Chapter 38
FAO NFMA – Support to Developing Countries on National Forest Monitoring and Assessment

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38.1 Development of the Support to National Forest Monitoring and Assessment Programme

The interest in forests and forestry has never been as great as it is today. In many countries forests are increasingly recognized as a crucial element for people who depend on forest resources as a source of a wide range of goods and services and opportunities for revenue generation. The future of forests depends upon national forest policies and their implementation by countries, particularly because deforestation and forest degradation are occurring at unprecedented rates and contributing to global warming and food insecurity.

The loss of forest cover, especially in developing countries, has become an international concern particularly considering that forestry and land use change account for nearly 20% of the global greenhouse gas emissions (GHG). The UNFCCC COP-13 held in December 2007 in Bali, adopted a decision to reduce GHG emissions from deforestation and forest degradation in developing countries (UNFCCC 2008). For this, and for other national information needs, monitoring of forest resources has become critical for countries as well as for international reporting. However, past Global Forest Resources Assessments (FRA) clearly highlighted the lack of institutionalized systems of national forest inventory (NFI) and monitoring, particularly in developing countries, where national data on forest are often acquired using methods other than observations of ground plots whose locations are based on probability sampling designs or rely solely on remote sensing analysis (FAO 2005).

During the last 9 years, the Forestry Department of FAO has invested substantial resources to develop a programme of support to national forest monitoring and assessment (NFMA) with the mandate of quickly responding to country requests for enhanced forest data acquisition and assist them in setting up and organising

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national forest monitoring and assessment systems (FAO 2009). The context in which NFMA operates is mainly that of countries in development, often with serious shortcomings in terms of technical, financial and institutional capacity. In this context, the actual process of data collection and analysis must be preceded by the process of building, or solidifying, the base for efficient and sustainable system for national forest monitoring. This means that the greatest challenge is to optimize available resources while maintaining scientific rigour.

38.2 Approach

The NFMA approach is characterized with three standards:

- *Demand driven*, meaning that the countries request FAO support and define the assessment scopes as well as information requirements. In some cases data requirements go beyond forestry parameters to include information for a wider range of land uses and natural resources such as agriculture, water and soil, such as in the case of Zambia or Kenya where Integrated Land Use Assessments (ILUA) were carried out. In its standard approach NFMA includes assessment of both biophysical and socio economic variables.
- *Participatory*, in the sense that the involvement of a wide range of stakeholders is encouraged, including government institutions, the private sector, NGOs, local communities, universities, research institutes, donors and international organizations, thus strengthening the national networks of experts.
- *Harmonized*, so that terms and definitions are consistent among national institutions and refer to internationally agreed terms and definitions. The harmonization allows comparison between countries and facilitates reporting to international reporting processes.

Finally, NFMA focuses on the establishment of a long term monitoring system with the objective of establishing a system that will be sustainable in time with repeated periodic measurements. This is accomplished by strengthening national capacity and institutionalizing the inventory process.

38.3 Objectives

NFMA's development objective is to contribute to the sustainable management of forests and trees outside forests by providing national decision makers and stakeholders with the means of acquiring accurate, relevant and cost-effective information on the state, uses, management of the forestry resources and land use changes. Such information is particularly relevant for national and international dialogue on forestry related policy issues and socio-economic development.

Specifically, FAO support to national forest monitoring and assessments aims at:

- Assisting countries in building their national capacities to design, plan and implement national field and remote sensing based forest inventories, to manage the generated information and disseminate it to decision makers.
- Generating baseline information on a wide range of forest and tree parameters on the basis of a harmonized set of variables, vegetation classification system and standard forest and tree survey sampling design for continuous monitoring. It covers the social, environmental and economic dimensions of forests and trees.
- Producing information on the management and uses of forests and their linkage to local communities and livelihood.
- Support the national policy and decision making processes and facilitate reporting to international conventions and processes (UNFCCC, CBD, CCD, UNFF, FRA etc.) (UNFCCC 2009; CBD 2009; UNCCD 2009; UN 2009; FAO 2005).
- Promoting multilateral cooperation, international partnerships, and experience sharing among countries to channel state-of-the-art technologies for NFMAs.

