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SECTION I: Background

The context

Forest monitoring has become a key issue in national and international environmental and developmental policy processes.

Information provided by forest monitoring activities plays a key role in many international agreements, such as the Rio Conventions (The United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Biodiversity (CBD), and the United Nations Convention to Combat Desertification (UNCCD)) and the Non-legally Binding Instrument on all types of forests (NLBI) of the United National Forum on Forests. In most of the cases, this information goes beyond forest boundaries and can be used as an indicator of biodiversity, production, hydrology, soil conservation, watershed management and urban/rural planning issues.

At the same time, national information needs on forests have grown considerably in recent years. These needs have evolved from forest area and growing stock information to cover other key aspects of sustainable forest management such as the role of forests in the conservation of biodiversity and the provision of other ecosystem services. More recently, information on carbon stocks, socio-economic aspects - including the contribution of forests to livelihoods and poverty reduction - governance and broader land use issues has become critical, for national planning purposes.

While the forest sector faces an increasingly large diversity of information needs on forest and land use, the capacity to collect, compile and analyze data and to generate and disseminate information and knowledge related forest resources tailored to the target audience needs strengthening in many countries. In 2010, only 45 countries worldwide were able to assess changes in forest area and characteristics through consecutive systematic national forest inventories¹.

¹ Food and Agriculture Organization of the United Nations (FAO).2010. Global Forest Resources Assessment 2010. Main Report. FAO Forestry Paper No. 163. Rome, Italy. 143 p

The need for improved forest monitoring is not new, and has been increasingly demanded in recent years, e.g. in decision 1/CP.16 of UNFCCC COP 16 (the Cancun Agreements²), which requested developing country Parties aiming to undertake REDD+ activities to develop “*robust and transparent national forest monitoring systems*” for monitoring and reporting REDD+ activities.

To address these needs, FAO has been supporting countries design and implement national forest inventories and information systems for many years.

During the last session of the Committee on Forestry, member countries recommended that FAO continue to support countries strengthen national forest information systems and requested FAO to “*work in close collaboration with member countries and relevant organizations to prepare a set of voluntary guidelines on national forest monitoring, which takes into account the requirements for REDD+ reporting and is in line with the principles and goals of the Forest Instrument*”³

The general role and justification of national forest monitoring

For the purpose of this document, national forest monitoring is viewed as a comprehensive process that includes the collection, analysis and dissemination of forest-related data and the derivation of information and knowledge at regular intervals to allow the monitoring of changes over time. It focuses on national level data and information on forests and trees outside forests, their condition, values and uses. The information obtained supports forest-related decision making at international, national and sub-national levels by providing timely, relevant and reliable information.

The term “National Forest Inventory” (NFI) is commonly used to describe the technical process of data compilation and analyses of forest resources from a multitude of data sources, including field

Box 1: The monitoring of forest resources has a long history. For centuries, forest managers have carried out standard data collections in their forests on a regular basis in order to have a data basis for proper mid-term planning and to optimize their forest management. Increasingly, also conservation groups and other fields are requesting data on the forest ecosystems and on forested landscapes when it comes, for example, to define bio-corridors or protected areas.

National Forest Monitoring refers to the national level and is to inform forest-related decision making on national level.

Historically, the major national interest in forests was in wood production and in using forest land as a reserve to meet future demands for conversion to other land-uses. Many national level forest inventory projects were installed in developing countries in the 1960s-1980s funded by international organizations and by bilateral programmes of technical cooperation – many of them implemented through FAO. These projects usually produced valuable information for one point in time and then disappeared without leaving much in terms of sustainability; the data are frequently not accessible any more, capacity has not been maintained nor further developed and permanent institutions were not built that could manage the data sets and establish a permanent national level forest monitoring programme.

Major publications by FAO on planning and implementing forest inventories stem from that time (Husch 1971¹, FAO 1981²); and attempts were undertaken then to develop forest inventory data processing systems to allow for basic standardized analyses.

¹ Bertram Husch. 1971. Planning a Forest Inventory. FAO, Rome.

² FAO 1981. Manual of Forest Inventory. FAO Forestry Paper 27.

inventories and remote sensing. “National Forest Monitoring” is a much more comprehensive process that includes the assessment, evaluation, interpretation and reporting of the data and the derivation of information, usually from repeated inventories that allow for the monitoring of change and trends over time. In many countries, however, the term “National Forest Inventory” is traditionally used also for the whole process of national forest monitoring.

