



Forestry Department

Food and Agriculture Organization of the United Nations

BRIEF ON NATIONAL FOREST INVENTORY NFI

CAMBODIA

Forest Resources Development Service

Rome, June 2007



Strengthening Monitoring, Assessment and Reporting (MAR) on Sustainable Forest Management (SFM)

FAO initiated activities to strengthen Monitoring, Assessment and Reporting on Sustainable Forest Management in January 2006 with the objective to facilitate development of harmonized forest related national monitoring, assessment and reporting (MAR) for contributing directly to the improvement of national sustainable forest management (SFM) regimes. It also aims to catalyze national discussions, analyses, policy actions and planning that promote national SFM regimes besides clarifying the contribution of forests to global environment and to human well-being. This initiative shares the ambition of the Collaborative Partnership on Forests (CPF) about simple, harmonised, efficient and action oriented MAR systems both at international and national levels and thus provides a response to some of the key recommendations made by the CPF task force on streamlining the reporting on forests with particular focus on national capacity building.

The MAR recently updated goals include country capacity building for better, consistent and regularly updated information to facilitate implementation of non-legally binding instrument (NLBI) on SFM, adopted at UNFF 6 (2007) that aims to,

- Strengthen political commitment and action at all levels to implement effectively sustainable management of all types of forests and to achieve the shared four global objectives ((a) reverse the loss of forest cover worldwide, (b) enhance forest-based economic, social and environmental benefits, (c) increase significantly the area of protected forests worldwide, and (d) reverse the decline in official development assistance for SFM);
- Enhance the contribution of forests to the achievement of the internationally agreed development goals, including the Millennium Development Goals, in particular with respect to poverty eradication and environmental sustainability; and
- Provide a framework for national action and international cooperation.

All countries can participate in this initiative, although the actual level and intensity of their involvement may vary among them. The initiative is organized under the Forest Resources Development Service (FOMR) of FAO Forestry Department. The contact persons are:

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The MAR-SFM Working Paper Series provides an important forum for the rapid release of preliminary findings needed for validation and to facilitate the final development of official quality-controlled publications. Should users find any errors in the documents or have comments for improving their quality they should contact Kailash.Govil@fao.org or Dan.Altrell@fao.org.

Brief Note on MAR-SFM Working Paper Series (AP) on NFI- Brief

The NFI – Brief for a country attempts to provide a bird’s eye view of the National Forest inventories (NFI). However, some countries conduct forest inventories at sub-national and or field management unit level. Therefore, this brief presents brief information on the forest inventories in a country at national level, sub-national level and or field management level depending on the available information.

It is useful to regularly update our understanding of elements and specifications of forest inventories because the information generated by forest inventories is simply manifestation of its span, design and methods to collect and analyse the primary information during its implementation. This is important because the NFI provides information on the state and trends of forest resources, their goods and services, and other related variables that support and many time define the policy and trade decisions, science and field initiatives, national and international reporting, and direct and indirect contribution of forests to society like poverty alleviation. Regular updates are necessary because countries do change the set of elements, their specifications, designs and methods over period of time to address new emerging demands and to take advantage of new technologies.

The purpose of developing the NFI-briefs is, therefore, to document (working paper) the current and historical span of elements (variables or fields), their specifications, sampling designs and methods used in NFI. The document may serve as data source as well as reference material.

These briefs have been initially developed on the basis of the country submission to FAO. The initial draft of this report was sent to following national focal point for review and country validation before its finalisation.

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B. Compilation and Supervision

This report has been compiled by Mr. Marco Piazza under supervision of Dr. Kailash Govil, Senior Forestry Officer, MAR.

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General Information

The Kingdom of Cambodia, formerly known as Kampuchea is a country in Southeast Asia with a population of over 13 million people, with Phnom Penh being the capital and largest city. The country borders Thailand to its west and northwest, Laos to its northeast, and Vietnam to its east and southeast. In the south it faces the Gulf of Thailand.

Map of the Country

Figure 1. Map of Cambodia



(Source: <https://www.cia.gov/library/publications/the-world-factbook/geos/bg.html>)

Land Area and Landuse

The total area of Cambodia is 181 040 square km and the following table presents the categorisation and projection of land use in Bangladesh for 1990, 200 and 2005 (FRA 2005).

