Forestry Department

Food and Agriculture Organization of the United Nations

BRIEF ON NATIONAL FOREST INVENTORY NFI

MYANMAR

Forest Resources Development Service

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MAR-SFM Working Paper 23/ 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

Myanmar is the largest country by geographical area in mainland Southeast Asia. It is bordered by the People's Republic of China on the north, Laos on the east, Thailand on the southeast, Bangladesh on the west, and India on the northwest, with the Andaman Sea to the south, and the Bay of Bengal to the southwest. One-third of Myanmar's total perimeter, 1,930 kilometres, forms an uninterrupted coastline. Its capital is Naypyidaw while its largest city is Yangon

Map of the Country

Figure 1. Map of Myanmar

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

Land Area and Landuse

The total area of Myanmar is 676 580square km and the following table presents the categorisation and projection of land use in Myanmar for 1990, 2000 and 2005 (FRA 2005).

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

FRA 2005 Categories	Area (1000 hectares)		
	1990	2000	2005
Forest	39 219	34 554	32 222
Other wooded land	10 219	10 629	10 834
Other land	16 317	20 572	22 699
Other land of which with tree cover			
Inland water bodies	1 903	1 903	1 903
TOTAL	**67 658**	**67 658**	**67 658**

Forests

Myanmar is rich in forest resources with 1,347 species of big trees, 741 species of small trees, 1,696 species of shrubs, 96 species of bamboo, 36 species of rattan and 841 species of orchids so far recorded. Out of the 2,088 tree species, 85 have been recognized and accepted as producing multiple-used timber of premium quality. As a result of great variation in rainfall, temperature, soil and topography, there are many different forest types in Myanmar. Tropical evergreen forests occur in high rainfall areas in the south of the country. Hill and temperate evergreen forests are found in the eastern, northern and western regions at elevations over 900 m. The forest types change to deciduous and then to dry forests along a line from the edge to the middle of the country as a result of decreasing rainfall (see figure 2 below). The forest area of the country has been estimated at over 32 million hectares by FRA 2005. Table 2 shows total area and percentage contribution by type of forest. The majority of the area is covered by mixed deciduous forest and hill and temperate evergreen forest (respectively 39 and 26 percent).

Table 2. Forest Area by Types of Forests

Types of Forests	Area (Hectares)	%
Tidal, beach and dune, and swamp forests	1,376,900	4
Tropical evergreen forests	5,507,800	16
Mixed deciduous forests	13,425,300	39
Dry Forests	3,442,400	10
Deciduous dipterocarp forest	1,721,200	5
Hill and temperate evergreen forest	8,950,100	26
Total	**34,423,700**	**100**

source: Myanmar Forest Department Statistics (1995)

As shown in table 3 below, about two thirds of the closed broad-leaved forest is under productive regimes while smaller areas of bamboo, mangroves and conifers are also classified as productive forests. In particular, bamboo grows abundantly throughout the country either mixed with tree species or in pure stands. Pure stands of Kayin-wa (Mellocanna bambusoides) stretch over and area of about 8,000 km2 on the Rakhine mountain range. Tanintharyi Division also contains pure stands of wa-ya (Oxytenanthera nigrociliata) over an area of some 1,800 km2 . The bamboos in the Bago Division are of mixed-forest type consisting of a number of different species of which kyathaung-wa (Bambusa polymorpha), Tin-wa (Cephalostachym pergraule) and Myin-wa (Dendrocalamus strictus) are commercially

important. Of the 96 known species of bamboo about 13 species are considered commercially important.

Table 3. Forest Area by Type of Vegetation and Productivity

Type of vegetation	Productive forest ('000 ha)	Unproductive forest (' 000 ha)	Total ('000 ha)
Closed broad- leafed	20,655	11,908	32,563
Mangrove	382	403	785
Bamboo	963	-	963
Conifers	113	-	113
Total	**22,113**	**12,311**	**34,424**

source: Myanmar Forest Department Statistics (1995)

With regard to forest plantations, the first attempts to establish teak plantation using taungya (agroforestry) method was first made in 1856. The success with this method led to a wide spread planting of teak, Acacia catechu, and Xylia kerri and by 1930, a total of over 19,000 ha had been planted. Extensive forest plantations in large blocks were formed commencing from 1972, and further large scale plantation programme was launched starting from 1980 and up till1995 a total of 543,288 ha had been planted

