Forest characteristics

Background paper to the Kotka V Expert Consultation

1 Introduction

The term "forest" encompasses a variety of different kinds of forests, both in terms of species composition, structure and degree of modification caused by humans, animals, diseases and natural disasters.

A continuum exists from primary forests with no – or no visible – indications of past or present human activity to intensively managed plantation forests of introduced species, primarily managed for a single product, often on a relatively short rotation. Between these two extremes lies a range of scenarios, and there are no clear cut-off points between possible classes along the continuum.

The request for information on forest characteristics for FRA 2005 aimed to provide more detailed information on forests, in terms of their 'naturalness' or the intensity of silviculture and management practices.

2 FRA 2005 variables

For FRA 2005, countries were asked to characterize their forests and other wooded land according to five classes: **primary, modified natural, semi-natural, protective plantation** and **productive plantation**.

The use of the five different classes aimed to clarify the extent to which forests are human-made or -modified, while at the same time providing an indication of the intensity of management and the potential for wood production, e.g. for use in global fibre supply models.

In regional and ecoregional criteria and indicator processes, as well as in national reports, more-detailed classifications of the forest area are often used, e.g. according to forest or vegetation type, age structure or diameter distribution classes. Because of the varying conditions and classification systems among countries and regions, it was not feasible to report on such classifications at the global level. However, country reports for FRA 2005 contain considerably more detail than is shown in the global tables. Moreover, thematic studies were prepared on planted forests, mangroves and bamboo that provide in-depth knowledge on these forest types and groups of species.

2.1 Definitions

Category	Definition
Primary	**Forest / Other wooded land of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.** Includes: Areas where collection of non-wood forest products occurs, provided the human impact is small. Some trees may have been removed.
Modified natural	**Forest / Other wooded land of naturally regenerated native species where there are clearly visible indications of human activities.** Includes, but is not limited to: Selectively logged-over areas, naturally regenerating areas following agricultural land use, areas recovering from human-induces fires, etc. ; areas where it is not possible to distinguish whether the regeneration has been natural or assisted.
Semi-natural	**Forest / Other wooded land of native species, established through planting, seeding or assisted natural regeneration.** Includes: areas under intensive management where native species are used and deliberate efforts are made to increase/optimize the proportion of desirable species, thus leading to changes in the structure and composition of the forest. Naturally regenerated trees from other species than those planted/seeded may be present. May include: areas with naturally regenerated trees of introduced species. Includes: areas under intensive management where deliberate efforts, such as thinning or fertilizing, are made to improve or optimize desirable functions of the forest. These efforts may lead to changes in the structure and composition of the forest.
Productive plantation	**Forest / Other wooded land of introduced species, and in some cases native species, established through planting or seeding mainly for production of wood or non wood goods.** Includes: All stands of introduced species established for production of wood or non-wood goods. May include: Areas of native species characterized by few species, straight tree lines and/or even-aged stands
Protective plantation	**Forest / Other wooded land of native or introduced species, established through planting or seeding mainly for provision of services.** Includes: all stands of introduced species established for provision of services, such as soil and water protection, pest control and conservation of (habitat) biological diversity; areas of native species characterized by few species, straight tree lines and even-aged stands

As can be seen from the definitions above, the first three classes comprise native forest tree species only, with the possible exception of small areas of natural regeneration of introduced or naturalized species in the semi-natural class. While the origin of primary and modified natural forests is natural regeneration, semi-natural forests are established through assisted natural regeneration, planting or seeding. All forest plantations are established through planting or seeding.

Planted forests thus comprise all forest plantations and parts of semi-natural forests. All planted forests of introduced species were classified as forest plantations in FRA 2005. Planted forests of native species were classified as forest plantations if characterized by few

species, straight, regularly-spaced rows and/or even-aged stands. If they resembled natural forests of the same species mix, such as many planted forests in Europe, they were classified as semi-natural forests.

2.2 Data availability

Of 229 countries and areas reporting, 174 reported on the characteristics of their forests. Their combined forest area is equivalent to 93 percent of the total forest area of the world. However, information on all five classes was not always readily available, because countries either did not collect information or used a different national classification system. Proxy values were often used, which made a detailed analysis of status and trends difficult. Information was unavailable for many of the countries in the Congo Basin, the second largest expanse of tropical forest.

Of the 180 countries providing information on the area of other wooded land, 114 provided information on the characteristics.