Table 1. Categorisation and projection of land use in Cambodia (FRA 2005).

FRA 2005 Categories	Area (1000 hectares)		
	1990	2000	2005
Forest	12946	11541	10447
Other wooded land	335	298	270
Other land	4371	5813	6935
Other land of which with tree cover			
Inland water bodies	452	452	452
TOTAL	18104	18104	18104

Forests

Cambodia has one of the worst deforestation rates in the world. Cambodia's primary rainforest cover went from over 70 percent in 1970 to 3.1 percent today and deforestation rates in Cambodia continue to accelerate. In total, Cambodia lost 2.5 million hectares of forest between 1990 and 2005, 334,000 hectares of which were primary forest. Today less than 322,000 hectares of primary forest remain. Illegal logging, combined with rapid development and population growth, is blamed for much of Cambodia's forest loss. Figure 2 presents an image of the forest cover and land use in Cambodia.

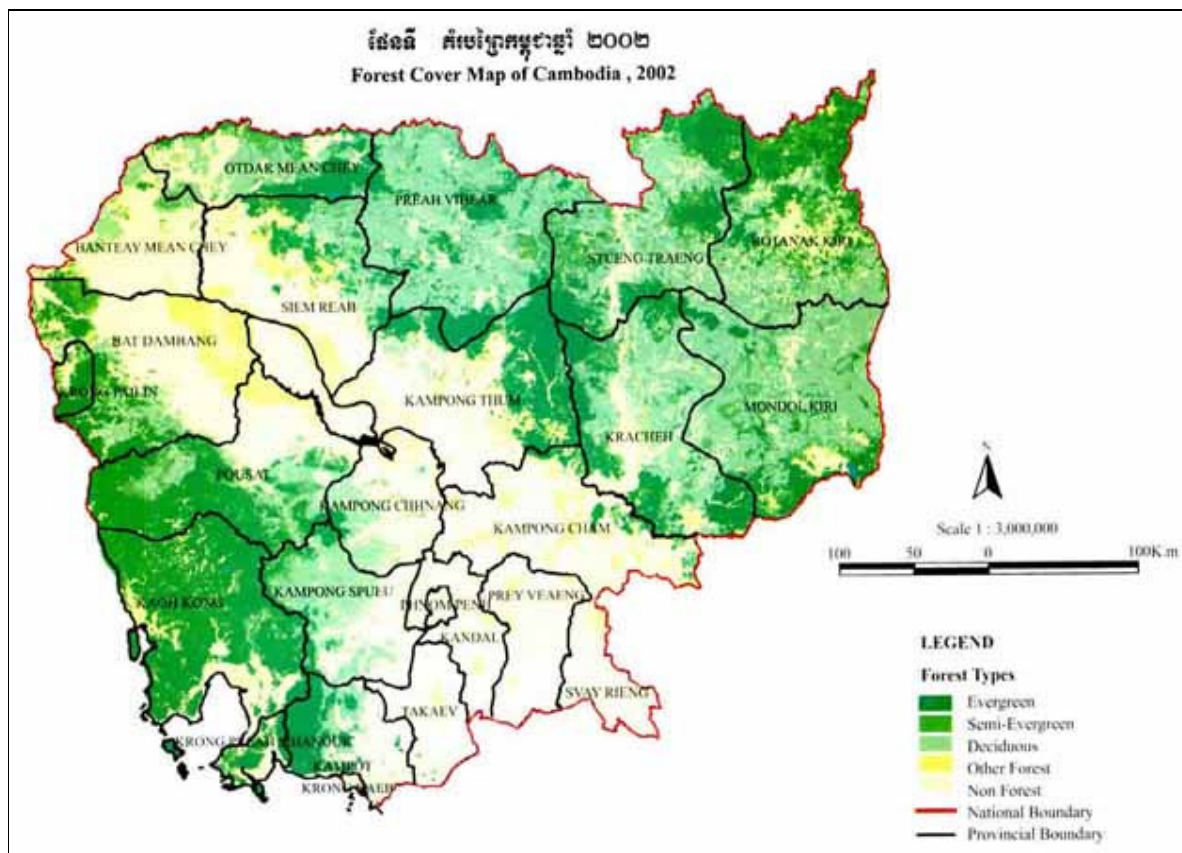


Figure 2. Forest Types in Cambodia

source: <http://www.forestry.gov.kh/AboutFA/ForestCoverMap.html>

Three main types of forest are found in Cambodia: relatively open deciduous forest; generally closed semi-deciduous forest; and evergreen closed forest. The first covers a larger area than the others, the second is the richest in timber, while the third represents an eco-floristic type, unique in Southeast Asia. A further subdivision of forest classes in Cambodia is presented in Table 2 as indicated by the Cambodian Department of Forestry and Wildlife (data of 2002/2003).

Table 2. Forest Cover types and other land uses in Cambodia

Forest Type	Area (ha)	%
Evergreen Forest	3,720,504	20.5
Semi-evergreen Forest	1,455,091	8.0
Deciduous Forest	4,833,138	26.6
Wood Shrubland Dry	138,939	0.8
Wood Shrubland Evergreen	150,017	0.8
Bamboo	28,952	0.2
Other Forest	1,065,706	5.9
Total Forest	11,392,347	62.7
Non Forest	6,768,323	37.3
Total area	18,160,670	100.0

Source: Cambodian Department of Forestry and Wildlife (2002/2003)
<http://www.forestry.gov.kh/Statistic/Forestcover.htm>

Brief History of Forest Inventories

