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Brazil: Development of the National Forest Inventory of Brazil

Joberto Freitas, Yeda Malheiros de Oliveira, Maria Augusta Rosot, Guilherme Gomide and Patricia Mattos

1 Development of the national forest inventory of Brazil

In the 1980s, Brazil carried out its first and only national forest inventory (NFI). The objectives were to produce information about timber stocks of planted and natural forests (Brena 1995, Machado 1984), as has been the case for the majority of the earliest national inventories around the world. (Holmgren and Persson 2002). Since then, only regional forest inventories have been carried out to address particular demands for information for purposes such as government planning strategies. More recently, some states have taken the initiative in setting up state forest inventories aimed at monitoring forest resources. However, these initiatives are completely independent of the NFI with respect to methodology and timing. Despite the fact that the states' initiatives are positive and, eventually will be more detailed, an NFI is ideally the most appropriate alternative to produce information on forest resources at the national level.

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

The national and global strategic importance of the Brazilian forest resource, as well as the lack of reliable information at national level, are among the motivations that led the Ministry of Environment to propose a new NFI. Brazil is the largest country in Latin America, occupying 8.8 million km² of which approximately 4.8 million km² are covered by forests (FAO 2005).

The NFI of Brazil is conducted by the Brazilian Forest Service (BFS) of the Ministry of Environment. The BFS was created in 2006 with the aim of promoting sustainable forest production through forest management in public forests, as well as promoting forest development at national level. One of its legal responsibilities is to implement a national forest information system of which the NFI is one of the most important components.

The NFI has not been implemented in field yet, but the field manuals and tests of the methodology in each of the six biomes are in final phases. Field implementation of the NFI is expected to start in 2009.

2 The uses and users of the results

Despite the importance of forest resources, the country does not have a regular national forest assessment to support public formulation of forest policies aiming at forest conservation and

sustainable use. Since the later 1980's, the most important government initiative for forest monitoring system is the INPE's (National Institute of Spatial Research) deforestation monitoring program (Brasil/INPE 2000) that annually reports deforestation rates for the Amazon region through satellite image analysis. This program serves as an important tool for controlling agencies and as indicators of loss of forest cover. The recent completion of the vegetation mapping effort of the Ministry of Environment (BRASIL/MMA 2007) was also a step forward in producing forest information at the country scale, although national vegetation mapping should be a regular government program.

However, the NFI will contribute information on forest stocks, composition, health and vitality, as well as the patterns of change in time by comparing estimates from successive inventory cycles. These estimates may serve to support the design of regional and national policies based on updated and reliable data, to identify strategies and opportunities for sustainable use of the forest resources by the forestry sector, and also to keep society and politicians informed on the national forest resources situation. Further, NFI information can be used to address the increasing demand by international organizations and agreements for forest information related to biodiversity, climate change, amongst others.

3 Methodological framework

The main purpose of the NFI is to generate information on forest resources, both natural and plantations, to support the formulation of public policies and projects aiming at forest development, use and conservation. The NFI will be nationwide and multisource, reporting information on forest resources in a 5-year measurement cycle. The project is composed of information components from five sources, as follow:

1. Vegetation mapping
2. Sample plots for tree measurements and forest evaluation
3. Interviews for socioeconomic evaluation
4. Landscape plots
5. Associated programs

3.1 Vegetation Mapping

A vegetation mapping scheme with 5-year updates based on topographic maps at a scale of 1:250,000 and CBERS (Chinese-Brazil Earth Resource Satellite) satellite images, or similar data, has been proposed. The vegetation map will serve as the basis for field sample plot selection, as well as to support estimation of areas of different post-stratification criteria such as biomes, vegetation classes, states, and species groups. A recent vegetation mapping of the natural vegetation (Brasil/MMA 2007), carried out in each of the six Brazilian biomes and based on Landsat satellite images from 2002, will serve as the first NFI edition. Forest types are classified according to the Geographic and Statistics Brazilian Institute classification – IBGE (Brasil/IBGE 1992).