38.4 The Use and Users of the Results

The NFMA methodology is adaptable by nature and continuous revisions and adjustments are made in order to best respond to evolving national and international reporting needs.

38.4.1 National Policy and Planning

The majority of the countries to which NFMA is introduced has never had an NFI. Decision making has been based on assumptions and not on reliable information. For this reason, establishing an institutionalized national forest monitoring system constitutes a major step ahead. The data produced from a national forest assessment is primarily used to create better awareness and as a sound information baseline for national level policy making and strategic planning for sustainable use and management of forestry resources.

The NFMA approach promotes the use of the results for developing national forest programmes (nfps).The integrated approach, involving a wide range of stakeholders creates the conditions for an inter-sectoral policy dialogue in which various factions are brought together for proposing most appropriate and concerted solutions to tackle forest-related challenges.

38.4.2 International Reporting

At the same time, international conventions and mechanisms are increasingly demanding forest data. The ability to report to, for example, UNFCCC, CBD,

CCD, UNFF and FRA, in the appropriate and harmonized classification system, gives the countries the ability to participate in the global forestry dialogue.

38.4.3 The Use of NFMA Data in UNFCCC Including Kyoto Reporting

Awareness of climate change threats has led to an increased demand for data on monitoring and managing carbon. NFMA methodology has recently been extended to address the reporting needs under the UNFCCC, including Kyoto reporting and Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) monitoring. This includes the development of methods for collecting data on all five forest carbon pools, and assisting the countries in reaching Tiers 2 or 3 reporting levels, providing there are sufficient financial resources to reach the required precision. IPCC guidelines are used to generate carbon estimates from inventory data (IPCC 2006). So far NFMAs have been only completed for a single inventory year, so it is not possible at this stage to generate estimates on change in carbon stock. However NFMA is designed as a monitoring system with repeated measurements thus allowing the production of time series necessary to assess change. As an example, Guatemala and Zambia are already planning their second NFMA.

38.4.4 The Role of NFMA in Assessing the Status of Biodiversity

A site's biodiversity is expressed in terms of the characteristics of its species, soil, fauna, forest structure, forest type distribution, forest area fragmentation. Diameter distribution by species and regeneration levels also provide indications of the current status of each individual species. The collection of all this information is part of the standard NFMA methodology.

In NFMAs biodiversity is assessed by the number and frequency of species and providing information on forest structure and the spatial distribution and extent of forest types (as indicated above). However, in the data analysis phase conclusions can be drawn from estimates of correlations among variables. In particular, estimates of correlations between information gathered through socio-economic interviews of local people and biophysical variables can shed light on the impact of humans on forest resources (e.g. a correlation between tree species frequency and measures of forest disturbance).

Data on fauna species are sometimes indicated as a priority for NFIs and indicators of presence/absence of key wildlife species have been introduced in some countries, such as Congo, Angola and Comoros islands. The NFMA socio-economic

interview scheme, in its standard approach, also allows collecting indicative data on fauna presence and human–animal interaction.

38.5 Methodology

The NFMA methodological approach combines field inventory and remote sensing. In the field, the collection of data on biophysical variables is complemented by interviews of local population to derive information on socio-economic aspects (use and users of forestry resources) and to better understand the interaction between humans and the land they live on. Remote sensing is used to provide information on spatial distribution and extent of forests. Details on inventory methods are outlined in the following sections.

38.5.1 Sampling Design

The sampling design adopted for the NFMA is systematic. Sampling units (SU) are selected at least at the intersection of every degree of the latitude/longitude grid. Depending on country's situations and information needs, a higher sampling intensity is applied to get sufficient sampling intensity and precision. Stratification may be adopted to optimize the design (precision and costs), based on stable strata such as ecological zones. The number of SUs (tracts) to be surveyed is determined by the required statistical reliability of the data, the available financial and human resources for the assessment, and with a view of enabling periodic monitoring.