2.3 Data quality

While many countries keep good statistics of the area of forest plantations, few countries had information on the area of primary forests. Others used the current area of forests in national parks and other protected areas as a proxy value or provided an expert estimate of the percentage of natural forests that could be considered primary according to the definition used for FRA 2005. The data on characteristics of other wooded land and the change estimates for primary forest are particularly weak.

2.4 Methodologies for data collection

The information on forest characteristics is most frequently collected through forest inventories and field surveys. Statistics on forest plantations are often kept, whereas information on primary forest is rarely directly available and most countries used proxy values such as area of forest in protected area or area of forest over a certain age where no intervention had been made for a certain number of years.

2.5 Issues related to classifications and definitions

There were inconsistencies in reporting planted forests of native species: some countries reported these as semi-natural forests, while others preferred to include them as forest plantations.

Many countries also had difficulties in distinguishing between modified natural forests and semi-natural forests based on the information available.

The class of modified natural forest spans from natural forests which have been selectively logged but which retains most of the structure and composition of primary forests to severely degraded forests and forests naturally expanding e.g. on abandoned agricultural land in various stages of succession.

The current classification system is a combination of regeneration method, origin of species (native/introduced) and management intensity. While it provided useful information on the extent to which forests are human-made or –modified, it did not lend itself to an analysis of all planted forests, since the class semi-natural forest is a combination of those forests established through planting and those established through assisted natural regeneration.

3 Proposals for FRA 2010

The proposals presented below are based on the responses to the FRA 2005 evaluation questionnaire sent to all national correspondents, FAO staff, the FRA Advisory Group and representatives of forest related organisations and reporting processes (Members of the Collaborative Partnership on Forests, criteria and indicator processes and environmental NGOs). Feedback received on the release of the Key Findings of FRA 2005 and the Main Report has also been included where relevant. These proposals have not been prioritised and are presented for discussion by working group participants.

3.1 Deletions

Delete other wooded land, as information availability/quality is a serious issue.
A suggestion to delete the current table on forest characteristics in its entirety has also been received.

3.2 Additions

Forest types. Several respondents have suggested including more information on forest by ecological zones or by forest types. Past attempts to include forest types have focused on **forest cover by ecological zone** (see Annex 1), **"open" versus "closed" forest types** and a distinction between **coniferous and non-coniferous species**. Attempts have also been made to assess the area of **bamboo** and of **mangrove** forests and requests have been received to include these in the main questionnaire.

Planted forests. Planted forests comprise all forest plantations and parts of semi-natural forests. As interest in planted forests is increasing, a thematic study on planted forests was prepared within the framework of FRA 2005 and it is foreseen that this will be repeated for FRA 2010. To facilitate the preparation of this study and the analysis on planted forests, it is suggested to ask countries to provide information on the total area of forests which are planted or sown as part of the reporting to FRA 2010.

Forest cover classes. Several respondents suggested that forests should be characterised according to the degree of crown cover, suggesting 3-4 classes, so as to be able to distinguish dense forests from more open forests. If spatial information is provided for more than one point in time, changes in this variable may also help assess levels of forest degradation and improvement (see below).

Forest degradation and improvement. Information on the extent of forests and their characteristics provides limited information on changes happening within forests such as degradation due to overexploitation or improvements through rehabilitation efforts or through natural regeneration. It has been proposed to include a measure of forest degradation in the next assessment.

3.3 Other changes proposed

The merging of the classes modified natural forest and semi-natural forests has been proposed.

The merging of the two classes of forest plantations and changing the name of the table to forest naturalness.

Others have proposed that the guidelines for this table be improved to make it easier to distinguish between the five classes. (Particularly between modified natural and semi-natural and how to classify planted forests of native species.)

3.4 Proposals for how the information should be obtained

Refer to Annex 1 which describes the initiative to estimate **forest cover by ecological zone** for FRA 2000. Participants are asked to evaluate whether the approach could be used for FRA 2010.

Thematic studies on **mangroves** and on **bamboo** were included for FRA 2005 and could be repeated for FRA 2010. Alternatively, information on these (and other) forest types could be included in the country reporting tables.

Information on the area of **planted forests** could be obtained through an addition to the current table on characteristics with additional information obtained through a thematic study.

Information on **forest cover classes** could be obtained through remote sensing.

