



## Course 1

Text-only version

# Why a national forest inventory?

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## Course 1: Why a national forest inventory?

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This introductory course lays the foundation for understanding a national forest inventory (NFI). This course describes the goals and purpose of a national forest inventory (NFI) and explores how NFIs inform policy- and decision-making in the forest sector. It then explores the importance of data in forest-related decision-making and evaluates the contribution of NFIs in national, international and climate change data reporting mechanisms.

### Who is this course for?

This course is primarily intended for people who are involved in NFIs, 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. National forest monitoring teams
3. Students and researchers, as curriculum material in forestry schools and academic courses
4. Youth and new generations of foresters

### Course structure

<b>Lesson 1: NFI: Definition and Goals</b>	This introductory lesson outlines the goals and purpose of an NFI and explains the terminology associated with it. It also traces the evolution of forest resource information gathering and describes the scope and changing priorities of an NFI.
<b>Lesson 2: Better NFI data, better decision-making?</b>	This lesson delves deeper into the fundamental rationale of an NFI and explores how the overall national forest monitoring system (NFMS) informs policy- and decision-making in the forest sector.
<b>Lesson 3: Common information and reporting</b>	This lesson further explores the importance of data in forest-related decision-making and reviews the role of criteria, indicators, and variables in determining forest inventory content.
<b>Lesson 4: National forest monitoring and international reporting</b>	The final lesson of this course evaluates the contribution of NFIs in national and international reporting mechanisms, and describes how they serve as a pillar of climate change data reporting.

### About the series

This course is the first in 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
 <b>Course 1: Why a national forest inventory?</b>	<b>(You are currently studying this course)</b>
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	NFI reporting and the importance of reporting in the context of REDD+ actions.

## Lesson 1: NFI: Definitions and Goals

### Lesson introduction

In this lesson, we will understand how a national forest inventory (NFI) responds to information needs arising from the targeted formulation of forest-related policies and their monitoring requirements.

This also includes monitoring the sustainability of forest management at a national level, where “managing” the forests refers to all human interventions in forests, covering the spectrum from wood harvesting to full protection.

We will also consider the basic terminology associated with forest inventories, and will look at the scope, overall goals and multipurpose nature of an NFI. We will conclude this lesson by looking at the relationship between NFIs and National Forest Monitoring Systems (NFMS).

### Learning objectives

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

1. Define an NFI
2. Explain the background and justification of NFI's and the targeted users of the provided data and information.
3. Describe the scope and the overall goals of an NFI.
4. Elaborate on the multipurpose nature of an NFI
5. Discuss how NFIs constitute an important element in NFMS.

### NFIs: An overview

#### What is a forest inventory?

Forests are complex natural systems that can be considered either an ecosystem (when taking on the nature-centered view), or a **resource** (when taking on the human-centered view).

Forest inventories are in general, **systematic collections of data** for a defined area of interest which constitutes the **population of interest**. They aim to **gather data on the location, composition and**

**distribution** of both the "resource forest" and the "ecosystem forest" that are relevant for forest-related processes in management, policy and research.

Forest inventories allow us to assess various forest functions, and are commonly recognized as prerequisites for forest planning and analyses because they estimate and assess not only the status of forest at a given point in time but also the changes over time that are central for forest planning and for monitoring the sustainability of forest management and forest policies.

Depending on the specific goals and decision processes, forest inventories are implemented at various geographic/political units - including farms, villages, municipalities, provinces, and even entire countries and regions.

### Evolution of forest inventories

Human beings have always depended on information about forest resources for their subsistence—food, energy, raw materials, health, housing, etc. However, as long as a resource is abundant (relative to its uses and users), information is not essential for its uses and management. But once a resource becomes scarce, comprehensive information on status and changes is crucial, in particular when we deal with a renewable resource like forests.

**As a concept, gathering forest information for management purposes is not new** - let's have a look at a rough timeline of the evolution of forest inventories.

<i>Early 16th century</i>	Early assessments of some relevant characteristics of the regulated harvesting of forest resources on local scales date back several centuries.
<b>Laws on forest resource use</b>	In Germany, France, and Spain, as early as in the 16th century, municipal and state ordinances demanded that logging should be moderate and imposed fines for illegal logging, often including specific diameter thresholds for each tree species for logging.
<i>17th century</i>	When forest resources—wood for energy and construction—became extremely scarce in Central Europe in the 17th century, various dukes and forest engineers expressed their concern about diminishing wood, particularly near settlements and industry.
<b>Towards sustainable forestry</b>	Carl von Carlowitz, a German mining engineer, addressed these concerns in his 1713 book " <i>Silvicultura Oeconomica – Anweisung zur Wilden</i>

*Baumzucht*" (Sylvicultura Oeconomica – Instructions for Wild Tree Cultivation) where he suggested to systematically manage forests (just like agriculture, therefore the term “silvi/sylvi”-culture) so that the supply of wood would be "sustainable".

This was **among the very early mentions of the term "sustainable" in the context of forestry**; however, von Carlowitz did not indicate how such sustainability may be monitored.

*19th century*

**Statistical sampling**

The **primary method used in gathering forest information before the 19th century were non-statistical - mainly visual and verbose descriptions of forest stands**, but this, of course, referred all to smaller area forests, not to the national level. However, after the "invention" of statistical sampling at around 1900, these novel techniques were gradually introduced also to forest inventories.

*Early 20th century*

**Further development of statistical sampling techniques**

The **first statistics-based NFI was implemented in 1919**. Norwegian forest biometricians significantly developed the field of statistical sampling with the implementation of systematic and strip sampling.

In the 1920s and 1930s the **notion of randomization was introduced as a basic requirement for statistical sampling**—elaborating the selection process much more as compared to the earlier "representative method" where it was where it was demanded that the sample be “representative” – without however, specifying how to accomplish this.

*Post World War II to today*

**FAO's role**

After World War II, interest in generating up-to-date information on wood resources on a global scale prompted the newly-founded Food and Agriculture Organization of the United Nations (FAO) to establish the [\*\*\*Global Forest Resources Assessment \(FRA\) Program\*\*\*](#).

In 1948 FAO published the first global survey: “Forest Resources of the World”. This report pointed out a lack of reliable forest inventory information for many countries. It is interesting here that similar arguments are still in use after more than 70 years: that there be still

considerable gaps in forest information.

From the 1960s to the 1980s, national-level forest inventory projects were implemented in developing countries, mostly funded by international organizations and bilateral programmes for technical cooperation. Many were implemented through FAO.

The FRA program has since then produced an overview report every 10 years on the State of the World's Forests from a compilation of national level forest information from individual countries. Starting in 2010, the assessment cycle has been reduced to 5 years, owing to the worrying dynamics of forest loss. Now, every 5 years a "State of the World's Forests" report is published by FAO. However, it needs to be emphasized that in the FRA program, FAO is not implementing a global forest inventory each in each cycle, gathering own original data. It is rather a compilation of nationally available forest data that are best possible harmonized to a common definition. That means: FRA depends on good forest data at the country level.

At the national level (in the interest of the countries, but also to feed FRA with good forest data), FAO implemented in 2000, the **National Forest Monitoring and Assessment program**, which assists its member countries with capacity building for setting up and manage National Forest Monitoring Systems.

### How does FAO define an NFI?

A National forest inventory is defined in the FAO's [\*Voluntary Guidelines on National Forest Monitoring \(VGNFM\)\*](#) as **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 particular points in time.** NFIs typically build upon multiple data sources, including field inventories and remote sensing.

An NFI is commonly a project type of activity with a defined beginning and end. It can be subdivided into



three phases of often equal duration: **planning, implementation/data collection**, and **analysis**. NFIs are core technical components of national forest monitoring systems (NFMS), a concept we will discuss later in this lesson.



### Quick tips!

Often, an overall lack of experience leads forest department officials to think that data collection is the longest phase of an NFI. Remember that in small countries, both planning and analysis can sometimes take as much time as data collection. Of course, all budget and HR planning needs to be properly adjusted to the project, in fact: to any project.