The major sampling unit is a square tract of 1 × 1 km. Each sampling unit contains a cluster of four permanent, rectangular, half-hectare sample plots, placed in perpendicular orientations. Smaller sub-units are delineated within each plot: three sets of subplots, three measurement points and three fallen deadwood transect lines.

Each plot is also divided into land use/cover sections (LUCS) representing homogeneous land use/vegetation cover units (forest, grasslands, crops etc.) with variable sizes and shapes that have been identified in the field.

Figure 38.1 and Table 38.1 show the design of the different inventory units and related specifications.

38.5.2 Field Data Collection

A wide range of biophysical and socio-economic data is collected in the field. Socio-economic data are gathered through interviews with key informants, focus

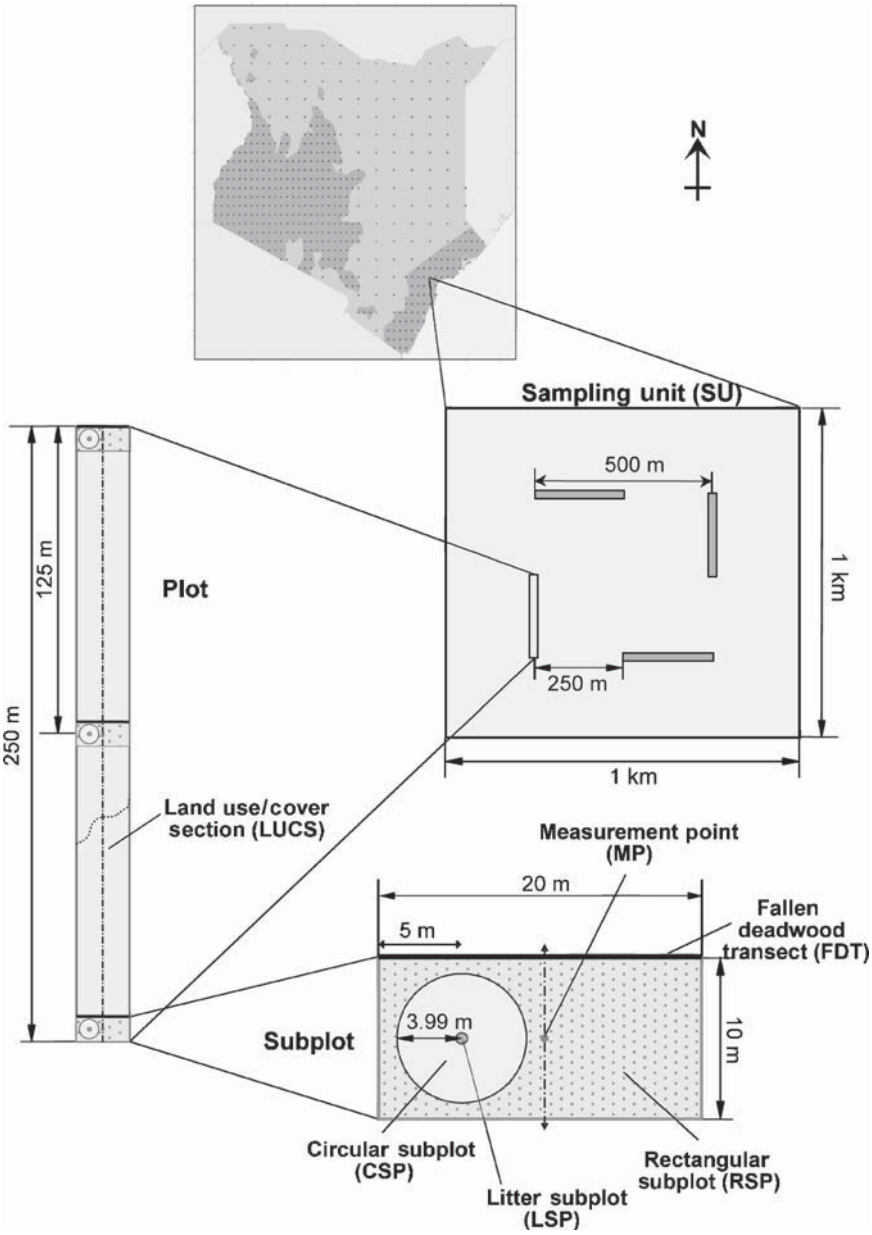

Fig. 38.1 Sampling unit, plot and subplot design

Table 38.1 Survey unit specifications[a]