One indicator of the level of **degradation/improvement** is the growing stock per hectare. If the growing stock per hectare in a given forest area shows a continuous decline over time, indications are that the wood resources are being overexploited and the ability of the forest to provide a range of goods and services is impaired. Although this variable does not relate directly to degradation in terms e.g. of loss of ability to conserve biological diversity, it could be a first proxy of the degree of forest degradation/improvement. One way to obtain this information would be to estimate annual rates of change in growing stock from a series of systematically laid virtual (geo-referenced) sample plots (linked to the grid proposed for the remote sensing component for FRA 2010) and to statistically blow up the information to sub-national and national level using pre-identified strata.

Another way would be to ask countries to estimate the percentage of their forest (or percentage of the area of modified natural forest), which is degraded.

A third option would be to use spatial information on forest cover classes from two or more points in time and focus on changes in these.

4 Summary of proposals

Tables:

Current T4

FRA 2005 Categories	Area (1000 hectares)					
	Forest			Other wooded land		
	1990	2000	2005	1990	2000	2005
Primary						
Modified natural						
Semi-natural						
Productive plantation						
Protective plantation						
TOTAL						

Alternative 1 (Keeping current classes, but adding information on planted forests and on species origin. Delete or keep other wooded land?)

FRA Categories	Area (1000 hectares)		
	Forest		
	1990	2000	2010
Primary (A)			
Modified natural (B)			
Semi-natural (C)			
... of which planted (C1)			
Productive plantation (D)			
... of which native species (D1)			
Protective plantation (E)			
... of which native species (E1)			
TOTAL (A+B+C+D+E)			

(Guidelines would ask for C1, D1 and E1 in percentages prior to the filling of this table).

Alternative 2: Forest naturalness

FRA Categories	Area (1000 hectares)		
	Forest		
	1990	2000	2010
Total forest area (A)			
Primary forest (B)			
Planted forest (C)			
... of which introduced species			

The remaining forest area (A-(B+C)) would be forest of native species, naturally regenerated (including assisted natural regeneration) and with visible signs of past or present human activities.

Information on productive/protective planted forests could come from the table on designated functions.

This would not allow for assessment of intensity of management/split between modified natural forest and semi-natural forest, nor an estimate of forest plantations.

Alternative 3a: Forest naturalness

FRA Categories	Area (1000 hectares)		
	Forest		
	1990	2000	2010
Total forest area (A)			
…of which primary forest (B)			
…of which forest plantation (C)			

3b: Regeneration method

FRA Categories	Area (1000 hectares)		
	Forest		
	1990	2000	2010
Naturally regenerated (D)			
Assisted natural regeneration (E)			
Coppice (F)			
Planted or sown (G)			
Total forest area (A)			

Modified natural forest = D-B
Semi-natural = E+F+(G-C)

3c: Species origin

FRA Categories	Area (1000 hectares)		
	Forest		
	1990	2000	2010
Native species			
Introduced species			
Total forest area (A)			

Add supplementary table estimating the percentage of forests which are degraded?

New table:

Forest types

FRA Categories	Area (1000 hectares)		
	Forest		
	1990	2000	2010
Predominantly coniferous (A)			
Predominantly broadleaved (B)			
... of which mangroves			
Predominantly mixed (coniferous and broadleaved) (C)			
Other (palms and bamboo) (D)			
... of which bamboo			
TOTAL (A+B+C+D)			

Thematic studies:
Planted forests
Primary forests
Mangroves
Bamboo
Rattan

Remote sensing component:
Forest cover classes (map + statistics (%) based on forest cover map)
Forest types/ecological zones (map + statistics (%) based on forest cover map)
Forest degradation

Annex 1: Ecological Zones

Introduction

Many environmental problems are no longer national or regional in character and must be addressed in a global context. Aggregating information on forest resources by ecological zones organizes reporting according to the natural characteristics of the vegetation, rather than along national boundaries, which frequently cut across natural ecosystems. Through reporting by ecological zones, valuable insight is obtained regarding characteristics of forest resources, which may serve to identify and resolve issues of importance to many countries, entire regions or even the planet as a whole.