### Management inventories vs. National forest inventories

The information produced for each forest inventory responds to specific objectives of that level.

For example, at the **farm or community levels** and other small areas, **forest inventories usually focus on preparing management plans as a prerequisite to obtain wood-harvesting/logging permits**; these inventories are also called “**forest management inventories**.” Because of their specific management orientation, they focus on a relatively limited set of core variables relevant for management, usually being basal area per hectare among the core variables. While sharing basic methodological design characteristics, they are significantly different from NFIs.

**National and subnational forest inventories aim to generate forest-related data and information for a whole country or a subnational administrative/geographic entity.** They are not specifically geared towards managing specific forests but provide the overall information required to formulate forest-related policies and regulations and to monitor the sustainability of all forest functions in a country or subnational entity. Such broader scope, of course, requires the observation and recording of more variables - whose number may exceed 200 in some NFIs.



## Did you know?

### **If forest management inventories are carried out on a regular basis, why are NFIs necessary?**

It is sometimes argued that an NFI is not necessary when forest management inventories are carried out on a regular basis for many forests all over the country, as one just needs to compile the data from the forest management inventories to produce national-level forest information. However, not one case has been identified where such application has actually worked. There are various issues associated with such an approach, including:

- forest management inventories are done at different points in time and it is difficult – may be not possible at all – to bring the results to one common point in time;
- there might be large portions of forests without forest management inventories or with no relatively recent data;
- there may be methodological differences between the different forest management inventories; and
- quality assurance is hardly possible when so many actors are involved in different non-coordinated inventory projects.

### **Can NFIs provide forest management information?**

It is sometimes expected that NFI data provide the base information for forest management on the state or district level. It is important to understand that this is not the primary goal of NFIs - NFIs generate data and information for larger units of reporting like provinces and entire countries.

In an NFI, the smaller the unit of reporting, the less precise the estimates will become, simply because then only fewer sample points are in this smaller area. So, commonly, **an NFI cannot provide sufficiently accurate forest management information for smaller geographical units**. However, there is currently (as of 2023) ongoing research to analyze to what extent small-area information can be extracted from NFIs. Intensive research is taking place on the so-called “small area estimation,” where the NFI field observations are linked to area-wide remote sensing data.

Remote sensing data serve here as auxiliary data that cover the whole area of interest, and the possible

relationships between remote sensing data and field observations then allow predictions to be made for smaller areas like forest stands or forest districts. Then, however, privacy issues may arise, as it will theoretically also be possible to make independent assessments of privately owned forests; which is actually an issue in some countries.



### Did you know?

#### How is the data for an NFI generated?

Various data sources are employed, the most important being: **sample-based field observations**, **remote sensing**, **national statistics** (if available, on land use and harvests), **allometric models** and **information from previous monitoring studies**.

### Goals and nature of an NFI

For a long time, national-level forest inventory and monitoring were viewed exclusively as a forestry issue and received little attention from other sectors. In developing countries, governments tended to provide only minimal investments, and national forest inventory and monitoring were implemented mostly through financial and technical support from international or bilateral cooperation.

This took the form of projects rather than programs, which were limited in time and scope, and not institutionalized within national systems. That is: there was hardly any sustainability regarding national forest monitoring but usually just some one-shot NFIs.

In general, the traditional role of an NFI has been to:

1. Provide reliable forest resource information covering a whole country to include computation of forestry statistics.
2. Assess forest areas, growing stock volumes, changes in biodiversity status, land use, carbon stock, and ecosystem services.
3. Generate scientific data and information with the primary goal to guide and support decision processes in forest-related policies.

4. Monitor the sustainability of forest management and forest policies on a national and sub-national level.
5. Enter into various international reporting processes, including the *United Nations Framework Convention on Climate Change (UNFCCC)* and the *United Nations Convention on Biological Diversity (UN-CBD)*.



### Did you know?

#### What is REDD+?

Reducing emissions from deforestation and forest degradation (REDD+) is a mechanism developed by Parties to the United Nations Framework Convention on Climate Change (UNFCCC). It creates a financial value for the carbon stored in forests by offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. Developing countries would receive results-based payments for results-based actions. REDD+ goes beyond simply deforestation and forest degradation and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

REDD+ is also recognized in Article 5 of the Paris Agreement, where Parties re-iterated their commitments to implement REDD+ activities, and that these should be an integral element of the Paris Agreement. Therefore, the WFR is a foundation for Parties engaged in REDD+ to fulfil the highest level of commitment to climate actions in the forest sector.

#### Changing scope of NFIs

Over time, various NFIs have developed towards general land use inventories where all (or many) land uses, including their relevant variables, are recorded. Other NFIs explicitly include tree resources outside the forest, which constitute an increasingly recognized tree resource in many regions. Inclusion of trees outside forests (ToFs) implies a development from "national forest inventory" to a "national tree inventory".



### Did you know?

After the 19th century, the main focus of NFIs was the wood resource. The **integration of biodiversity indicators became an additional focus in the 1990s**, as was the **monitoring of sustainable forest management**; this enhancement of the NFIs went along with developing the comprehensive framework of Criteria and Indicators for sustainable forest management.

### United Nations Decade's declaration on Ecosystem Restoration 2021-2030

With the [United Nations Decade's declaration on Ecosystem Restoration 2021-2030](#) by the UN General Assembly, the topic of Forest Restoration is now considered as one of the potential new areas for NFIs. The Decade of Ecosystems Restoration aims to massively scale-up the restoration of degraded and destroyed ecosystems as a proven measure to fight climate change and improve food security, water supply and biodiversity.

Over the past decade, especially in tropical forests, a key area of focus of national forest monitoring programs, has been the contribution towards reducing carbon emissions from deforestation and from forest degradation. Well-implemented NFIs are compliant with MRV (Measurement, Reporting, and Verification), and aligned to the quality demands defined in the [Conference of the Parties \(COP\)](#) decisions to UNFCCC, in particular regarding "transparency, consistency, completeness" which essentially make clear that only data from methodologically and scientifically sound forest monitoring systems are accepted as evidence for reduced GHG emissions from forests.



### Did you know?

#### The Conference of the Parties (COP)

The [Conference of the Parties \(COP\)](#) is the supreme decision-making body of an international convention whose scope is to review the implementation of a given Convention, such as the Convention on Biological Diversity and United Nations Framework Convention on Climate Change, and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation

of the Convention. Participants at the COP are the country's ministers or their representatives of all States that are Parties to the COP. The COPs are commonly prepared by technical expert groups who provide drafts of texts that are then being negotiated - and possibly endorsed as COP decisions. The COP can also make amendments to the convention, create expert advisory bodies, review progress reports by member nations, and collaborate with other international organizations and agreements. The Conference of the Parties uses expertise and support from several other bodies that are established by the convention.

### Goals and nature of an NFI

National forest inventories may be viewed as a part of policy processes in the context of "environmental governance": a comprehensive, reliable, and transparent database is essential for informed decision-making as well as communicating and defending policy on scientific grounds.

In general, the goal of national forest inventory/monitoring is to generate a reliable national-level data and an information base on forests and trees. Specifically, NFIs seek to accomplish the following:

1. To support the formulation, monitoring, and adjustment of national and subnational level policies related to forests and forested landscapes. This increasingly includes the support for the development of policies at the intersection of economics, social systems and the environment.
2. To reduce speculations on forests by providing scientific evidence.
3. To inform interested citizens and stakeholders (including forest owners and dwellers, environmental NGOs, forest-based industries, research organizations, academicians, citizens, etc.) about the status characteristics, services, and development of the forest resources of their home country.
4. To facilitate discussions on and the formulation of agreements at the international level and to submit regular national reports adhering to the reporting commitments by signatory nations that originate from the related international conventions and processes (i.e., UNFCCC, UN-CBD, FAO FRA, etc.).
5. To provide relevant and reliable baseline data to enable the evaluation of progress towards sustainable forest management on the national level.