Unit	Shape	Size (area)	Number
Sampling unit (SU) (or tract)	Square	1,000 × 1,000 m (1 km^2)	1
Plot	Rectangle	250 × 20 m (5,000 m^2)	4/SU
Rectangular subplot (RSP)	Rectangle	20 × 10 m (200 m^2)	3/plot
Circular subplot (CSP)	Circular	Radius r = 3.99 m (50 m^2)	3/plot
Litter subplot (LSP)	Circular	Radius r = 18 cm (0.1 m^2)	3/plot
Fallen deadwood transect (FDT)	Line	20 m	3/plot
Land use/cover sections (LUCS)	Variable	Variable	Variable
Land use/cover class (LUCC)	Variable	Variable	Variable
Household survey area (HSA)	Circular	Radius r = 2 km (12.6 km^2)	1

[a]All units (shape and size) can be adapted and optimized according to country context.

groups and randomly selected households, while biophysical information is collected through measurement and observations.

Different data are collected according to the survey unit:

- Sampling unit (or tract): general data on location, population, water and wildlife observation.
- Plot: identification of different land use/cover sections (LUCS) and measurements of trees and stumps with diameters at breast height (dbh) $\geq$ 20 cm, or $\geq$ 10 cm for the trees outside forest.
- Land use/cover section (LUCS): Information collected includes:
  - General information related to the area (designation, land tenure, environmental problems, vegetation cover, etc.).
  - Forest and other wooded land management practices (harvesting, silviculture, etc.) and structure.
  - Crop management practices.
- Land use/cover classes (LUCC): corresponds to each land use class found in the SUs (in all four plots). Information on forest and trees products, on environmental services, invasive and threatened species, wildlife abundance, and land use change is collected at this level.
- Rectangular Subplot (RSP):

  Data related to small diameter trees and stumps (10 cm $<$ dbh $<$ 20 cm) in forest. Data related to shrubs Indicator plant species.
- Circular subplot (CSP): tree regeneration data (only in forest, other wooded land and woodlots).
- Litter subplot (LSP): data are collected on litter including all non-living biomass with diameter less than 10 cm. The average depth of the litter layer and its main composition are also recorded.
- Fallen deadwood transect (FDT): measurements of fallen deadwood branches ($\geq$ 10 cm) are taken along the transect lines. The decomposition status of the deadwood branches is also registered.

Table 38.2 Trees and stumps measured per level and corresponding forms

Level	Measured trees/stumps		Measurements
	Forest	Other LUCC	
Plot	$dbh \geq 20$ cm	$dbh \geq 10$ cm	Species, location, diameters, total height, health, quality, decomposition status of dead trees
Rectangular subplot (RSP)	$dbh \geq 10$ cm	None	Species, location, diameters, total height, health, quality, decomposition status of dead trees
Circular subplot (CSP)	Tree height $\geq$1.30 m and $dbh < 10$ cm	Tree height $\geq$1.30 m and $dbh < 10$ cm (only in OWL and woodlots LUCC)	Number of trees by species

- Measurement point (MP): topographic and soil data are collected at the three measurement points.

The measurements of trees (living or dead) and stumps are summarized in Table 38.2

Soil measurements: two methods are proposed to collect data on soil, depending on information requirement and available funds: soil visual assessment, based on observations carried out in the field, and soil sample collection, which implies subsequent laboratory analysis to measure, in particular, soil carbon. Both methods might also be applied jointly because they provide different information.

Data on products and services (on forest, trees outside of forests, crops and fish products) are collected for each land use/cover class (LUCC) present in the sampling unit (SU). This information originates from interviews with local people or from people accompanying the field team but is also verified and complemented through direct field observations.