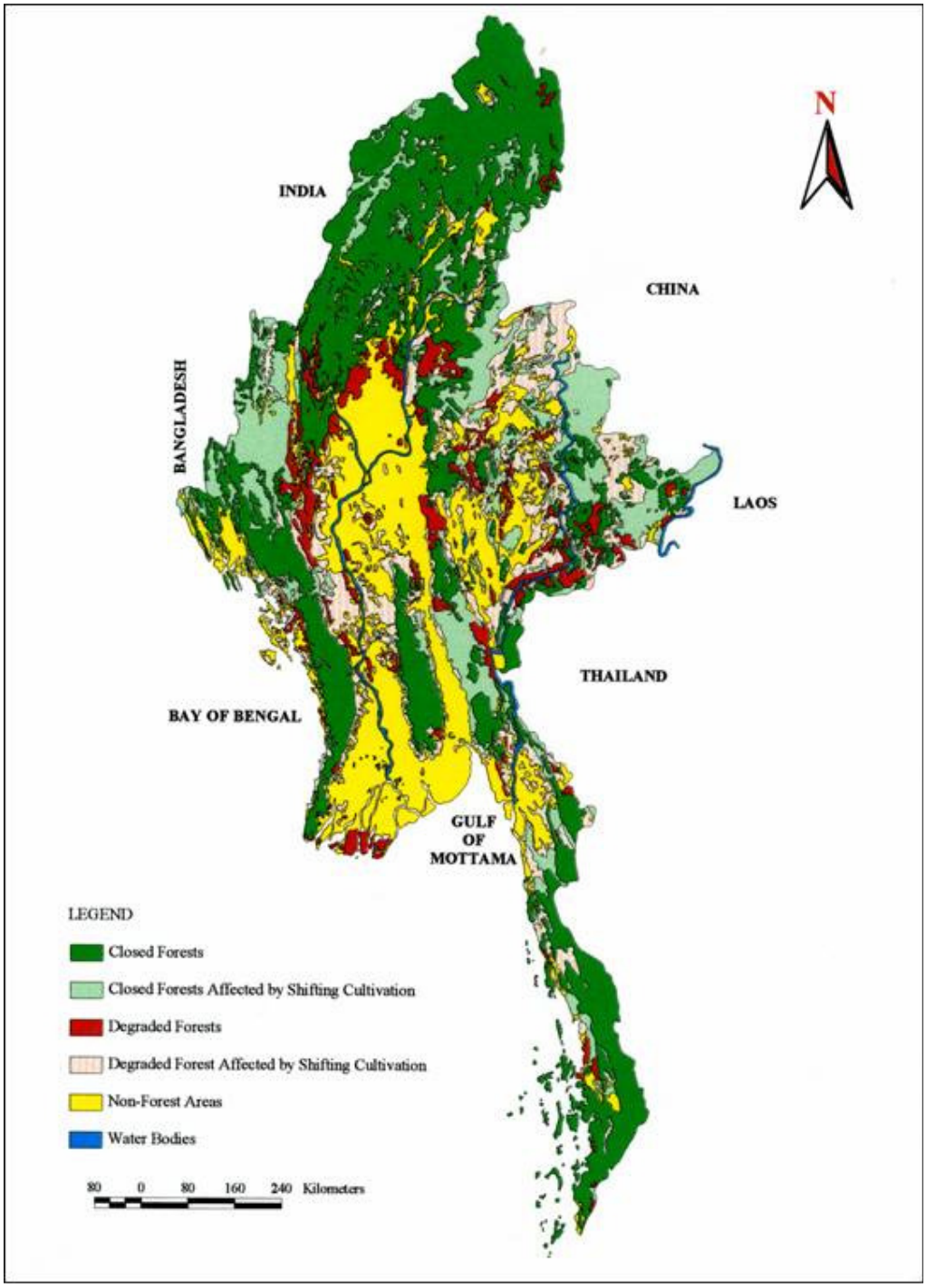

Figure 2. Forest Cover Map of Myanmar

Brief History of Forest Inventories

Assessment of forest resources in Myanmar has been conducted through field inventory, aerial photographs and lately using Remote Sensing (RS) data and Geographic Information System (GIS). The earliest assessment of forest resources in Myanmar was done by Dr. Dietrich Brandis in the 1850's by employing subjective linear surveys in the Bago Yoma to collect information for the regulation of Teak yield. This practice continued until the 1930's.

Scientific sampling methods were applied only in post-war forest inventory. A pilot survey applying an objective sampling technique was conducted in 1963 and about one forest division (out of the existing 36) was inventoried every year up to 1975. It was only in 1982 that a forest inventory was initiated at the national level.

Myanmar was also one of the countries in the tropics which have been using aerial photographs for forestry purposes as early as 1920s. Forest areas in Lower Myanmar covering Taninthayi, Dawei and the Ayeyarwady were photographed during 1923-24 for the production of forest type maps. During the post war period, from 1953-54 to 1961-62, several photographic missions were made for forest cover estimations over the whole country.

