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## The New Brazilian National Forest Inventory

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**Abstract.**—The new Brazilian national forest inventory (NFI) is being planned to be carried out through five components: (1) general coordination, led by the Brazilian Forest Service; (2) vegetation mapping, which will serve as the basis for sample plot location; (3) field data collection; (4) landscape data collection of 10 x 10-km sample plots, based on high-resolution satellite imagery interpretation; and (5) associated programs. The mapping will be based on 1:250,000-scale topographic maps and China-Brazil Earth Resource Satellite images. The standard sample plot distribution will be based on a systematic grid of 20 x 20 km. The NFI will be held based on a 5-year measurement cycle.

### Introduction

In the 1980s, Brazil carried out its first and unique national forest inventory (NFI), which aimed at producing information about timber stocks of planted and natural forests (Brena 1995, Machado 1984) as most of the earliest national inventories did (Holmgren and Persson 2002). Since then, only regional forest inventories have been carried out to attend to particular de-

mands on information such as government planning strategies. More recently, some States have taken the initiative in setting up their State forest inventories aiming at monitoring forest resources. These initiatives, however, are completely independent in terms of methodologies and timing. Despite the fact that States' initiatives are positive, and potentially more detailed, it is argued that, ideally, an NFI is the most appropriate alternative to produce information on forest resources at the national level.

Among the motivations that led the Ministry of Environment to propose a new NFI certainly is the forest resource strategic importance, both for the country and at the global level, as well as the lack of reliable information at the national level. Brazil is the largest country in Latin America, occupying 8.8 million square km, of which approximately 4.8 million square km are covered by forests (FAO 2005). Despite the importance of forest resources, the country does not have a regular national forest assessment to support public forest policy formulation aimed at forest conservation and sustainable use.

The process of designing a project for the new NFI started in 2005, when the Ministry of Environment carried out a national workshop to identify the main components and methodological approaches to be considered in the project. A technical committee was then designated to coordinate a participatory approach to set up a nationwide project. Therefore, the conceptual basis for the project took into consideration the contributions of experts and groups of interest from different institutions and regions through workshops as well as international collaboration with more experienced countries. A second national workshop, held in December 2006, presented the first version of the project.

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This article aims at to inform on the Brazilian NFI process and to present the main characteristics of the project. The article first describes the institutional framework and then presents the main methodological approaches.

## **Institutional Framework**

The main purpose of the NFI is to generate information on forest resources, both natural and plantations, based on a 5-year measurement cycle, to support the formulation of public policies aiming at forest resources use and conservation. Considering the country extension and the forest resource diversity, a national project requires contributions from different national institutions in an adequate institution framework.

The Brazilian NFI will be coordinated by the Brazilian Forest Service, a recently (2006) created institution that is also responsible for maintaining the Brazilian National Forest Information System. The Brazilian Forest Service will be responsible for providing financial and technical resources to the NFI execution and managing the institutional agreements and technical cooperation with the participating national institutions.

Because the NFI will involve several other institutions in a nationwide survey, there will be technical consultative committees at the national and State levels, aiming at supporting the Brazilian Forest Service for designing guidelines and planning according to regional particularities. Furthermore, the NFI planning process will include an ad hoc committee that may join experts in discussing specific themes such as sampling, biodiversity, and socioeconomics whenever a high level of knowledge support is required to assure the success of the NFI.

Considering the complexity and diversity of the activities and subjects related to the NFI, the project will be based on partnerships with other institutions, which will coordinate specific components of the project to supply the Brazilian Forest Service with the required data to produce the NFI results. Among the partner institutions are the Brazilian Institute of Geography and Statistics, which is responsible for vegetation mapping; the Brazilian National Institute of Spatial Research, which will coordinate satellite image interpretation at the landscape level;

and Embrapa Forestry, the forestry branch of the Brazilian Agricultural Research Corporation, which will coordinate the research program to support the NFI. Universities will take part through the quality control program, and private companies or organizations will be involved in field data collection through business contracts.

## **Methodological Framework**

The NFI will be a nationwide and multisource project. It is organized into the following five components:

1. General coordination.
2. Vegetation mapping.
3. Field data collection.
4. Landscape data collection.
5. Associated programs.

### **General Coordination of the NFI**

The general coordination component will be led by the Brazilian Forest Service, acting as the NFI headquarters in Brasilia, the capital of Brazil. The main activities of the component include administrative and technical support, managing the information system, and establishing and refining technical procedures aimed at adopting national standards. In practice, the general coordination component will integrate data gathered from other components, to process them and make available the NFI outcomes for different interest groups. Furthermore, the general coordination component will maintain a permanent strategy of communication, which includes also contact with national and international groups dealing with forest assessment.