### **Multipurpose nature of NFIs**

Forests produce multiple goods and services— benefiting society, and supplying a diverse range of needs. Forests are embedded in a landscape of various land covers and land uses, and defining forest boundaries can be a challenge. The interaction of forests with other land uses provides additional products and services to the population, such as pollination, hydrological services, and erosion reduction, just to mention a few.

A **multipurpose national forest inventory** (a term and concept coined in the '70s) promotes **collecting different types of data to provide the necessary information to respond to particular needs**. Such a multipurpose NFI addresses a comprehensive evaluation of forests and their conditions, management and uses, covering all the thematic elements of sustainable forest management.

### **Types of information**

Due to their multipurpose nature, NFIs usually have a long list of forest characteristics that are recorded and analyzed. Some NFIs gather data on more than 200 variables which can be attributed to four types of information to be generated.

#### ➤ **FOREST Biophysical and environmental information**

Related to the Forest - the extent of forest, forest biological diversity, health and vitality, and protective and productive functions. These information can also relate to the landscape, including topography and -transportation infrastructure.

#### ➤ **Information regarding the interactions at landscape level**

Related to the interactions of the forest land use and the others land uses, including all the products and services from those different interactions. This dimension is inclusive of dimension 1, 2 and 3 at a landscape level.

#### ➤ **THE USE Governance and management information**

Related to the manner in which the forests are managed - in other words, the legal, policy and institutional framework.

#### ➤ **USERS Socioeconomic information**

Related to the users (who is using the forest, where, why, and to what extent) and the related socio-economic and socio-ecological information.

## What is an NFMS?

### What is a National Forest Monitoring System (NFMS)?

The tasks of NFM are commonly embedded into **National Forest Monitoring Systems (NFMS)**, a term that refers to the entire monitoring setting, comprising the people, institutions, and resources that make national forest monitoring happen. In the ideal situation, an NFMS is led by a governing body that is responsible for conceptualization, planning, and execution within a clear and well-defined mandate, based on the principles and elements elaborated in FAO's VGNFM.

### How NFI and NFM are related

Both **NFI and NFM focus on national-level data and information**, specifically on forests (and in many cases also extending to trees outside forests), their condition, values, and uses. More and more, additional emerging topics are being integrated into these large-area monitoring systems so the initial emphasis on “forest monitoring” is moving towards a more inclusive “landscape monitoring” approach.

### On terminology in national forest inventory and monitoring

While we make here a clear distinction between NFI and NFM, we also need to mention that in many instances they are used synonymously. In particular, NFI is typically used when in reality NFMS is meant. There are actually more terms that are used when referring to NMFS and NFIs - the table below serves as a summary of all these, and makes things easier to understand.

<b>National Forest Assessment</b>	The systematic process of gathering, collecting, analyzing, and using information from diverse sources to assess the value, quality, or importance of forests at a national level, taking into account all their functions.
<b>National Forest Inventory</b>	A technical process of data compilation and analysis for the forests of a whole country, typically building on multiple data sources, including field inventories and remote sensing.
<b>National Forest Survey</b>	Commonly used synonymously with NFI.
<b>National Forest Monitoring</b>	A longer-term endeavor to monitor the forests of a country and their development over time. National forest monitoring has a “program character” - it is commonly without an explicitly defined end, and contains repeated NFIs as major technical components.



<b>Forest enumeration</b>	The term occurs for forest inventory (used for example in South Africa) – but mainly for forest management inventories and not in the context of national-level monitoring.
<b>National Forest Monitoring System (NFMS)</b>	According to the VGNFM, an NFMS 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.

### Increasing relevance of NFMS

Today, NFMS also meet many requests for data from sectors beyond forestry, including nature conservation and biodiversity protection, extending the scope from merely forests to forested landscapes.

The information obtained from NFMS supports forest-related decision-making at international, national, and sub-national levels by providing timely, relevant, and reliable data in a transparent and consistent manner.

Also, data generated by NFMS are increasingly recognized by scientists as a valuable source of large area forest information so that many scientific publications are seizing these data sets. NFI-generated data is being used in variety of ways today - these include:

1. Increased global interest in protecting and enhancing forests – while concerns on the progressing deforestation are also increasing.
2. Increased awareness of governments seeing their forests as a national asset.
3. Increased interest of other sectors in addition to forest-related information - in particular for biodiversity conservation and nature protection.
4. Increased availability of secondary/ancillary information.
5. Improvements in road infrastructure for field work
6. Technologically, remote sensing has been a breakthrough for data analyses (Unmanned Aerial Vehicles (UAVs), High-Resolution imagery, Lidar, Cloud Analysis, Big Data, Artificial Intelligence, data cubes, etc.).

7. The request to the UNFCCC from the 16th Conference of the Parties (COP16), to undertake activities to develop robust and transparent national forest monitoring systems for Reducing emissions from deforestation and forest degradation in developing countries and other activities (REDD+).
8. Climate models need information on vegetation cover and for calibration and scenario simulation.

### NFMS as a process

An NFMS collects data from various sources, with sample-based field observations and remotely sensed data being the most commonly used data sources in forest monitoring. The VGNFM promotes the integration of field and remote-sensing data.

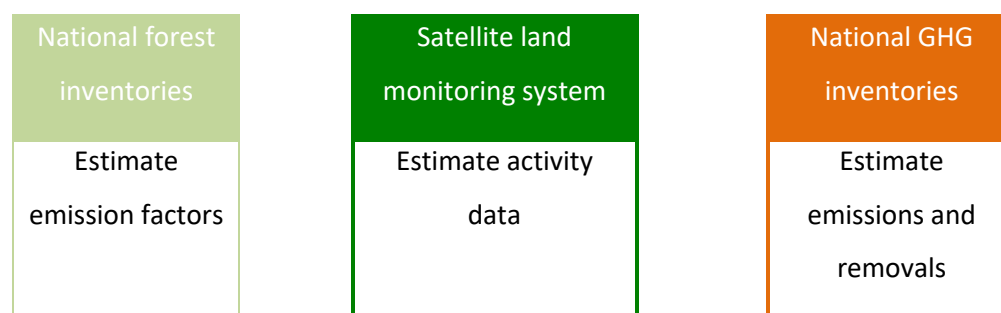
The integration of field and remote-sensing data is also promoted in the framework of the COP, with an emphasis on providing estimates that are transparent, consistent, and accurate (as much as possible).

### Components of an NFMS

A NFMS is the basis for the required measurement, reporting and verification (MRV) processes that ensure the quality and reliability of forest data, including forest-carbon estimates that are critical to the battle against climate change caused by deforestation and degradation of forests.

An NFMS includes repeated NFIs, along with satellite land monitoring systems (SLMS) and National Greenhouse Gas (GHG) inventories.

### Components of a NFMS in the context of REDD+



### Summary

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

- A National Forest Inventory (NFI)—an integral and complex component of a National Forest

Monitoring System (NFMS)—is a technical process that compiles data and provides (in the best case) unbiased estimates on relevant variables about characteristics of forests and forested landscapes.

- Various data sources are used in NFIs, including field inventories, remote sensing, and other ancillary information, on a national level at particular points in time. From the estimates that NFIs produce, relevant information may be retrieved that supports forest related decision making.
- NFIs historically focused very much on the production function of forests, mainly wood resources. However, over time, as humanity recognized the many functions and benefits of forests, NFIs have evolved to include more target topics, such as biodiversity, carbon stocks, restoration, forest degradation, sustainable forest management, etc.
- National Forest Monitoring is the longer-term endeavor to monitor the forests of a country and their development over time with repeated NFIs as major technical elements.
- Generally, an 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 documented in FAO's Voluntary Guidelines on National Forest Monitoring.

## Lesson 2: Better NFI data, better decision-making?

### Lesson introduction

This lesson delves deeper into the fundamental rationale of an NFI and explores how the overall national forest monitoring system (NFMS) informs policy- and decision-making in the forest sector.