The application of satellite imagery for forestry purposes in Myanmar was initiated by FAO/UNDP with images taken between 1973 and 1979 and interpreted to estimate forest cover as well as the extent of degradation. GIS technology has been introduced in the mid 1990s. Table 4 below presents a summary of the history of assessments.

Table 4. 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]			
1991	Forest Cover of Myanmar, the 1989 Appraisal.	Government of Myanmar (GOM)		1975 & 1989			Kyaw Tint and Tun Hla, Yangon January	
1997	ISDP (Information System Development Project for the Management of Tropical Forest),	GOM		1997			Rakhine, Yangon, Bago, Magwe, Chin, Mandalay, Kayah, Sagaing, Ayeyarwady State and Divisons	
1997	Land Use and Land Cover Mapping for Mon State	GOM		1997				
1998	Anti-narcotic sampling frame mapping, Landuse Map of Shan States	GOM		1998				
2000	Tanintharyi Division, Study on forest resources and landuse changes in the southern part of Myanmar.	FAO, GOM Forest Dept.						
2000	Kachin State Land Cover Mapping.	Inter Departmental Project, Forest Dept.						
2000	Karen State Land Cover Mapping,	Inter Departmental Project, Forest Dept.						

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

Systematic sampling design has been used in Myanmar since 1982 for the collection of forest inventory data up to the latest NFI which was carried out in 2006 at the sub-national level. Forest Inventories are conducted at three levels: Pre-investment, Reconnaissance and Management. Pre-investment level surveys with a sampling intensity of about 0.1 percent are conducted on forests which are commercially significant. whereas Reconnaissance level surveys are carried out in forest with less important commercial value with a sampling intensity of less then 0.1 percent. Management level surveys, with a sampling intensity of 0.5 percent are carried out to obtain detailed data ty be used for the development of management plans in selected forest areas.

Remote Sensing

Remote Sensing and GIS Section of Planning and Statistics Division, Forest Department, under the Ministry of Forestry, is the organization responsible for processing forest cover data of Myanmar. The successive appraisals and relative methodologies used are indicated below while a tabulated summary is presented in Table 5.

First Appraisal (1955)

The first forest cover assessment of the whole country was done in 1957 using 1:24,000 scale aerial photography of 1953-57. The hilly areas were photographed at 1:50:000 while other areas at 1:20:000. The result of a 57 percent forest cover has been accepted as official data up to 1989.

Second appraisal (1975)

Under a FAO / UNEP project (Tropical Resources Assessment Project) an appraisal of the forest cover of the whole country was carried out using 1:1,000,000 scale Landsat imageries from 1972-1979 (colour composite from 80m x 80m MSS data).

The UNDP funded project BUR/79/011 'National Forest Survey and Inventory' (1981-86), aimed at covering the whole country by aerial photography and two sets of Landsat MSS imageries for the period 1974-1980 at 1:1,000,000 and 1:250,000 were acquired. This work was done independently from Myanmar forest officers, thus it is not officially recognized.

Third appraisal (1989)

A follow up project (MYA/85/003) National Forest Management and Inventory provided the means for continuing aerial photography work and resulted in the completion of 95 percent of country covered. A set of Landsat TM imagery for the period 1989-90 at 1:500, 000 scale data (30m x 30m resolution) was acquired and a countrywide land use map was produced by visual interpretation. Over 400 forest type maps were also produced. This work resulted in the officially recognized third appraisal and an update of the actual forest cover, set at 43.2 percent of total country area in 1989.

Fourth appraisal (FRA2000 or 1997)

The fourth appraisal consisted in a combination of various surveys however, the majority of the work was based on digital classification of 30m x 30m Landsat TM data. Digital image

processing system was installed in the forest Department in early 1996 with financial assistance from the Watershed Management for Three Critical Areas Project (MYA/93/005). Landsat digital data of 5 TM scenes were acquired along with the digital image processing system PCI EASI/PACE.

In the same period, JFTA and Myanmar Forest Department conducted an Information System Development Project for the Management of Tropical Forest. The project covered 68 percent of the country and the working scale was the re-sampled 50-meter resolution of the Landsat TM images. Field surveys and verifications were also performed.

in 1999 Total Oil Company donated 5 Landsat TM scenes to perform land use mapping in the Tanintharyi Division in south Myanmar and the National Space Development Agency of Japan assisted with ADEOS data covering Mon state for field testing. The former have been used for FRA 2000 assessment of Myanmar.

The latest appraisal has data from Landsat 7 ETM databases, some of the areas have been checked in the field thoroughly by using 1 meter resolution
IKONOS images from anti-narcotic surveys.