Goals and scope of national forest monitoring

The goal of national forest monitoring is to generate a reliable data and information base

² UNFCCC (United Nations Framework Convention on Climate Change). 2011. 1/CP.16 The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention. In: Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010. Available at: <http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf>

³ FAO (Food And Agriculture Organization of The United Nations). 2012. Report on the Committee on Forestry, Twenty-First Session: COFO 2012/REP paragraf 50, page 7. Rome, Italy. Available at: <http://www.fao.org/docrep/meeting/026/me988e.pdf>

- 1) to support formulating, monitoring and adjusting national and sub-national level policies related to forests and to forested landscapes;
- 2) to inform interested citizens and stakeholders (including forest owners, environmental NGOs, forest-based industries, research organizations, academia etc) about the status and development of the forests and its many characteristics and services at the national level;
- 3) to facilitate discussions and the development of agreements at the international level and to report to international conventions and processes that request the signatory nations to report on a regular basis using pre-defined questionnaires.

As such, national level forest monitoring pursues exactly the same goals as many other data gathering activities that national governments implement, either permanently or on a regular basis: most nations have a population census at fixed time intervals that informs the government about social and economic characteristics of the population.

Economic data are collected to adjust fiscal and monetary policies, agricultural data are collected to monitor government subsidies, and intelligence agencies provide the governments with data and information on national security issues; to name just a few.

It is probably justified to look at forest monitoring as a normal data provision requirement for good “environmental governance”. Only by having a comprehensive, reliable and transparent data base can informed decisions be made, communicated and defended on scientific grounds.

Increasing information needs at national level

Contrary to other national information needs, long-term information on forest resources and on the forest ecosystem has been considered by governments in developing countries to be of lesser importance for decades. However, the view on the relevance of up-to-date forest information has changed considerably over the past years and decades. By pointing to the outstanding role that forests play in biodiversity, climate change, combating desertification, securing livelihoods and to efforts towards increasing food security, the UN has put forests very high on the global agenda and has assigned a much higher priority to forests, their conservation and their sustainable management and supports member states in their efforts to protect and sustainably develop their forests.

The sustainability of forest management and forest policies is at the core of national forest planning; and national forest monitoring should provide the scientific information base to support implementation and monitoring of national forest programmes and forest development plans. The criteria of sustainable forest management, therefore, define the framework for national forest monitoring; and the indicators of sustainable forest management define the core set of attributes to be surveyed, assessed and monitored in national forest monitoring (see section below).

Box 2: National level forest inventory and monitoring has long been looked at as an exclusively forestry issue, not receiving much attention from other sectors nor from the governments in many countries. For long time periods, hardly any efforts or investments were made by governments in developing countries: national forest inventory and monitoring was mostly implemented by projects of technical cooperation through international or bilateral cooperation. They had usually the character of projects rather than programmes, were limited in time and scope and were not sustainably institutionalized within the national administration.

This has changed considerably and many countries now recognize their forests now as a national asset about which up-to-date data and information needs to be available in order to monitor status and changes over time and as a basis for informed decisions.

National forest monitoring may be considered a standard survey activity just as other activities that governments implement in order to be informed, including population census, community surveys, economic surveys.

“If you start out with certain broadly pro-democratic assumptions (that democracy is the best form of government and works best with well-informed voters and high-level of participation), reliable, publicly available data is vital for a healthy country, just as symmetric information (which includes publicly available data) is essential for efficient markets” (Gelman and Palko 2013)¹

¹ Gelman A and M Palko. 2013. Ethics and statistics: the war on data. *Chance* Vol.28, No.1, 2013, p.59.

Where payment for environmental services are being developed - and in REDD+ -- developing countries will be financially rewarded for successful implementation of “pro-forest sustainable policies” and the corresponding payments in many programmes will be strictly performance-based and released only when there is credible evidence that the agreed and announced goals have been achieved. This credible evidence is largely generated by forest monitoring efforts.

However, governments in many developing countries have not invested in the permanency of national level forest monitoring, which has caused a considerable capacity gap in many countries (Herold 2009, Romijn et al. 2012). To cope with increasing information needs and the increased demand for expertise in national forest monitoring, comprehensive efforts need to be undertaken to build or strengthen such national capacity and this also requires establishing an institutional setting for forest monitoring and related activities.

Key issues and key questions for national forest monitoring

National forest monitoring in these Voluntary Guidelines is based on the premise that forests constitute one land use system embedded in other land use systems within landscapes and that forestry represent one sector that is closely interlinked and interacting with other sectors.

National forest monitoring strives to produce information that improves the understanding of the roles of trees and forests in the relationships and interactions between the different land uses. It strives to inform decision processes towards an improved sustainable management of these landscapes in order to maintain and enhance their environmental and socio-economic service functions in a broad sense to support sustainable development and to contribute to the well-being of people and societies. By that it becomes obvious, that national forest monitoring takes into account not only the biophysical dimension but also the dimensions of economy and society.

National forest monitoring should not focus exclusively on lands that are defined as forest, but include all other lands that have trees; a resource which is usually referred to as “trees outside forests”. And it should not only look at the biophysical stocks, but also at the use of forests and trees. This implies that not only measurements of biophysical variables are done but also interviews with forest owners and those who use the forest or who benefit from forests. By doing so and by analyzing the current uses and the expectations of the forest users, relevant insights are gained about the efficiency of forest related policies and about potential trends.