Although popular opinion is that having more data at hand leads to a more informed and robust policy-making process—do we really know to what extent countries actually take up monitoring results in policy-making? What makes forest monitoring systems so relevant to policy-making? Let's find out!

### Learning objectives

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

- Analyze the potential impact of an NFI on policy- and decision-making.
- Identify the characteristics that can make an NFMS more impactful.
- Review country experiences where forest monitoring led to evidence-based policy-making

### Towards impactful forest monitoring

#### The science-policy linkage

Data and analysis undoubtedly have the potential to support and improve the outcomes of decision-making. For this reason, **providing decision-makers with information** is seen as an important strategy towards **rationality and transparency of decisions** and possibly also towards progress, beyond unsubstantiated or corrupt decision.

This **science-policy linkage holds good for forestry as well**. Recent efforts to tackle climate policies in relation to forests have created opportunities and economic incentives to implement monitoring systems that, besides contributing to international reporting, can further support forest-related policy-making and the development of evidence-based forest programs at the national level, but the question remains.

*How exactly can forest information lead to better decision making, and why does this not always happen? What kind of enabling conditions are required?*

A sensible starting point to answer these questions is to look at the dynamics of the policy-making cycle and at the role that data and scientific evidence may play.

### The policy-making cycle

Political science often uses a cyclical model to understand public policy. While this framework is a highly idealized way of representing reality, nevertheless its approach can still be applied to NFIs. In this context, the reference to the policy-making cycle is an attempt to fit a typically complex process into a clear, recognizable framework.

In order to investigate whether NFIs and forest monitoring efforts can effectively contribute to the drafting of forest sector policies, it is necessary to analyze **the components (stages) of the policy-making cycle** (or problem-solving cycle).

Typically, new policies are stimulated by **recognizing** a problem. The next step involves **identifying** possible solutions and setting targets. **Solutions** (actions) are then implemented and, in the last step, **monitoring** results provides the information needed to evaluate the policy action or become the basis for a new problem-solving cycle.

Let's look at each step of the policy-making cycle in a little more detail.

#### Problem recognition

Data and analysis can:

- highlight problems that need to be addressed in public policy or corporate activities; and
- support problem recognition, and help engage communities in setting an agenda for change.



#### Identification of solutions and target setting

Once a problem is recognized, solutions can be identified and targets can be set in order to:

- provide the analytical backdrop for building agreements among diverse stakeholders;
- serve as the basis for identifying entry points for action; and
- set quantitative targets and track how they are achieved.



### Putting solutions into effect

Once decisions have been made and targets have been set, solutions need to be put into effect, that can:

- underpin policy instruments (on fiscal or regulatory actions; and support decision-making in government programs and corporate operations.



### Monitoring results

Monitoring the results of policy implementation can:

- support the evaluation of government efforts;
- provide accountability (especially if data are accessible to civil society);
- be a basis for learning;
- reduce the risk of poorly-informed, ineffective or wasteful actions.



### Quick tips!

It is important to realize that while forest monitoring results can contribute to all stages of the policy-making cycle, **true policy change requires a window of opportunity combined with the political will** that data and analysis can catalyze but not create. A window of opportunity typically opens in the presence of an actual need expressed by stakeholders, when a sound, technical solution exists and when an external event triggers change.

### Towards impactful forest inventories in the context of an NFMS

Scientific literature outlines the fundamental characteristics that an NFMS should possess in order to efficiently support and inform forest-related policy-making at the national level.

**Main government agency who implements the NFI:** Decision-makers need meaningful and focused messages that demystify statistics, estimates and results.

**Agencies closely related to forestry (e.g. agriculture):** Countries need to make the data inexpensive, quick to obtain, and available in user-friendly formats.

**NFI technicians:** Analyze field data and provide reports in order to ensure that the NFI process is long-lasting, sustainable and affordable.

### Characteristics of NFMS in decision-making

Four key characteristics make forest monitoring systems more impactful to inform policy-making for forests: **Accessibility, Relevance, Reliability** and **Sustainability**.

#### ➤ Accessibility

NFI outputs should be easily accessible to stakeholders and policy-makers, and results and methodologies should be presented and packaged in user-friendly formats. Open data agreements would ensure information sharing among different sectors. Data and analysis need to be conceptually accessible; overly-complex data products will not readily be taken up.

#### ➤ Relevance

Relevance refers to the alignment of the NFI outputs to the original data needs that emerged during the planning phase, and the ability of answering questions that are relevant to national forest-related policy goals and targets, key stakeholder interests and international forest-related policy commitments.

To be relevant, NFI outputs should include spatial and temporal detail and the ability to assess change.

#### ➤ Reliability

Reliability refers to the technical and statistical soundness and known uncertainty of data and analysis, and also implies transparency of definitions, measurements, methods, models, estimation approaches, and sources of uncertainty.

Quality control mechanisms should be in place to avoid (or minimize) sources of error.

#### ➤ Sustainability

Sustainability refers to the affordability of running and maintaining a monitoring system including its databases and information systems. It also implies ownership and long-term commitment and integration with institutional and procedural arrangements, and ensuring that there is a sufficient number of permanent staff with appropriate technical knowledge.

An NFI should ensure consistency of data collection and analysis methods and the comparability of data over time.

### How can recommendations translate into actual policy?

In order to ensure that national forest monitoring systems are relevant, accessible, reliable and

sustainable, all interested parties (or as many as possible) need to work together towards the following goals:

1. Data should be available in an **easily accessible and understandable format**, and results should be tailored to diverse audiences and widely published.
2. Key **government agencies, civil society and academia must work together through all phases of forest monitoring** to continually improve transparency and quality of data and analysis.
3. **Governments can play a leading role in building forest monitoring systems** that generate data with spatial, temporal and thematic detail to respond to the need for data and analysis of multiple stakeholders throughout all stages of public policy-making.
4. **National administrations should operate resource-efficient forest monitoring systems** using domestic funding with strategic international support.

## Country examples

Can forest information influence policy-making?

Information on forests can contribute to forest-related decision-making. In this concluding section of the lesson, we will look at four examples in which monitoring has played a pivotal role in the development of forest policies.

1. Vietnam's efforts to achieve a sustainable forest transition benefitted from the existence of a well-established forest monitoring system.
2. In Cameroon, forest information was instrumental in restructuring the concessions regime in a difficult governance context.
3. Brazil has built several policy instruments from its forest datasets that have helped to invert deforestation trends.
4. New private-sector commitments to sustainability, in various countries, have been motivated by forest monitoring results and use data to underpin decision-making.

### Country Examples

#### **Vietnam**

Vietnam underwent a forest transition in the early 1990s with a three-fold objective: accelerating



agricultural transition, addressing rural poverty, and expanding a self-sufficient forest industry.

When data showed serious forest decline, the government took on ambitious forest-area targets and launched a new monitoring campaign to track progress. The national forest inventories and assessments implemented between 1991–1995, 1996–2000, 2001–2005 and 2006–2010, created a strong information base for policy formulation.

Vast tree plantings were undertaken, in particular the "5 Million ha Reforestation Project (1998-2010)" that aimed to protect existing forest resources, speed up forest planting to improve ecosystems, conserve biodiversity and establish raw material for processing industries.

The government also enacted several partial logging and export bans, using the results of a national forest inventory to tightly control logging, and revised legislation on land and forest protection. In addition, in 2007, the Prime Minister approved the

### **Cameroon**

Over the decades of 1990 and 2000, Cameroon took important steps to reform its forest concessions regime. A fiscal crisis and the need to enhance government revenues triggered efforts to create the basis for orderly forest management and clamp down on corruption.

Upgraded forest management planning required concession-level inventories to be collected and independent forest monitoring became a basis for management oversight. Forest policy progress could therefore be transparently evaluated, based on independent forest monitoring results. It is especially remarkable how in the following decade, the area with approved forest management plans followed an upward trend, which can also be attributed to policy reforms.

