BRIEF ON NATIONAL FOREST INVENTORY NFI

MALAYSIA

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 initiative has 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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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. It also defines 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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General Information

Malaysia is a federation of thirteen states in Southeast Asia. The country consists of two geographical regions divided by the South China Sea: Peninsular Malaysia (or West Malaysia) on the Malay Peninsula shares a land border on the north with Thailand. Malaysian Borneo (or East Malaysia) occupies the northern part of the island of Borneo, bordering Indonesia and surrounding the Sultanate of Brunei. It consists of the states of Sabah and Sarawak and the federal territory of Labuan. Its capital and largest city is Kuala Lumpur.

Map of the Country

Figure 1. Map of Malaysia
(Source:https://www.cia.gov/library/publications/the-world-factbook/geos/bg.html)

Land Area and Landuse

The total area of Malaysia is 329 750 square km and the following table presents the categorisation and projection of land use in Malaysia for 1990, 2000 and 2005 (FRA 2005).

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

FRA 2005 Categories	Area (1000 hectares)		
	1990	**2000**	**2005**
Forest	22 376	21 591	20 890
Other wooded land			
Other land	10 479	11 264	11 965
Other land of which with tree cover [1]			
Inland water bodies	120	120	120
TOTAL	**32 975**	**32 975**	**32 975**

[1] Area of "Other land with tree cover" is included in the area reported under "Other land" and should therefore be excluded when calculating the total area for the country.

Forests

Malaysia's forests are generally moist tropical forests covering approximately 20 million hectares or 60 percent of total land (see figure 2). As shown in table 2, forest area in Peninsular Malaysia is 5.88 million ha, 4.40 mill. ha are in Sabah and 9.24 mill. ha are in Sarawak. The forest types present in Malaysia include montane forests, upper-, hill-, and lowland- dipterocarp, freshwater/peatswamp forest, coastal vegetation and mangroves. It is estimated that approximately 17.15 mill. ha consists of dipterocarp forests while the remaining are fresh-water swamp (1.54 mill.ha.), mangrove (0.58 mill. ha) and plantation forest (0.25 mill. ha.). The dipterocarp forests are characterized by the predominance of the family Dipterocarpaceae with many species of the genera Anisoptera (Mersawa), Dipterocarpus (Keruing), Dryobalanops (Kapur), Hopea (Merawan) and Shorea (Meranti).

Table 2: Distribution and Extent of Major Forest Types in Malaysia, 2005 (million ha)

Region	Land Area	Dipterocarp Forest	Swamp Forest	Mangrove Forest	Plantation Forest	Total Forested Land	Percentage Total of Forested Land
Peninsular Malaysia	13.16	5.40	0.30	0.10	0.08	5.88	44.7
Sabah	7.37	3.83	0.12	0.34	0.11	4.40	59.7
Sarawak	12.30	7.92	1.12	0.14	0.06	9.24	75.1
Malaysia	**32.83**	**17.15**	**1.54**	**0.58**	**0.25**	**19.52**	**59.5**

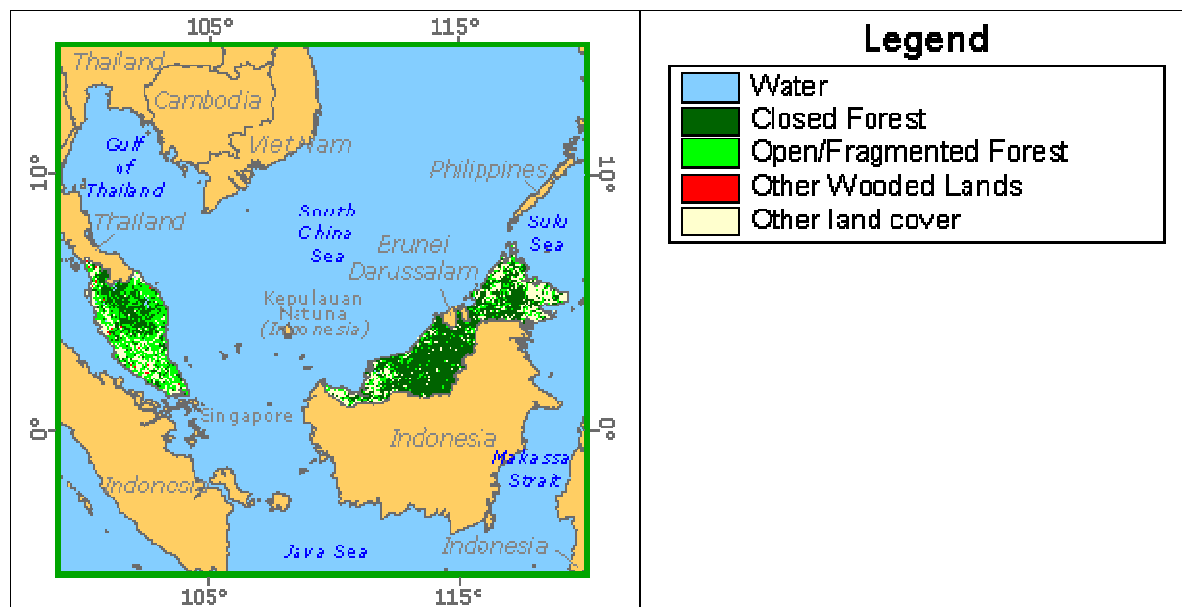Source: FDPM, 2006. Briefing on Status of Forestry in Malaysia.

