An Assessment of the Status of the World's Remaining Closed Forests

ISBN: 92-807-2028-7

For bibliographic and reference purposes this publication should be referred as:

UNEP (2001). An Assessment of the Status of the World's Remaining Closed Forests. UNEP/DEWA/TR 01-2.
Division of Early Warning and Assessment (DEWA)
United Nations Environment Programme (UNEP)
P.O. Box 30552, Nairobi, Kenya

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Our special thanks to Professor John Oates of the Hunter College City University, New York, Dr. K.D. Singh of the Center for International Development, Harvard University, Dr. Tom Loveland of USGS EROS Data Center, Garry Mann of the US Forest Service, Dr. Eugene Fosnight and Mr. Mark Ernste of UNEP/GRID-Sioux Falls, Raytheon, Christian Lambrechts and Jinhua Zhang of UNEP, Jeffery Danielson, Eric K. Waller of USGS EROS Data Center for their valuable comments and Kim Giese for her excellent job in producing maps and graphics.

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Forests provide a variety of socioeconomic and ecological goods and services. During the last two decades forests have attracted unprecedented global attention. Numerous international conferences, conventions and agreements including the Forestry Principles agreed upon during the Earth Summit in 1992 and the Convention on Biological Diversity have called for the protection of global forests. However, forest resources around the world are increasingly under threat due to conversion of forestlands to other land uses and overexploitation of forests for timber. Short of a miraculous transformation in the attitude of people and governments, the Earth's remaining closed-canopy forests and associated biodiversity are destined to disappear in the coming decades. Knowing it is unlikely that all forests can be protected, it would be better to focus conservation priorities on those target areas that have the best prospects for continued existence. Hence it is critical to assess the extent and distribution of such areas using the latest scientific information.

In this study a new detailed analysis of global forest cover was conducted using satellite data to assess the actual extent and distribution of the World's Remaining Closed Forests (WRCF; canopy closure > 40%), their protection status and threats to such forests due to population pressure. This study reveals that because the majority of such forests are concentrated in only a few countries and many of these areas have low population densities, the protection of these forests first would provide the "biggest bang for the buck".

Future policy options for the conservation of these forests should include implementation of strong protection measures, raising the public's awareness about the value of forests and concerted actions for reducing pressure on forest lands by providing alternatives to forest exploitation to meet the growing demand for forest products.

Klaus Toepfer
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The extent of World's Remaining Closed Forests (WRCF) in 1995 is estimated at approximately 2.87 billion hectares, which occupies about 21.4% of land area of the world.

Fifty-four countries have over 30% of their land area under closed forests.

About 80.6% of the WRCF are concentrated in fifteen countries. Ranked in the highest to lowest order are - Russia, Canada, Brazil, the United States, Democratic Republic of the Congo, China, Indonesia, Mexico, Peru, Colombia, Bolivia, Venezuela, India, Australia and Papua New Guinea.

Three countries - Russia, Canada and Brazil – contain about 49% of the WRCF.

Only about 9.4% of the WRCF have been accorded some sort of a formal protection status.

An estimated 83.6% of the WRCF have low population density, 11.3% medium population density and the remaining 5.1% high population density in and around closed forests.

In the top 15 countries, an estimated 88% of the WRCF have low population density, 9% medium population density and 3% high population density in and around closed forests.

Many of these forest areas with low population densities offer significant opportunities for conservation if appropriate steps are taken now by the national governments and international community.

The policy options for the protection of the WRCF should include:

a. Strong protection measures;

b. Education, and;

c. Alternatives to forest exploitation.

Forests are vital for sustaining the life support systems of the Earth. Forests also play a significant role in the socio-economic development of many nations by providing raw material to various industries, meeting basic needs of fuelwood, food, fiber, small timber and employment to local people. The prominent role of forests in biodiversity (plants and animals) conservation, watershed protection, soil conservation, moderating the global climate, recreation, food security and sustainable development has been widely recognized (UN, 1993). However, the forest resources of many countries around the world have been under mounting pressure due to increasing human population, conversion of forestlands to other land uses and overexploitation for timber.

"Attack what can be overcome"

- Art of War, Sun Tzu

FAO Image, G. Diana

There have been many recommendations for the conservation and sustainable management of forests in the last thirty years since the Stockholm Conference on the Human Environment, 1972, the Earth Summit, 1992, and the recent Intergovernmental Forum on the Forests (IFF) under the aegis of the United Nations. (http://www.un.org). Despite the pledge and commitments made by governments and growing concerns from the public, tropical forests continue to disappear and "most remaining tropical forests could be lost over the coming century, destroying priceless biological resources and limiting options for sustainable growth (The White House, 2000)". It is now time to move from dialogue to actions. National governments, with the full participation of civil society, should revise their forest policies and programmes to incorporate the international consensus reached at the IPF/IFF Proposals for Action, and prioritize actions on (i) strong protection measures; (ii) education, and; (iii) alternatives to forest exploitation.

The Objectives of the Study

The basic objectives of this study are to:

- Assess the extent and distribution of the world's remaining closed forests using the most comprehensive, consistent and current satellite data sets.
- Assess the protection status of the world's remaining closed forests.
- Assess threats to the world's remaining closed forests due to population pressure.
- Summarize some policy options and actions by the national governments and the international community for the protection of the world's remaining closed forests.

The Food and Agriculture Organization (FAO) of the United Nations has a mandate to carry out the global forest cover assessment on a periodic basis (FAO 1982, 1990, and 1999). According to the latest estimates (FAO 1999, UNECE 2000) the total area of world forests (with crown cover more than 10%) at the end of 2000 was 3.5 billion ha, of which 1800 million ha were in developing countries and 1700 million ha in developed countries. The FAO's assessments (1993, 1995) reveal that world forests are unevenly distributed. More or less intact forests (1680 million ha) are concentrated in the following two big blocks:

- Boreal forests (1000 million ha) occurring in Russia, Scandinavian countries, Canada and the USA. Population density is still less than 10 people per sq. km.
- Rain forests (680 million) occurring in tropical Asia (160 million ha), Africa (80 million ha) and South America (440 million ha). The population pressures (people per sq. km.) in Asia are 120 people per sq. km., Africa: 40 people per sq. km. and South America: 25 people per sq. km.

The remaining forests (1820 million ha), very fragmented and under high pressure, are:

- Temperate and subtropical forests (680 million ha) in the developed countries with 150 people per sq. km.
- Temperate and subtropical forests (180 million ha) in the developing countries mostly confined to mountain regions with 120 people per sq. km.
- Tropical deciduous lowland forests (760 million ha) in the developing countries with 300 people per sq. km.
- Tropical mountain forests (200 million ha) with more than 70 people per sq. km. (FAO 1993).

FAO (1993) estimated total annual deforestation in the tropics during 1980-1990 to be 15.4 million ha; while the forest area in developed countries was either stable (more correctly speaking fluctuating slightly up and down within error limits) as in the North America and Commonwealth of Independent States (CIS) or slightly increasing by 2-5% per decade as in Europe (FAO-ECE 2000).

Despite the apparent accuracy of the quoted figures for the area under forests and the annual rate of deforestation, there is a large uncertainty regarding the exact magnitude of the problem. A detailed review of the problems associated with assessment of deforestation is available in FAO Forestry papers (FAO 1993, 1995, and 1999). According to these reports, the assessment of global deforestation or that within a country is complicated due to several reasons:

- There is no globally accepted definition of forest or

deforestation. Some definitions include only primary forest whereas others include all forests (primary or disturbed, and closed or open).

- Assessing deforestation requires a minimum of two consistent observations over time. In many countries or regions, even one observation is lacking due to weak capacity in forest inventory.
- Rain forests located in inaccessible terrain are costly to survey. Perpetual clouds in the equatorial zone prevent acquisition of cloud free imagery. Radar imagery, due to their cloud penetrating capabilities, hold a promise, but offer less information.
- Sometimes, ineffective methodologies are employed and figures are reported for a country without giving the associated error. Fearnside (1993) presents an account of varying estimates of deforestation reported for the Brazilian Amazonian region.
- Even in countries with a tradition of forest inventory, techniques used have not always been very appropriate for monitoring changes and do not provide a statistically sound comparison of estimates on two dates.
- Sometimes areas reported as "forest" based upon remote sensing studies may not be considered "forests" by others - i.e. orchards, oil palm plantations, etc.

3.1 Varying Estimates of Area Under Forests

There are numerous studies and reports concerning areas of forest and forest loss. However, there are significant differences in results due to different methodologies, perspectives and definition of forests. Furthermore, due to lack of regular monitoring systems it has been a challenge to assess the status and trends of actual forest cover in many countries.

For the assessment of forest resources, FAO mainly depends upon the information furnished by the countries. FAO compiles the statistics related to forests and "area under the forests" following a common system of classification and definitions. Because of the differences in the classification and definition, the figures published by FAO sometime do not tally with the figures reported by countries. Furthermore, there are areas, normally, designated as "forest lands" though they may not necessarily have tree cover. For example, in India after regular monitoring of forest cover using satellite data, it was discovered that although the designated forest area in the country was about 23% of the geographical area, some kind of forest cover existed over 19% but real and meaningful forest cover (i.e. closed canopy forest with density >40%) extended to only about 11% of the area (FSI, 1997). The World Resources Institute (WRI, 1997) in the

report "The Last Frontier Forests" assessed the state of the world's remaining large, intact natural forest ecosystems using the existing global map of current forest cover and input of experts around the world. The quality, accuracy and dates of these national and regional maps vary and annotation of boundaries of forest areas by experts seems to be a rather subjective. A comparative analysis of varying estimate of area under forests for selected countries is given in Table 1.

For Canada and the United States, NOAA AVHRR data of 1km resolution were in the analysis. For India, the assessment was done in 1995 using LISS II data from Indian Remote Sensing Satellite (IRS-IB) with 36 meter resolution. The estimate for area under closed forests based in remote sensing surveys is available only for India. Definitions of forests given in some of these studies are cited on the next page to highlight the issue.

In order to get a geographically comprehensive estimates with the latest information, there have been several studies to map forest cover using satellite data at the regional or continental scale such as the TREES study (Malingreau *et al.* 1995), the Humid Tropical Forest Landsat Pathfinder study (Skole and Tucker,

Table 1: A comparison of area under forests from different sources for selected countries (% of the total area of the country).

Country	Official Published Statistics[1]	FAO[2]	Estimates Based on Remote Sensing[3]	WRI[4]
Canada	45.3	26.5	42.7	34.9
India	23.2	21.9	19.1	
United States	33.0	23.2	30.7	32.6

Note:

1. Official published area is quoted from the Canadian Forest Service (CFS) (1999, http://www.nrcan.gc.ca/cfs/), the Forest Survey of India (FSI) (1997), and the U.S. Forest Service (USFS) (1992) respectively.
2. FAO, State of the World's Forests 1999 (http://www. fao.org/forestry).
3. Estimate based on remote sensing for Canada, Cihlar, et al. (1996), for India, Forest Survey of India (1997) and for the United Sates, Zhu and Evans (1994).
4. The Last Frontier Forests (WRI, 1997).

1993) and Using Remote Sensing to Estimate Tree Cover and Carbon Stocks in Forests (Townshend et. al. 1999). The recent United States Geological Survey's (USGS) global land cover characterization database, completed in cooperation with a number of organizations around the world, provides a complete global coverage, and was produced using a consistent methodology and a flexible database philosophy (Loveland *et al*., 2000). The global database was produced on the basis of an unsupervised algorithm using 1992-1993 National Oceanic Atmospheric Administration (NOAA) Advanced Very High-Resolution Radiometer (AVHRR) Normalized Difference Vegetation Index (NDVI) data.

Definition of Forests

Forest Area – *Definitions applied for developing countries:* Areas with a minimum of 10 percent crown cover of trees and/or bamboos, generally associated with wild flora and fauna and natural soil conditions, and are not subject to agricultural practices. *Definitions applied for developed countries:* Land with tree crown cover (stand density) of more than 20 percent of the area (FAO, 1999). See http://www.fao.org/forestry/fo/fra/index.jsp for the updated definition used in the Global Forest Resources Assessment 2000 (FRA 2000).

Recorded Forest Area – All lands statutorily notified as forest, though they may not necessarily bear tree cover. (FSI, 1997).

Forest Cover – All lands with a tree canopy density of more than 10 percent, though they may not be statutorily notified as forest. (FSI, 1997).

Closed Forests – Defined as all lands with a forest cover of trees with their crowns interlocking and a canopy density of 40% or above. The boundary of 40% coverage is convenient because it can be estimated with ease when the coverage of the trees is 40% the distance between two tree crowns equaling the mean radius of a tree crown (UNESCO, 1973).

Frontier Forests – The world's remaining large, intact natural forest ecosystems. (WRI, 1997).

Forest Land – Land at least 10% stocked by forest trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated (USFS, 1993).

Forest Land – The data regarding Canada's forest land are based on the Canada Forest Inventory 1991 (revised 1994) (CFS, 2000).