### **Brazil**

New fiscal and regulatory instruments and improved law enforcement helped Brazil to cut deforestation by over two-thirds between 2005 and 2014 (although afterwards the trend has inverted, likely due to changing political regimes). Forest monitoring results were not only instrumental in creating the necessary political momentum but became an integral part of several policy instruments – as well as private-sector action. Moreover, forest monitoring allowed Brazil and its resource partners to keep track of progress, and to operate the results-based Amazon Fund.

### **Private sector**

The past decade has seen progressive mainstreaming of deforestation concerns into corporate decision-making. Alarming data on global forest area trends provided evidence for vigorous NGO campaigning. In response, procurement by consumer goods companies, plantation management by agribusinesses and lending decisions by financial firms are being reoriented to address deforestation risks, all drawing on forest monitoring results for operational decision-making

### **Summary**

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

- Forest monitoring can create momentum and inform change, if the conditions are right.
- A window of opportunity for policy change needs to be open, and forest monitoring data needs to be suitable to inform policy-making—this premise can be the basis for designing and operating forest monitoring systems and for targeting capacity development strategically.
- Forest monitoring should not in itself be expected to drive change, but should be thought of as a catalytic element facilitating problem-solving.

## Lesson 3: Common information and reporting

### Lesson introduction

In this lesson, we will consider the ‘what’ aspect of the information commonly collected and reported on within NFIs, ‘why’ that information is critical to international and national reporting, and ‘how’ it is organized.

This lesson also introduces the concepts of criteria and indicators, the related variables that countries typically collect within an NFI, the national and international processes that drive the make-up of those core variables, and critical harmonization efforts that allow comparisons among countries.

While there are a core set of common variables across all NFIs, not all NFIs collect exactly the same data. This is because data needs and priorities in countries are dynamic, as discussed in Lesson1. The NFI variables ultimately included in a given NFI reflect these evolving needs and priorities as well as available budgets.

Additional guidance: How variables emerge from the information needs assessment is addressed in

### Course 2: Preparing for a national forest inventory (NFI).

#### Learning objectives

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

1. Describe how forest information relates to and is used for Sustainable Forest Management (SFM) in national and international reporting processes.
2. Evaluate the importance of criteria, indicators and variables typically recorded in an NFI.
3. Identify the importance of data harmonization.

### Forest information and Sustainable Forest Management (SFM)

#### What is Sustainable Forest Management (SFM)?

Most NFIs conducted around the world **aim to provide information that promotes Sustainable Forest Management**. This is done in order to optimize the benefits of forest resources to meet societal needs in a way that maintains forests now, as well as in the future.

Sustainable Forest Management is a dynamic concept that aims to maintain and enhance the economic, social and environmental values of all types of forests, for the benefit of present and future generations. It comprises [seven thematic elements](#), acknowledged by the [UN Forum on Forests](#) that are used as a reporting framework for FAO's Global FRA Program.

### How do NFIs contribute to SFM?

The information collected from an NFI is used to **prepare forest sector strategies and master plans that adopt the principles of SFM**. As more and more countries are now setting **ambitious targets of reducing carbon emissions and loss of forest cover**, NFIs have become increasingly important because of their **central role in generating data to monitor progress** on meeting these targets.

NFIs provide the most comprehensive data on forests at national level that allow monitoring progress towards SFM.



### Did you know?

NFI-generated data typically include a **core set of forest characteristics**—such as species composition, forest area, age class, volume, biomass and site class. This data provides essential reference information for national-scale planning and support of SFM policies, regulations and practices

Rapid population growth intensified resource consumption, and land-use conversion, compounded with climate-driven threats to forests, continue to propel deforestation globally. These trends imply that policymakers will require broader (and timelier) data, including information on trends and outlooks, demand for food, energy, wood fiber, and employment, as well as rural development. In the context of REDD+ results reporting, NFIs need to also meet the growing demand for evidence of forest management outcomes, particularly from donors.

So how exactly does a country determine progress on SFM? Let's find out next!

### NFI data: Criteria, indicators and variables

### Criteria, indicators and variables

Countries determine progress on SFM through a set of criteria and indicators (C&I) that help to measure, assess, monitor and demonstrate progress toward achieving the sustainability of forest functions in a specified forest area over a period of time.

Progress of any criteria is measured by particular indicators, which are calculated from the necessary variables, these need to integrate by the NFI planners accordingly.

**Criteria** Criteria are related to WHAT kind of information should be derived and define the essential elements against which sustainability is assessed, with due consideration to the productive, protective, and social roles of forests and forest ecosystems. It represents the key aspects of sustainable forest management.

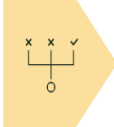


Each criterion relates to a key element of sustainability and may be described by one or more indicators. One can think of a criterion as a condition that should be met to confirm that forests are managed sustainably. This could be, for example, enhancement, protection, or conservation of the essential elements of SFM, Sustainable Development Goals (SDG), Nationally Determined Contributions (NDC), etc.

**Indicators** Indicators are related to HOW to measure progress against each criterion. Indicators are calculated from one or more variables. For example, Volume and Biomass are indicators of calculated from variables like height, dbh (diameter at breast height), wood density, etc. They measure and monitor the status and changes of forests in quantitative, qualitative and descriptive terms.

**Variables** Variables are unique identifiers, or metrics that describe the data being collected. One or a group of variables can define one indicator, for example data on height and dbh (variable) can provide us with information on biomass and volume (indicators).

Variables can be considered as the entities that are being observed in forest inventories. From these variables, indicators may be derived which may be interpreted and evaluated towards the criteria.

Let us understand this better with the help of an example.

	Variables	DBH (ft)	Height (ft)	Species	Forest area (ha)	Wood Density	Tree Species count	Forest type	Number of mammal species
	Indicators	Number of forests	Dependent Species	Species composition	Level of fragmentation	Connectedness of forest ecosystem			
	Criteria	Sustainable development Goals		Biological Diversity					

### Criteria and indicators in SFM

Criteria and indicators have emerged as a powerful tool in promoting SFM, providing a framework that characterizes its essential components, and recognizing forests as ecosystems with a wide range of environmental, economic and social benefits to society. NFIs supply vital information on indicators and variables that can ultimately measure just how sustainable forest management is in a given country.

SFM implementation is based on the Forest Principles, which were included in [Chapter 11 of Agenda 21](#), adopted by many nations at the 1992 [United Nations Conference on Environment and Development](#).

Since then, various efforts have been made to develop criteria and indicators for SFM processes.

Currently, there are six sets of 'C&I for SFM' processes which proactively coordinate and support their member countries. Most indicators are assessed using NFI data that provides the necessary means for monitoring forest sustainability criteria. NFI supplements required information to the policy makers for taking timely management decisions.

While some countries determine and implement C&I under one or even two processes, the degree of activity and/or involvement in the determination and implementation of criteria and indicators may vary considerably between countries. Also, the processes differ in several attributes, such as the forest type for which they were developed (e.g., temperate, boreal, tropical, dry forests), the level at which they are applied (regional, international), and by the number of criteria and indicators to address SFM.