38.5.3 Remote Sensing

Remote sensing is used in combination with the field survey to improve estimates of extent of forest and other attributes (carbon stocks), provide information on the spatial distribution of forest and land uses, on forest fragmentation and area change and therefore help in the stratification process. Integration of remote sensing and field data is also done through GIS modelling. Two main techniques for remote sensing mapping are employed (either alone or combined):

- Full-cover mapping: to produce national maps and statistics of forest cover
- Sampling survey for in-depth studies to assess, e.g., changes of forest resource as well as trends and deforestation

38.5.4 Project Management

A typical NFMA project follows a conceptual framework that includes consecutive phases: (1) planning and designing, (2) data collection, (3) analysis and reporting.

Phase one includes (1) planning of project activities, (2) defining information needs through wide participation of stakeholders, (3) fine tuning and adaptation of the NFMA approach to meet specific country scenarios, (4) designing forest/land use classification systems, (5) setting up the project organisation and its institutional and monitoring arrangements, (6) procurement of field inventory equipment and remote sensing data, (7) recruiting professionals and support staff, (8) procuring equipment and supplies, (9) developing manuals and guidelines, (10) training of national staff, and (11) designing and developing the database application. This phase requires 6–9 months depending on the country.

Phase two is mainly for data collection through a field survey at sample plots and through a remote sensing survey. Approximately 12–18 months are needed to complete the fieldwork and remote sensing survey.

Phase three, lasting 6–9 months depending on the countries, is dedicated to processing and analysing the field data, producing thematic maps and reports, disseminating the findings (info packaging) and initiating the policy analysis.

According to the size of the country, resources available and other factors, NFMA projects usually have durations of 18 and 36 months. Starting from a standard set up, each project is customized according to the country context and needs. Country specific methodology, documentation, and reports are produced.

More details on NFMA project management including cost and time analysis can be found at NFMA's website (FAO 2008, 2009).

38.5.5 Data Analysis, Reporting and Dissemination

Data collected are managed and analyzed (stored, queried, updated) through a country specific database built from a template database application.

Results are produced and final reports include all major statistics of the variables collected. The depth of the analysis is often dependent on the capacity and availability in country and in general the potential of the data gathered allows for further analysis. In some cases, academic and research institutions are involved for a more in-depth use of the data and to highlight correlations and dependencies among sets of variables. The better the analysis, the more useful the information is for policy and decision makers.

Throughout the duration of the project, informative notes are released to press agencies with the purpose of sensitizing the population as a whole on the development of the project and its importance. At project's end, final reports are produced as well as policy and thematic reports. A full coverage of the project's details and results is also displayed on web portals. A full display of countries aggregated data is currently under development.

Table 38.3 Status of NFMA Country projects activity

NFMA project completed	NFMA project ongoing
Bangladesh	Algeria
Cameroon	Angola
Costa Rica	Brazil
Guatemala	Comoros
Honduras	Ecuador
Lebanon	Kenya
Philippines	Kyrgyzstan
Zambia	Nicaragua
	Perú
	Republic of Congo
	Tanzania
	The Gambia
	Uruguay
	Vietnam

38.6 Current and Future Prospects

NFMA projects undertaken with FAO assistance are funded through different sources, including the Technical Cooperation Programme (TCP) of FAO, Unilateral Trust Funds (UTF), the Government Cooperation Programme (GCP) and contribution in cash or in-kind from the concerned governments. Other projects are also financed from extra budgetary resources under partnership agreements among FAO and donors like Sweden, the Netherlands, Finland, Republic of Korea and Norway (UN-REDD). NFMA continuously supports countries in finding new and suitable sources of funding.

From the methodological point of view, NFMA actively works to update and refine its approach in order to provide the countries with the best possible processes in line with world's trends, always considering the specificity of the context in each country. Expert consultations, ad hoc consultancies and feedback and experience gained while working in the countries enable constant improvement of methods, tools and processes.

The countries requesting support to carry out NFMA far exceed the actual capacity of FAO to respond. For this reason, new sources of funding are continuously being sought. As of 2009, NFMA has completed projects in nine countries and is currently working in 14, as shown in Table 38.3 and Fig. 38.2.