4.1 Data Sources

This analysis was carried out using comprehensive and consistent 1-km spatial data sets developed through remote sensing and other source materials. Geographic Information System (GIS) tools were used for analysis, integration, and visualization of results. The following four data sets were used in the analysis.

4.1.1 Global Closed Forest Cover Distribution Data

In this study the USGS land cover database was refined to FAO forest cover classes (FAO 1995). Vegetation classification and descriptions in the USGS land cover database are built on characteristics of vegetation seasonality determined in terms of weekly composite of NDVI derived from NOAA AVHRR sensor for the period 1992-93. In many parts of the world data were updated for the year 1995. In the database, unique NDVI signatures and associated attributes, such as terrain and ecoregions, characterize large-area land cover patterns. Because the USGS seasonal land cover database was not intended to optimize forest cover, no direct relationship exists to enable a simple conversion of the seasonal land cover classes to the FAO classes. Rather, a two-step methodology was designed that allowed certain interactive flexibility in deriving and correcting the USGS seasonal land cover database to FAO classes:

- **Adapting the USGS seasonal land cover classes to the FAO classification.** The full USGS seasonal land cover classes were used as the baseline data on the continent-by-continent basis. The refinement methods to fit USGS classes to FAO definitions are similar to the methods used in producing these USGS classes, namely that refinements depend on local conditions of land cover and rely on a careful study of all available evidence. The country-level forest database maintained by the FAO is also used as a general reference for country-level forest classification. Loveland *(et al. 2000)* described the overall approach in detail. "Class merges and splits are aided by ancillary data sets, such as ecoregions and digital elevation models. Spectral reclustering, as well as user-defined polygon splits, is also used". This approach has been found to be effective for many seasonal land cover classes, including most non-forest classes, such as sparsely vegetated areas. However, those land cover patterns that are highly mixed in terms of the FAO forest classes require further analysis to differentiate both mixture conditions and the degree of forest canopy openness.

- **Estimating percent forest cover using two techniques.** The concept of spectral mixture analysis quantifies pixels as fractions of basic surface components (Smith *et al*., 1990, Wessman *et al*. 1996), or "endmembers," such as green vegetation, soil and shade. It is generally understood that, in relatively small study areas and with sufficient spectral information, unique and representative endmembers can be identified to produce reasonable results. Unfortunately, endmember fractions do not directly correspond to forest fractions; closed forests can consist of mixtures of different types of green vegetation and shade (Roberts *et al*., 1993). This, together with limited spectral bands and a large mapping area, led to the development of a combined linear mixture modeling and NDVI scaling approach.

In the combined approach, the traditional unmixing method is modified slightly to apply only to pixels with high reflectance in AVHRR band 2 (infrared) and relatively high reflectance in band 1 (visible). These bright pixels tend to be mixtures of forest (particularly deciduous forest), cropland, and bare soil, which have high reflectance in these bands. These cover types are treated as endmembers, and the bright pixels are unmixed on each monthly AVHRR composite. Fraction classes range from closed forest to open forest, fragmented forest, and non-forest land cover. Dark pixels (with relatively low reflectance in AVHRR bands 1 and 2), on the other hand, are generally found to be indicative of dense, undisturbed forests, particularly conifer forests. However, these dense forests can be confused with low illumination or flooding. A scaled NDVI is a better indicator of forest density than mixture analysis for these dark pixels. Closed forest, open forest, and woody savanna are found to be closely related to decreasing NDVI, approximately between 0.8 and 0.3.

To avoid the NDVI saturation effect, the choice of maximum NDVI for scaling is flexibly set between different forest cover patterns. To provide the least atmospherically affected result, final percent forest cover is determined over the course of the year on the basis of maximum monthly forest cover value achieved, regardless of the methods chosen (mixture analysis or scaled NDVI). Figure 1 illustrates the two techniques used in estimating percent forest cover.

Using the estimated forest density and information about the two methods, a simple modeling process is developed to guide decisions on adapting the mixed seasonal classes (in terms of the FAO forest cover classes) from the first step. Pixels with greater than 40 percent canopy cover are

classified as closed forest. The modeling process determines the level of forest fragmentation if forest density is from the modified mixture analysis and separation of various types of forest and woodland from other land cover is based on results from the linear NDVI scaling. Because of varying ecological conditions within and between continents, flexible regional rules are developed according to reference data in determining forest density threshold values for the FAO forest classes.

4.1.2 Global Population Database

The geographically referenced population database was provided by United Nations Environment Programme, Division of Early Warning and Assessment - North America, EROS Data Center (UNEP/GRID; http://www.na.unep.net). These data sets for 1990 were generated using a model incorporating many variables, including the location of protected areas. Global population data in tabular form were taken from the World Resources Database CD-ROM (1998-1999)

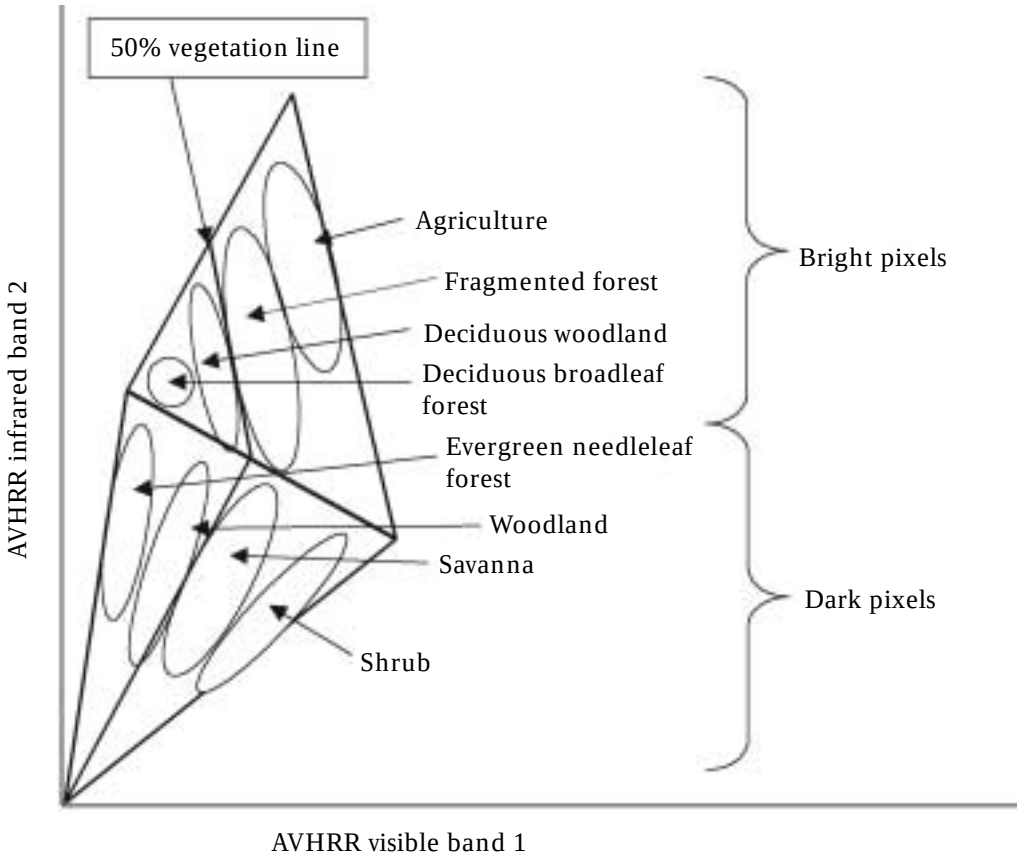


Figure 1. Estimating percent forest cover using the traditional mixture analysis for bright pixels and linear scaling of NDVI for dark pixels. The ellipses indicate pixel clouds of likely land cover types in the spectral space of the AVHRR bands 1 and 2. Pixels with greater than 40 percent canopy cover are classified as closed forest.

published by the World Resources Institute (WRI).

4.1.3 Global Protected Area

The protected areas database was provided by the UNEP World Conservation Monitoring Center (WCMC; http://www.unep-wcmc.org). Some of the smaller protected areas may not have been accounted for due to the coarse resolution of data.

4.1.4 Political Boundaries Data

Political boundaries data was taken from the US National Imagery and Mapping Agency's (NIMA) Vector Map Level 0 (VMAP0) series CD-ROM. This data set provides, among other things, a 1995 version of the political boundaries of the world at 1:1,000,000 nominal scale. This data was compared to the NIMA Digital Chart of the World (DCW) data set and found to be in error in several places. Wherever it was appropriate, DCW linework was added to the VMAP0 data to correct and complete the VMAP0 data. Attribute assignments were verified and corrected as needed for the resulting polygon coverage and subsequently theses coverages were joined to generate an updated map.

4.1.5 *General Considerations About the Data Used*

The closed forests and population data sets covering all of the world are the best available. Considerable regional errors are known to exist in the mapped distribution of other land cover type.

The population data set is generated using a model incorporating many variables, including the location of protected areas. Hence the areas of intersection between population and protected areas are compromised. This does not invalidate conclusions drawn from the analysis of the proximity of the protected areas to the areas of high population density.

The protected areas database is not current for all countries. Some of the smaller protected areas may not have been accounted for due to the coarse resolution of data. Where information is not available for the exact extent of a protected area, a point has been inserted representing the center of the site. Polygons were made for such locations by using the information in textual databases and drawing a circular polygon of the relevant area around the point location of the site. None of these data sets have been rigorously validated, so local relationships and distributions should be viewed with caution.

Availability of high-quality, current data remains a stubborn barrier in such analyses. It highlights the need to support development and updating of such databases.

4.2 Methodology

Data processing was performed using several software : 1) IMAGINE -Version 8.3 (ERDAS) for stratification and digitizing of vector polygons, 2) ENVI (Research Systems, Inc) for image

interpretation, graphical analysis and determining models and 3) Land Analysis System (public domain) for modeling. GIS analysis was performed using software donated by the Environmental Systems Research Institute (ESRI), Inc. Most of the work was done in the GRID module of ARC/INFO. Tabular manipulation of the data was done within the INFO module and Microsoft Excel. Raster and vector data layers were in an Interrupted Goode Homolosine Projection and all raster data sets had a cell size of 1,000 meters (1 km).

4.2.1 Population Distribution Overlay Using GIS

Whenever population is mentioned as high, medium, and low/none density, the following classification was used:

Low population: <25 people per sq. km.

Medium population: 25-100 people per sq. km.

High population: >100 people per sq. km.

These data layers were analyzed individually or combined with other data layers in order to assess possible spatial relationships among them. For example, "closed forest layer" and "population layer" were digitally overlaid in order to assess the population pressure on closed forest cover area.

4.2.2 Percentage of Closed Forests within Country

The closed forests cover distribution in each country was estimated by combining the political boundary grid with the closed forests cover distribution grid.

4.2.3 Protection Status of Closed Forests Within Country

The protection status of the closed forests was estimated by combining the protected area grid with the closed forests distribution and political boundary grid.

4.2.4 Population Density Within Closed Forests Area

Combining the closed forest grid with the population and political boundary grid, then summing up the population for each country or continent, provided an estimate of the population in closed forest areas. The population density in the closed forest areas was calculated by multiplying the population value by the total number of pixel occurrences.

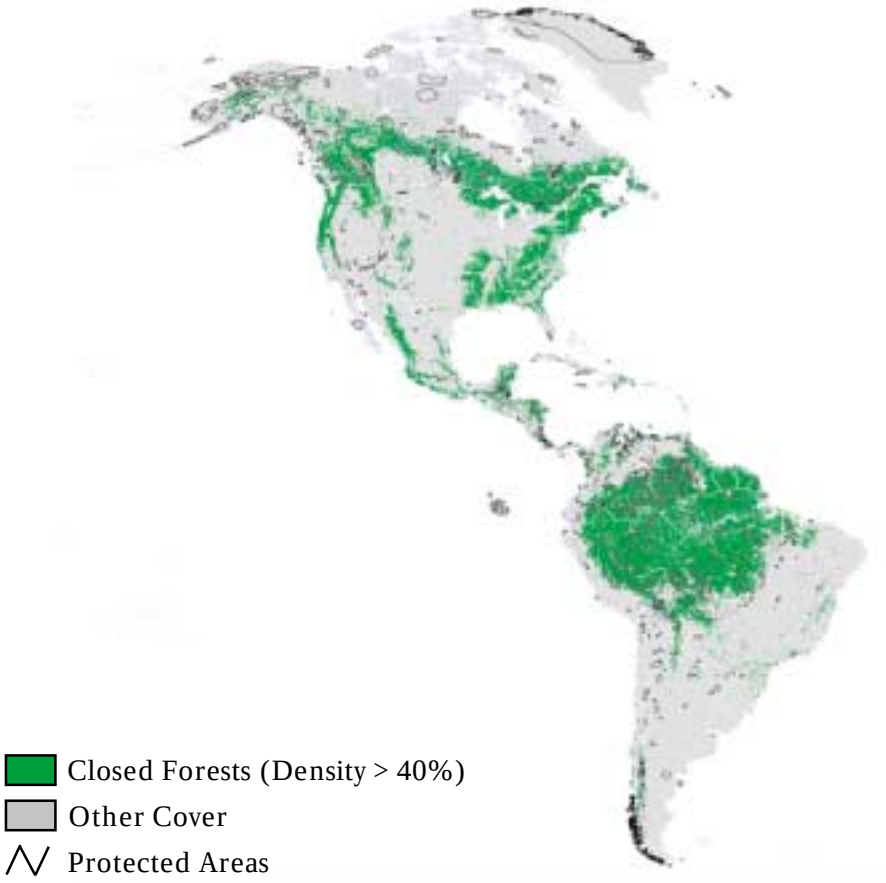


Figure 2 World's remaining closed forests cover map.