### Examples of NFI variables

While every country has its own specific information needs, a core set of common forest variables are

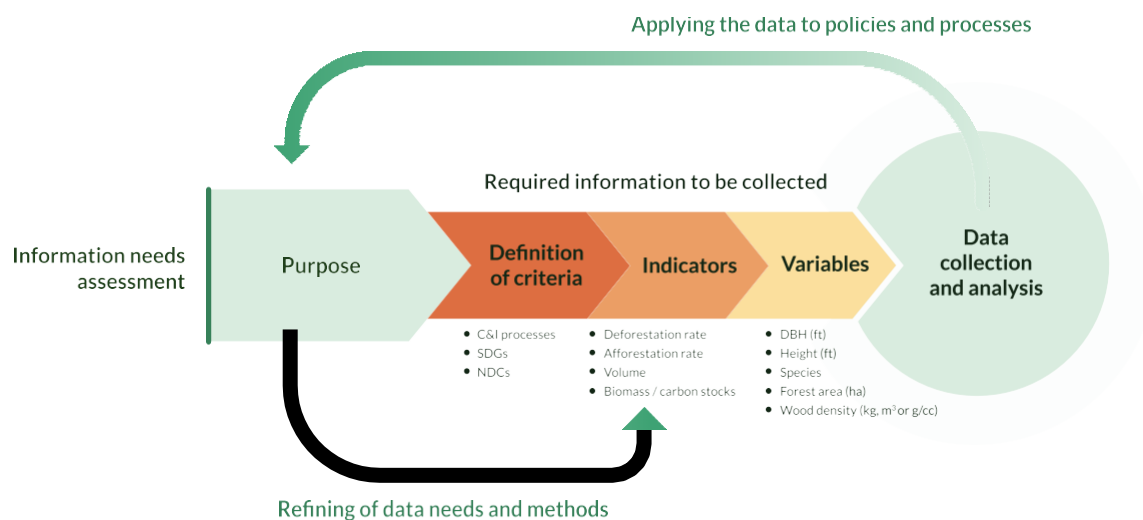
typically included in all NFIs. This core set of forest variables has broadened over the last century to meet new information requirements.

Considering the SFM-oriented C&I described earlier, FAO has compiled a [list of NFI variables](#) as a starting point for countries who request assistance. These variables—both biophysical and socioeconomic—have been defined by international reporting needs and they also coincide, in many cases, with national information needs.

The variables (including their definitions and options) as well as field data **need to be tailored according to country specifications**, based on socio-economic conditions and information requirements at the national level.

### How are variables defined in an NFI?

Together, the criteria, indicators, and variables—as well as the information needs assessment and available resources—define the framework within which the detailed planning of the statistical design of an NFI or NFMS will take place.



Typically, there is a common core set of variables that is a part of any forest inventory, because there are so many common goals among different NFIs. However, when additional variables are added, the indicator/variable decision process is implemented. As shown, the process of translating information needs to these additional indicators and variables is a blend of research and political consensus. This is because the data encapsulated in an NFI are defined through decision processes in forest policy.

## International reporting

### Global Forest Resources Assessment

The FRA reflects the ever-expanding role of forests and has resulted in an increase in the number of indicators and variables requested by countries over the years. *FRA 2020* now includes approximately 60 variables intended to measure progress on SFM.

FRA's 2020 *Guidelines and Specifications* describe the specifications of the FRA 2020 national reporting tables and elaborate on how countries should report on these indicators and variables. It reflects the standing and changing trends of global forest resources.



#### Did you know?

How is data for the seven thematic elements generated?

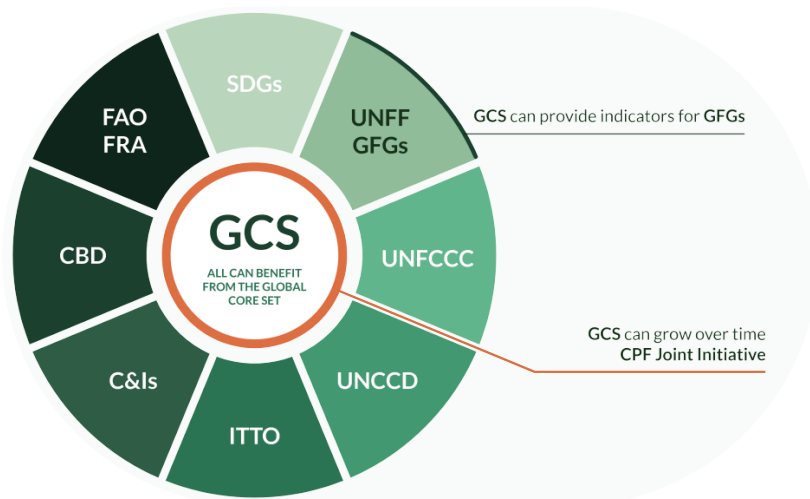
It is useful to remember NFIs alone cannot generate that data on the seven thematic elements - they need to rely on desk studies, remote sensing data, ground data and other ancillary data that can be collected either as part of or independent from an NFI.

### The Global Core Set (GCS) indicators

In recent years, there have been many developments in measuring progress towards sustainable development and SFM goals. One of these is the development of a *Global Core Set (GCS) of forest-related indicators* organized by the *Collaborative Partnership on Forests (CPF)*.

The GCS includes a limited number of indicators, which comprehensively address the topics identified in high-level political commitments. The GCS initiative is intended to streamline and support measuring the progress of a number of major international commitments including SFM and forest-related Sustainable Development Goals (SDGs)





*The Global Core Set (GCS) of forest-related indicators*

*ITTO: The International Tropical Timber Organization*

*UNCCD: United Nations Convention to Combat Desertification*

*CPF: Collaborative Partnership on Forests*

*UNFF: United Nations Forum on Forests (UNFF)*

*GFG: Global Forest Goals*

Created as a one-stop-shop of global indicators, it consolidates multiple international reporting commitments. Proposed indicators to be included in the GCS have already been harmonized with the FRA 2020 reporting process. NFIs can serve as important vehicles through which data is captured for the GCS. For example, forest area change and biomass/carbon stock are key indicators in FRA, particularly to support countries reporting on “Life on Land” within the SDGs indicators.

### **Challenges of data harmonization**

NFI data harmonization, a prerequisite for national and international reporting, is the process of making inventory data and estimates comparable across time (i.e. when attempting to combine repeated forest management inventories), and space (i.e. harmonizing among sub-national inventories or between these, national and supra-national ones). However, differences in forest types between tropical, temperate and boreal forests have repeatedly challenged harmonization efforts, as has the broadened scope of NFIs through the years.

### **Reclassification: Dealing with data harmonization challenges**

The challenge of harmonization is particularly relevant when NFI results must be aggregated to produce larger-area results, such as what FAO's FRA does for the globe or the European Union does for its countries.

The global FRA deals with harmonization challenges through a process of reclassification, which allows national data to correspond to the categories defined for FRA. Reclassification is performed by assigning percentages in a “reclassification matrix” in which each national class is assigned a percentage that applies to each FRA category. After reclassification, estimation and forecasting is necessary to report national data in terms of the FRA reference years.

For some results, harmonization is straightforward and can be implemented without introducing additional uncertainty. In other cases, additional uncertainty cannot be avoided and needs to be accepted.

### **Data harmonization initiatives**

Over the last two decades, a number of initiatives and networks have sought to address the comparability challenges of definitions used in NFIs.

One of these networks, the European National Forest Inventory Network (ENFIN), was established to “promote NFIs as comprehensive monitoring systems by harmonising information on forest ecosystems.” The group seeks to enhance cooperation between organizations in the hopes of continuous improvement of methods, data collection and data analysis within the NFIs.

The **COST Action E43**, a forest data harmonization initiative launched by ENFIN, builds upon and integrates previous harmonisation efforts by establishing a general harmonization approach for European NFIs relying on common reference definitions and bridging functions. Its main objective was achieved through the development of agreed common inventory definitions. The Action developed and relied upon “reference definitions” as the formal basis for harmonization.

The harmonization process of European NFIs has continued through a follow-up initiative Under the Horizon 2020 project called the “ **Distributed, Integrated and Harmonised Forest Information for Bioeconomy Outlooks**” project (DIABOLO Project, 2015-2019).



### Note

#### Use of standard templates to collect variable data

Pre-defined surveys, or templates, that include a number of these variables are currently in development under the FAO-led *Open Foris* initiative that seeks to develop new tools for forest assessments and streamline data collection processes through the creation of survey templates.

These templates will be available for use on *Open Foris Arena*, *Open Foris Collect* and *Collect Mobile*, which is a data collection tool for field-based surveys.