Table 5. Summary of results of four successive forest assessments of Myanmar

Assessment year	1955	1975	1989	1997
Area of forest over total land area (%)	57.0	47.8	43.2	37.4
Actual forest area (crown cover >40%) [square kilometres]	385 635.2	323 392.3	292 270.9	252 895.5
Interpretation level	1:20,000 1:24,000 1:50,000 aerial photo	1:1,000,000 Landsat MSS diapositives	1:500,000 Landsat TM hardcopies	Landsat TM DIP 1:250,000 hardcopy 1:50,000 ADEOS Hardcopy

source: Myanmar Forestry Department (2000)

Field Inventory

The sampling unit is composed by a strip of 15 m wide to the left and right of a centre line which runs 175 meters in East-West and North-South direction. It is distributed systematically in a grid of 3km x 3km in the forest area with a sampling intensity 0.11 percent. The strip has an Inverted L-shape and is divided into seven units of size 30m x 50m equal to 1.05 ha as shown in figure 3.

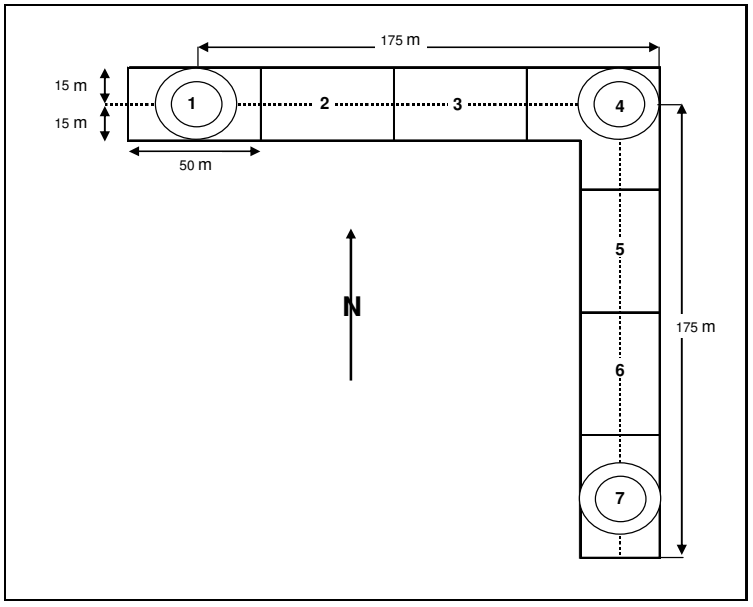

Figure 3. Sampling Unit

Measurements

During sampling inventory, all living trees with a diameter at breast height of over 20cm are measured. For volume equations, sample trees are measured from 30cm above ground to the crown point, stem length is measured and volume is calculated. The branches are not measured and their volume is not included in the growing stock. This means that growing stock given is the marketable part (as timber) above the stump. Details of field inventory measurement are indicated in Table 6. which also reports the threshold values for each variable for the purpose of calculating growing stock.

Table 6. Specification of country threshold values

Variable	Unit	Value
Minimum diameter at breast height of trees included in Growing stock	cm	20
Minimum diameter at the top end of stem for calculation of Growing stock	cm	10
Minimum diameter of branches included in Growing stock	cm	not included
Minimum diameter at breast height of trees in Commercial growing stock	cm	20

source: Myanmar country report FRA 2005

In the three special sample plots (15 meters radius circular plots numbered 1, 4, and 7 in figure **X**), trees having diameters of 10 cm and above are enumerated. In the special circular plots the enumerated trees are also labelled with aluminium tags and their position is recorded.

Of the 9 800 sampling units established under the National Forest Survey and Inventory project, a total of 2 485 units (roughly 25 percent), are designated as permanent sample plots which are re-measured every five years. The permanent sample plots are distributed systematically following a grid of 6 km x 6 km.

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
Altitude				
Topography				
Orientation (or Aspect)				
Slope				
Soil				
Geological structure				
Rainfall				

Bio-Physical

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

Forest extent

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

Forest characteristics (Naturalness) and forest type

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

Coniferous				
Broadleaved				
Mixed forest				
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		Reports & Plans
Area of forest for protection of soil and water		X		Reports & Plans
Area of forest for conservation of biodiversity		X		Reports & Plans
Area of forest for social services		X		Reports & Plans
Area of forest for multiple purpose		X		Reports & Plans
Forest area available for wood supply		X		Reports & Plans
Forest area within protected areas				

Social Services

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

Mapping of forest distribution

	N	SN	MU	Methodology
Distribution of forests				
Forest Characteristics				
Land use				
Administrative/political/legal boundaries				
Designated functions of forests				
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				
Disturbance caused by other abiotic				

factors				

Biodiversity

	N	SN	MU	Methodology
Tree species		X		National/ Local knowledge
Shrub species				
Herbs species				
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				
Forest legislation				
Forest administration				
Forest education and research				
Annual outlay, expenditure, investment in forestry sector				

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