Figure 2. Forest Cover of Malaysia
Source: FAO Global Forest Resources Assessment 2000

Brief History of Forest Inventories

Forest Inventories have been conducted in Malaysia since many decades with a variety of objectives and methods. Forest Management inventories have been conducted to obtain information on stands of forest districts to provide information for management decisions. National Forest inventories were aimed at providing data for large scale planning. Due to the geographical composition of Malaysia, different inventory efforts have taken places in Peninsular Malaysia and in the state of Sabah and Sarawak however, methodologies and objectives have often overlapped.

Peninsular Malaysia

The first documentation of forest inventory methods implemented in peninsular Malaysia is the "Manual of Malayan Silviculture for Inland Lowland Forest" published in 1954. Since then, various forest inventory methods have been formulated and documented.

In peninsular Malaysia forest inventories are carried out at three levels: macro, management and operational level. The procedure used in each of these levels differs in terms of sampling design, type of information collected and frequency.

At the macro level, The First National Forest Inventory of Peninsular Malaysia (hereafter known as NFI-1) was carried out between 1970-1972 by FDPM with assistance from the Food and Agriculture Organization of the United Nations (FAO) with aid from the United Nations Development Programme (UNDP) through the "Forestry and Forest Industries Development Project (FO: DP/MAL/72/009)" (Anon 1973).

The cluster sampling design which was adopted for use during the NFI-1 of Peninsular Malaysia was not only to compensate for the major fluctuations in the stand structure of the Peninsular Malaysia's rainforests, but also to balance the volume estimates at the microsite level, which become increasingly homogenous over expanding areas of the forest of Peninsular Malaysia. These would therefore negate the use of simple random sampling for NFI-1.

The Second National Forest Inventory (NFI-2) of Peninsular Malaysia undertaken solely by the FDPM during the 1980-1982, was largely to update the existing forest resources information collected previously during the First National Forest Inventory. During the NFI-2, some of the sampling units measured during the NFI-1 in 1970 - 1972 were remeasured, in addition to establishing new sampling units, thereby ensuring the continuity of the system. As such, these NFIs were considered as, Inventories on Successive Occasions with Partial Replacement.

NFI-2 followed the same design as NFI-1, with primary sampling points being fixed at the intersection of the 5 minute grid and within each primary sampling point were the 12 fixed secondary sampling points, each being a rectangular plot measuring 20x50 meters and covering an area of 36 hectares (Anon 1987). All trees having diameters of 30 cm and above were enumerated (Anon 1987). However, NFI-2 differed from NF-1, as it included an added dimension, in that all trees of between 15-30 cm diameter classes were measured, during the sub-sampling of 3 of the 12 secondary sampling points, as well as sampling of rattan and bamboo species.

The sampling design for the Third National Forest Inventory (NFI-3) was formulated through a joint project between the Government of Malaysia (GOM) and the Food And Agriculture Organization (FAO) of the United Nations, with aid from the United Nations Development Programme (UNDP) through the Project entitled "Forest Inventory and Management System, as part of the Forest Resources Conservation Programme (MAL/89/001)" (Anon 1987).

The NFI-3, a follow-up to the previous NFI (NFI-1 and NFI-2), was undertaken during 1990-1992 to collect the most recent and up-to-date data on the forest resources in Peninsular Malaysia, for use in the planning, management and development of the present and future forest resources. The NFI-3 was planned in such a way to be carried out continuously and to fit into the framework of the Continuous Forest Resources Monitoring System (CONFORMS), using forest inventory data and satellite imagery to formulate and develop suitable methodologies for classifying the natural forest into appropriate management and productivity classes under sustained yield management. The fieldwork of CONFORMS was planned to coincide with that of the NFI-3.