To know more about data management tools, visit Course 5: NFI Data management

### Summary

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

- Sustainable forest management (SFM) is the primary goal of national forest programmes and policies.
- Monitoring progress towards SFM requires criteria and indicators (C&I) that define many core variables of national forest monitoring and assessment.
- NFIs take part in international reporting processes as providers of information.
- International processes like FRA and GCS help guide the variables included in NFIs and provide guidance on how to harmonize definitions, terms and methods to be comparable with other country indicators.
- The common variable list in an NFI is partly composed of standard core variables and partly of country-specific variables that are a product of a comprehensive process that identifies national information needs.
- International reporting depends on harmonization of data, which allows for comparisons of data and estimates among countries and regions.

## Lesson 4: NFI contribution to international reporting process and the climate change agenda

### Lesson introduction

The final lesson of this course evaluates the contribution of NFIs in national and international reporting mechanisms, and describes how they serve as a pillar of climate change data reporting. It also describes how international reporting processes have benefited from installing NFMS in many countries.

**Note:** The subject of reporting as an integral part of NFIs will be addressed in detail in Course 8: Reporting and dissemination of NFI results.

At the end of this lesson, you will be able to explain how data from NFIs is used for climate change reporting.

### Forest monitoring and international reporting

#### Why is forest monitoring critical to international reporting?

In many countries, NFIs are the only national-level process for gathering data on landscapes, vegetation, ecosystems and natural renewable resources. As part of a broader and longer-term effort to monitor forests, NFIs can serve as effective vehicles for providing comprehensive forest-related data for international reporting.

More specifically, NFIs are also contributing towards fulfilling international commitments such as reporting to the [UNFCCC](#), [Convention on Biological diversity \(CBD\)](#), [Global Forest Resources Assessment \(FRA\)](#), as well as progress on the [Sustainable Development Goals \(SDGs\)](#).

#### How NFI data contributes to CBD reporting

Forest biodiversity, crucial to the ecological and economic well-being of society at large, is increasingly threatened as a result of deforestation, forest degradation and fragmentation, climate change and other threats. Countries have now agreed to adhere to international agreements that focus on maintaining, restoring, and monitoring biodiversity, and NFIs are the primary source of data and information that allow them to do so, when it comes to terrestrial and in particular forest biodiversity.

NFIs regularly contribute to the CBD, which focuses on the status and trends in forest biodiversity, and

aim to develop national strategies for the conservation and sustainable use of biological diversity.

[Reports from the Convention](#) are often seen as key documents on sustainable development.



### Reality check

Remember that NFIs can only provide some forest biodiversity-related information, such as landscape fragmentation and tree species diversity. Many biodiversity attributes cannot be smoothly integrated into a typical NFI.

### Country Example: Papua New Guinea

Let's now look at a case study to see how an NFI contributed to national policies and the national forest monitoring system of Papua New Guinea, as well as towards achieving climate change and biodiversity goals. Read the complete [case study: https://www.fao.org/3/cb4911en/cb4911en.pdf](https://www.fao.org/3/cb4911en/cb4911en.pdf).

**Country context** - Papua New Guinea, located on the eastern half of the island of New Guinea in the Asia-Pacific region, has one of the largest extents of tropical forest in the world. The island is highly biodiverse, and a hotspot for endemism. Forests are very important economically, culturally and spiritually, with a majority of the population relying directly on forests for their livelihoods.

**Papua New Guinea launches its first NFI** - Together with Costa Rica, Papua New Guinea proposed the concept of REDD+ to the UNFCCC back in 2005, and since then has been working on preparing for REDD+ and setting up its NFMS. The country officially launched its National Forest Inventory (NFI) in March 2016, and field activities began in May 2017. Using its NFI data, Papua New Guinea submitted its Forest Reference Level to the UNFCCC in 2017 and the same year prepared its National REDD+ Strategy as well.

**Commercial logging as a driver of deforestation** - In 2018, Papua New Guinea submitted its first Biennial Update Report including the REDD+ Technical Annex, which showed that commercial logging was the primary driver of deforestation in the country. This led to the establishment of the National Timber Legality Verification System.

**Importance of education and training for the sustainability of NFIs** - NFI data is already being used

to support policy and decision making in Papua New Guinea. The project recognized the importance of education to the continuation and sustainability of NFIs. NFIs and sixteen scholarships for Master of Philosophy studies on NFIs were issued. Additionally, with the support of two universities, trainings were conducted and manuals and field protocols were produced on data collection, management, and analysis.

### **NFI contribution to the Global Forest Resources Assessment**

Data, obtained through a transparent, traceable reporting process and a well-established network of officially nominated national correspondents, is at the core of the FRA process. The [FRA 2020 main report](#) highlights that data on growing stock, biomass and carbon is becoming more robust as more countries conduct national forest inventories as part of their NFMS. In many cases, however, historical data can be inaccurate or insufficient, affecting the reliability of trend analyses.

For complete access to the FRA reporting and dissemination platform check the Global Forest Resources Assessment Platform: <https://fra-data.fao.org/assessments/fra/2020>

### **Learning from FRA data**

[A study on FRA data](#) shows substantial improvements in national forest monitoring capacities around the globe. Forest area monitoring using remote sensing at good to very good levels increased from 55 countries in FRA 2005 to 99 in FRA 2020. The number of countries with good to very good use of NFI rose from 48 in FRA 2005 to 102 in FRA 2020.

The same study also concluded that tropical countries have started to implement NFIs, but multi-date or even permanent NFIs remain rare, particularly in Africa and parts of Asia and South America.

Globally, 53 percent of the countries use the highest quality data for reporting forest area status covering ~93 percent of the forest cover. However, the use of the highest quality data is lower for monitoring growing stock, biomass, and carbon pools in Africa, parts of Asia and South America, and Eastern Europe.

Therefore, greater efforts should be made in these regions to enable countries to implement NFIs which will also help to improve data quality, especially for the biomass and carbon pools that depend on NFI data.

### NFMS and the SDGs

In September 2015 at the UN Sustainable Development Summit in New York ("[Transforming our world: the 2030 Agenda for Sustainable Development](#)") 17 [Sustainable Development Goals \(SDGs\)](#) were formulated and adopted. While the 17 SDGs formulate generic and quite abstract goals, they are specified each into concrete targets, publications, events and actions so that they are well operationalized. Forests have manifold functions that relate to the SDGs: forests contribute to rural livelihoods, forests provide a source of energy, forests help maintaining biodiversity and clean water, forests contribute in general to human health, forests grow resources like wood and NTFPs that are the basis for rural industries thus contributing to the economic development.

NFMS thus provide a piece of information required to monitor the achievements towards the SDGs. This refers mainly to [SDG15](#) "Life on land": Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

In SDG15, forests are explicitly mentioned as one relevant domain. However, the development of the forests in a country have also a meaning for other SDGs including [SDG1](#) (no poverty), [SDG2](#) (zero hunger), [SDG3](#) (good health and wellbeing), [SDG6](#) (clean water and sanitation), [SDG7](#) (affordable and clean energy), [SDG13](#) (climate action).

### Forest monitoring and climate change reporting

#### Halting forest loss and degradation

It is useful to know the role of forests in the climate change discussion to better understand the role that NFMS play therein.

The Agriculture, Forestry and Other Land Use (AFOLU) sector is one of the most significant sources of global greenhouse gas (GHG) emissions and accounts for about a quarter of global emissions, ranking second to only transportation. Reducing forest loss can have multiple benefits for ecosystems and people:



Cutting GHG  
emissions

Sequestering  
carbon

Providing  
other  
ecosystem  
services

Maintain intact  
functioning  
forest

Reducing forest loss has multiple benefits for ecosystems and people - cutting GHG emissions, sequestering carbon, providing ecosystem services and maintaining intact, functioning forests

Halting the loss and degradation of forest ecosystems and promoting their restoration has the potential to contribute to climate change mitigation that is required to meet the objectives of the [Paris Agreement](#) by 2030.

### Initiatives to combat climate change

Climate change is undoubtedly one of the most significant challenges that we face today. Over the last half century, the international community has established conventions, which are legally binding agreements between states of the United Nations, and pledged global and national commitments in an effort to galvanize action to combatting climate change. Let's look at some key milestones that laid down principles that are followed even today in the fight against climate change and environment degradation.