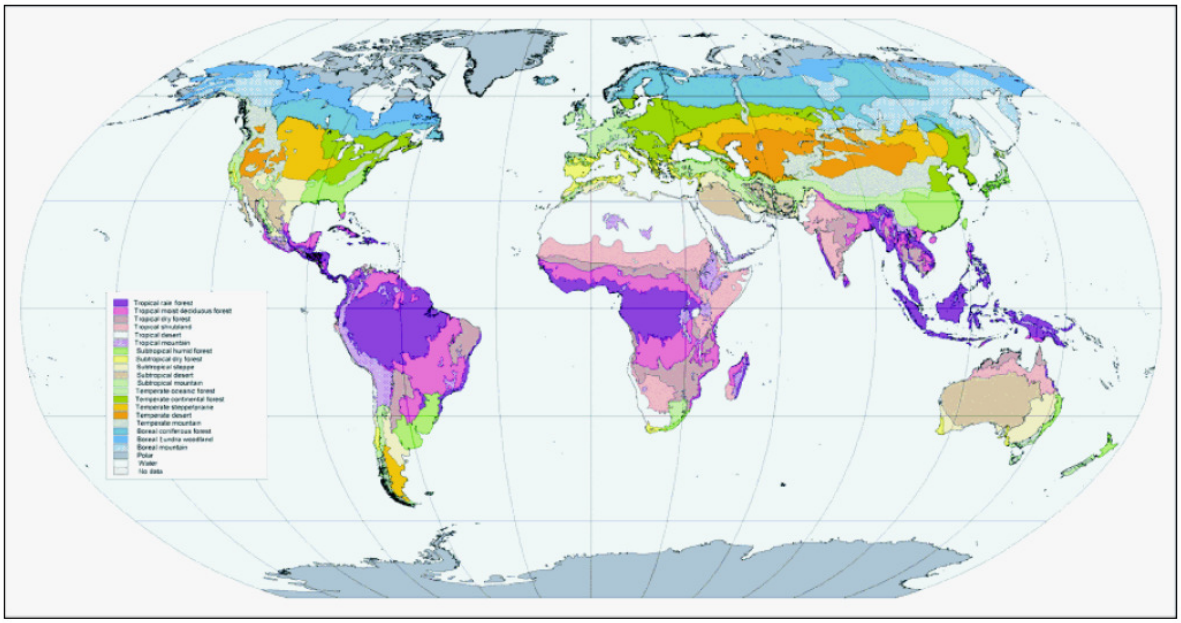
To achieve meaningful reporting, classes in a global ecological framework must identify and accurately group broad yet relatively homogenous natural formation of forest vegetation. The global classification cannot be overly detailed, which would likely confuse reporting by fragmenting major global ecosystems and risk creating an incomprehensible number of classes. Conversely, and overly simplistic scheme could degrade the utility of the map by representing too few classes of forests and aggregating too wide a variety of forests within the same zone.

Ecological zone map

The underlying strategy for the FRA 2000 ecological zoning reflected both the thematic and technical needs of the map as well as the many operational constraints that were expected in its development. In terms of ecosystem principles, the map requirements were such that zones or classes were defined and mapped using a holistic approach. That is, both biotic and abiotic components of ecosystems were considered in the zoning scheme. Beyond the thematic content and zoning, practical aspects of digital cartographic production, such as data availability, currency, scale and the associated reliability of the map inputs, were also taken into account (Simons 2001).

FAO conducted two preliminary studies to identify specific alternatives and constraints in the development of a global ecological zone (GEZ) map appropriate for FRA 2000 purposes (Preto 1998; Zhu 1997). Findings from these studies, experience in the development of the tropical ecological zone map for FRA 1990, and recommendations from other parties consulted in the process indicated that FAO could not complete an entirely new global ecological zoning map by 2000 because of the large amount of scientific, organizational and financial resources and time required. FAO therefore focused on identifying an existing scheme that might be used or adapted to the programme's needs. A Workshop on Global Ecological Zones Mapping, held in Cambridge, United Kingdom in July 1999, and attended by experts from 15 countries, helped set the framework.

Figure 1. FRA 2000 global ecological zone map



Because of the enormity of conducting the work on a global scale, a classification scheme had to be chosen that would meet FAO's thematic requirements, be practical to construct with available resources and meet the scrutiny of diverse users from all parts of the world. Existing schemes were each developed for specific purposes according to various environmental criteria. Macroclimate (temperature and precipitation) was an element used by most (Preto1998; WCMC 1992). Since macroclimate correlates well with the potential vegetation associated with a particular locale, it was considered a logical basis for the FRA ecological zoning as well.

However, a climatic map showing such key features as temperature and precipitation is not necessarily an ecological map until the boundaries are shown to correspond to significant biological boundaries. Likewise, maps of landform types (derived from digital elevation data) are not necessarily ecological maps until it has been shown that the types co-vary with other components of the ecosystem, such as vegetation (Bailey 1998).