38.7 Harmonization and Synergies of NFMA Projects

The NFMA programme constantly seeks new synergies and partnerships with international and national institutions and programmes. South–south collaboration is one of the pillars of the programme, as national specialists trained in one country

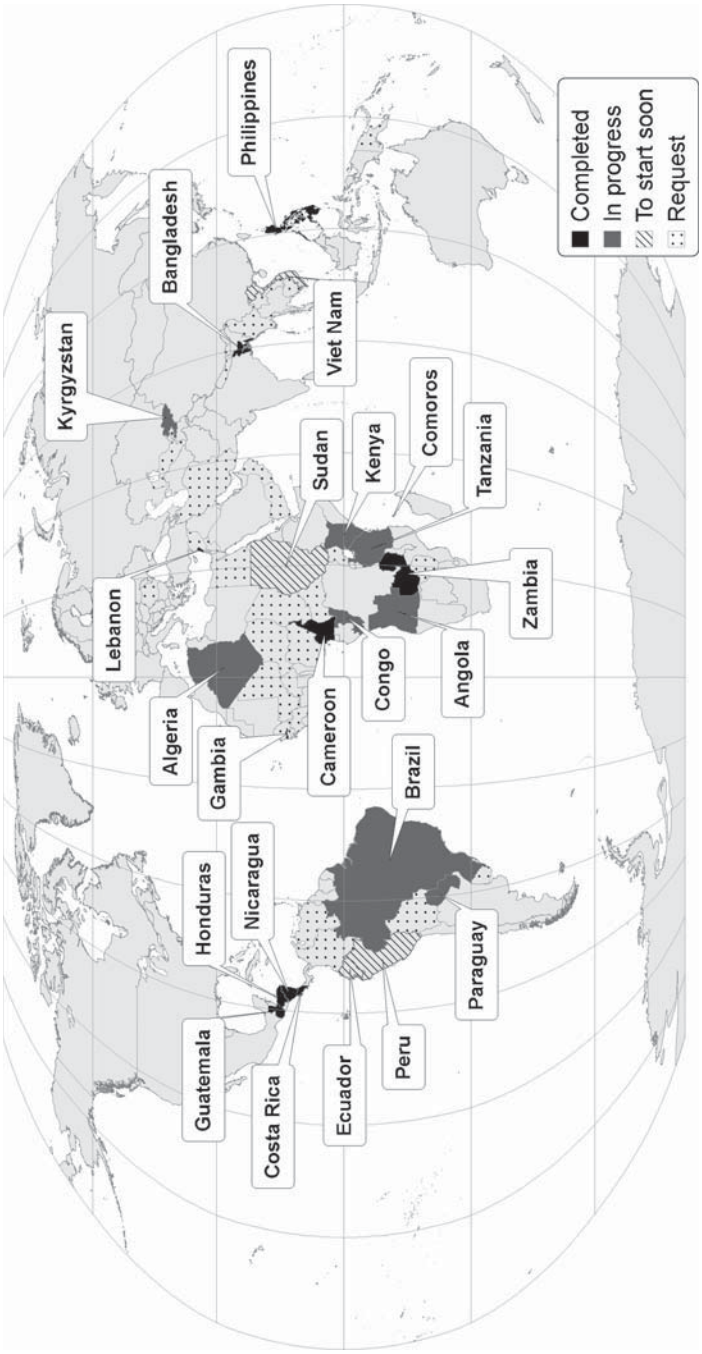

Fig. 38.2 Map of NFMA Country projects and pending requests

assist other countries in developing their NFMA, thus creating a network of technical experts who transfer their knowledge and share their experiences.

Partnerships with IPCC and UN-REDD have been established in order to jointly test new methodologies. The collaboration is strengthened by the fact that some of the countries in which NFMA is working are also UN REDD countries.

A network of experts (including NFI experts who participated in COST Action E43) (COST Action E43 2009) has provided guidance to evaluate the NFMA program through consultancies, technical meetings and expert consultations. In addition, an advisory board will be created in late 2009 to provide further and regular direction to the programme, review its achievements and provide recommendations on the way forward.

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