3.2 Tree measurements and forest evaluation

The sampling design for field data collection will be based on cluster plots distributed over a systematic grid of 648 x 648 seconds of potential sampling points, which, at the Equator corresponds approximately to a 20-km x 20-km grid (figure 1). Plots to be measured in the field will be located both in forested sites or /non-forest sites. Sub-multiple grids of 10-km x 10-km or 5-km x 5-km can be adopted whenever states wish to invest in higher intensity sampling for increased precision for forest types of high economic or ecologic value or state forested areas for which the national sample size is too small. Fixed-area sampling units will be grouped in clusters of four rectangular sample plots, at azimuths of 90 degrees and distances of 30 m from the central sampling point, with sizes and shapes determined on the basis of biome characteristics. Trees with DBH \geq 10 cm are selected and measured on 20-m x 50-m sample plots. In the Amazonia biome, 20-m x 100-m plots are used to increase

selection of larger trees ($DBH \geq 40$ cm). In each sample plot, saplings and seedlings are measured on 10-m x 10-m and 5-m x 5-m nested sub-plots. At the central point of each cluster, soils are sampled and two perpendicular 10-m transects are used to collect data on down dead woody material. Data collection on sample clusters includes measurement of quantitative and qualitative forest attributes or variables, measurement of the classical dendrometric variables, species identification, and measurement of qualitative variables that are useful for forest ecosystem characterization.

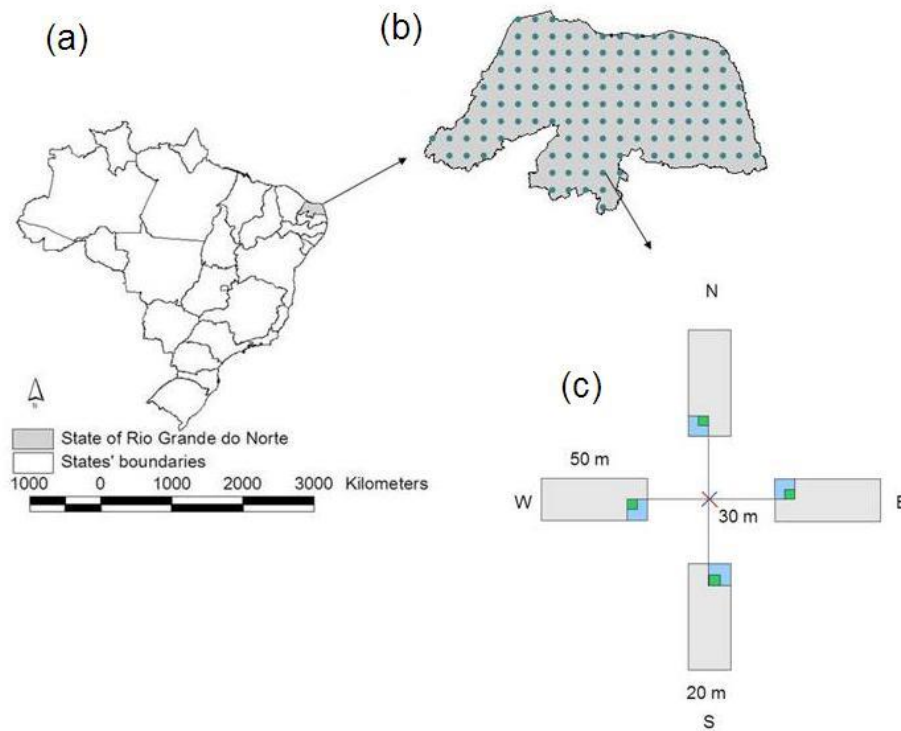


Figure 1: . Brazil map (a) showing the State of Rio Grande do Norte, and details of the sampling design: 20 x 20 km base grid (b) laid out over the state and the basic cluster sample plot design (c) with plots (20 x 50 m) and the nested sub plots for saplings (10 x 10 m) and seedlings (5 x 5 m).