5.1 Distribution of the World's Remaining Closed Forests (WRCF)

The extent of the World's Remaining Closed Forests (WRCF) in 1995 is estimated at approximately 2.87 billion hectares which occupies about 21.4% of land area in the world (see Table 2, Figure 2, and for country-wise detail Appendix 1).

The continental distribution of total area under the WRCF is estimated at 9.65% in Africa, 6.23% in Australia and Pacific, 37.93% in Europe and Asia, 24.32% in North and Central America and 21.87% in South America. Eurasia has the largest share, and Australia and Pacific have the least.

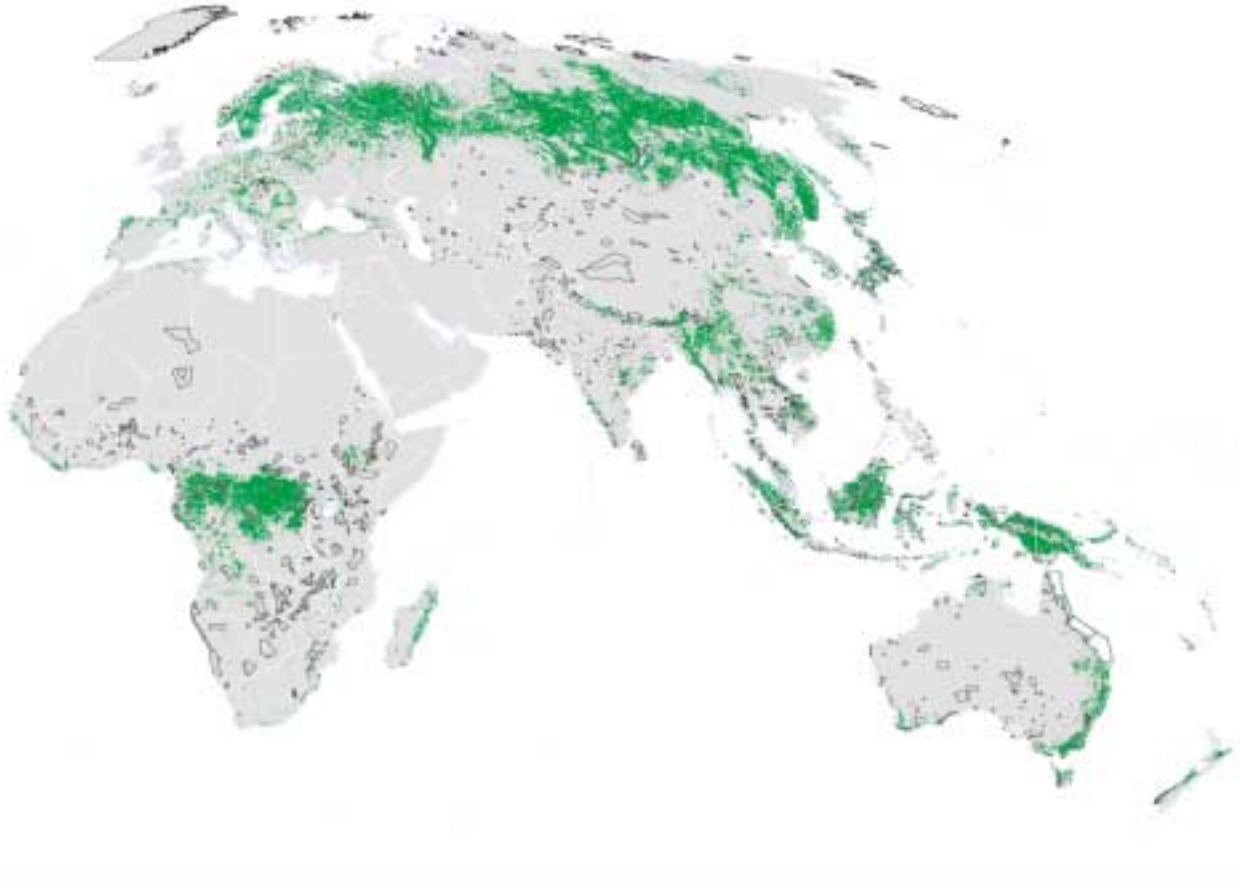


Table 2: Distribution of the world's remaining closed forests by continents.

Continents	Population (1990)	Total Land Area (000 hectares)	Area Under CF* (000 hectares)	% of Total WRCF	% of CF Total Area	Population Density (people / 1000 ha)
Africa	630,000,000	2,997,168.8	277,200.6	9.65	9.25	210
Australia and Pacific	269,000,000	1,064,717.7	178,882.9	6.23	16.80	252
Europe and Asia	3,700,000,000	5,162,654.8	108,9426	37.93	21.10	724
North and C. America	426,000,000	2,408,167.1	698,632.8	24.32	29.01	177
South America	295,000,000	1,772,654.3	628,221.5	21.87	35.44	166
World	**5,300,000,000**	**13,405,362.7**	**2,872,363.8**	**100**	**21.43**	**400**

* CF: Closed Forest

Table 3 Distribution of the world's remaining closed forests in the top 15 counties

Countries	Population	Total Land Area (000 hectares)	Area Under CF* (000 hectares)	% of CF Total Area	Population Density (people / 1000 ha)
Russia	148,292,000	1,681,414.4	669,651.8	39.83	88
Canada	27,791,000	983,400.2	368,650.9	37.49	28
Brazil	148,002,000	850,063.3	361,597.2	42.54	174
United States	254,106,000	940,626.9	236,683.3	25.16	270
Democratic Republic of the Congo (Zaire)	37,405,000	233,814.5	116,204.2	49.70	160
China	1,176,397,000	940,234.9	111,578.9	11.80	1,251
Indonesia	182,812,000	188,748.2	92,753.4	49.14	969
Mexico	83,226,000	195,378.4	60,107.7	30.76	426
Peru	21,569,000	129,554.8	59,312.2	45.78	166
Colombia	32,596,000	114,115.9	51,931.9	45.51	286
Bolivia	6,573,000	108,868.2	41,942.9	38.53	60
Venezuela	19,502,000	91,408.4	40,709.0	44.54	213
India	850,793,000	315,440.8	37,952.2	12.03	2,697
Australia	16,888,000	768,639.9	35,548.5	4.62	22
Papua New Guinea	3,839,000	45,929.1	32,422.3	70.59	84
Total	**3,009,790,000**	**7,587,637.9**	**2,317,046.4**	**30.54**	**397**
World	**5,368,000,000**	**13,405,362.7**	**2,872,363.8**	**21.43**	**400**

*CF: Closed Forest

5.1.1 Continental Distribution of the World's Remaining Closed Forests (WRCF)

As shown in Figure 3, the WRCF occupies about 9.25% of the land area in Africa, 16.8% in Australia and Pacific, 21.1% in Europe and Asia, 29% in North and Central America and 35.44% in South America. Percentage of the WRCF to total land area is the highest in South America and the lowest in Africa.

A total of 54 countries have over 30% of their land area under closed forests: eight countries in Africa, five in Australia and Pacific, eighteen in Europe and Asia, thirteen in North America (including Central America), and nine countries in South America (see Appendix 2).

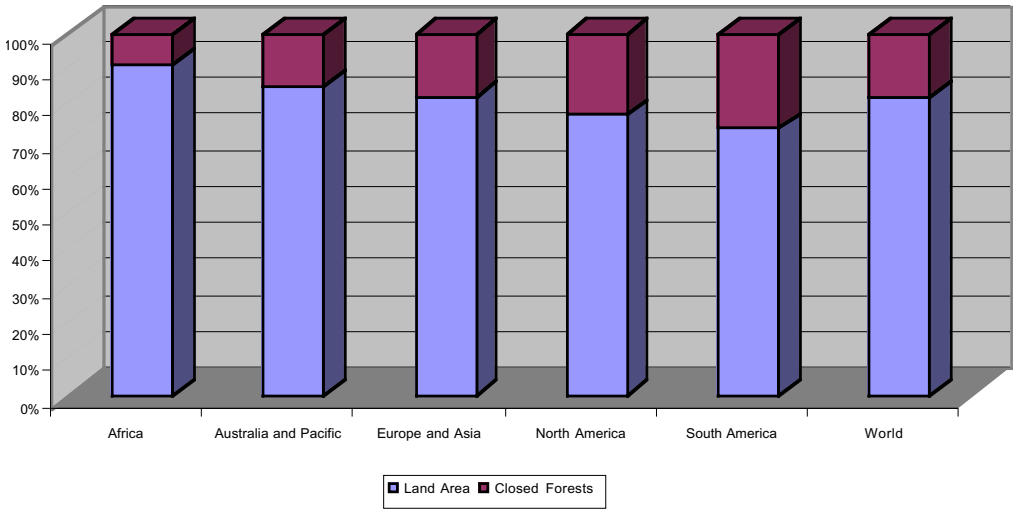
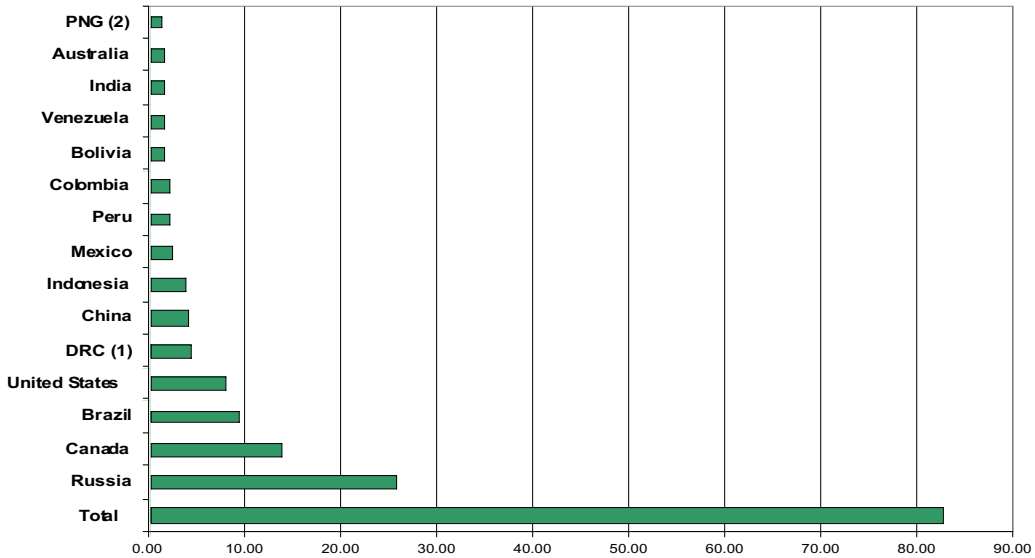


Figure 3 Continental distribution of total area under the world's remaining closed forests.

5.1.2 Distribution of the World's Remaining Closed Forests in the Top 15 Countries

About 80.6% of the WRCF are concentrated in the top 15 countries ranked in the highest to lowest order - Russia, Canada, Brazil, United States, Democratic Republic of the Congo, China, Indonesia, Mexico, Peru, Colombia, Bolivia, Venezuela, India, Australia and Papua New Guinea (Figure 4). Four of them, namely Russia, Canada, USA and Australia, are developed countries; the remaining 11 are developing countries. An average of 30.5% of land area of these countries are under closed forests, with the highest 70.6% in Papua New Guinea, and the lowest 4.6% in Australia (Table 3).



(1) Democratic Republic of the Congo (Zaire), (2) Papua New Guinea.

Figure 4: Top 15 countries containing the world's remaining closed forests (percent).

