



Forestry Department

Food and Agriculture Organization of the United Nations

FRA 2000

**VOLUME/BIOMASS SPECIAL STUDY:
GEOREFERENCED FOREST VOLUME
DATA FOR LATIN AMERICA**





The Forest Resources Assessment Programme

Forests are crucial for the well-being of humanity. They provide foundations for life on earth through ecological functions, by regulating the climate and water resources, and by serving as habitats for plants and animals. Forests also furnish a wide range of essential goods such as wood, food, fodder and medicines, in addition to opportunities for recreation, spiritual renewal and other services.

Today, forests are under pressure from expanding human populations, which frequently leads to the conversion or degradation of forests into unsustainable forms of land use. When forests are lost or severely degraded, their capacity to function as regulators of the environment is also lost, increasing flood and erosion hazards, reducing soil fertility, and contributing to the loss of plant and animal life. As a result, the sustainable provision of goods and services from forests is jeopardized.

FAO, at the request of the member nations and the world community, regularly monitors the world's forests through the Forest Resources Assessment Programme. The next report, the Global Forest Resources Assessment 2000 (FRA 2000), will review the forest situation by the end of the millennium. FRA 2000 will include country-level information based on existing forest inventory data, regional investigations of land-cover change processes, and a number of global studies focusing on the interaction between people and forests. The FRA 2000 report will be made public and distributed on the world wide web in the year 2000.

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The FRA Working Paper Series provides an important forum for the rapid release of preliminary FRA 2000 findings needed for validation and to facilitate the final development of an official quality-controlled FRA 2000 information set. Should users find any errors in the documents or would like to provide comments for improving their quality they should contact either Robert Davis or Peter Holmgren at fra@fao.org.

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Abbreviations

BEF	Biomass Expansion Factor
BV	Biomass of inventoried volume
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
Cirad	Centre de coopération internationale en recherche agronomique pour le développement
EDC	Eros Data Centre
FAO	Food and Agricultural Organization of the United Nations
FORIS	Forest Resources Information System
FRA	Forest Resources Assessment
GIS	Geographic Information System
SNU	Sub National Unit(s)
UN-ECE	United Nations Economic Commission for Europe
VOB	Volume Over Bark
WD	Wood Density
WCMC	World Conservation Monitoring Centre

1 Introduction

The assessment of environmental functions of forests is essential for FAO Forest Resources Assessment 2000 (FRA 2000). It directly relates to role of forests in the carbon cycling and maintenance of biological diversity. The present report deals with forest biomass estimate and specifically describes the progress made so far towards the establishment of a geographic information system and an electronic information system, containing integrated cartographic and tabular information for data analysis, modeling and the implementation of special studies on selected thematic elements.

A global database on forest biomass is needed to support the information requirements of FRA 2000, including estimates for tree volume/biomass by broad type categories and political units. Information on forest volume and biomass is important for developing global perspectives on wood supply and for computations of carbon cycling for climate change analyses.

The first step was to screen and analyze the existing information on volume and biomass and to organize the existing knowledge in the framework of the existing FRA Forest Resources Information System.

Given the various sources and types of forest volume data available at FAO Headquarters in Rome, an in-depth review of existing documentation was undertaken, specifically aimed at assessing the completeness and reliability of baseline data. Following the review, the organization and classification of the baseline documentation in country boxes conforming to the general procedures adopted within FRA was undertaken. The classification of baseline documentation included the coding of forest inventory specifications, including information such as the description of the surveyed area, sampling method, author and reference year. Of the entire body of documents reviewed, those forest inventories and/or documents that were considered of some utility were entered into a general database, Biomass.dbf. Of these documents, those considered relevant to the FRA Volume/Biomass Special Studies were described in further detail in a linked database. The later documents were considered in function of their reliability. The reporting units of the documents in this database, Bio_tab.dbf, were then georeferenced into the FRA Geographic Information System. The following is a detailed report of the sequence of steps taken, from the review of existing documentation to the georeferencing of the data.

2 The Review of the Existing Documentation

The review of the existing documentation was organized in the following steps:

- Review of the documentation present in the documentation room of the FRA project
- Search at the Forestry Library and at the Main Library of FAO
- Partial Search of the GFSS database

In the documentation room, the work proceeded country by country. At the beginning a screening of all of the documents inside of the country boxes was done. In this way a first selection of the documents containing information on volume/biomass was achieved. For the same country a search through the virtual library (intranet) was done to verify if other useful material was present at the Forestry Library and at the Main Library of FAO. At the Forestry Library only documents that are 7-8 years old are stored. Considering that for the most part, forestry inventories were dated 1960-70 most of the documents reviewed were found either in the documentation room or at the Main Library. The consultation of documents in the Main Library was not immediate as the documents required some days to be acquired. For these reasons the review of documentation from the Main Library was conducted in parallel with the work in the documentation room. After a personal communication with Ms. Annalisa, a review of the country boxes at the Forestry Library was done to avoid the possibility of missing the most recent documentation not yet registered in the intranet database.

