, organizational, legal or technical barrier. Currently, the most common ways to disseminate open data are online repositories and downloads on digital storage media.

FAIR principles of data

Open Data is often seen as a way to achieve transparency. It involves the release of data so that anyone can access, use and share it and ultimately facilitates accountability by both data providers and decision-makers.



An open release of data involves proper data management and follows the FAIR principles (observe, though, that FAIR-following data do not necessarily implies open data!). FAIR principles imply that data must be:

Principle	Objective	Application
Findable	Ensures that humans and computer systems can readily find your data	Put data in a standard repository, or at least description (i.e., machine-readable metadata) of the data. Metadata assigned globally unique and persistent identifier (e.g. a Digital Object Identifier, commonly abbreviated as a DOI)
Accessible	Ensures that data and metadata are stored for the long term in order to be retrievable (downloaded or locally used) by humans and machines using standard communication protocols	Make sure that others can actually access your data by downloading it – also ensuring it is machine-readable. Usually involves uploading them in a repository for long-term storage
Interoperable	Data must be in common formats/programming languages easily usable by others (e.g, .csv instead of .pdf)	Ideally data should be uploaded to repository that is easily used with other platforms and structured (e.g., Excel), open non-proprietary (e.g., csv), and linked to other data (i.e., Rdata from the R package). Metadata use standard vocabularies.
Reusable	Data should be clearly described and have associated data-use standards (e.g., a license) that allow others to re-use it	Metadata released with clear and accessible usage license and are well described with a number of accurate and relevant attributes

What is metadata?

A fundamental principle of online repositories is the preparation of metadata following internationally agreed standards. Metadata is the **documentation that transforms the data of a set of numbers and characters into information**. It describes concepts such as scale, scope, units of measurement, codes used, survey design, quality control procedures, and initial study objectives. In its simplest form, metadata should aim to establish a common set of questions that guide the data user to reproduce the

results of the reports following the FAIR principles.

What information does metadata contain?

Good metadata answers the following questions:

Who	What
Who collected the data?	What are the data about?
Who processed the data?	What project were they collected under?
Who wrote the metadata?	What are the constraints on their use?
Who should I contact for questions?	What is the quality?
Who should I contact to order data?	What are appropriate uses?
	What parameters were measured?
	What format are the data in?
Why	When
Why was the data collected?	When were the data collected?
	When were the data processed?
How	Where
How were the data collected?	Where were the data collected?
How were the data processed?	Where were the data processed?
How do I access the data?	Where are the data located?
How do I order the data?	
How much do the data cost?	

Metadata standards for forest-related repositories

At present, there is a lack of a metadata standard for forest-related repositories, although international efforts have been made for data standardization and methodological harmonization for reporting.

Currently there are several well-developed alternatives:

- ➔ An established related standard is the [Ecological Metadata Language \(EML\)](#). It contains features that other more general metadata protocols lack, such as specific basic information about geographic boundaries or taxonomic information. However, metadata on forestry and natural resources usually contains information on socio-economic studies, which are studies

that are not fully covered by the EML.

- Another more general approach followed by the World Bank is the [Data Documentation Initiative \(DDI\)](#). Initially, it was designed to cover data from the social sciences; however, it is comprehensive enough to cover most of the information typically contained by NFIs, and was also adopted by FAO's [Food and Agriculture Microdata Catalogue \(FAM\)](#).
- Other metadata standards exist that may include useful information such as detailed geospatial data, but they are normally more appropriate for satellite and geographic information.

Some current metadata standards amenable to in-situ forest data

Metadata language	Framework	PROS	CONS	User community
Ecological Metadata Language	Ecological data	<ul style="list-style-type: none"> • Contains specific geospatial frame (but NOT geospatial detail) and taxonomic information • Available R package for automatic metadata generation 	Not optimized for socioeconomic information	Ecological/forest research
Data Documentation Initiative	Survey data	<ul style="list-style-type: none"> • Specialized in surveys, including socioeconomic • Simple structure (Excel) 	Lacking explicit geospatial taxonomy information	International agencies and statistical offices
Dublin Core Metadata Initiative	General format	<ul style="list-style-type: none"> • International, widely approved standard 	Lacking specific for forest in data	Many disciplines
ISO 19115	Geospatial standard	<ul style="list-style-type: none"> • Specific geospatial information (i.e., polygons) • 	Not specific to in-situ data	Geospatial disciplines (USGS, NASA,..)

Ultimately, any agreement on metadata standards must focus on the end data users and remain true to the principles of open data, while respecting countries' national circumstances and privacy obligations, which in the case of forest-related data go beyond those typically used by national or international statistical organizations. Examples include sensitive taxonomic information, such as species with protected status under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and their specific geographical locations.



Reality check

While academic goals should aim to open all data as much as possible, international agreements should respect each country's legal and political limitations. A commitment to data disclosure should be considered through honest discussion among all stakeholders.

Data sharing: a public need and a matter of compromise

Public money means public information

National forest data is primarily collected through taxpayer finances, either through national or international cooperation funds. Greater public financing of large-scale data collection and sharing ultimately means greater information available to the public, enhancing public trust and increasing opportunities for investors and researchers. Open, transparent, and reliable forest data can also enhance private investment, which is urgently needed to trigger transformation of forest and land management for climate action and other multiple benefits. Accurate and reliable forest data created from public funds has the greatest potential to reach the public and multiply government transparency efforts.

Achieving open data through compromise

Forest-related information continues to be scattered across many platforms. In addition, issues related to data confidentiality contribute to an initial distrust to data sharing. Potential users are usually very willing to respond positively to data exchange offers from others, but are reluctant to share their own data, something that raises the conflicts behind achieving compromises between data users and providers about the risk versus usefulness of open data. To overcome resistance to data sharing, legal agreements that release individual contributors from conflicts with the institutions involved in data sharing are needed, with updated and harmonized measures to ensure anonymity of legal subjects and/or spatial coordinates. Further, data ownership recognition standards should encourage data sharing. Government officials and researchers need to follow the FAIR guiding principles for data management and stewardship, thereby making the case that in the end the benefits of sharing outweigh the disadvantages.

In this respect, the forest community is signaling a more positive attitude towards disclosing their data openly and with a higher level of detail than previously done. This trend was also confirmed by a recent FAO survey of national correspondents of the Global Forest Resources Assessment (FRA). The results show that 63 countries find it useful to have a global online platform to store national forest inventory data, while 34 countries are hoping to have new data openly available in the coming years.

Summary

Before we conclude, here are the key learning points of this lesson.

- The release of data to the public at large is generally defined as “opening the data”. Transparency is one of the key concepts of the Paris Agreement and a prerequisite for accessing performance-based payments in the context of REDD+ and other results-based, climate-focused payment schemes
- To follow the internationally recognized principles of open access and data management, data must be available to all users and not be hindered by any financial, organizational, legal or technical barrier.
- Metadata is the documentation that transforms the data of a set of numbers and characters into information.
- Open, transparent, and reliable forest data can enhance private investment, which is urgently needed to trigger transformation of forest and land management for climate action and other multiple benefits.