Data and information provided by national forest monitoring systems are of interest for various domains including all those domains on national level which deal with issues related to land use such as forestry, agriculture, biodiversity conservation, urban development, wood industry, community development etc. The generated data inform decision processes at national and international levels, but also research. In particular in the context of large area mapping and the estimation of carbon stocks and biodiversity indicators, data from national forest monitoring efforts are increasingly used in research projects and as crucial input for the discussions within the UNFCCC.

National circumstances vary with respect to land uses and forest types, with the socio-economic and environmental role of forests, the expertise and institutions, and with the position that national forest monitoring has on the political agenda. Also, expectations of the information users vary. But there are some common key technical questions that usually drive national forest monitoring. In the optimal case, these questions are being determined and collated by a comprehensive formal information needs assessment, a process that experts in forest monitoring need to closely coordinate with as many of the relevant information users as possible.

These key questions commonly include:

What and how much is out there – and where is it (area by forest type and ownership; growing stock, biomass, carbon; diversity, removals, ...)?

What are structure, quality, vitality? Are there threats ?

How is the forest and tree resource being used? Is utilization sustainable? What are hindrances to sustainable utilization?

*Who is benefiting from / depending on the services of forests? And how?
 What are the changes and trends in the development of the forests and its functions?
 Can indicators or drivers of such changes be identified?
 What are relationships between different variables?
 How accurate and precise are the estimates?*

To efficiently provide the required information, various data sources are being employed in national forest monitoring, the most important being (1) sample based field observations, (2) remote sensing, (3) allometric models and (4) available prior information from earlier monitoring studies.

Adjusting to the specific goals, the most efficient blend of data sources is used in national forest monitoring: when the production of maps and spatially explicit analysis is in the foreground, there needs to be a strong remote sensing component. If estimation of statistical precision of core attributes is the major focus, a sufficiently large sample size of field observations is crucial as are appropriate allometric models.

There is no “one-fits-all” design for national forest monitoring. The design planning is always a demanding optimization process.

Box 3: *National forest monitoring has two major dimensions: (1) the technical-scientific dimension of producing relevant, high-quality and credible data and (2) the policy dimension.*

When designing and implementing a national forest monitoring system, both dimensions must equally be in focus. It must never be considered a mere technical task since it always serves a function in complex information and decision processes. Mere technology driven approaches to more comprehensive data collection are sometimes tempting but should be avoided; unless their efficiency can be evidenced.

Planners of national forest monitoring systems must understand the policy processes to which they give support, and must be able – in the planning phase - to translate the information requirements of these processes into attributes, that can be measured or observed in forest inventory systems.

Likewise – in the analysis and reporting phase - they should be able to convert the results of monitoring into messages and stories that are relevant and meaningful for those who drive the related policy processes.

Many technical questions need to be dealt with and, at times, the design of national forest monitoring systems is seen as a mere technical exercise. The key issues and key questions as presented here, however, should make it clear that forest monitoring has two major dimensions: (1) the technical-scientific dimension of producing relevant and credible data and (2) the policy dimension that refers to the translation of data into meaningful information and the target-oriented use of such information. National forest monitoring must never be exclusively technology driven or considered a mere technical task: it is never an end in itself but serves a specific function within complex information and decision processes.

Indicators of sustainable forest management as core attributes to be assessed in national forest monitoring

Sustainable forest management is the ultimate goal of national forest programmes and policies. Therefore, criteria and indicators for sustainable management define the core attributes of national forest monitoring and assessment.

“Criteria and indicators are tools used to define, assess and monitor periodic progress towards **sustainable forest management** in a given country or in a specified forest area, over a period of time. **Indicators** are parameters which can be measured and correspond to a particular criterion. They measure and help monitor the status and changes of forests in quantitative, qualitative and descriptive terms that reflect forest values as seen by those who defined each criterion” (FAO. 2008. <http://www.fao.org/forestry/ci@45047/en/>).

Sustainable forest management has the following seven thematic elements, which are acknowledged by the UN Forum on Forests and which are used as a reporting framework also for FAO’s Global Forest Resource Assessment Programme FRA. The term “forest resources” in these thematic elements comprises the class “trees outside the forest” (TOF) as well (<http://www.fao.org/forestry/sfm/24447/en/>):

1. Extent of forest resources;

2. Forest biological diversity;
3. Forest health and vitality;
4. Productive functions of forest resources;
5. Protective functions of forest resources;
6. Socio-economic functions of forests;
7. Legal, policy and institutional framework.

National forest monitoring is recording data, producing information and reporting predominantly on the thematic elements 1 - 6, focusing on status and trends.