### **Vegetation Mapping**

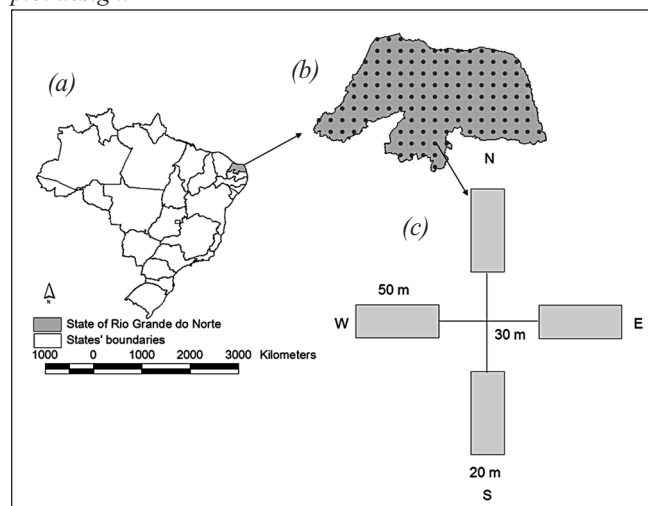
This component encompasses the preparation of topographic maps and the vegetation mapping. It is proposed as a vegetation mapping scheme, to be updated every 5 years, based on topographic maps at a scale of 1:250,000 and China-Brazil Earth Resource Satellite images. The vegetation mapping component will serve to guide the field sample plot selection and support forest area estimates for different poststratification criteria such as biome, vegetation class, State, species group, and so on. A

recent vegetation mapping project of natural vegetation remnants, carried out in each biome and based on Landsat satellite images from 2003, will serve as the basis for the first NFI edition.

### Field Data Collection

The sampling design for field data collection will be based on the cluster plot distribution over a systematic grid of 20 x 20 km potential sample points (fig. 1) established from the framework offered by the 1:250,000-scale topographic maps. Plots to be measured in the field will be selected according to their status of forest or nonforest and according to the vegetation mapping data. Fixed-area sampling units will be grouped in clusters of four rectangular sample plots, with size and shape defined according to biome characteristics as well as the status of forest plantations. Data collection on sample clusters will report quantitative and qualitative forest attributes or variables by measurement of the classical dendrometric variables, species identification, and recording qualitative variables that are useful for forest ecosystem characterization. Simultaneously to each sample plot measurement, it is proposed that an expedited socioeconomic survey be conducted nearby consisting of two to four interviews aimed at gathering data to describe how local communities view and are using their available forest resources and also informing them about some national programs of forestry incentives (Kleinn *et al.* 2005).

Figure 1.—Brazil map (a) showing the State of Rio Grande do Norte and details of the sampling design: a 20-x-20-km base grid (b) laid out over the State and (c) the basic cluster sample plot design.



### Data Collection for Landscape Analysis

Using the same sampling framework offered by the 1:250,000-scale topographic maps, an additional sample design will be developed based on a grid of 40 x 40 km sampling points from which data will be collected at the landscape level. Instead of field measurement, this sample unit of 10-x-10-km plots will be based on high-resolution satellite image interpretation. Some of the landscape attributes to be analyzed include forest fragmentation, changes on forest cover and land use, and the condition of permanent protected areas required by law.

### Associated Programs

The associated programs component aims at supporting the NFI with improved methods and procedures and producing complementary information that, because of its nature, will not be collected in the sampling frameworks described previously.

The main associated program is the Research and Development Program, which will be of particular importance for the initial edition of the NFI because several demands exist for research and methodological procedures to be incorporated by the different components of the NFI. For example, the NFI field manual will be elaborated and will include content on the state of the art of vegetation measurement protocols in each biome. A second associated program is the Training Program, which will aim at providing human resources able to accomplish the NFI needs with the required standard quality. A third associated program is the Quality Control Program, which will aim at establishing procedures for data quality control and checking a fraction of the measured sample plots. A fourth associated program will be set up by the Brazilian Forest Service to produce annual forest indicators, based on secondary data gathered from different sources. The program is proposed to monitor annually at least three forestry indicators at the national level: (1) area of natural forest under sustainable management, (2) area of plantations, and (3) forest growth and yield data based on permanent sample plot networks already established in every biome (Oliveira *et al.* 2005). These indicators will be recorded annually but will be analyzed for the NFI 5-year measurement cycle. Additional associated programs may be designed according to the needs and priorities identified in the context of NFI purposes.

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## Future Developments

So far, the new Brazilian NFI has been built through a project preparation phase of which at least two aspects are important to be mentioned. The first important aspect is that the project proposes a methodological approach and an institutional framework for implementing the NFI at the national level. The project preparation phase is an important step to obtain financial resources as well as the required institutional and political support for the project's implementation. The second important aspect is that the project preparation phase has been a participatory process in which the main institutions dealing with natural resources monitoring were involved as well as many experts on forest inventory. This participatory process is important to make the NFI a national project instead of just one more project at the regional level. Given these initial efforts, project implementation is a process yet in development. Some of the next important steps include testing the methodology of field data collection in every biome, which will contribute methodological refinements and more accurate cost estimates; establishing the general coordination component and the NFI information system; establishing the required agreements with the institutions responsible for every component; and initiating the Research and Development Program based on immediate priorities already identified. In the meantime, it will be also important to disseminate the project and its potential value for the society as a means of gaining political support, which is important to guarantee one of the main characteristics for national forest inventories: to be a national permanent program.

## Acknowledgments

The authors thank Tasso Azevedo, Tatiana Sá, Peter Holmgren, Mohamed Saket, Alberto Sandoval Uribe, Ron McRoberts, Brad Smith, Liz Mayhew, Michelle Zweede, and Pedro Arraes for their cooperation in this project.

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