The first forest inventory of Cambodia was done by FAO/UNDP between 1958-62 in the Region of East Mekong River covering 5,520,000 ha of land, almost one-third of the country. A national inventory was planned between 1960-62 by USAID, for which the country was divided into seven sampling units. However, the field work was done only in Sampling Unit No.1 in the Cardamom Range covering 3,792,000ha, nearly one-fifth of the country, the results of which are not available. A manual on national forest inventory and volume tables, for broad forest types are useful contributions of the 1960-62 USAID inventory project. An inventory of 300,000ha of Cardamom Range around the bay of Kampong Som was carried out between 1968 and 1970 by FAO/UNDP.

Cambodia never had its forest resource assessed completely at national level. The inventory results from the limited forest inventories that were carried out more than two or three decades ago cannot be used at present for planning or policy decision. An inventory work was carried out in 1998 under the project: Establishment of a Forest Resources Inventory Process in Cambodia. Department of Forestry and Wildlife RGC/UNDP/FAO Project CMB/95/002, Phnom Penh, Cambodia). The inventory was on a pilot scale with limited resources and was aimed at establishing a nucleus of inventory staff to play a positive role in future forest resource assessments and updating.

Table 3. History of Assessments

Publication Year ¹	Title ²	Institution ³	Ground Inv. Year(s) ⁴	Remote Sensing		Estimation Level ⁷	Country Coverage (Full/Partial, %) ⁸	Thematic cover**
				Data Year(s) ⁵	Scale of Interpretation ⁶			
1962	Forest Inventory	FAO/UNDP	1958-62				East Mekong River (5.520,000 ha)	
1960-62	National Forest Inventory	USAID					Inventory done on one of seven sampling units (Cardamom Range, 3,792,000 ha)	
1970	Inventory of the Cardamom Range	FAO/UNDP	1968-70				300,000 ha of the Crdamom Range.	
1997	Forest Cover Monitoring Project	H-J Stibig. MRC/GTZ. c/o Dept. of Forestry and Wildlife Phnom Penh, Cambodia		LandSat 96/97	Sat. Images	National - Map at 1:250,000	Complete	NF, PL, OWL,
1998	Forest Cover Statistics	Dept. of Forestry and wildlife, Forest Wildlife Research Institute. Phnom Penh, Cambodia				National area stats broken down by province and forest type/land use type. Data from	whole country	NF, PL, OWL, FAC

Legend: **NF=Natural Forest; **PL**=Plantations; **OWL**=Other Wooded land; **FAC**=Forest Area Change; **TV**=Total Volume; **TB**=Total Biomass; **CV**=Commercial Value; **PA**=Protected Areas; **BD**=Biodiversity; **FO**=Forest Ownership; **WSP**=Wood Supply Potential; **NWGS**=Non-wood Goods and services; **TOF**=Trees outside of forest; **FF**=Forest Fires