For the choice of climatic parameters to be used in the FRA 2000 map a number of global systems were surveyed (Köppen 1931; Trewartha 1968; Thornthwaite 1933; Holdridge 1947). Köppen modified by Trewartha was selected as the best candidate because of the number of classes that corresponded well to FRA 2000 needs. Moreover, while Köppen-Trewartha is based on climate, there is a demonstrated good correspondence between its subzones or climatic types and the natural climax vegetation types and soils within them (Bailey 1996).[56]

[56] This is largely because Köppen derived his climate classes from observations on the distribution of natural vegetation types on various continents (Köppen 1931).

Table 1. Ecological zone breakdown used in FRA 2000

EZ Level 1 – Domain		EZ Level 2 – Global Ecological Zone		
Name	**Criteria (equivalent to Köppen-Trewartha climatic groups)**	**Name (reflecting dominant zonal[a] vegetation)**	**Code**	**Criteria (approximate equivalent of Köppen–Trewartha climatic types, in combination with vegetation physiognomy, and one orographic zone within each domain)**
Tropical	All months without frost: in marine areas over 18°C	Tropical rain forest	TAr	Wet: 0-3 months dry,[b] during winter
		Tropical moist deciduous forest	TAwa	Wet/dry: 3-5 months dry, during winter
		Tropical dry forest	TAwb	Dry/wet: 5-8 months dry, during winter
		Tropical shrubland	TBSh	Semi-arid: evaporation > precipitation
		Tropical desert	TBWh	Arid: all months dry
		Tropical mountain systems	TM	Approximately > 1 000 m altitude (local variations)
Subtropical	Eight months or more over 10°C	Subtropical humid forest	SCf	Humid: no dry season
		Subtropical dry forest	SCs	Seasonally dry: winter rains, dry summer
		Subtropical steppe	SBSh	Semi-arid: evaporation > precipitation
		Subtropical desert	SBWh	Arid: all months dry
		Subtropical mountain systems	SM	Approximately > 800-1000 m altitude
Temperate	Four to eight months over 10°C	Temperate oceanic forest	TeDo	Oceanic climate: coldest month over 0°C
		Temperate continental forest	TeDc	Continental climate: coldest month under 0°C
		Temperate steppe	TeBSk	Semi-arid: evaporation > precipitation
		Temperate desert	TeBWk	Arid: All months dry
		Temperate mountain systems	TM	Approximately > 800 m altitude
Boreal	Up to three months over 10°C	Boreal coniferous forest	Ba	Vegetation physiognomy: coniferous dense forest dominant
		Boreal tundra woodland	Bb	Vegetation physiognomy: woodland and sparse forest dominant
		Boreal mountain systems	BM	Approximately > 600 m altitude
Polar	All months below 10°C	Polar	P	Same as domain level

[a] Zonal vegetation: resulting from the variation in environmental, i.e. climatic, conditions in a north-south direction.
[b] A dry month is defined as the month in which the total precipitation expressed in millimetres is equal to or less than twice the mean temperature in degrees Centigrade.

FAO, in cooperation with EDC and UNEPWCMC, thus developed a prototype zoning scheme for FRA 2000 based on Köppen-Trewartha. The zoning was made hierarchical using Köppen-Trewartha's climatic groups and climatic types as FAO ecological zone levels 1 and 2, respectively (Table 1). A third level was also tested during the pilot project, representing the differentiation within the first two levels according to landform – distinguishing mountains with altitudinal zonation from lowland plains. This third level was ultimately not used.

At level 1, the broadest level, equivalent to Köppen-Trewartha's climatic groups, five domains are distinguished based on temperature: tropical, subtropical, temperate, boreal, polar. At the second level, 20 classes or ecological zones are distinguished, which indicate broad zones of relatively homogeneous vegetation, such as tropical rain forest, tropical dry forest and boreal coniferous forest. The names of the global ecological zones reflect the

dominant zonal vegetation. Typical azonal vegetation types, for instance mangroves, heath and swamps, are not separately classified and mapped.

Level 2 is the reference or working level for the GEZ mapping. The ecological zones were delineated by using both macroclimate data and existing climax or potential vegetation maps. Use of vegetation maps ensured a more precise delineation of the ecological zones. If generalized climate maps had been used alone, the zones of the final map would probably have corresponded poorly to boundaries of homogeneous vegetation transitions.