The Forestry Instrument (Non-Legally Binding Instrument on All Types of Forests) makes explicit reference to these 7 thematic elements when recommending countries to develop monitoring programs and to design research programs (e.g. UNFF/ECOSOC 2007⁴). Forest monitoring is to accompany these processes by providing information to design and monitor them.

Forest monitoring as complex undertakings

Forests are complex systems and their monitoring requires approaches and techniques that exhibit likewise a certain complexity: National Forest Monitoring is driven by interests of many stakeholders, it involves many actors and it draws upon a suite of data and information sources, including remote sensing, field observations, existing maps, reports and other documents and expert information. Data on many and very diverse forest and landscape attributes are recorded, stored and processed, serving as indicators to produce the required policy-relevant information.

The major scientific disciplines that are involved in the technical side of forest monitoring are forest mensuration, forest inventory, statistical sampling, statistical modeling, botany, remote sensing and information systems. Experts that manage all these fields are scarce if not largely absent in most developing countries. This has also to do with the fact that large area forest inventory and forest monitoring is rarely covered by academic curricula. Forest inventory courses are usually exclusively focusing on forest management inventories because this is a field that is needed in many countries for the establishment of forest management plans which in turn is a prerequisite to obtain wood harvesting permits. As a consequence, national capacity and national expertise in the technical side of national forest monitoring has not been systematically formed in academia in most developing countries.

Box 4: “Good decisions require good information” – this or similar general statements are frequently used to justify data collection projects. We also make this “linear” assumption when establishing national forest monitoring systems. Similar statements are used in scientific research when it is about improving forest inventory and remote sensing techniques.

However, it should be noted, that there is hardly any scientific research nor evidence regarding national forest monitoring that establishes a clear relationship between information quality and decision quality; and political sciences stress that policy processes are usually not just following simple linear and rational lines.

The reason is probably that, while it is scientifically relatively straightforward to quantify data quality from statistically based estimation, it is much more difficult to evaluate “information quality” and eventually “quality of decisions”.

However, beyond this stipulated simple “linear” relationship between information quality and decision quality: scientific information coming from national forest monitoring, if appropriately packaged and communicated, will always inform stakeholders and interested parties and the public, and will contribute significantly to reducing speculations.

The need for voluntary guidelines

The scientific foundation in national forest monitoring is urgently needed to properly plan and implement such systems: it is generally accepted that credibility can only be generated by strictly

⁴ United Nations Forum on Forests Report of the seventh session / Economic and Social Council, Official Records, 2007, Supplement No. 22 (E/2007/42 E/CN.18/2007/8): “V. National policies and measures” paragraph (t) and (w); and “VI. International cooperation and means of implementation” paragraph (o).

following science-based forest monitoring - otherwise, any finding can be disputed on scientific grounds.

Many national level forest monitoring projects have been successfully implemented. FAO has been intensively supporting various countries through its National Forest Monitoring and Assessment (NFMA) Programme since the year 2000; and has developed an approach that has been adjusted to national circumstances and adopted successfully in many developing countries asking for such technical and organizational support.

There are many disciplinary textbooks in all fields relevant to forest monitoring covering all technical aspects of data collection, statistical analysis, image processing and interpretation; and there is a wealth of scientific articles for many specific technical-scientific questions of forest monitoring.

National level forest monitoring systems, however, can usually not be designed along textbooks examples, nor is there a one-fits-all design. The design needs to be tailored to the particular national circumstances in terms of biophysical conditions, infrastructure, objectives, human and financial resources etc. It is partly a scientific challenge, but also an organizational challenge with a number of policy and communication implications.

Scope and goals of the guidelines

While there is no such thing as a “best forest monitoring practice”, there are a number of widely accepted principles and basic elements along which a successful national forest monitoring system should be designed. What appears to be missing within the wealth of publications is a compilation of guiding principles for national level forest monitoring, based on science and on implementation experiences, covering the wider context of adjusting a monitoring methodology to the whole set of national circumstances. The aim of the Voluntary Guidelines is thus to compile good practice principles, guidelines, lessons learned and selected methodologies and tools and to present a general framework and a set of decision-support tools for planning and implementing a multi-purpose national forest monitoring system grounded in nationally appropriate and scientifically sound practice taking into consideration national information needs as well as international reporting requirements.

The Guidelines will not only be looking at the technical-scientific approaches to optimizing inventory, statistical modeling and estimation and remote-sensing, but also include guidance on strategic planning, information packaging and communication and dissemination of results. They will build on the experience and lessons learned by FAO member countries and by past and present FAO projects and initiatives including the Global Forest Resources Assessment Programme, the National Forest Monitoring and Assessment Programme and the UN-REDD Programme among others.

The Guidelines will be designed as a technical reference intended for governmental bodies in charge of forest monitoring, the public and private sectors, educational and research institutions, as well as the civil society concerned with national forest monitoring.