Legend:

[1] Publication Year	Year in which the assessment was published
[2] Title	Title of the assessment
[3] Institution	Institution(s) responsible for the Assessment
[4] Ground Inventory Year(s)	Year or Interval of years during which the field inventory has been carried out
[5] Remote Sensing Data Year(s)	Year(s) of the Remote Sensing Images
[6] Remote Sensing Scale of Interpretation	Scale of Remote Sensing Images (e.g. 1:250,000)
[7] Estimation Level	Whether the Assessment was at National, Sub-national, District, Management Unit, etc. level
[8] Country Coverage (Full / Partial, %)	Amount of country area covered by the assessment (e.g. full, partial). If partial, indicated by % of total area.

Latest National Forest Inventory Design

Cambodia never had a forest resources inventory at the national level however, an inventory work was carried out in 1998 on a pilot scale with limited resources and was specifically aimed at establishing a methodology and process for future forest resource assessments. The following sections present the methodology used during the forest resources assessment in 1998.

Remote Sensing Survey

A nationwide aerial survey was implemented in 1958-60 with photographs taken at a scale of 1:40,000 or 1:10,000 by USAID. However, none of these photographs are available today. The 1992/93 programme by FINMAP sponsored by the Mekong River Commission covered nearly two thirds of the country, the remaining third was covered in 1996. Six sets of black and white aerial photographs of the 1992/93 are available at 1:30,000 scale in Cambodia, additional sets are available from other sources. The Japan Forest Technical Association (JAFTA) assisted in development of 1990/93 Landsat digitally classified data. The GTZ Forest Cover Monitoring Project (FCMP) has helped in development of interpretation of 1992/93 and 1996/97 Landsat hardcopy imageries and digitized data. The FCMP made use of Landsat imageries at a scale of 1:250,000, few SPOT imageries at scales of 1:50,000 and 1:100,000, and aerial photographs of 1:20,000 and 1:30,000.

Recently, a national forest cover change assessment for 2005/06 with financial assistance from the Royal Danish Embassy-Danida was recently implemented by the Remote Sensing and Geographic Information System (RS-GIS) unit within forest administration using Landsat ETM+ data (Figure 3). (Documents available at www.twgfe.org). Independent quality assurance and data verification was carried out by GRAS A/S- University of Copenhagen.

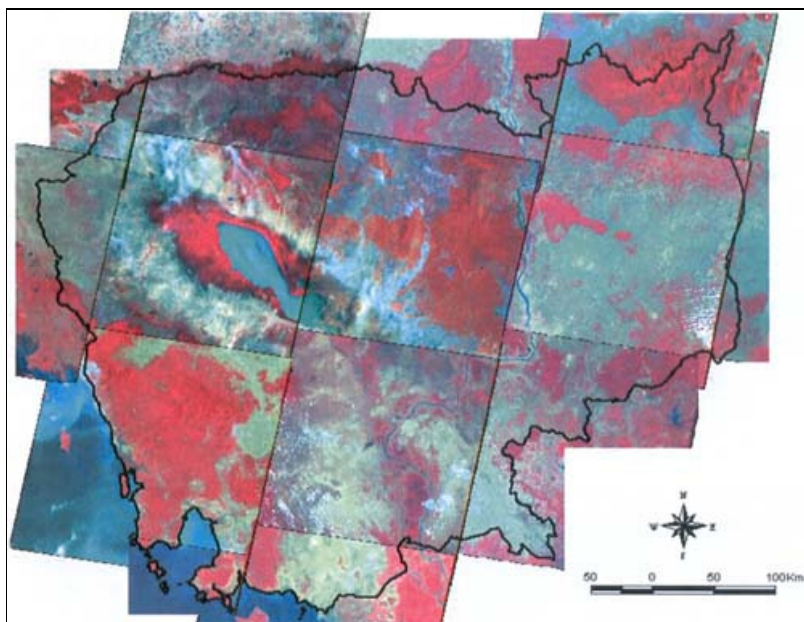


Figure 3. Landsat 7 satellite image of Cambodia

In January 2007 the Forestry Administration of Cambodia finished their assessment of the forest cover of Cambodia for 2005/2006 based on visual analysis and digitization on Landsat ETM satellite imagery. The test sites were selected using systematic random sampling and a total of 83 points were selected for field verification. Sites in remote areas were also selected for testing using cluster sampling of aerial photos or very high resolution (VHR) satellite data.