Within each domain (level 1) a zone of mountain systems is distinguished at level 2. Mountain systems usually contain a variety of vegetation types and include forests, alpine shrubs, meadows and bare rock. The current global framework cannot address the high, mostly small-scale diversity of mountain habitats. The polar domain is not further subdivided, as it is treeless, and only very sparse shrub or grass vegetation occurs locally. Here the second level is equivalent to the first.

A main principle in delineating the global ecological zones involves aggregating or matching regional ecological or potential vegetation maps into the global framework. The following steps can be distinguished:

- identification of Köppen-Trewartha climatic types and mountains occurring in a region to approximate the level 2 ecological zone class of the FAO scheme;
- establishment of correspondence between regional/national potential vegetation types and the global ecological zones;
- final definition and delineation of the global ecological zones, using the maps and source data consulted in the first two steps;
- edge-matching between adjacent maps;
- validation.

To ensure the best use of regional knowledge and information, existing regional/national maps on vegetation, biogeography, ecology and climate were used to generate the GEZ map. In some countries, such as the United States, classification is based on the Köppen-Trewartha climate system and translation to the FAO scheme was straightforward. In other cases, a more thorough study of mapping criteria, including physiognomy, phenology, floristics and dynamics of vegetation types, was needed to establish the correspondence. A benefit of using the existing country/regional maps is that they could form the basis or provide supporting information for more detailed regional ecological zoning beyond FRA 2000 (see Table 2). The country/regional vegetation maps also helped in harmonization of ecological zone boundaries across countries or regions. The experts who attended the Cambridge workshop contributed in a major way to definition of the ecological zones of their respective regions as well as to edge-matching between adjoining geographic regions.

Both the existing FRA 1990 ecofloristic zone map and several existing regional maps were produced using the ESRI Arc/Info GIS software. Thus, it was convenient for the rest of the work to be conducted using Arc/Info, or at least to be Arc/Info importable. After study of the digital map in the Arc/Info coverage environment and confirmation that the digital version

had appropriate attributes for the ecological zones (represented in the map by polygons), the coverage was edited and attributes for FAO ecological zone levels 1 and 2 were added.

Table 2. Source maps used for the delineation of FAO global ecological zones

Region	Name of map	Scale	Projection	Thematic information / classification criteria
Canada and Mexico	Ecological regions of North America (CEC 1997)	1:10 million	Lambert Azimuthal Equal Area	Holistic classification system based on climate, soils, landform, vegetation and also land use. Hierarchical system: 15 Level I ecological regions and 52 Level II regions.
United States	Ecoregions of the United States (Bailey 1995)	1:7.5 million	Lambert Azimuthal Equal Area	Classification based on Köppen climate system: broad domains equivalent to climate groups, subdivided into divisions approximately equivalent to climate types.
Central America	National Holdridge life zone maps, transformed to a regional base map (Bolanos & Watson 1991; De la Cruz 1976; Hartshorn 1984; Holdridge 1962; Holdridge & Tosi 1971; Tosi 1970; Tosi & Hartshorn 1978)	Various scales Base map at 1:1.5 million	x	Holdrige life zones are defined using the parameters (bio)temperature, rainfall and evapotranspiration.
South America, Africa, Tropical Asia	Ecofloristic zones maps (LET 2000)	1:5 million	Lat-Long	28 groups of ecofloristic zones are defined, based on climate, vegetation physiognomy and physiography, i.e. altitude. The EFZ identifies the most detailed ecological units, based on the additional criteria of flora and geographic location.
Near East	Vegetation map of the Mediterranean zone (UNESCO/FAO 1970)	1:5 million	x	Distribution of potential vegetation formations in relation to climate. The various formations are distinguished mainly on the basis of physiognomy.
Europe	General map of the natural vegetation of Europe (Bohn *et al.* 2000)	1:10 million	Equidistant_Conic	Distribution of potential natural plant communities corresponding to the actual climate and edaphic conditions. At broadest level 19 vegetation formations defined, of which 14 zonal and 5 azonal formations.
Former USSR	Vegetation map of the USSR (Isachenko *et al.* 1990)	1:4 million	Lambert Azimuthal Equal Area	Distribution of broad vegetation formations related to climate, altitude and also current land use. 133 vegetation classes are aggregated into 13 categories of vegetation.
China	Geographic distribution of China's main forests (Zhu 1992)	x	x	Main aim to identify and map China's forest vegetation. A hierarchical classification is used based on climate and distribution of forest types and tree species. 27 forest divisions are mapped.
Australia	Interim biogeographic regionalisation for Australia (Thackway & Cresswell 1995)	1:15 million	Albers Equal Area	Major attributes to define biogeographic regions are: climate, lithology/geology, landform, vegetation, flora and fauna and land use. A total of 80 IBRA regions have been mapped.
Caribbean, Mongolia, Korean Peninsula, Japan, New Zealand, Pacific Islands	Terrestrial ecoregions of the world (WWF 2000)	x	Lat-Long	Ecoregions are defined by shared ecological features, climate and plant and animal communities. Main use is for biodiversity conservation.