In essence, the Guidelines as they are presented here intend to offer a blend of (1) science bases and (2) implementation experiences and aim to serve as a hands-on reference for those who craft the design of a national forest monitoring system. Scientific-technical details will not be covered in detail, but only briefly addressed and reference will be made to the corresponding scientific literature.

One of the major goals of these Guidelines is to support the national forest monitoring design process.

Another important goal is to contribute to developing basic standards (or elements of standards) that facilitate comparison in space and time. This also includes standardization of terminologies. Much confusion arises in the wider forest monitoring context because terms are differently understood or differently used. It is frequently not so much about the question which terminology is “right or wrong” or “correct or incorrect” but it is about “clearly defined” and “not clearly” defined.

These guidelines also wish to contribute to streamlining terminology in national forest monitoring.

Box 5: Terminology is key in all surveys. *Without clearly defined terms and methods, the results of an inventory cannot be unequivocally understood nor interpreted, nor can they be properly communicated.*

SECTION II: Principles of National Forest Monitoring

Basic considerations

Forest monitoring is done to inform decision processes and is as such one component in comprehensive decision processes. It is never an end in itself, but has an explicit serving function in ongoing processes. For national forest monitoring, the context and justification are those national and sub-national policy processes and decision processes that strive to enhance and monitor the implementation of all thematic elements of sustainability of forest management. These processes may take place in different sectors, not only within forestry. Many actors are involved in these processes at different government levels and administrative levels, and a variety of other interested parties accompany them, including NGOs and research institutions.

This challenge of enhancing sustainable forest management at the national level and mainstreaming it into national policies is guiding the formulation of the principles of these voluntary guidelines on national forest monitoring. While no such principles have been explicitly compiled before, various principles have been addressed in different contexts, including the “Forest Instrument” (the non-legally binding instrument on all types of forests), the “IPCC guidelines for greenhouse gas inventory”, and various UNFCCC CoP decisions related to REDD+. In addition, the long history and the comprehensive research and development on national forest monitoring have shaped what can be named principles.

The Principles of National Forest Monitoring

National forest monitoring systems exhibit various dimensions which can be addressed by various groups of principles:

- 1) Governance Principles, referring to the institutional setting and governance,
- 2) Scope Principles, referring to the identification of information needs,
- 3) Design Principles, referring to data collection and analyses (including sample based field inventories and remote sensing analyses), and
- 4) Data Principles, referring to information generation, reporting and dissemination, and, in particular, to data availability.
- 5) Overall principles, which suggest general guidelines

Governance principles

1. Country ownership and responsibility

Implementing a national forest monitoring system and generating a reliable database on the forests of a country and their uses is primarily a national issue. Knowledge generated by a national forest monitoring system informs national governments and provide input to facilitate informed decision making. It informs the society and NGOs so that speculation in policy discussions about the status and trends in forests can be replaced by scientific evidence.

As such, national forest monitoring should be considered a standard data collection activity of a government that supports informed decision making and informed discourses.

National forest monitoring must therefore, be based on country ownership. This is the best way to guarantee sustainability and to pave the way for a comprehensive usage of the information generated.

Box 6: *Lack of considering and pro-actively fostering country ownership from the beginning may be seen as one of the major failures of early national forest inventory and national forest monitoring efforts, as carried out by many donor and international agencies in the 1960s-1980s. Many of these inventories were implemented as projects with a defined lifespan, defined resources and without a clear follow-up vision.*

The lack of country ownership came probably both from a lack of awareness in the national governments, who were not willing or able to invest into this project, and from a lack of considering this as an important component on the donor's side.

As a consequence and in retrospect, with exception of few examples, these inventories might have produced very relevant findings for one point in time, but they have not developed into long-term monitoring programmes nor has country capacity sustainably been built.

In various cases it is not even clear whether the data are still available, and where.

National forest monitoring which is implemented as a shorter-term project only and without full adoption and integration by the government can be a starting point for a successful long-term system, only when full transfer into country ownership is envisaged as part of the project.

The following principles directly derive from the Ownership Principle: Legal Basis (Principle 2), Institutionalization (Principle 4) and Research Infrastructure and Capacity Building (Principle 5).

2. Legal basis

Where appropriate and indicated according to national circumstances, it is helpful to generate a legal basis for the national forest monitoring, for example by adding a corresponding paragraph to the national forest law.

This underlines the country ownership (Principle 1), it may be the basis for institutionalization (Principle 4) and it may otherwise generate the basis for implementation of national forest monitoring (e.g. legally permitting measurements in private forests).

By defining a legal bases, a formal link of the national forest monitoring system to the national forest programme, if existing, can be established.

3. National Forest Monitoring needs a landscape view

Forests are part of landscapes and as such interwoven into a network of environmental functions and socio-economic interests, both local and large-scale. The development of forests is largely driven by forces outside the forestry sector. It is, therefore, indispensable to look at forests as one component within a forested landscape. As a consequence, it may be considered to develop forest monitoring step by step towards landscape monitoring, focusing on the tree resources rather than just on the forest resource. There are various successful experiences available already of integrated land use assessments.