The overall accuracy when testing the points visited in the field against the classification is approximately 60 %. Some of the most important classes (eg. Evergreen forest, Deciduous forest) are mapped with a high accuracy whereas the smaller classes such as Woodshrub dry, Woodshrub evergreen and Bamboo have low accuracies. For the cluster based VHR sampling, a total of 76 points were checked in 4 subsets of 5 x 5 km from. For these areas the overall accuracy is 80 %. The higher accuracy compared to the field results is probably that the classes in remote areas away from roads are more pure and homogeneous as the human impact is limited.

Combining the results of the field sampling and VHR cluster sampling the overall accuracy is 71 % with acceptable accuracies for the main classes and low for the smaller classes.

Field Inventory

The field inventory specification and sampling design outlined below refers to a low intensity forest sampling survey undertaken in Sandan District in Kampong Thom province within the project “Establishment of a Forest Resources Inventory process in Cambodia”, RGC / UNDP / FAO, 1998.

The field inventory used cluster sampling. In order to select field sampling points, a 4 x 4 Km grid was drawn on 1:50,000 maps and grid intersection were studied on aerial photographs to locate them in the forest. Each cluster contains nine plots each of 60 meter x 20 meter size. Three plots are laid in each line at a distance of 100 meters between plots and between lines (see figures 4 and 5) aligned in the North direction. The initial point for each cluster was determined by locating a recognizable point (stream, road junction, etc.) that is nearest to the the intersection of the 4 x 4 Km gridline.