Two problems occurred in polygon edgematching along country and regional boundaries. One was mismatch of polygon definition translations between polygons in adjacent maps. This problem was generally easy to solve by going back to the original maps, checking the translation and modifying as needed. The other problem was the misalignment of lines of the polygons on both sides, even though they may have had the same labels. To resolve this problem, FAO manually edited the coverage and changed the locations of the boundaries. This sometimes required verification using ancillary data and maps such as composites of United States National Oceanic and Atmospheric Administration (NOAA) AVHRR spectral bands, classified continental-scale land cover data (such as the United States Geological Survey [USGS] global land cover database) and digital elevation model (DEM) data.

Following the classification and guidelines outlined above, the global map was compiled in a region-by-region approach. Case studies on North America and South America provided

useful experiences and guidelines for GEZ mapping in other regions. In the course of the work regional experts actively participated or were consulted. EDC was responsible for producing the ecological zone maps for the temperate and boreal regions and jointly with FAO compiled the global map and database, while LET, Toulouse produced the ecological zone maps for the tropical regions, i.e. South America, Africa and Asia. FAO provided overall technical and conceptual guidance. After the Cambridge meeting in July 1999, it took one year to produce a draft global map. The draft map was reviewed at a meeting in Salt Lake City, Utah, United States (5-7 July 2000), and the final map and database were completed by October 2000.

After production of the regional GEZ maps the global GEZ map was composed from all the regional tiles. Edge-matching was an issue, particularly for the vast area of Europe and Asia, where a number of different tiles had to be brought together with large bordering areas. The delineation of ecological zones between bordering areas of Europe and the former Union of Socialist Soviet Republics (USSR) matched well, with only small adjustments needed. The same applies to the ecological zone boundaries between Europe and the Near East. More work was needed to match the tiles for tropical Asia, China and the former USSR; the task was complicated by the presence of extensive mountain systems on the border areas. After the edge-matching problems were resolved, the regional tiles were registered to a global base map, ESRI's *Digital chart of the world*, 1st edition, December 1994 (base scale 1:1 000 000). The GEZ map, together with other global maps produced by FRA 2000, is presented on the FAO Forestry Web site (www.fao.org/forestry/site/24815/en) under "World maps".

Forest cover by ecological zone

The GEZ map can be used to aggregate information on forest resources by ecological zone. Consequently, it is now possible to produce reports according to the natural characteristics of the vegetation rather than by national boundaries, which frequently cut across natural ecosystems.

This is particularly important today, with the growing awareness that many environmental problems are not national in character. For example, analysis of global change in climate and forest resources and of change in regional biological corridors requires information with a broad geographical context. Through ecological zone mapping, valuable insight is being obtained about the characteristics of forest resources which may serve to identify and resolve issues of importance to many countries, entire regions or the planet as a whole. For FRA 2000 reporting purposes, an overlay of the forest cover map with the ecological zoning map was used to prepare a map of forest cover by ecological zone (Figure 2) and to derive area statistics on forests according to ecological zones (Table 3).