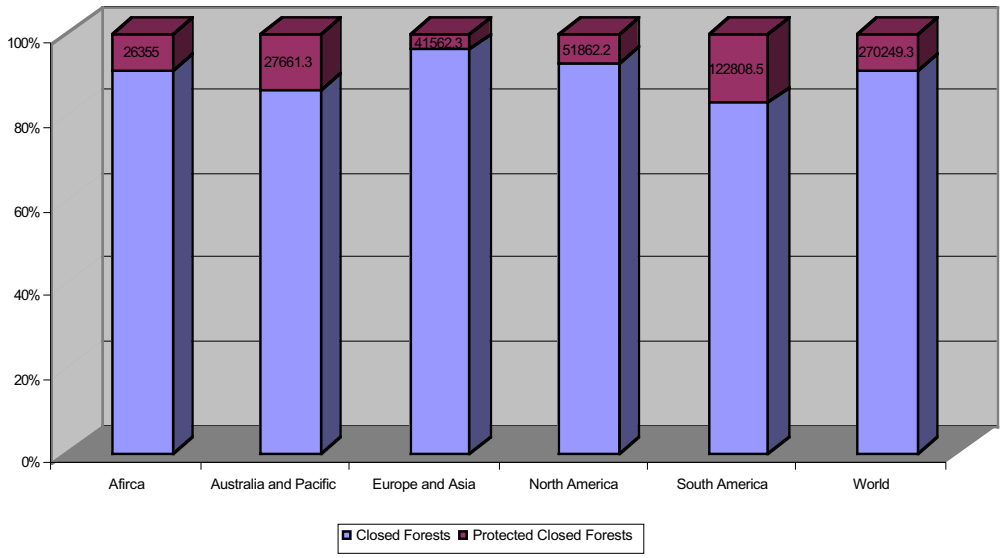


Figure 5: Protection status of the world's remaining closed forests.

5.2 Protection Status of the World's Remaining Closed Forests:

5.2.1 Protection status of the WRCF by continents

"Protection Status" means designated protected areas (see http://www.unep-wcmc.org). About 9.4% of the WRCF have been accorded some sort of formal protection status, the highest being in the South America (19.5%) and the lowest being in Europe and Asia (3.9%) (Table 4, Figure 5).

Table 4: Protection status of the WRCF by continents (Area: 1,000 ha)

Continents	Total Land Area	Total Protected Area	% of Protected Land Area	Area Under Closed Forests	Protected Closed Forests	% of Protected Closed Forests
Africa	2,997,168.8	190,888.7	6.4	277,200.6	26,355.0	9.5
Australia and Pacific*	1,064,717.7	73,924.1	6.7	178,882.9	27,661.3	15.5
Europe and Asia	5,162,654.8	170,843.0	3.3	1,089,426.0	41,562.3	3.8
North and Central America	2,408,167.1	185,215.8	7.7	698,632.8	51,862.2	7.4
South America	1,772,654.3	197,614.1	11.1	628,221.5	122,808.5	19.5
World	**13,405,362.7**	**818,485.7**	**6.1**	**2,872,363.8**	**270,249.3**	**9.4**

* Protected coral reefs in Australia are not included.

Figure 6: Protection status of the world's remaining closed forests: Africa.

Africa: Biodiversity-rich tropical evergreen broadleaf forests in Africa occupy slightly over 26,300,000 ha or 9.5% of the total WRCF (Figure 6). Figure 6 also shows that in Africa the WRCF have lower proportional protected areas, notably in the Congo basin compared to other ecosystems, such as savanna, grassland. The WRCF under protection status are only about 13.8% of total protected areas in Africa. In the African Great Lakes region, the WRCF cover approximately 1.4 million sq km of the area, and only about 100,000 sq. km., or slightly over 7%, of these forests are protected, leaving the bulk of the tropical forests unprotected. Furthermore, the degree to which the closed forests areas are effectively protected varies.

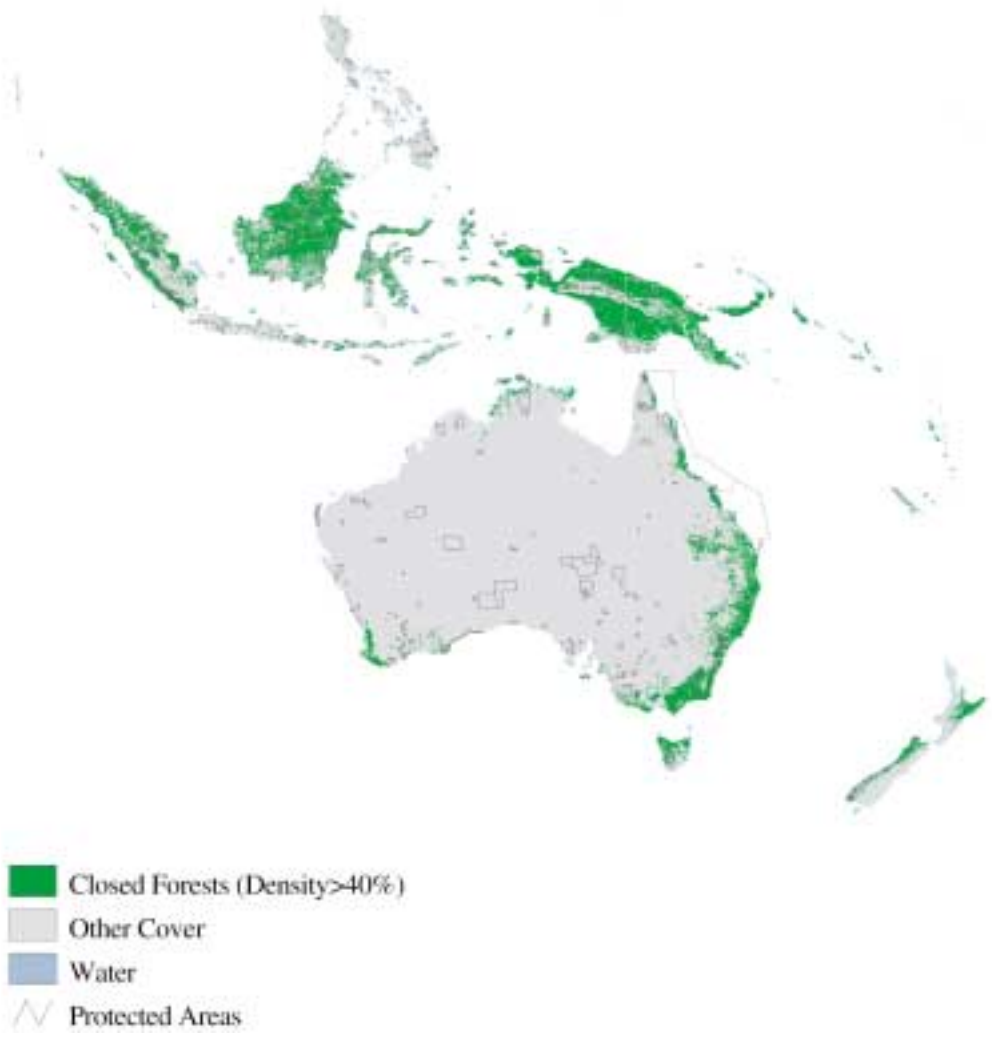


Figure 7: Protection status of the world's remaining closed forests: Australia and Pacific

Australia and Pacific: The WRCF under protection status in Australia and Pacific occupy slightly over 27,661,300 ha, 15.5 % of the total WRCF and 37.4% of total protected areas (Figure 7). Within the region, the status of the WRCF varies greatly by countries and forest type. Most of the WRCF are legally protected in New Zealand. Papua New Guinea still possesses large areas of WRCF. About 85% of the WRCF in Papua New Guinea are under moderate or high threat, primarily from logging, agricultural clearing, and mining. The similar situation has also been observed in Indonesia.

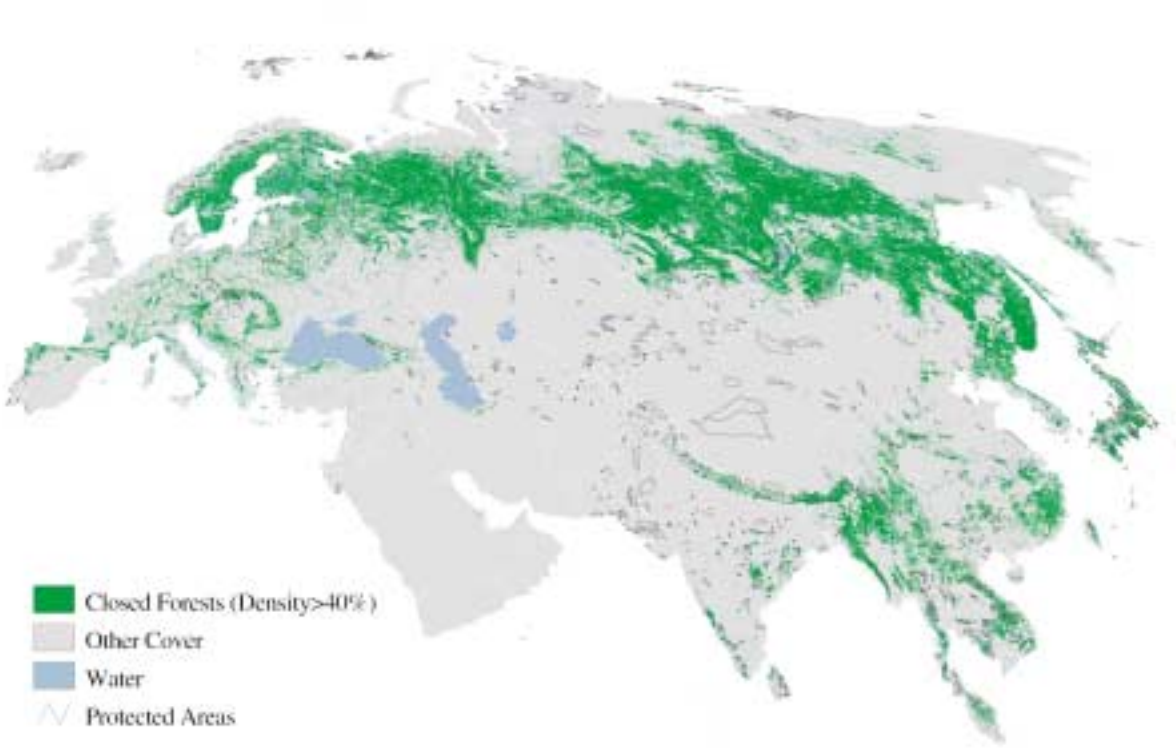


Figure 8: Protection status of the world's remaining closed forests: Europe and Asia.

Europe and Asia: The WRCF under protection status in Europe and Asia occupy about 41,562,300 ha or 3.8% of the total WRCF, 24.3% of total protected areas in the region (Figure 8). Europe's last few large blocks of forest areas in Sweden and Finland are well protected. Russia's boreal forests are still largely intact. The percentage of protected areas in Russia is very low.

Asia has a limited area under closed forest compared with the land area. More than half of Asia's closed forests are under moderate to high threat, particularly from logging. An even greater long-term worry is Asia's burgeoning population and its ever increasing demand for food and agricultural land.

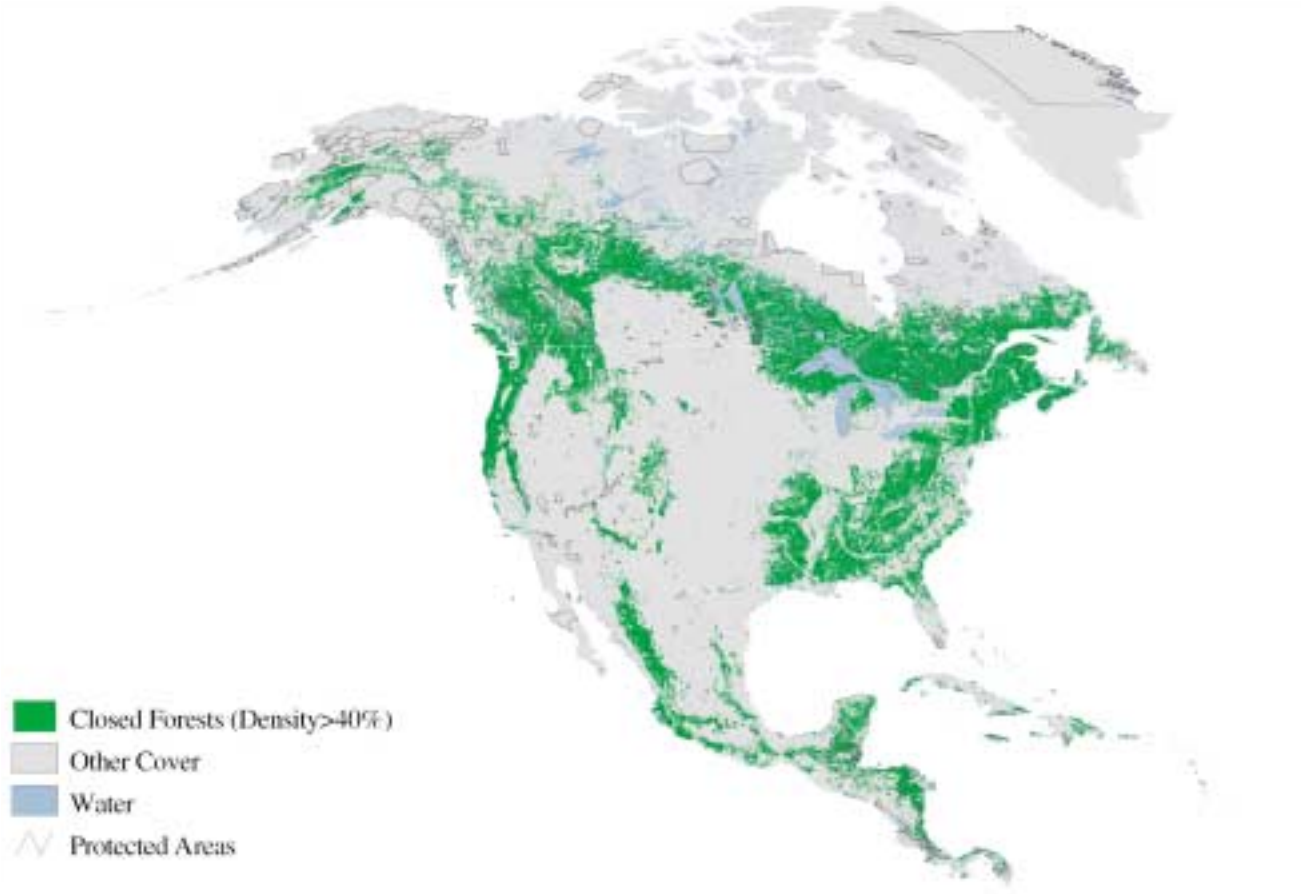


Figure 9: Protection status of the world's remaining closed forests: North America.