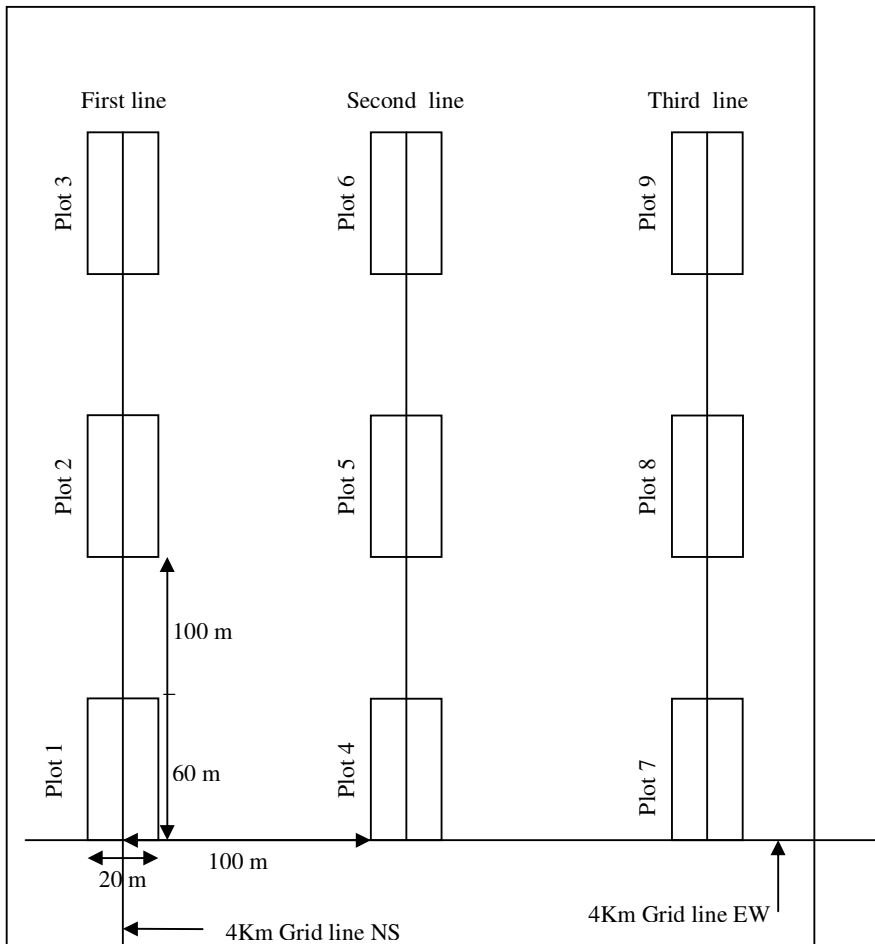


Figure 4. Cluster sampling Layout

From the starting point, the first line of the cluster is laid out due north and the first plot (60 x 20 m) is laid out, 10 meters on either side of the center line. Trees are considered in a cluster plot if they are wholly within a distance of 10 meters from the center line, measured at right angle. Plots 2 and three are laid out at a 100 meters distance along the centre line. The second cluster line (plots 4,5,6) starts at 100 meters due east of the starting point and the third cluster line (plots 7,8,9) at 200 meters east of starting point.