The NFI 4 inventory design is described as a stratified satellite based on randomly distributed permanent sample units.

Sabah

In Sabah, the first statewide forest inventory was conducted from 1969 to 1972 under the Canadian Bilateral Aid Programme (Colombo Plan). Another statewide forest inventory of the disturbed forests has also been carried out during the period 1986-87 by the State Forest Department of Sabah with the assistance of UNDP/FAO.

Sarawak

A forest resource inventory was carried out by FAO during the period 1969-72 under the Forestry and Forest Industries Development Project. Eight industrial units of Mixed Dipterocarp forest covering a total area of 1.2 million hectares were inventoried. Following FAO's forest resources inventory, the State Forest Department of Sarawak has been carrying out forest inventories on different forested areas annually.

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]			
Peninsular Malaysia								
1972	First National Forest Inventory (NFI1)	Forest Industries Development Project - UNDP / FAO.	1970-72			National		
1982	Second National Forest Inventory (NFI2)		1981 -82			National		
1997	Third National Forest Inventory (NFI3)	Forestry Department Peninsular Malaysia, UNDP / FAO	1991-93	1992	Landsat TM images	National		NF, FAC, TV, CV, PA, NWGS
2007	Fourth National Forest Inventory (NFI4)	Forestry Department Peninsular Malaysia, GTZ	2002-04	2000	Landsat TM images	National		NF, FAC, TV, CV, PA, NWGS
Sabah								
1972	Forest resource inventory	Canadian Bilateral Aid Programme (Colombo Plan)	1969 -1972			Statewide		
1987	Statewide forest inventory of the disturbed forests	State Forest Department of Sabah with the assistance of UNDP / FAO	1986 -87			Statewide		
Sarawak								
1972	forest resource inventory	Forestry and Forest Industries Development Project	1969-72			Statewide	Eight industrial units of Mixed Dipterocarp forest covering a total area of 1.2 million ha	

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.

National Forest Inventory Design

Field Inventory

First and Second National Forest Inventory

The inventory design consisted of a random cluster sampling in which each cluster included twelve separate sample plots of 50 x 20 m, as shown below in figure 3. In order to select sampling points, a five minute grid was superimposed on broad forest type maps of scale 1:250,000. All trees having a minimum Dbh of 30 cm were enumerated in all twelve sample plots while trees of Dbh between 15 cm and 30 cm were enumerated in three special plots of 50 m x 5 m). In all twelve sample plots, the following parameters were recorded: stump height, diameter at breast height, log quality, log length. Additional measurements, as well as the occurrence of bamboos and rattans, were also recorded in smaller special plots

Third National Forest Inventory

The third National Forest Inventory was implemented under a program called Continuous Forest Resource Monitoring System (CONFORMS). By integrating remote sensing, geographical information system (GIS) and field data, the system is composed by three phases. Phase 1 involves the collection of information on all types of natural forest and forest plantations from fixed monitoring points based on satellite imageries. Phase 2 involves the establishment of a GIS database to describe the past and present forest situation, as well as to monitor changes to the resource base. Phase 3 entails collection of field data on a continuous basis from randomly selected grid points according to predetermined standards.

Fourth National Forest Inventory

The sampling design consists of permanent sample units (satellites) of square shape with one sample plot in each corner. Each sample plot consists of a sample circle for small size trees and a point sample. Each sample unit consists of four (4) sample plots and three (3) sample strips. Each sample plot is a combination of a fixed sample circle of 4 m in radius and a point reference. The distance between the sample plot is 100 m. The total sample area is 0.12 hectare. Within the sample circle only commercial trees <10 cm Dbh and >1.5 m in height and some key medicinal plants are assessed. The strip sample area is about 0.02 hectare resulting in total sample area at 0.14 hectare.

Management Level Forest Inventory

At the management level, the forest inventory is carried out with sample plots laid along sampling lines 100 m. apart and 200 m. between plot centers. However, this type of inventory is seldom carried out due to shortage of funds and manpower. Hence, in order to quantify the forest resources at the management level, a systematic sequential sampling (SSS) is carried out in the logged over a disturbed forest types. The inventory design then consists of principal plots of 60m x 20m and four sub-plots of 20 x 20m, 10 x 10m, 5 x 5m and 2 x 2m with the principal plots being 120 m apart along the sampling line or 180 m from one plot center to the next while the distance between sampling lines is of 200 m. The different sampling plots sizes are designed for collecting different size class trees.