North America and Central America: Closed forests under protection status in the region occupy about 51,862,200 ha or 7.4% of the total area under closed forests, and 28% of the total protected areas (Figure 9). Compared to other regions, the WRCF in this region rank among the least threatened in the world.

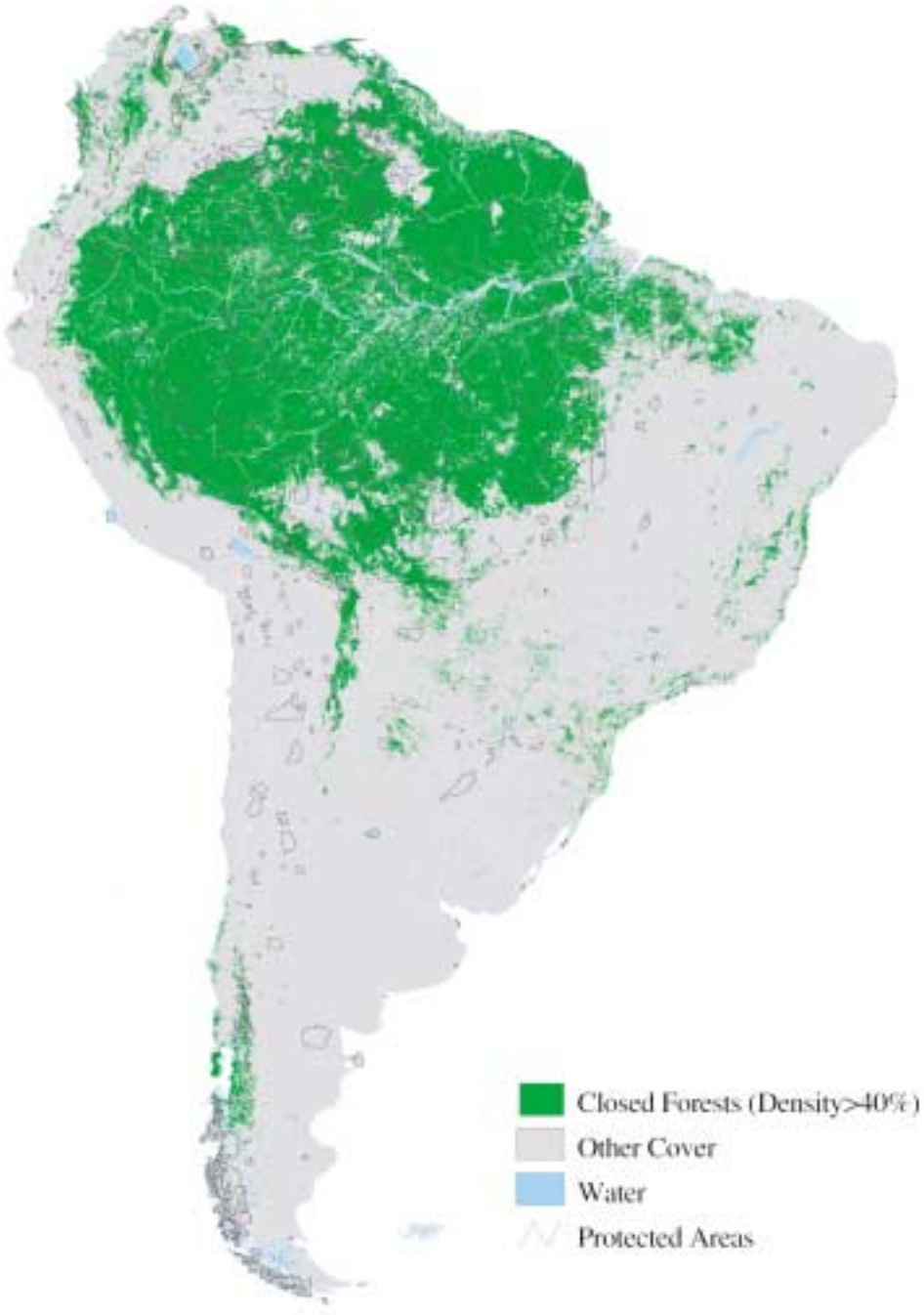


Figure 10: Protection status of the world's remaining closed forests: South America.

South America: Closed forests under protection status in South America occupy about 122,808,500 ha or 19.5% of the total WRCF, and 62.15% of total protected areas (Figure 10). South America maintains vast areas of intact tropical and temperate forests and forests of the Northern Andes rank among the Earth's biologically richest areas.

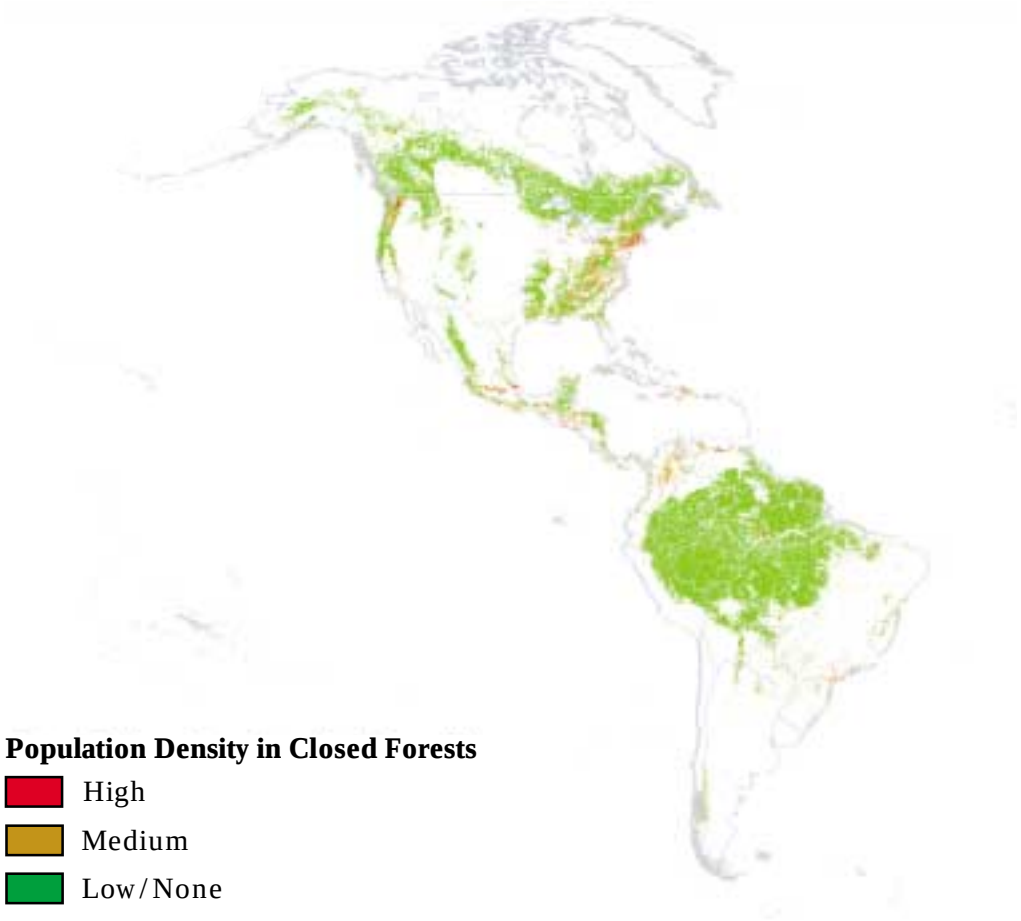
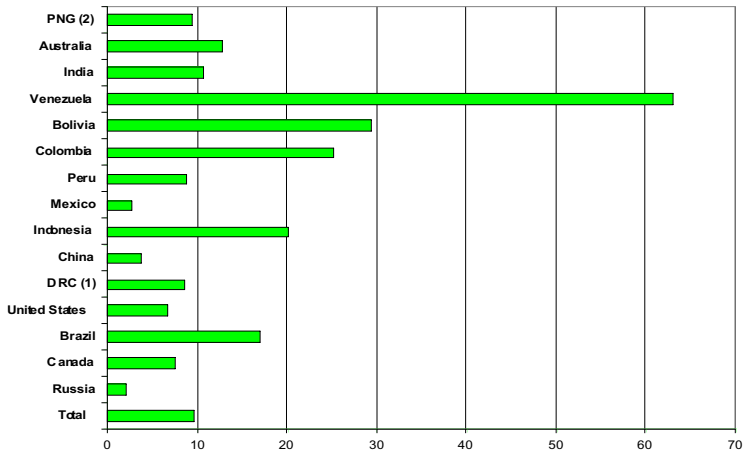


Figure 12: Distribution of population density associated with the world's remaining closed forests.



(1) Democratic Republic of the Congo (Zaire), (2) Papua New Guinea.

Figure 11: Top 15 countries protection status of the world remaining closed forests (percent).

5.2.2 Protection status of the WRCF in the top 15 countries

About 9.5% of the remaining closed forest in the top 15 countries are under the protection status, the highest being in Venezuela (62.9%) and the lowest in Russia (2%) (Table 5, Figure 11).

5.3 Population Distribution Associated With the WRCF

More than half of the world's human population, 2.99 billion out of estimated 5.37 billion (1990), is concentrated in these 15 countries with China

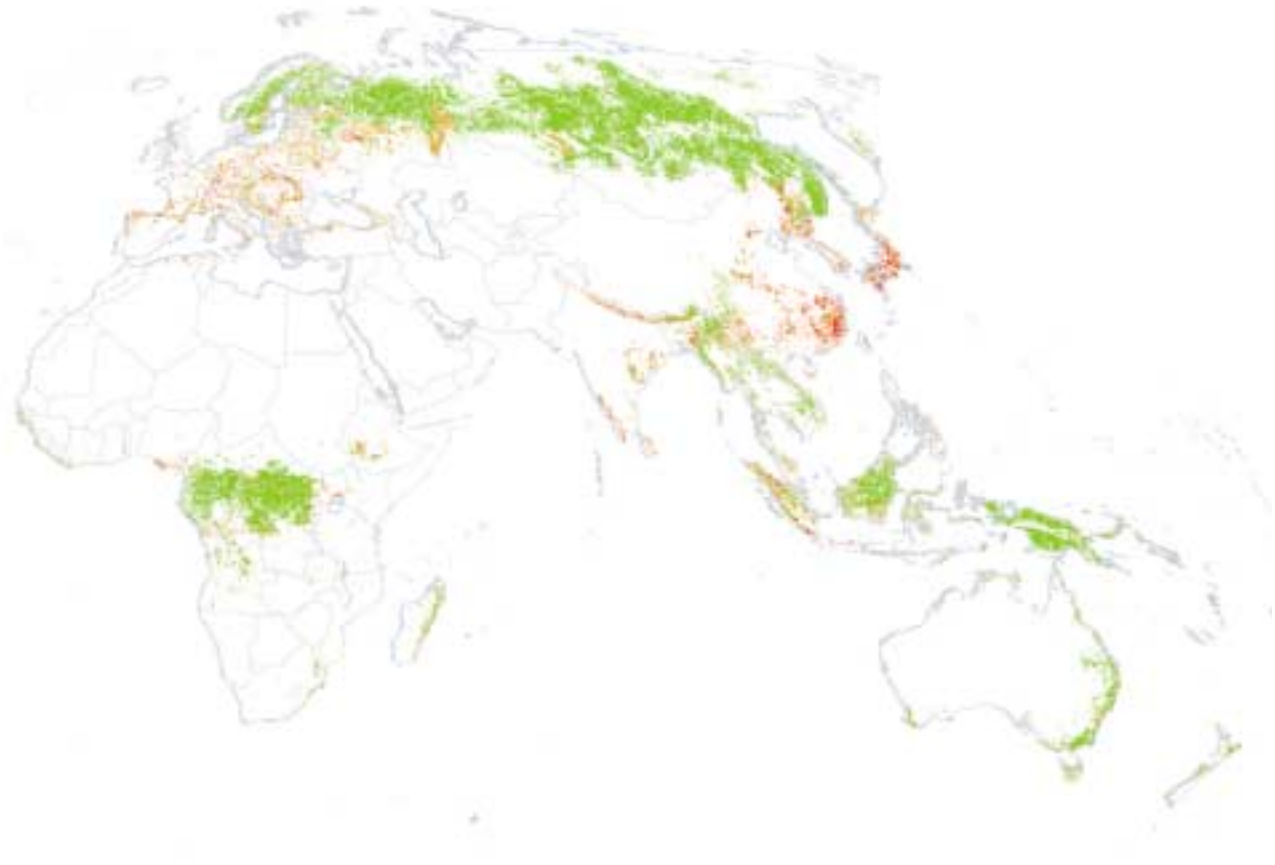


Table 5: Protection status of the WRCF in the top 15 countries (Area: 1000 ha)