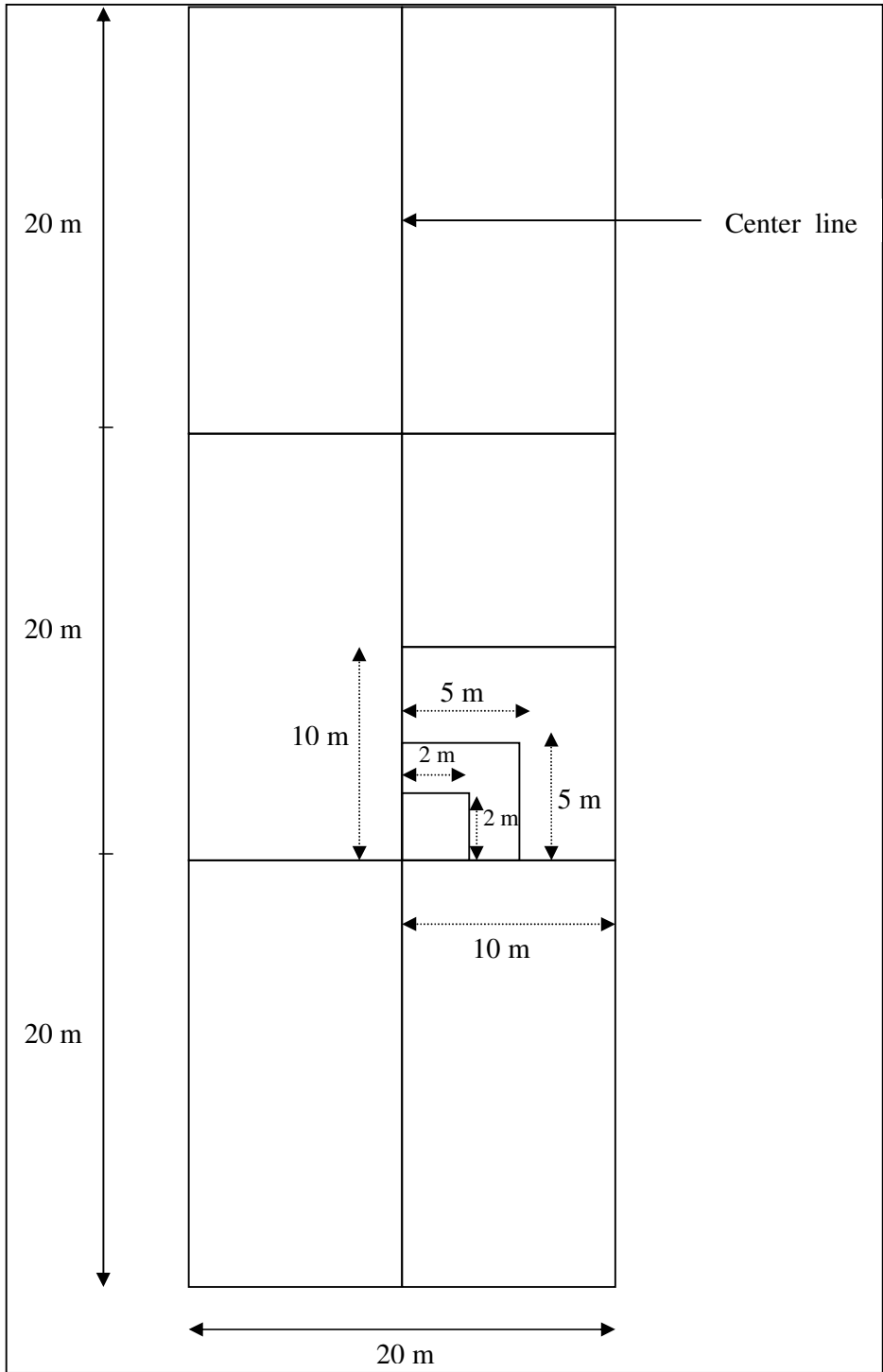


Figure 5. Plot Diagram

Measurements

The following measurements were recorded at the main plot level:

- Altitude: It was recorded from map (center of principal plot).
- Topography: Both the natural and the man-made features (rivers, roads, etc.) were recorded.
- Orientation (or Aspect): The direction in which the principal plot was facing (in classes of 45 degrees intervals) was noted.
- Slope: Degrees of slope was taken for average slope downhill at the center of principal plot using a clinometer.
- Soil: Soil type were recorded and classified as Sandy, Sandy loam, Clay, Clay loam.
- Geology: Geological structure was recorded and classified as: Rocks or boulder, Erosion, Swamps, Water logged, Quarry or other forms of mining.
- Height: Height of trees was recorded for trees over 30 cm DBH over bark in three classes: 5-20 m; 21-30 m; >30 m.
- Area: Area of forest canopy/crown cover was recorded in four classes: 10-20%; 21-40%; 41-70%; >70%.
- Number: Number of trees of different diameter and size classes was counted within different size-sub-plots.

The plot was divided in smaller plots (figure 4) for in depth information. The Table 4 indicates the size class of trees to be tallied in each plot and subplots. The sampling sequence therefore is as follows:

- (a) Enumerate all seedlings <1.5 meter height in the 2 x 2 meter plot
- (b) Enumerate all saplings >1.5 meter height in the 5 x 5 meter plot
- (c) Enumerate all trees with diameter 5 -10 cm. in the 10 x 10 meter plot
- (d) Enumerate all trees with diameter 10 -30 cm. in the 20 x 20 meter plot
- (e) Enumerate all trees with diameter greater than 30 cm in the three 20 x 20 meter plots and bamboo clumps in the central 20 x 20 meter plot.

Table 4. Size class of trees recorded in plots and subplots

Dimension of sample plot (meters)	Area (ha)	Size classes
2 x 2	0.0004	< 1.5 height (seedling)
5 x 5	0.0025	> 1.5 height < 5 cm DBH (saplings)
10 x 10	0.01	5-10 cm DBH
20 x 20	0.04	10-30 cm DBH
60 x 20	0.12	> 30 cm DBH

All inventory data are stored by means of a Forest Inventory Data Processing System 2 (FIDAPS2) developed by FAO and installed in the project computers in 1996. The FIDAPS2 has considerable flexibility to process cluster, plot and strip inventory data.

Content and Methodology of data collection in NFI

Note: [N=National; SN=Sub-National; MU=Management Unit]

Geo-physical

	N	SN	MU	Methodology
Geo-Coordinates	X			no info available
Altitude	X			Field Survey
Topography	X			Field Survey
Orientation (or Aspect)	X			Field Survey
Slope	X			Field Survey
Soil	X			Field Survey
Geological structure	X			Field Survey
Rainfall	X			no info available

Bio-Physical

	N	SN	MU	Methodology
Number of trees	X			Field Survey
Diameter of trees	X			Field Survey
Height of trees	X			Field Survey
Length of stem	X			Field Survey
Stump height				
Age class				
Twigs				
Bark				
Leaves				

Forest extent

	N	SN	MU	Methodology
Forest land area	X			Remote Sensing Survey
Area of forest canopy/crown cover	X			Remote Sensing Survey
Area under forest management	X			Remote Sensing Survey
Area under formal forest management plan	X			Remote Sensing Survey
Area under sustainable forest management	X			Remote Sensing Survey
Forest area with certification				
Area under public owned forest	X			Remote Sensing Survey / Documents
Area under private owned forest	X			Remote Sensing Survey / Documents