Operational Level Forest Inventory

At the operational level, three types of forest inventory are being carried out as follows: (i) linear enumeration of big trees, (ii) pre-felling forest inventory and (iii) post-felling forest inventory. The linear enumeration of big trees is usually carried out to estimate the volume of timber present in a given area prior to logging. The sample or enumerate area consists of 20 m wide, straight, serially numbered strips, 10 m on both sides of the sampling line.

The pre-felling forest inventory is carried out to determine the stand structure of the forest before harvesting starts and to determine the appropriate felling regime which will be equitable to both logger and forest owner and to ensure ecological balance and environmental quality. The inventory is carried out using systematic line plots of 50 x 20 m. with four sub plots of 25 x 20m, 10 x 10m, 5 x 5m and 2 x 2m. Different size trees are enumerated in each size subplot. The presence of bamboos, *Eugeissona triste* (bertam), palms and ferns is also recorded in the principal plot of 50 x 20m along with other features such as slope, aspect, elevation, soil and forest type.

The objective of post-felling forest inventory is to determine the regeneration status of the harvested forest in terms of stocking, composition, size and distribution in order to consider appropriate silvicultural treatments. Two sampling designs are used for post felling forest inventory. The first sampling design uses strip sampling which is also known as Linear Regeneration Sampling I (LRS I). The strip consists of two quadrants of size 10 x 10 m and 2 x 2 m. along sampling lines laid out 200 m. apart. The second sampling design consists of systematic line plots of 50 x 20 m with four sub plots of 25 x 20m, 10 x 10m, 5 x 5m and 2 x 2m, similarly to the pre-felling forest inventory.

Besides inland forests, the mangrove forests in peninsular Malaysia are enumerated using systematic line plots of 5 m. radius (0.008 ha) laid along sampling lines at 100 m intervals with distance between plot centers of 20m..

Remote Sensing

In Peninsular Malaysia the first attempt at extensive spatial data acquisition based on aerial photographs in forestry was made in 1961. Aerial photographs with scales ranging from 1:10,000 to 1:90,000 were investigated and it was determined that the best results for consistency in stratification and forest typing could be obtained from photos with a scale ranging from 1:25:000 to 1:40:000.