Figure 2. Forest cover by ecological zone, 2000

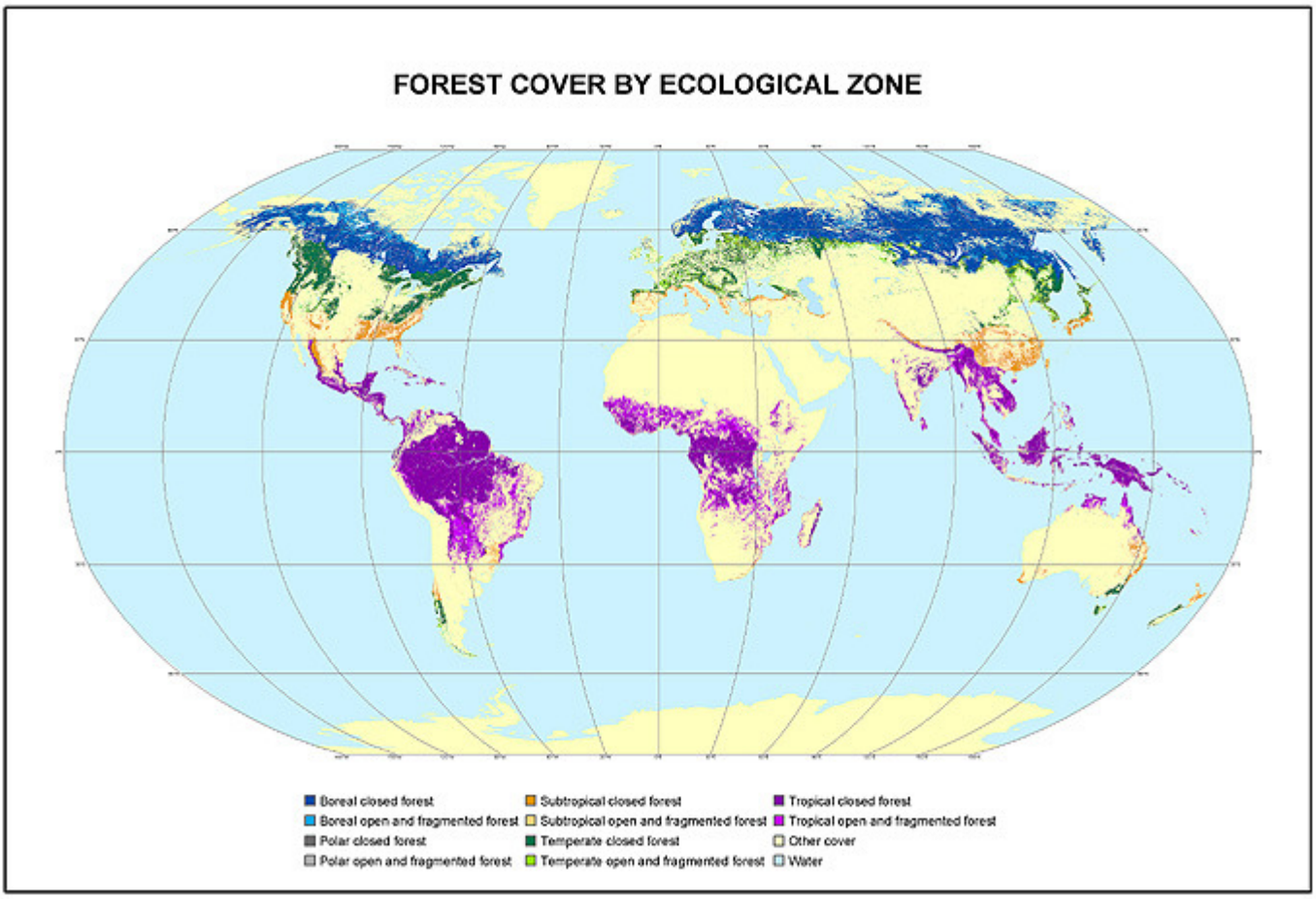


Table 3. Distribution of forests by ecological zone, 2000

Ecological zone	Total forest %	Africa %	Asia %	Oceania %	Europe %	North and Central America %	South America %
Tropical rain forest	28	24	17	-	-	1	58
Tropical moist deciduous	11	40	14	6	-	9	31
Tropical dry	5	39	23	-	-	6	33
Tropical mountain	4	11	29	-	-	30	30
Total tropical forests	**47**	**28**	**18**	**1**	**-**	**5**	**47**
Subtropical humid forest	4		52	8	-	34	6
Subtropical dry forest	1	16	11	22	30	6	14
Subtropical mountain	3	1	47	-	13	38	1
Total subtropical forests	**9**	**2**	**42**	**7**	**7**	**37**	**5**
Temperate oceanic forest	1	-	-	33	33	9	25
Temperate continental forest	7	-	13	-	40	46	-
Temperate mountains	3	-	26	5	40	29	-
Total temperate forests	**11**	**-**	**17**	**4**	**39**	**39**	**2**
Boreal coniferous forest	19	-	2	-	74	24	-
Boreal tundra woodland	3	-	-	-	19	81	-
Boreal mountain	11	-	1	-	63	36	-
Total boreal forests	**33**	**-**	**2**	**-**	**65**	**34**	**-**
Total forests	**100**	**17**	**14**	**5**	**27**	**14**	**23**

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