#### ↳ **First Earth Summit (1972)**

The UN Scientific Conference was held in Stockholm in 1972. Also known as the First Earth Summit, the conference adopted a declaration that set out principles for the preservation and enhancement of the human environment and launched an action plan containing recommendations for international environmental action.

#### ↳ **United Nations Conference on Environment and Development (1992)**

In Rio, the United Nations Conference on Environment and Development was held in 1992. This conference saw 172 governments adopt three major agreements to guide future approaches to



development:

- Agenda 21, a global plan of action to promote sustainable development;
- the Rio Declaration on Environment and Development, a series of principles defining the rights and responsibilities of States; and
- the Statement of Forest Principles, a set of principles to underpin the sustainable management of forests worldwide.

In addition, two legally binding instruments were opened for signature at the Summit: the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity.

### **Kyoto Protocol (1997)**

In Japan, the international community took a concrete step to combat global warming as part of the Kyoto Protocol, with 192 countries agreeing to reduce net global emissions by 5.2 percent below 1990 levels.

### **Warsaw Framework for REDD+ (WFR)**

Adopted at COP 19 in Warsaw, December 2013, this provides the complete methodological and financing guidance for the implementation of REDD+ activities.

### **Paris Agreement**

In December 2015, world leaders gathered in Paris for one of the biggest climate conferences of all time. At this 21st Conference of the Parties (COP21), the global community again made significant decisions to collectively tackle the challenges related to climate change.

The Paris Agreement, negotiated and adopted by representatives of 196 state parties during the COP21, is a legally binding international treaty on climate change. The agreement is a landmark treaty in the multilateral climate change process because for the first time in over 20 years of UN negotiations, a binding agreement brought all nations together for a common cause—combating climate change and adapting to its effects.

The goal outlined in the Paris Agreement is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.

The explicit mention of forests in [Article 5 of the Paris Agreement](#) sent a clear signal halting

deforestation and forest degradation could no longer remain a marginal topic but needed to be a part of high-level domestic political agendas. It stipulated that Parties should:

- conserve and enhance their reservoirs of GHGs, including forests,
- implement and support—through results-based payments—the existing framework and decisions agreed under the Convention for:
  - a) incentivizing activities related to reducing emissions from deforestation and forest
  - b) emphasizing the role of conservation, SFM and enhancement of forest carbon stocks in developing countries; and
  - c) reinforcing adaptation approaches for SFM with a continued focus on the associated non-carbon benefits.

The message was clear—forests and climate are intrinsically linked: forest loss and degradation are both a cause and an effect of our changing climate.

### **National forest monitoring data for climate reporting**

By acting as an essential carbon sink, forests can contribute to approximately one-quarter of total emission reductions planned by countries. And that's not all. Forests play four major roles in climate change:

1. They currently contribute about one-sixth of global carbon emissions when cleared, overused or degraded.
2. They react sensitively to a changing climate.
3. When managed sustainably, they produce wood fuels as a benign alternative to fossil fuels and energy-intensive materials.
4. They have the potential to absorb significant volumes of carbon into their biomass, soils and products and store them for extended periods of time.

Hence, forest monitoring is critical because it informs to what extent countries stay on target with emission reduction goals. For some countries, forest monitoring serves as the evidence base required to

prove emissions reductions, a requirement for result based payments. Additionally, establishing a NFMS enables countries to align their forest policies with up-to-date, reliable, transparent, and accessible information.



### Did you know?

#### **How do countries intend to meet the goals set out in the Paris Agreement?**

Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of the long-term goals it sets out to achieve. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.

Parties are requested to submit the next round of NDCs (new NDCs or updated NDCs) by 2020 and every five years thereafter (e.g. by 2020, 2025, 2030), regardless of their respective implementation time frames. Visit the [NCDs public registry website](#) for additional information.

#### **Which data acquired from an NFI is used for climate reporting?**

The NFI allows a country to estimate greenhouse gas emissions and removals associated with forests as it includes field measurements that allow the estimation of forest carbon stocks and changes.

All results of sample-based NFIs are generally estimates (e.g. estimated mean values such as biomass per hectare) and are accompanied by a measure of uncertainty (e.g. error variances and confidence interval).

Specifically, volume, biomass, and carbon stock are not directly measured in the field, but are predicted using tree-level allometric equations, converting direct measurement of a tree's height and diameter at breast height (DBH) to estimate carbon content. NFIs are a valuable source of data for emissions and removals estimations, in particular, with respect to above-ground biomass, and by extension below-ground biomass. NFIs increasingly include the dead wood pool, and some countries have started also to collect data related to soil organic carbon and litter, although estimating temporal change in these pools

is challenging (Global Forest Observations Initiative (GFOI), 2020).

### Country Example

#### How South Korea used the NFI to assess the carbon storage of soil and litter

Having identified soil and litter carbon as priority information needs, South Korea decided to use their NFI as a vehicle to obtain this information. Soil and litter plots were included in the inventory and carbon stocks were assessed at 0-30 cm. They were then able to map their soil and litter carbon stocks with valuable data obtained from the NFI combined with random forest models.

Three main types of forest in South Korea were studied - **coniferous, deciduous, and mixed**.

#### Litter and soil at 0–30 cm carbon stock in South Korea (unit: t C ha<sup>-1</sup>, mean ± standard error)

Results showed that the litter carbon stocks (t C ha<sup>-1</sup>) were:

Coniferous: 4.63 ± 0.18 | Mixed: 3.98 ± 0.15 | Deciduous: 3.28 ± 0.13

The soil carbon stocks (t C ha<sup>-1</sup>) were:

Coniferous: 33.96 ± 1.62 | Mixed: 35.75 ± 1.60 | Deciduous: 44.11 ± 1.54

Note: Numbers with the ± symbol denote the central estimate (e.g. mean) and its associated error, which can be added or subtracted from the mean estimate

### Capacity development initiatives in forest data monitoring

Capacity development has led to unprecedented transparency of forest data, with a growing number of countries able to meet international reporting requirements. Furthermore, continued capacity development on the NFMS and experience from REDD+ reporting have both provided useful lessons in drawing up the **Paris Agreement's enhanced transparency framework** in the forest sector. Under this framework, robust data collection is at the basis for reporting on emissions and removals and tracking Nationally Determined Contributions (NDC) progress.

### REDD+ WEB PLATFORM

An NFI is essential for estimating forest-related emissions and removals for the Land Use, Land Use Change and Forestry (LULUCF) or Agriculture, Forestry and Other Land Use (AFOLU) sector, including the emissions reduction mechanism under REDD+. Learn more about the efforts to reduce emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries on the [REDD+ web platform](#).

### THE NATIONAL GREEN HOUSE GAS INVENTORY FOR LAND USE

The Intergovernmental Panel on Climate Change (IPCC) has developed and continues to refine an internationally recognized method for calculating and reporting national greenhouse gas emissions and removals, encouraging its use by country signatories to the UNFCCC. You can learn more about the use of the IPCC guidelines for estimating emissions and removals in the land-use sector by accessing the FAO elearning course on [The national greenhouse gas inventory \(NGHGI\) for land use](#).

### FOREST AND TRANSPARENCY UNDER THE PARIS AGREEMENT

You can learn more about the role of forest data in the battle against climate change in the FAO eLearning course: [Forests and transparency under the Paris Agreement](#). This training is also available in [French](#), [Spanish](#) and [Chinese](#), [Arabic](#) and [Russian](#).

### Summary

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

- In many countries, NFIs are the only national-level process for gathering data on landscapes, vegetation, ecosystems and natural renewable resources.
- Countries have now agreed to adhere to international agreements that focus on maintaining, restoring, and monitoring biodiversity, and NFIs are the primary source of data and information that allow them to do so, when it comes to terrestrial and in particular forest biodiversity.
- Forest monitoring is critical because it informs to what extent countries stay on target with emission reduction goals.