The use of Remote Sensing in Malaysian NFI started with the first inventory in 1971, using panchromatic aerial photographs of scale 1:25,000. The aerial photographs were used to stratify the mixed tropical forests into eleven broad forest types (excluding mangrove forests). The same approach was also used for the second NFI in 1981 to assess forest changes in peninsular Malaysia since the first inventory. For the third NFI (1991-93), space-borne remote sensing data were utilized in recognition of the usefulness of remote sensing for forest monitoring. Therefore, the third NFI was carried out using Landsat Thematic Mapper (TM) data instead of aerial photographs.
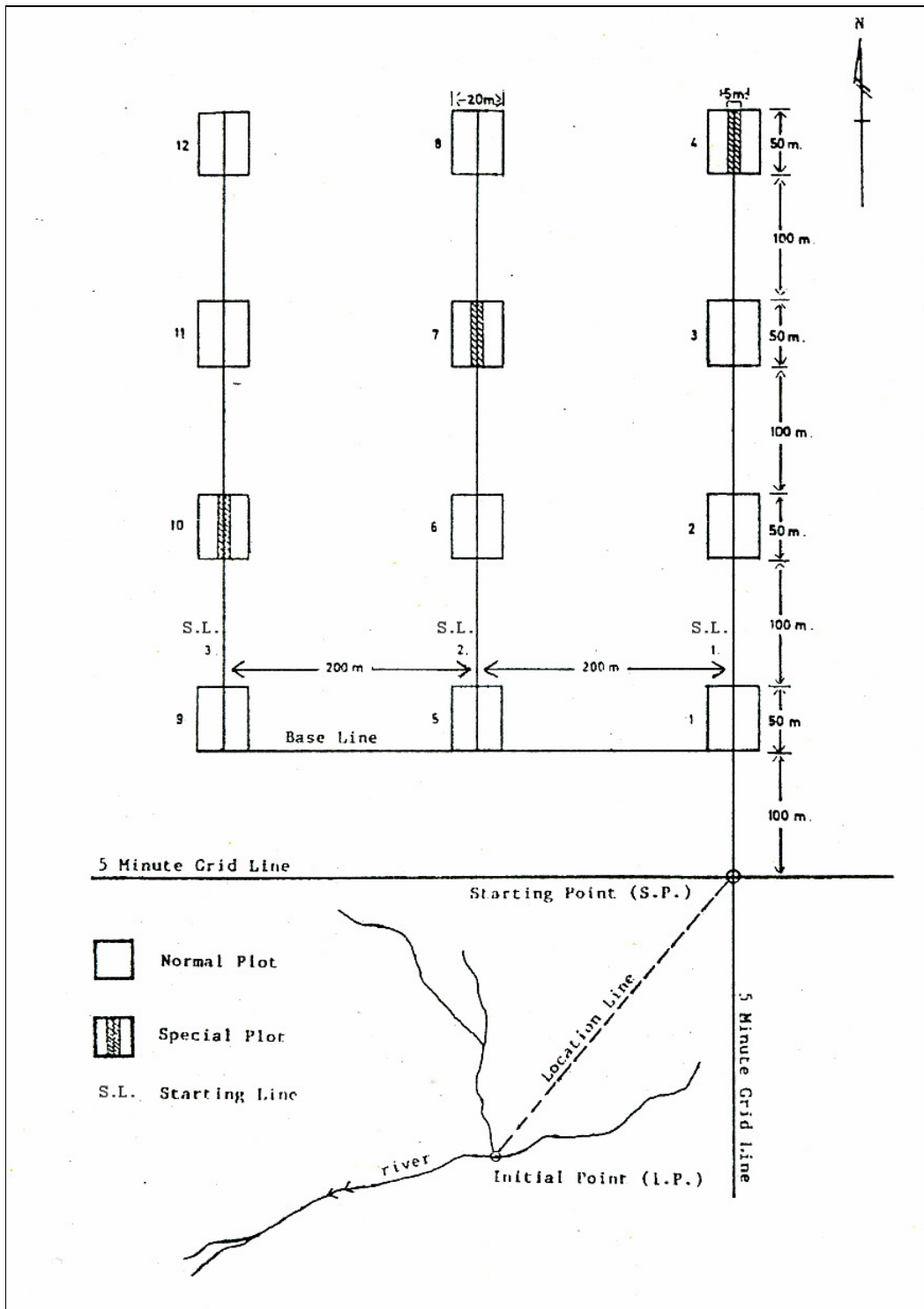
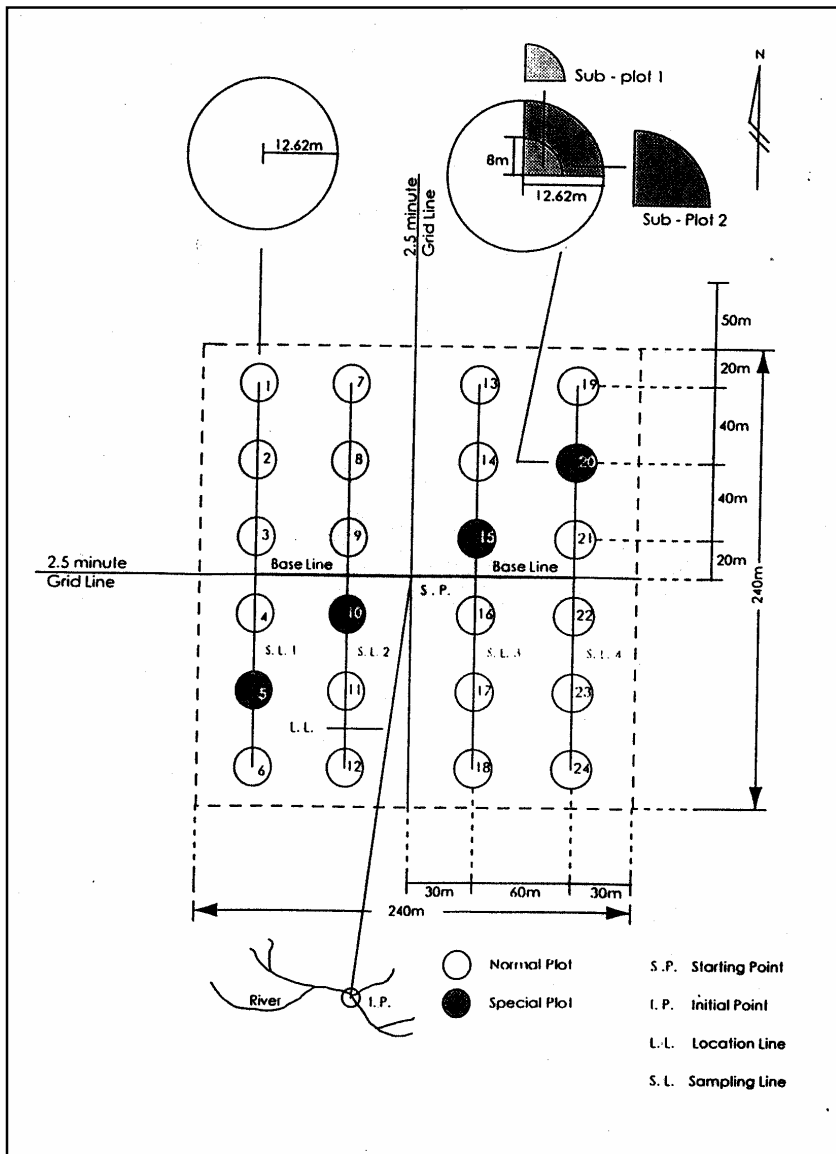**Figure 3**. Layout of sampling unit in first and second NFI