Countries	Total Land Area	Total Protected Area	% of Protected Land Area	Area under Closed Forests	Protected Closed Forests	% of Protected Closed Forests
Russia	1,681,414.4	38,236.2	2.3	669,651.8	13,071.2	2.0
Canada	983,400.2	78,207.6	8.0	368,650.9	27,366.3	7.4
Brazil	850,063.3	79,628.0	9.4	361,597.2	61,390.7	17.0
United States	940,626.9	67,622.0	7.2	236,683.3	15,804.4	6.7
Dem. Rep. of Congo(Zaire)	233,814.5	18,060.9	7.7	116,204.2	9,707.9	8.4
China	940,234.9	49,832.4	5.3	111,578.9	4,016.8	3.6
Indonesia	188,748.2	29,156.5	15.4	92,753.4	18,598.2	20.1
Mexico	195,378.4	4,653.5	2.4	60,107.7	1,605.3	2.7
Peru	129,554.8	9,120.0	7.0	59,312.2	5,187.7	8.7
Colombia	114,115.9	19,973.9	17.5	51,931.9	13,005.1	25.0
Bolivia	108,868.2	21,347.0	19.6	41,942.9	12,329.9	29.4
Venezuela	91,408.4	38,704.0	42.3	40,709.0	25,604.1	62.9
India	315,440.8	14,277.3	4.5	37,952.2	4,101.5	10.8
Australia*	768,639.9	33,179.3	4.3	35,548.5	4,560.0	12.8
Papua N. Guinea	45,929.1	4,931.5	10.7	32,422.3	3,020.5	9.3
TOTAL	**7,587,637.9**	**508,371.7**	**6.7**	**2,317,046.4**	**220,119.4**	**9.5**

* Protected coral reefs in Australia are not included.

and India having the lion's share of over 2 billion people. In these top 15 countries, Australia has the lowest population density, 2 people per sq.km, whereas India has the highest population density, 270 people per sq. km (Figure 12, previous page).

5.3.1 Continental Distribution of Population Density Associated With the WRCF

Estimated 83.6% of the WRCF have low/none population density, 11.3% medium population density and the remaining 5.1% under the high population density (Table 6, Figure 13, 14).

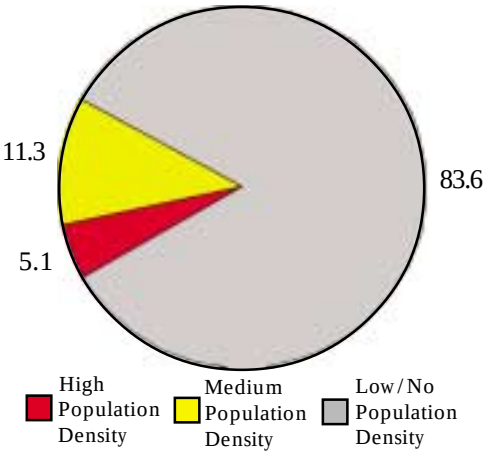


Figure 13: Percent distribution of population density in the world's remaining closed forests.

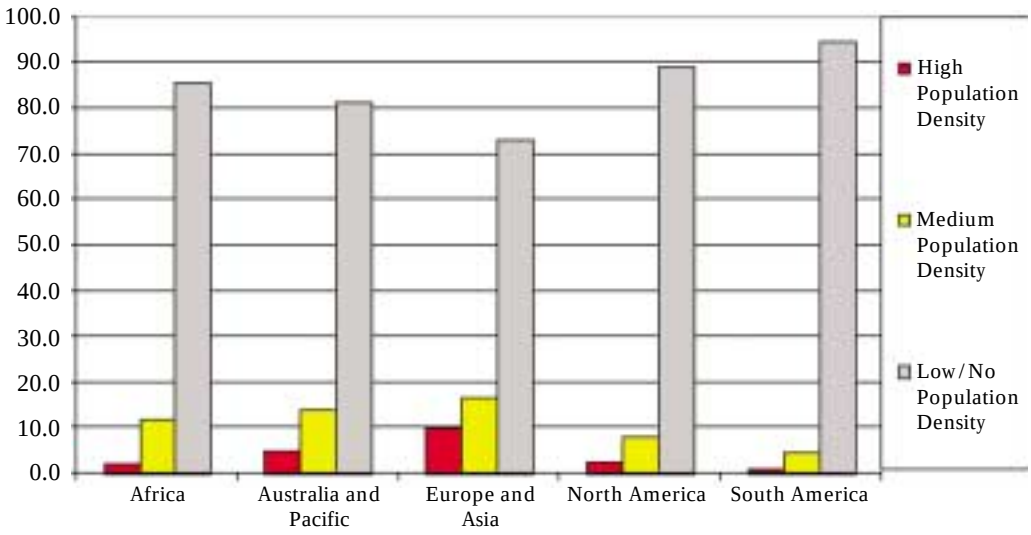


Figure 14: Population density distribution associated with the world's remaining closed forests by continent.

Table 6: Distribution of population density associated with the WRCF (Area: 1000 ha)

Continents	Total Area of Closed Forest	CF with High Population Density		CF with Medium Population Density		CF with Low Population Density	
		Area	%	Area	%	Area	%
Africa	276,818.1	6,221.9	2.2	33,493.6	12.1	237,102.6	85.7
Australia and Pacific	187,909.3	8,856.9	4.7	26,151.0	13.9	152,901.4	81.4
Europe and Asia	107,048.0	107,289.1	10.0	178,434.7	16.7	784,760.2	73.3
North and Central America	696,110.9	18,854.9	2.7	56,940.2	8.2	620,315.8	89.1
South America	627,737.2	5,261.9	0.8	28,679.6	4.6	593,795.7	94.6
World	**2,859,059.5**	**146,484.7**	**5.1**	**323,699.1**	**11.3**	**2,388,875.7**	**83.6**

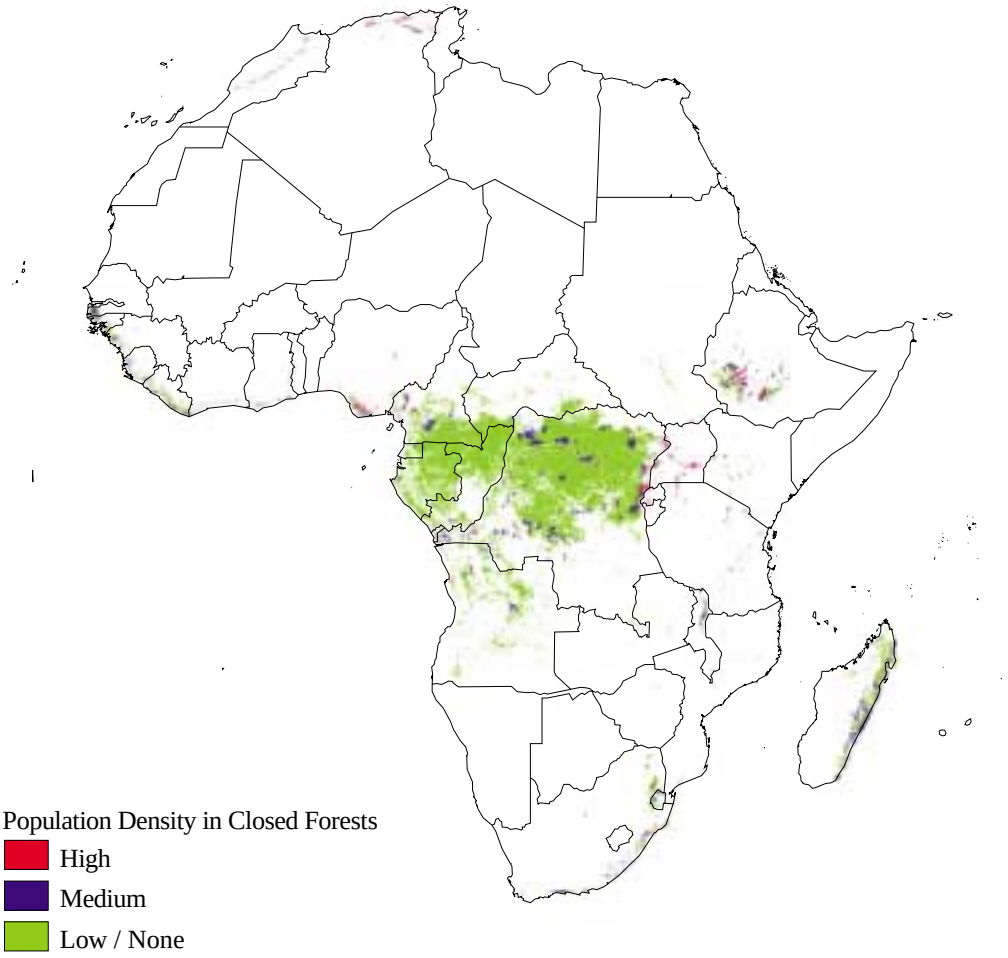


Figure 15: Distribution of population density associated with the world's remaining closed forests: Africa.

Africa: Shown in the map (Figure 15) is the correlation between the WRCF and population density. Areas in the white are non-forested. Areas shown in the red (high-density population), light blue (medium-density population), and yellow (low-density population) are forested. From this map, three broad areas of population pressure on forests can be seen: the west coast, particularly from Guinea east to Nigeria; the northern coast, including Morocco, Algeria, and Tunisia; and east Africa, predominantly in Ethiopia, Kenya, and Uganda. Land under the WRCF sustains approximately 10% of Africa's population. About 2.2% of the WRCF are occupied by high-population density, 12.1% by medium-population density, and 85.7% by low-population density. Higher population density translates into greater ecological degradation. Rapid population growth in forested areas will inevitably lead to increased deforestation.

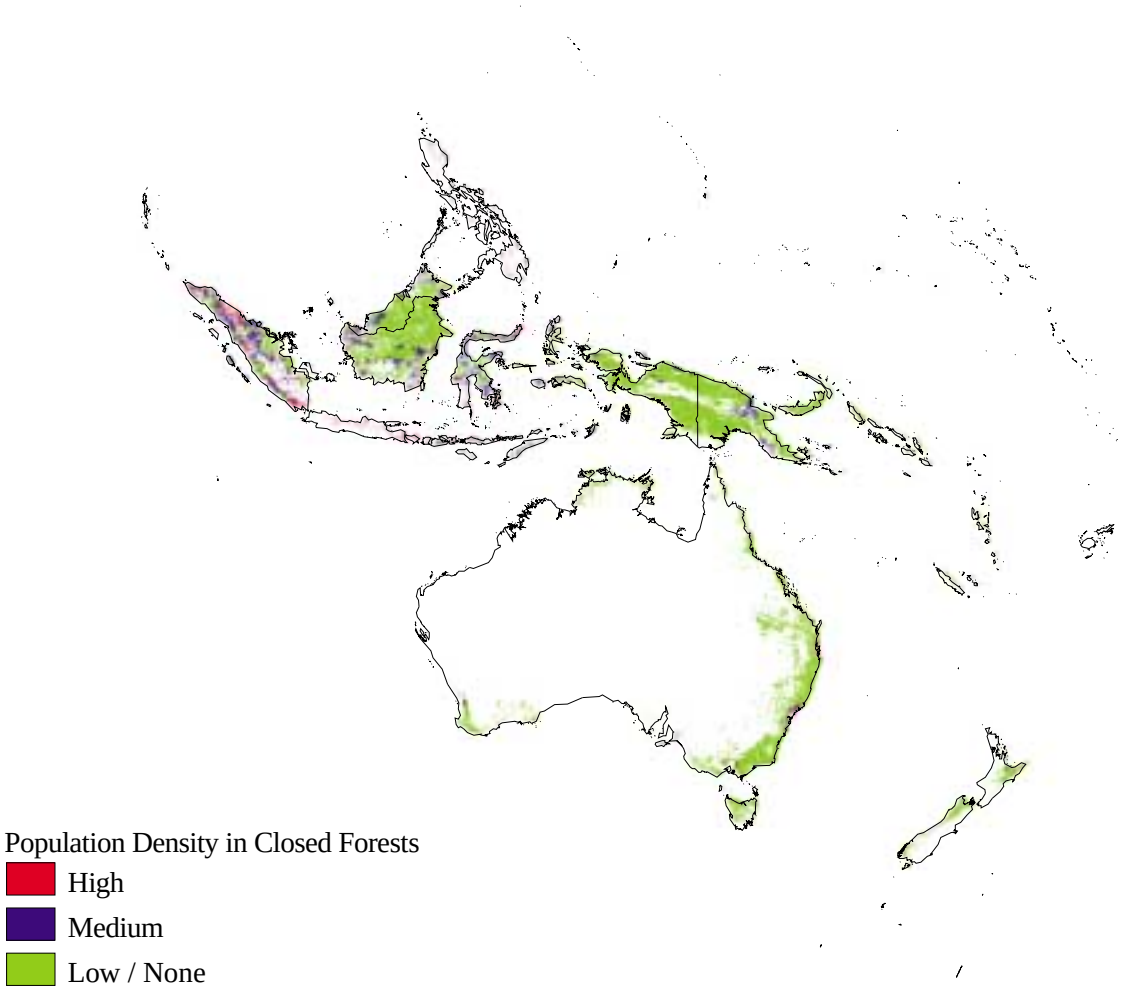


Figure 16: Distribution of population density associated with the world's remaining closed forests: Australia and Pacific.