Forest characteristics (Naturalness) and forest type

	N	SN	MU	Methodology
Primary forest	X			Field Survey, Map
Modified natural forest	X			Field Survey, Map
Semi-natural forest	X			Field Survey, Map
Productive plantation	X			Field Survey, Map

Protective plantation	X			Field Survey, Map
Coniferous	X			Field Survey, Map
Broadleaved	X			Field Survey, Map
Mixed forest	X			Field Survey, Map
Forest area by dominant species (bamboo, mangroves, rubber)	X			Field Survey, Map
Forest area by ecological zone (tropical, subtropical, temperate, boreal, polar)	X			Field Survey, Map

Use (designated functions) of forests

	N	SN	MU	Methodology
Area of forest under production	X			Survey,report,Plans,Map
Area of forest for protection of soil and water	X			Survey,report,Plans,Map
Area of forest for conservation of biodiversity	X			Survey,report,Plans,Map
Area of forest for social services	X			Survey,report,Plans,Map
Area of forest for multiple purpose	X			Survey,report,Plans,Map
Forest area available for wood supply	X			Survey,report,Plans,Map
Forest area within protected areas	X			Survey,report,Plans,Map

Social Services

	N	SN	MU	Methodology
Area of forest managed for recreation	X			Survey,Map
Area of forest managed for tourism	X			Survey,Map
Area of forest used for education	X			Survey,Map
Area of forest managed for conservation of cultural/spiritual site	X			Survey

Mapping of forest distribution

	N	SN	MU	Methodology
Distribution of forests	X			Remote Sensing Survey, Map
Forest Characteristics	X			Remote Sensing Survey
Land use	X			Remote Sensing Survey
Administrative/political/legal boundaries	X			Survey, Map
Designated functions of forests	X			Survey,Map
Other wooded land	X			Remote Sensing Survey
Other land with tree cover				
Other land				

Status of the forest and disturbances affecting forest health and vitality

	N	SN	MU	Methodology
Disturbance by insects				
Disturbance by diseases				
Disturbance by other biotic agents				
Disturbance by fire				
Disturbance caused by other abiotic				

factors				
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Biodiversity

	N	SN	MU	Methodology
Tree species	X			Survey/International and local knowledge.
Shrub species	X			Survey/International and local knowledge.
Herbs species	X			Survey/International and local knowledge.
Endangered species	X			Survey/International and local knowledge.
Critically endangered species	X			Survey/International and local knowledge.
Vulnerable species	X			Survey/International and local knowledge.
Native species	X			Survey/International and local knowledge.
Endemic species	X			Survey/International and local knowledge.
Introduced species	X			Survey/International and local knowledge.

Beneficiaries of forest goods and services

	N	SN	MU	Methodology
By locality of user (e.g. indigenous/local/national)?	X			Field Observation
By good/service (e.g. timber, fuelwood, NWFP, bamboo/rattan, water, etc) used by them	X			Field Observation
By economic class of the beneficiaries (high, medium, low income)	X			Field Observation
By level of dependency on forest (as percentage of total employment)	X			Record
By physical accessibility to the forest (distance from forest)	X			Map

Economic value

	N	SN	MU	Methodology
Removal of timber	X			Statistical analysis
Removal of fuelwood				
Removal of other wood products				
Removal of wood products derived from forest under sustainable management				
Removal of wood products derived from forest plantations	X			Statistical analysis
Removal of non wood forest products				
Annual allowable cuts/yields	X			Statistical analysis
Social services	X			Economic survey
Environmental services	X			Environmental survey
Employment	X			Economic survey
Support to livelihood of communities	X			Economic survey
Market price/cost of wood in forest				
Market price/cost of non wood forest products				
Estimate of value of social services				
Estimate of value of environmental services				
Estimate of value of employment				
Estimate of the contribution of forest sector to national economy				

Policy, legal and institutions (PLI) framework

	N	SN	MU	Methodology
Forest policy	X			Documents
Forest legislation	X			Documents
Forest administration	X			Documents
Forest education and research	X			Report
Annual outlay, expenditure, investment in forestry sector	X			Documents

Bibliographies and References for further reading

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