Finally a fast screening was done also of the GFSS database. However, no relevant documents not already found in either the documentation room, Main or Forestry Libraries were found. The documents of the GFSS database appear to be secondary documents, i.e. government reports. In total 248 documents were reviewed. The selected documents were then analyzed in-depth with the aim of assessing their completeness, i.e. meeting the requirements necessary to satisfy the Volume\Biomass Study. The requirements can be summarized as follows:

- all species were considered in the inventory
- volume was reported for all species,
- minimum diameter was inferior to 40 cm (d.b.h),
- reliability of the data

Regarding reliability, the sampling design, the intensity of the inventory, the use of stand and stock tables or how many trees were cut and measured were carefully examined. At the same time the consistency of the data was verified.

Even if the document didn't satisfy completely the requirements but were for different reasons interesting they were entered into the general database and marked in the field Bio_util as "F" (false).

Inventories reporting data for the inventoried area as a whole, without giving details per forest block or unit, were considered as one spatial unit. For those inventories reporting data for forest blocks where it was not possible to locate geographically with sufficient precision, the block location average (the weighted average) between the strata was calculated and applied to the whole area inventoried.

Out of the 248 documents reviewed, 179 were considered to meet the requirements of the Volume/Biomass Study, resulting in forest inventory data entered for 286 blocks.

To achieve one of the objectives of the work, attention was paid on how to locate the area and the plots inventoried from a geographical point of view. Most of the documents were without a map. Some maps were annexed but supposedly were lost. In others there were maps but without any coordinates. In some inventories, while the maps were absent, the description of the area was so detailed that geographically locating the area was possible. However, this was possible only when the limits mentioned were natural limits, e.g. rivers, coastline, etc., or administrative boundaries at sub-national levels. For this I took advantage of the map library (A.G.L.). Normally these maps were at 1:500000/1000000 scale.

3 Organization of Baseline Documentation

For all the documents entered into the general database, a fotocopy of the front page was made, the **id** code was written in red ink in the copy and placed in the volume/biomass folder. The actual documents found in the documentation room were grouped and placed in their respective country boxes. On the label of the country box, the name "volume" was added to indicate the location of the documents considered most important for the Volume/Biomass Study. If the document was found at the Forestry Libray or at the Main Library, only a fotocopy of the front page was added to the country box.

4 Compilation and Coding of Meta Information Related to the Forest Inventories

Two databases were created in Fox Pro to store meta information directly extracted from the inventory reports: **Biomass.dbf**, containing the more general information (Table n.1) and **Bio_tab.dbf**, with more specific information (Table n.2). The two tables were linked via the **id** code, where of the six characters, the first 3 represent the FORIS Country Code and the last 3 are a serial number. The structures of **Biomass.dbf** and **Bio_tab.dbf** are the following:

Structure for table	c:\alessa~1\biomas s\biomass.dbf
Number of data records	248
Date of last update	01/12/1999
Memo file block size	64
Code Page	0

Field	Field Name	Type	Width	Dec	Index	Collate
1	CTY_CO DE	Numeric	4			
2	ID	Character	6			
3	COUNTRY	Character	10			
4	AUTHOR	Character	150			
5	BIBL_REF	Character	254			
6	PUB_DATE	Character	4			
7	NAMEOFINV	Character	254			
8	INV_DATE	Character	4			
9	NATIONAL	Logical	1			
10	GEOLOCATIO	Character	254			
11	INVAREA	Numeric	10	1		
12	MAP	Logical	1			
13	STRA_CRIT	Character	100			
14	DESIGN	Character	200			
15	INTENSITY	Character	9			
16	COVERAGE	Character	25			
17	DIAMETER	Numeric	3			
18	VOL_TYPE	Character	25			
19	BIO_UTIL	Logical	1			
20	NOTES	Memo	10			
Total			1326			

Field name	Description
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CTY_CODE	Country code (FORIS)
ID	Country code (FORIS) and serial number
COUNTRY	Country
AUTHOR	Author or Organization
BIBL_REF	Title of the document
PUB_DATE	Date of publication
NAMEOFINV	Name of the inventory
INV_DATE	Date at the end of the field work
NATIONAL	The administrative level of the inventory
GEOLOCATIO	Location of the area inventoried, name of the district, or any useful reminder
INVAREA	Area in hectares covered by the inventory
MAP	"T" when the inventory provides a map
STRA_CRIT	Information about the use of stratification or not
DESIGN	Inventory design and sampling methods
INTENSITY	Intensity of the sampling
COVERAGE	Species for which the volume was reported
DIAMETER	Minimum diameter (d.b.h) of trees for which the volume is reported
VOL_TYPE	Volume type: under bark, over bark, with branches etc.
BIO_UTIL	"T" if the document at the end of the review and GIS georeferencing procedure satisfied all of the requirements and could be used in the volume/biomass study
NOTES	Description of particular information