Australia and Pacific: In Figure 16, four broad areas of population pressure on the WRCF can be seen: coastal areas in Australia, Papua New Guinea, Indonesia, Philippines and some of the small island countries. Land under the WRCF sustains approximately 15.5% of Australia and Pacific population. About 4.7% with high-population density, 13.9% with medium population density, and 81.4% with low population density.

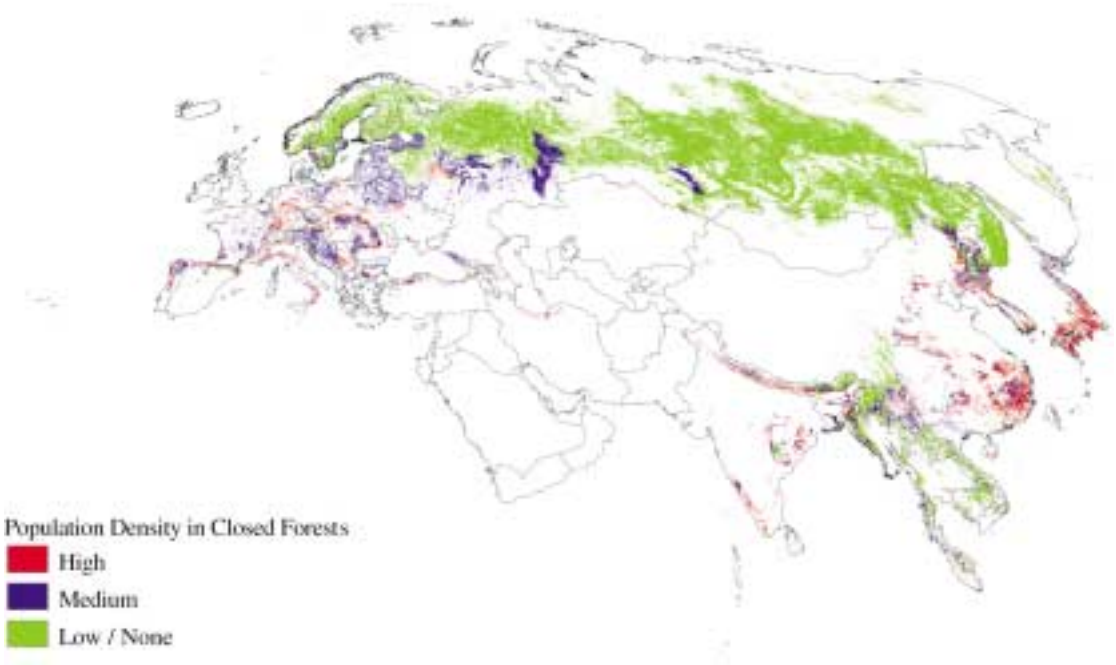


Figure 17: Distribution of population density associated with the world's remaining closed forests: Europe and Asia.

Europe and Asia: Figure 17 highlights broad areas of population pressure on forests: Eastern Asia, including China, Japan, South and North Korea; South-eastern Asia and South Asia, and western Russia and Europe. Land under the WRCF sustains approximately 11% of Europe and Asia's population. About 10% of the WRCF in this region are associated with high-population density, 16.7 % with medium-population density and 73.3% with low-population density. In East, Southeast and South Asia, population pressure in the WRCF is extremely high.

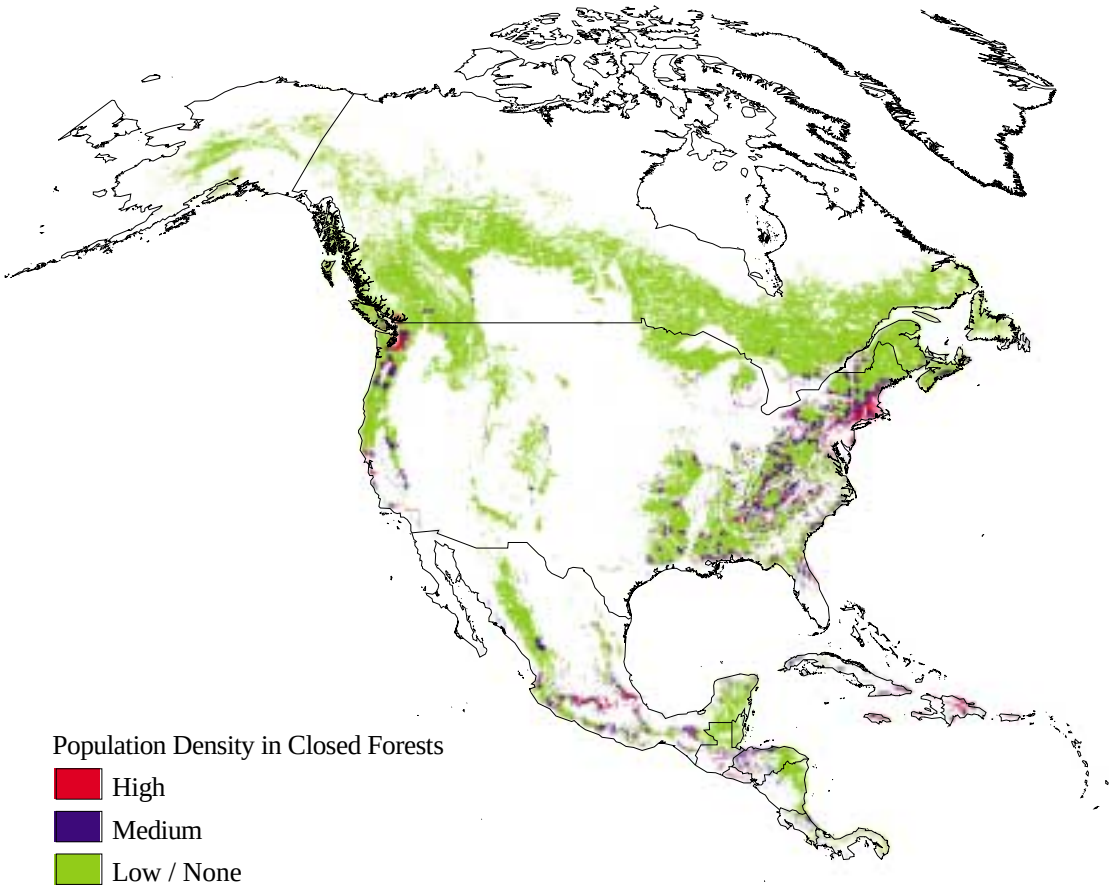


Figure 18: Distribution of population density associated with the world's remaining closed forests: North America.

North America and Central America: In this map (Figure 18), several broad areas of population pressure on forests can be seen: from British Colombia (Canada) to Washington state and California (USA), the eastern part of the USA and from southern Mexico to Central America. Boreal forests stretching from Newfoundland to Alaska have low population pressure. Land under the WRCF sustains approximately 24.3% of North America's population. About 2.7% of the WRCF is occupied by high-population density, 8.2% by medium-population density, and 89.1% by low-population density.

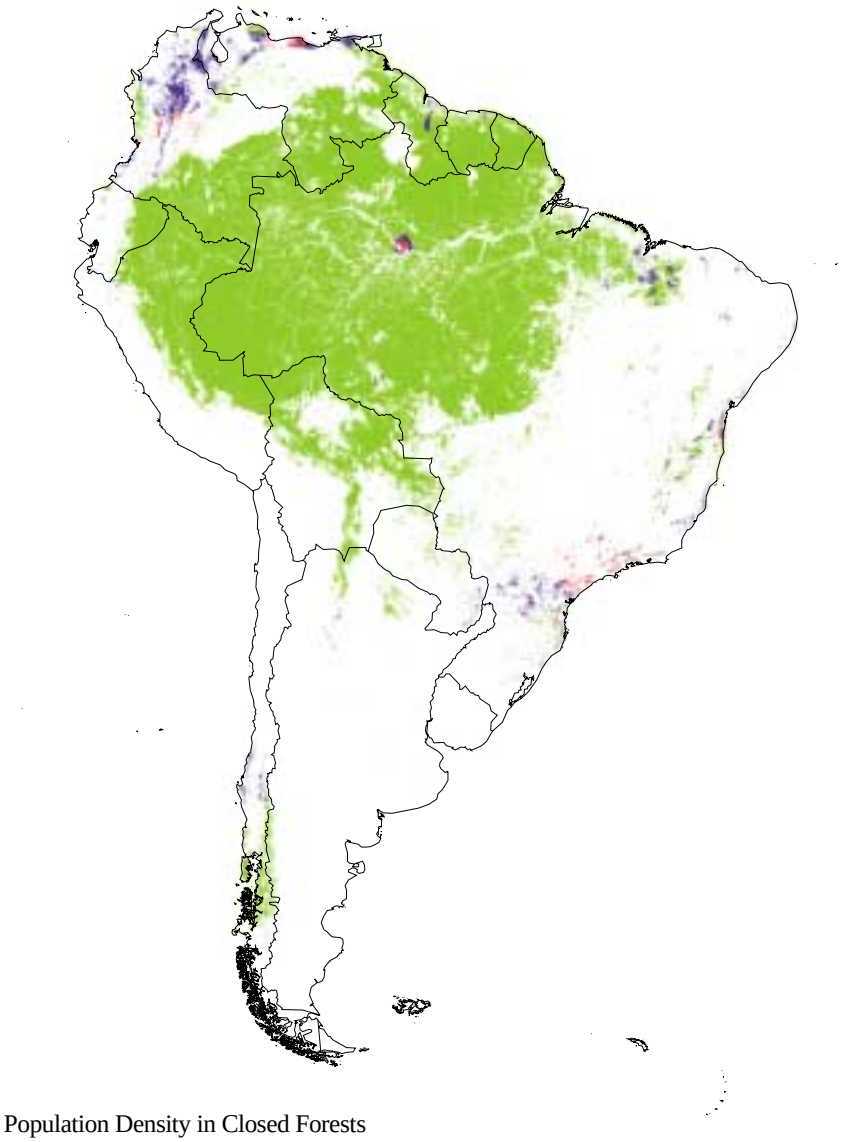
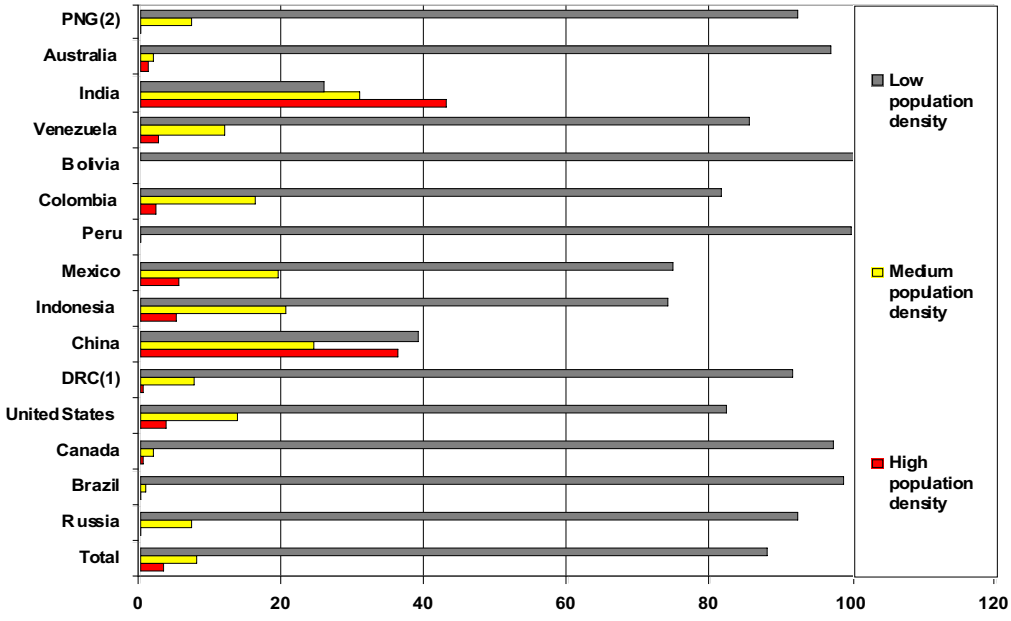


Figure 19: Distribution of population density associated with the world's remaining closed forests: South America.