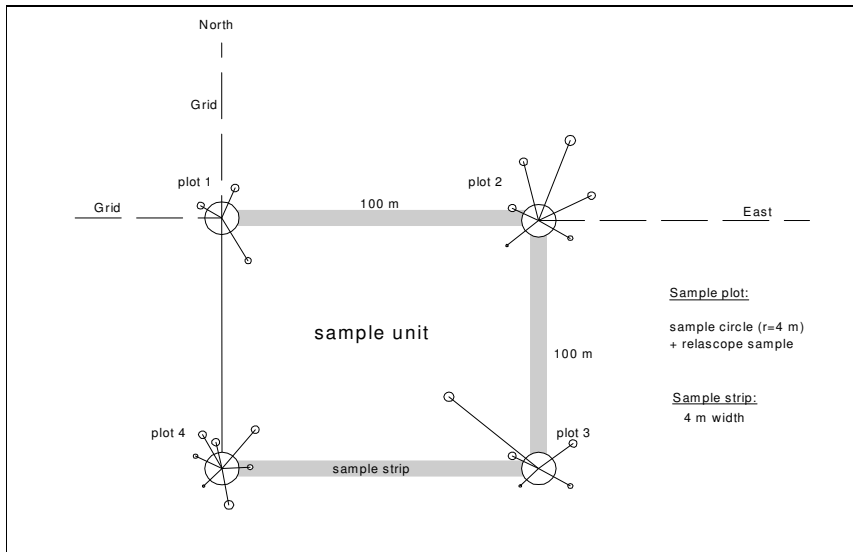**Figure 4**. Layout of sampling unit in third NFI

Figure 5. Layout of sampling unit in fourth NFI

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			Map, Remote Sensing Survey
Altitude	X			Survey
Topography	X			Survey
Orientation (or Aspect)	X			
Slope	X			
Soil	X			Records, Field Survey
Geological structure				
Rainfall				

Bio-Physical

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

Forest extent

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

Forest characteristics (Naturalness) and forest type

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

	N	SN	MU	Methodology
Coniferous				
Broadleaved				
Mixed forest	X			Survey, Map, Remote Sensing
Forest area by dominant species (bamboo, mangroves, rubber)				
Forest area by ecological zone (tropical, subtropical, temperate, boreal, polar)				

Use (designated functions) of forests

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

Social Services

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

Mapping of forest distribution

	N	SN	MU	Methodology
Distribution of forests	X			Survey, Map, Remote Sensing
Forest Characteristics	X			Survey, Map, Remote Sensing
Land use				
Administrative/political/legal boundaries				
Designated functions of forests	X			Survey, Map, Remote Sensing
Other wooded land				
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	X			Survey, Record
Disturbance caused by other abiotic factors				

Biodiversity

	N	SN	MU	Methodology
Tree species	X			Field Survey
Shrub species	X			Field Survey
Herbs species	X			Field Survey
Endangered species				
Critically endangered species				
Vulnerable species				
Native species				
Endemic species				
Introduced species				

Beneficiaries of forest goods and services

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

Economic value

	N	SN	MU	Methodology
Removal of timber				
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				
Removal of non wood forest products				
Annual allowable cuts/yields				
Social services				
Environmental services				
Employment				
Support to livelihood of communities				
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			Survey, Reports
Forest legislation	X			Survey, Reports
Forest administration	X			Survey, Reports
Forest education and research	X			Survey, Reports
Annual outlay, expenditure, investment in forestry sector	X			Survey, Reports

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