Adopting a landscape approach when developing a national forest monitoring system requires technical adjustments of the monitoring design, and it is above all also a matter of inter-sectoral communication and agreements, as the mandate for national forest monitoring usually ends at the forest edge.

4. National Forest Monitoring should be institutionalized

One of the major distinct features of forestry in general is its long-term character. Consequently, national forest monitoring is a long-term endeavor and requires a long-term structure that is best be implemented through a permanent institution. A properly equipped national level institute - wherever located within the national administration – will essentially guarantee the following:

- Long-term availability of data, including adequate data management. This is, for example, an indispensable prerequisite for trend analysis from repeated observations; and also in the framework of a defined data policy (Principle (12)).
- Long-term availability of expertise, referring to (1) monitoring techniques, (2) data analysis, and to (3) mainstreaming the monitoring information into the national and international policy processes.
- Long-term vision and adequate further development of approaches along adjustments in scope and objectives: continuity of related research. This supports Principles (9) regarding revision and further development of the national forest monitoring approach.

The selection or development on an appropriate institution for a national forest monitoring depends on the country circumstances and the available capacity. This is a challenging task because national forest monitoring efforts, when for example implemented every 5 or 10 years, typically exhibit a cyclic distribution of workload which may cause a difficult situation for any permanent institution. One solution to this problem may be the implementation of data collection on a rolling basis such as e.g. done in the United States of America and Sweden.

Efforts should be made to build on existing national institutions and existing national capacity keeping in mind that long-term and secured adequate funding is required .

5. Research infrastructure and capacity building

Any national survey requires appropriate national capacity and a research infrastructure in order to be successfully implemented under country ownership. Both, research infrastructure and capacity, need to be developed and / or enhanced starting from the particular country circumstances; and both tasks are longer-term endeavours.

Capacity building includes both short-term training and longer term academic and technical education and can either be implemented through national expertise or by international cooperation. FAO, for example, has a long experience in designing and implementing training in forest monitoring in different countries. It makes sense, wherever possible, to combine training and education activities directly with the design and implementation of the monitoring system and offer interested staff an immediate possibility to gather hands-on experience.

Research plays a very relevant role in National Forest Monitoring. For every country, in the planning phase, an adjustment / optimization of the design to the particular country circumstances is needed; this is usually not a standard task but requires methodological expertise in order to come up with an appropriate tailor-made design. The same holds for the estimation process which needs to be perfectly in line with the inventory design. Many research questions arise during the planning phase of the monitoring design: optimal integration of remote sensing, optimal field plot type, size and number, biomass functions for species or species groups, analysis of different error sources etc. The design and implementation of a thoughtful and scientifically planned pilot inventory may help finding an optimal design.

Research may play another important role once the data are there. Besides standard analyses which is demanded by decision makers, the data sets from national forest monitoring usually offer plenty of opportunities for high level research; an opportunity which is not everywhere fully exploited by research groups.

Specific research in forest monitoring requires specific expertise in fields like forest mensuration, statistical survey sampling, statistical modeling, remote sensing image processing and is usually not built in short time. Establishing a research infrastructure and capacity building may, therefore, also be considered part of the “Institutionalization Principle (4)” and may be closely linked to existing research institutions in the fields of forest management.

Scope Principles

6. Participatory discussion process among national stakeholders on the scope and objectives of forest monitoring

National forest monitoring systems are to generate data and information on the forest and trees at national level. It is obvious that not only the forestry sector will be interested in such information but various other sectors/fields as well, including environment, agriculture, tourism, infrastructure development.

Defining and agreeing on the scope and objectives of the national forest monitoring system is thus crucial. This should take place in a process that involves all relevant groups in government, research and society. These interested and relevant groups need to be identified first: it is not necessarily obvious who these groups are and some of them may not have a powerful lobby which is well-connected to political decision making.

The scope and objectives can first be defined in terms of the expected outcome and then broken down into more concrete elements, including sectors to be involved in detail planning and in funding, variables to be recorded, responsibilities to be assigned.

The planning of the scope and objectives of the national forest monitoring system should be an inclusive process. It is usually driven by experienced experts but needs to be inclusive in the sense that interested parties are not only welcome to contribute but are invited to do so.

The scope and objectives may be adjusted from cycle to cycle as may techniques and approaches; this is a normal process that must be driven by maintaining methodological consistency while integrating emerging issues (Principle (9) – Revision and Emerging Issues), lessons learned and technological innovations.

Experience has shown that the most significant suggestions for adjustment will be raised once the results of a monitoring cycle are presented and discussed: the presence and availability of concrete results frequently causes constructive discussions on improvements because the scope and potential of a national forest monitoring system are clearly illustrated at this point in time.