Table 1

Structure for table: c:\fao\max\biomass\bio_tab.dbf
Number of data records: 286
Date of last update: 22/12/98
Memo file block size: 64
Code Page: 0

Field	Field Name	Type	Width	Dec	Index	Collate
1	ID	Character	6			
2	ID GIS	Character	3			
3	REPO_UNIT	Character	50			
4	UNI_AREA	Numeric	10	1		
5	VOL_HA	Numeric	5	1		
6	SAMP_ERR	Numeric	5	1		
7	STAND_STOC	Logical	1			
8	COMMENTS	Memo	10			
9	GEO_COOR	Logical	1			
Total			92			

Field name	Description
ID	Country code (FORIS) and serial number
ID_GIS	Unique ID used to link the information with the GIS
REPO_UNIT	Report unit of the inventory or block
UNI_AREA	Area in hectares of the report unit
VOL_HA	Volume in cubic meters per hectare
SAMP_ERR	Sampling error
STAND_STOC	"T" if stand stock tables were provided
COMMENTS	Information and additional information on the volume or reporting units
GEO_COOR	"T" if the coordinates were available

Table 2

5 Georeferencing Forest Inventory into the FRA Geographic Information System

Not all of the inventories had a map with which it was possible to geographically locate the area inventoried. The reasons for this were different. The map was annexed in a separate document but this document was not found. The map should have been annexed with the report but the envelope-page was empty. The map was just a scratch map without coordinates. There was map of the global area inventoried but not of the different units or strata. Or only the coordinates of the four corners were available.

In order to georeference the volume, depending on the information available, different procedures were applied. In the case of a missing map, the description of the area was very useful and from this it was occasionally possible to understand and locate the area inventoried in a generic country map. Infact very often inventories' limits were considered natural limits such as rivers, lakes, or administrative boundaries. Due to this, it was very important to invest time and energy to find country maps with the same information reported in the inventory description. In order to achieve this, the library (A.G.L.) was very useful. Normally the map used was at 1:500000/1000000 scale.

When it was possible to locate the area inventoried in a map with coordinates, the procedure was the following:

- The borders of the area inventoried (the smallest unit for which the volume was reported) were drawn on an acetate with a 0.2 mm pen. In order to save time during the next steps, if the units were more than one block or additional inventories covered in a neighboring zone, they were included on the same lucid paper.
- At least four tic marks (normally six or nine) were drawn on the acetate and their **id** and coordinates reported in a tixxxxxx.txt file (xxxxxx represents the **id** code).
- The polygons drawn on the acetate were scanned at 200 dpi, and saved as a compressed .tif file (imxxxxxx.tif).
- The files were imported into Arc\Info GIS and vectorized. For corresponding tic marks, tic points were added.
- The cover was then edited to clean all the superfluous arcs. All the needed corrections were done.
- To georeference the map, a cover of just tics was created and projected. Very few inventory maps included information on the projection system characteristics. When it was not possible to figure out the projection system, the projection characteristics of the topographical maps used in the respective countries was adopted. The cover with the polygons was "Transformed" on the tics cover earlier projected.
- A new Item in the coxxxxxx.pat file was added to register the **Id_gis** code.
- The polygon labels were added and coded with the **Id_gis** code.

When it was not possible to locate the area inventoried on a map, but the coordinates of the four corners were provided, the procedure consisted in building a cover of polygons directly from a .txt file where the coordinates of the four corners were reported. The ID of the polygon reported in the .txt file corresponds to the **Id_gis**. In this way it was possible to avoid the labelling phase.

When two or more inventories covered the same area or part of it, to keep the polygons separate, and consequently the volume, the Region function of Arc\Info was used.

The following annexes contain samples of the most important fields from the two databases. As they are generated in Access, the annexes can be made available on hard copy upon request to FRA Programme.

Appendix 1: Documents considered useful for the Volume/Biomass Study

Appendix 2: Documents that don't meet the requirements necessary for the Volume/Biomass Study

FRA Working Papers

1998

1. *FRA 2000 Terms and Definitions* (18 pp. - E/F/S)
2. *FRA 2000 Guidelines for assessments in tropical and sub-tropical countries* (43 pp. - E/F/S)

1999

3. *The status of the forest resources assessment in the South-Asian sub-region and the country capacity building needs.* Proceedings of the GCP/RAS/162/JPN regional workshop held in Dehradun 8-12 June 1998. (186 pp. - E)
4. *Volume/Biomass Special Study: georeferenced forest volume data for Latin America* (93 pp. E)

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