3.3 Interviews for a socioeconomic survey

Simultaneously with measurement of each sample plot, an expedited socioeconomic survey has been proposed to be conducted nearby. The survey is based on 2-4 interviews aimed at gathering data that describe how local communities view and use their available forest resources, to describe their perception of the forest resource's use and conservation, and to inform them about national forest incentive programs.

3.4 Landscape scale plots

Using the same framework as for the NFI systematic sampling grid, an additional sampling design based on a 40-km x 40-km grid will be used to collect data at the landscape level. The 10-km x 10-km sample units located at the grid intersections will be assessed by interpreting higher resolution satellite images instead of field measurement. Among the landscape attributes to be analyzed are forest fragmentation, changes in forest cover and land use, and the condition of permanent protected areas along rivers and waterbodies as required by law. The aim is to support the design of restoration programs.

3.5 NFI associated programs

The component of associated programs aims at supporting the NFI with improved methods and procedures, as well as producing complementary data and information that, because of their nature, are not collected in the sampling framework described above.

The main associated program is the Research and Development Program, which will be of particular importance for the initial editions of the NFI, because different components of the NFI demand incorporation of research and methodological procedures. For example, development of the Field Manual is based on consideration of state of the art vegetation measurement protocols and analyses in each biome, as well as models for volume, biomass and carbon estimation that will be required to process data. A second associated program will be a Training Program aimed at providing human resources able to satisfy the NFI standard quality requirements. A third associated program is the Quality Control Program which aims 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 Forest Service to estimate annual forest indicators, based on secondary data gathered from different sources. At least three forestry indicators have been proposed for annual monitoring at the national level: i) area of natural forest under sustainable management; ii) area of plantations, and iii) forest growth and yield data, based on permanent sample plot networks already established in every biome (Oliveira 2005). These indicators will be recorded annually, but analyzed for the NFI 5-year measurement cycle as one of its results. Additional associated programs may be designed according to the needs and priorities identified in the context of NFI purposes.

4 Institutional framework and strategies for implementation

The general coordination of the NFI will be led by the Forest Service from its headquarters in Brasilia, the Brazilian capital. The main activities of the BFS are administrative and technical support, management of the information system, and establishment and refinement of technical procedures aimed at adopting national standards. Further, the BFS will maintain a permanent strategy of communication which includes contact with national and international groups dealing with forest assessment. Considering the size of Brazil and the diversity of its forest resources, such a national project requires contributions from different national institutions in an appropriate institutional framework. Therefore, technical consultative committees at national and state levels will be established to support the Forest Service for designing guidelines and planning consistent with regional particularities. Temporary *ad hoc* committees, bringing together experts on specific themes such as sampling, biodiversity, remote sensing, and socioeconomic topics, may be established whenever a high level of knowledge support is required to assure the success of the NFI. The project will be based on partnerships with other institutions, which will coordinate specific components of the project, in order to supply the Forest Service with the required data to produce the NFI results. Examples of such institutions include the Brazilian Institute for Geography and Statistics (IBGE), the National Institute for Spatial Research (INPE), and Embrapa Forestry, the forest branch of the Brazilian Agricultural Research Corporation (Embrapa) which coordinates 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.

5 Future prospective

The field manuals with detailed procedures appropriate for each of the six biomes are in the final phase of completion. These procedures are based on the core methodology proposed during the national workshops, specifics of tree measurements in each biome when required and, most importantly, field tests of the entire NFI methodology in each biome at an experimental scale. Although the general methodology is the same, unique aspects of forest types in each biome may require particular measurement methods, as well as confirmation that plot sizes and tree

measurements have been harmonized, identification of logical constraints, and checking for code inconsistencies. Simultaneously with the field tests, development of procedures for interviews (socioeconomic survey), development of the information system, and higher resolution image interpretation for landscape plot analysis are ongoing. A technical cooperation project between BFS and FAO (FAO 2008) is conducted to complete the methodological tests. As soon as the field tests are finished, the NFI can be implemented at the country scale by contracting executing agencies or private companies for field data collection.

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