In the discussion and decision process on the scope and objectives, feasibility considerations must play an explicit role: the scope can only be widened and objectives added when options can be identified for how to realistically implement the suggested additions, which includes identification of funding (Principle (11) - Feasibility).

Box 7: *Defining the “information needs” to guide the design of a national forest monitoring system, is a demanding task. The incremental cost of adding one variable is frequently not large so that many variables are added. Frequently, in forest inventories, data on more than 100 variables are collected.*

While many existing national forest monitoring systems collect data that are not immediately analyzed and processed for national policy processes, these data are not necessarily useless: they may be an excellent basis for research and they may turn out to be important for future analyses (emerging issues, Principle (9)).

Information needs also evolve over time. For example, in the FAO inventories in the 1970s, hardly any forest inventory planner would have accepted to integrate information on forest use into the inventory and complicating the implementation by adding interviews with forest owners and forest users. Today, such socio-economic data are considered extremely welcome and valuable.

7. The National Forest Monitoring must satisfy national level information needs

Information needs regarding the national level forest and tree resources are manifold. The consensus-oriented discussion process as of Principle 3 prepares the grounds for a comprehensive identification of priority information needs at the sub-national and national level, but also to efficiently support international reporting commitments.

The identification of information needs is usually an iterative process that is adjusted in the beginning of each cycle. Different sectors partly share the same information needs while each has its specific expectations.

This identification process should be accompanied by an analysis of how the *information needs* can be translated into *indicators* that can feasibly be observed in a monitoring process. While for many information needs (e.g. forest area, growing stock) there are established observation and estimation techniques, this is not so for information needs on other features like “forest biodiversity” or “naturalness of the forests”. The translation of “information needs” into “observable indicator variables” is partly a research issue, partly a political consensus process. At the end, however, an agreement is required and should be transparently documented.

Major data users, actors and interest groups should be consulted in this process while feasibility aspects are permanently to be observed. It is helpful to analyze existing national forest monitoring systems from the region and to invite experts to report on the possibilities and limitations of national forest monitoring systems – and on the corresponding cost implications (Principle (11)).

A good distinction in order to prevent overloading a national forest monitoring system is the one between “need-to-know” and “nice-to-know”. While there will usually be hardly any doubt about the integration of the “need-to-know” data (these core data needs are usually shared by several interested parties, and usually financing is also straightforward), the integration of the “nice-to-know” data depends on good justification and cost trade-offs.

Design Principles

8. Integration of and consistency with existing information sources

National forest monitoring should not be considered a stand-alone initiative but, in the best case, an undertaking that is – within the scope of its particular mandate - interlinked with other national and sub-national initiatives that generate national level information. This requires - where technically and organizationally possible - compatibility with other information sources. A careful analysis of the methods and definitions underlying the generation of such information is, therefore, necessary.

There is no general rule as to which information sources are to be used in national forest monitoring, neither for the collection of data nor for the generation of information. For economic and technical optimization, national forest monitoring systems should make use of all available relevant information keeping in mind the need to check for compatibility, accuracy and completeness of information.

9. A flexible approach in order to integrate emerging issues and allow for periodic revisions

Requiring long term efforts, the technical and organizational design of national forest monitoring systems needs to be able to integrate emerging issues as they may occur in the course of time. Origins of such emerging issues include changes in national policies, new issues brought up by international processes or new scientific findings. The flexibility of the approach is, therefore, an important element of the strategic and long-term orientation of national forest monitoring systems.

So far, the history of national forest monitoring has demonstrated that such integration is feasible under many different conditions and for various different issues. Integration, however, requires technical and organizational expertise, and above all, intensive communication between different interest groups.

Emerging issues are unknown and cannot be taken into account during planning; so not only the technical design must be flexible to allow for adjustments, but also the organizational design must be able to adapt to changes.

Periodic revisions and adjustments may also be necessary, when national forest monitoring systems are to provide information to be used to comply with international reporting obligations. It is essential that concepts and definitions used are being updated and made compatible with the international processes.

10. National forest monitoring should follow a multi-purpose approach.

Information and knowledge generated by national forest monitoring systems need to feed into and support national and international forest-related processes. In order to serve these processes national forest monitoring systems need to be multi-purpose. This is also a logical consequence of “Principle (3) Landscape View” where a wider geographical scope is stipulated. However, maintaining a multi-purpose approach also means that multiple thematic fields are being integrated, such as biodiversity, carbon, and utilization of non-timber products. While national forest monitoring systems have the potential to integrate many more variables in a feasible manner, the multi-purpose orientation requires inter-sectoral communication and coordination. In

Box 8: *There are several examples of how national forest monitoring has developed, adjusted and integrated emerging issues. The terminology demonstrates such changes: while early forest inventories focused on the assessment of the status of the wood resources, these inventories were transformed to multi-purpose forest inventories, also integrating other objectives than wood production. Today, the considerably wider term national forest monitoring is in use, which emphasizes the long-term character and the focus on trends.*

Other emerging issues that have been integrated in many recent national forest monitoring systems are the trees outside forests and socio-economic variables.

FAO has been pioneering this integration when setting up its NFMA program (Support to National Forest Monitoring and Assessment), and has been successfully supporting a number of countries in implementation.

Another example that has taken place in many countries, refers to the new requirements stemming from carbon accounting and from biodiversity monitoring.

the end, however, the multi-purpose approach may support the feasibility and cost-efficiency of national forest monitoring efforts (referring to Principle (11)) when the development of the design not only succeeds in integrating new issues from other sectors, but also in raising the corresponding co-funding.

11. Feasibility including cost-efficiency

Information provision, including data gathering, storage and analysis and running a permanently institutionalized forest monitoring unit must be feasible and affordable according to national circumstances. The lack of priority that has been assigned to national forest monitoring in the past has caused a lack of readiness of governments to invest into long-term monitoring systems. Perhaps the current international processes, where reliable national forest information plays an important role also in monetary terms, will help change this attitude.

Still, national forest monitoring needs to be feasible and follow approaches that are financially affordable. This principle refers to all other components addressed here, be it the technical implementation, the institutionalization or the capacity building. The same principles hold here as for any other government expense: it needs to be technically justified and economically reasonable, and there must be a legal basis for the expenditure.

While a full-blown cost-benefit analysis is not possible (in the absence of possibilities to quantify in monetary-terms the benefit of improved information) the guiding principle will be that the defined objectives are achieved at minimum cost – without compromising data precision, accuracy or quality.

Data Principles

12. A well-defined data and information sharing policy

Data and information produced by national forest monitoring systems are of interest to many different parties. They should be, along with national legislation on data privacy and protection of individual rights, accessible to different users, either as original data sets or as aggregated data sets. This does not necessarily mean that public access to a database is being granted, but that a clear data sharing policy is formulated to which national and international interested parties can refer. This policy may, of course, contain restrictions along national interests and legislation. For example, in many cases it will be difficult to make geo-referenced data available for private forests.

In particular research institutions will be highly interested in having access to original or aggregated data.

Defining a data policy that regulates the access to national forest monitoring data sets or sub-sets also means that long-term data storage and management need to be secured; this refers directly to Principle (4), Institutionalization: it embraces essentially three levels, (1) database structure (software) and physical database (hardware), (2) experts, who know the database, and how to access data and meta-data, and (3) an institution where the database and the experts are located.

Overall Principles

13. Credibility through transparency and quality

The design and implementation of national forest monitoring systems are large undertakings that are methodologically complex, involve many actors and are accompanied by many interested parties. The overall goal is to maintain credibility of the results. This implies that the results must be produced in a manner that is scientifically defensible which means essentially that each methodological and organizational step of the approach needs to be fully and transparently documented and justified; this includes also a comprehensive and critical analysis of all error sources and implementation challenges.

The user of the information products generated by the national forest monitoring system should be able to fully understand what has been reported and should be able to assess the quality and

credibility, founded on a complete and transparent documentation. This documentation shall contain the definitions of the population, the variables and the precision requirements for the major target attributes, the elements that guide the design of a national forest monitoring system.

Quality also refers to precision and accuracy and to a transparent management of errors and error sources. Any estimate should be accompanied by an estimate of the corresponding estimation error that informs about the statistical reliability of the estimate. Quality control measures should be implemented at all phases of the process, and properly documented. This includes control measurements / check cruising, calibration of measurement devices, and also continuous communication with and training of those who generate data and results (such as field teams, remote sensing analysts and statistical analysts).

There is no such thing like a general “best practice guide” for national forest monitoring and it is unlikely that it can be written in general terms: all national forest monitoring systems need to be developed based on the specific country circumstances regarding natural conditions, infrastructure, institutional setting and capacity available. It is important that these conditions are spelled out clearly, completely and transparently.

This principle, together with Principle 8, is in line with the formulation of the five reporting principles that the IPCC Good Practice Guidance stipulates: consistency, comparability, transparency, accuracy and completeness. While IPCC, with these five principles, is explicitly focusing on the reporting phase of a carbon assessment, it is suggested here to apply the principle of “Credibility through transparency and quality” to the entire national forest monitoring process.

14. Collaboration at the international level

At the international level, there are comprehensive experiences in all aspects of national forest monitoring. Collaboration in planning, implementing and analyzing different national forest monitoring systems is an excellent way of knowledge exchange and of avoiding common errors and pitfalls. In addition it may efficiently support national capacity building. It is expected that international organizations and bilateral donors may be interested in supporting such exchanges of experiences, for example through regional networks. This international collaboration is, of course, meant to be complemented by collaboration on national level between all interested parties