South America: In this map (Figure 19), several broad areas of population pressure on closed forests can be seen: from northern Colombia and Venezuela to southeast Brazil. There is a spot of high population pressure around Manaus City, Brazil while the Amazon Basin, southern Colombia and Venezuela, Peru and Guyana Shied house low population pressure. Land under the WRCF sustains approximately 13% of South America's population. About 0.8% of the WRCF are occupied by high-population density, 4.6% by medium-population density, and 94.6% by low-population density. Population pressure in South America's closed forests is the lowest in the world, but logging remains a main threat.

5.3.2 Distribution of population density associated with the WRCF area in the top 15 countries

In the top 15 countries an estimated 88% of the WRCF have low/none population density, 9% medium population density and 3% high population density. Higher population pressure in closed forest areas can be seen in India and China, where the percentage of area under closed forests with high population density is 43% and 36%, respectively. Almost all closed forests areas in Peru and Bolivia are free from high population pressure (Table 7, Figure 20).



(1) Democratic Republic of the Congo (Zaire), (2) Papua New Guinea.

Figure 20: Top 15 countries population density distribution in the world's remaining closed forest (percent).

Table 7: Distribution of population density associated with the WRCF area in the top 15 countries (Area: 1000 ha)

Country	Area Under CF	High Population Density		Medium Population Density		Low Population Density	
		Area	% of CF	Area	% of CF	Area	% of CF
Russia	669,651.8	2,005.8	0.3	51,091.6	7.6	616,554.4	92.1
Canada	368,650.9	571.5	0.2	3,780.1	1.0	364,299.3	98.8
Brazil	361,597.2	1,934.7	0.5	7,426.3	2.1	352,236.2	97.4
United States	236,683.3	9,547.0	4.0	32,880.7	13.9	194,255.6	82.1
DRC[1]	116,204.2	587.5	0.5	9,211.5	7.9	106,405.0	91.6
China	111,578.9	40,503.1	36.3	27,560.0	24.7	43,515.8	39.0
Indonesia	92,753.4	4,987.2	5.4	18,881.2	20.4	68,884.9	74.3
Mexico	60,107.7	3,351.5	5.6	11,715.6	19.5	45,040.7	74.9
Peru	59,312.2	2.3	0.0	121.6	0.2	59,188.3	99.8
Colombia	51,931.9	1,244.7	2.4	8,468.3	16.3	42,218.9	81.3
Bolivia	41,942.9	0.0	0.0	0.00	0.0	41,942.9	100.0
Venezuela	40,709.0	1,105.4	2.7	4,836.8	11.9	34,766.8	85.4
India	37,952.2	16,353.4	43.1	11,755.2	31.0	9,843.6	25.9
Australia	35,548.5	416.4	1.2	746.5	2.1	34,385.6	96.7
PNG[2]	32,422.3	86.8	0.3	2,420.2	7.5	29,915.4	92.3
Total	**2,317,046.4**	**83413.7**	**3.6**	**189,997.8**	**8.2**	**2,043,634.9**	**88.2**

* CF: Closed Forest [1] Democratic Republic of the Congo (Zaire) [2] Papua New Guinea

6. Discussion and Conclusions

The extent and distribution of area under global forests continues to be examined by different organizations and scientists using many different methods. This assessment of the WRCF is the latest study using wall to wall coverage of low resolution satellite data. The FAO figures seem to underestimate the extent of the global forests when compared to others assessments. The largest discrepancies are found in North America such as Canada and the United States. Although derived using totally different methodologies, official published forest area data from Canada and the United States show a good agreement with WRCF (see Table 1). The results are very comparable to those given for India (FSI, 1997) which are derived from the Indian Remote Sensing Satellite (IRS-IB) high resolution data using a similar classification system.

FAO Image, L. DeMatteis

India (FSI, 1997)		***Current Estimate***
Percent of area under forest cover	Percent of area under closed forest (density > 40%)	Percent of area under closed forest (density > 40%)
19.12	11.17	12.03

A comparison of the results of this study and WRI, 1997 for selected countries are given in the table 8. It may be cautioned here that the results are not very comparable due to different definitions of forests and methodologies used in these studies. It is interesting to note that three countries - Russia, Canada, and Brazil - house almost 70% of the world's remaining frontier forests, whereas these three countries accounts for only 49% of the world's remaining closed forests.

Although the forest cover and population data sets used in this study were the most comprehensive and consistent data sets available for the entire earth surface, considerable regional errors are known to exist in the mapped distribution of forestlands due to coarse resolution of data. None of these data sets have been rigorously validated, so local relationships and distributions should be viewed with caution. Despite of significant limitations of global data sets, the general conclusions drawn here are expected to be closer to the ground realities.

It must be emphasized here that many of the WRCF areas, in combination of low population densities, offer a unique opportunity for conservation if appropriate steps are taken now by the national governments and international community. This opportunity must be founded upon the increased public and government awareness that forests have a vast importance to the welfare of human and ecosystem services, such as biodiversity, watershed protection and carbon balance. Paramount to this opportunity is the increased scientific understanding of forest dynamics and the technical capacity to install global observation and assessment systems,

Table 8: A comparison of the WRCF* and FF (WRI) for selected countries (in million ha)**

Countries	WRCF			FF (WRI)		
	Area Under WRCF	% of total WRCF	Cumulative % of total WRCF	Area Under FF	% of World's FF	Cumulative % of World's FF
Russia	669,651.8	23.31	23.31	344,800	26	26
Canada	368,650.9	12.83	36.15	342,900	25	51
Brazil	361,597.2	12.59	48.74	228,400	17	68
United States	236,683.3	8.24	56.98	30,700	2	70
Democratic Republic of the Congo (Zaire)	116,204.2	4.05	61.02	29,200	2	72
China	111,578.9	3.85	64.87	No Data		
Indonesia	92,753.4	3.23	68.10	53,000	4	76
Mexico	60,107.7	2.09	70.19	No Data		
Peru	59,312.2	2.06	72.26	54,000	4	80
Colombia	51,931.9	1.81	74.07	34,800	3	83
Bolivia	41,942.9	1.46	75.53	25,500	2	85
Venezuela	40,709.0	1.42	76.94	39,100	3	88
India	37,952.2	1.32	78.27	No Data		
Australia	35,548.5	1.24	79.50	No Data		
Papua New Guinea	32,422.3	1.13	80.63	17200	1	89
Total	2,317,046.4	80.63				
World	**2,872,363.8**	**100.00**			**100**	**100**

**WRCF: World's Remaining Closed Forests ** FF Frontier Forest*

based on high resolution satellite data such as Landsat 7 and other satellite operations. These provide unprecedented monitoring options for governing authorities. Technological innovation can contribute to the way forests are protected. The use of satellite imagery for regular monitoring and the internet for information dissemination provides an effective tool for raising worldwide awareness about the significance of forests and intrinsic value of the nature.

7. Summary For Policy Makers

Forests will be protected when the people conclude that forest conservation is more beneficial (e.g. generates higher incomes or has ecological or social values) than their clearance. If not, forests will continue to be cleared and degraded. Generally speaking, the WRCF have survived because (a) they are economically not worth exploiting as they lack sufficient quality of commercially valuable species; (b) they are located in remote or inaccessible areas, or (c) they have been protected as national parks and sanctuaries.

In many cases concerned governments have zealously protected forests from further exploitation. For example, one of the basic objectives of the Indian National Forest Policy, 1988, 7th Dec., 1988, Ministry of Environment and Forests, Government of India, New Delhi, is

> "*Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country*".

As a result, in India, conservation policies that emphasize protecting forests and wildlife from human exploitation have succeeded even when there is an acute human population pressure and widespread poverty.

The WRCF may continue to exist to the end of the 21st century, depending more than anything else, on government policies (Terborgh, 1999). Direct focused actions, such as strong protection measures and raising public concern for the value of nature, and by indirect actions, such as reducing pressure on forest lands by alternatives to forest exploitation, may help conserve much of the WRCF. The low population densities in and around the majority of the WRCF areas offer an excellent opportunity for conservation, if appropriate steps are taken now by the national governments and the international community. The cornerstone of future policies for the protection of WRCF should be based on:

- Protection;
- Education, and;
- Alternatives to forest exploitation.

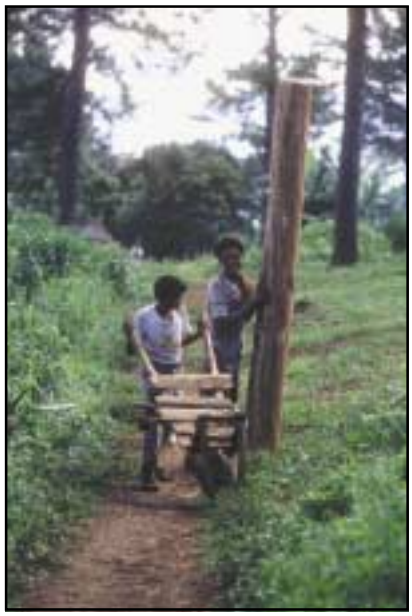
7.1 Protection

The current strategy of integrating conservation and economic development has often been unsuccessful in conserving forests and wildlife. When put into practice, these policies tend to have effects opposite to those articulated by their proponents. After a rigorous analysis of experiences gained in West Africa, Oates (1999) concluded that forest and wildlife conservation has now become captive to myriad international groups and consequently has lost its focus on the real issue of conserving nature. Rather, conservation has come to be considered as a utilitarian process involving the management of natural resources as a part of sustainable development. This is leading to further depletion of forests and

wildlife in many parts of the world. Hence there is an urgent need for a fresh look at the policies and strategies for the protection of the WRCF.

The basic principle should be "that nature is worthy of protection for its intrinsic value and for aesthetic pleasure it can bring to many people. The continued existence of wild animals, plants and places can provide many satisfactions to present and future human generations in all countries. A major role of national government is to orchestrate policies that are in the best long term interest of the nation's people as a whole" (Oates, 1999). The following protection measures are envisaged:

- National governments should strengthen activities that improve the effectiveness of forest conservation systems and protect remaining closed forest areas. These activities should include anti-smuggling and anti-poaching patrols, better communication systems in national parks and forest reserves, staff training, incentives and strengthening the enforcement of laws.
- In a majority of forested areas, the best management for such forests is no management except for forest fire prevention measures and pest and diseases control. If forest management activities are needed, they should be confined to buffer zones, which are at best already degraded, to meet the subsistence needs of the local communities.
- Conversion of forestlands for other purposes should be done only after exhausting all other alternatives. There is a need to strengthen the planning processes so that objective analysis of land-use allocations can be established and strictly enforced.



FAO Image, G. Bizzari

- Further development activities such as construction of roads and dams in such areas should be subject to rigorous scrutiny. In this regard a memorandum by former President of the United States, William J. Clinton, on **"Protection of Forest "Roadless" areas**" is an excellent initiative (a copy of which is reproduced in Appendix 3). Similar analysis for road and other developmental activities in the forested regions need to be conducted and implemented by governments.
- New protected forest areas should be established in areas that are representative of closed forest ecosystems and critical to the protection and maintaining environmental services. Efforts should also be made to link protected forest areas with corridors and buffer zones to form networks that will increase the protection function / capacity of protected areas.
- Wealthy countries should find ways of encouraging developing

countries to protect their remaining natural heritage. Investments needed for protection of such areas are likely to be rather modest. They should provide developing countries tools and resources to strengthen their economies by protecting, not destroying, their irreplaceable forests. Also mechanisms such as, **Debt-for-Nature Swaps**, to save threatened forests while relieving developing country debt, should be vigorously implemented by focusing on targeted countries and areas (The White House, February 4, 2000). Even in rich countries like the United States, environmental groups are offering cash incentives for conservation, and similar efforts could be expanded to the developing world (USA TODAY, Feb 4, 2000).

7.2 Education

Public sentiments and new government policies are needed to increase commitments to protecting forests. It is critical to educate decision-makers about the vital importance of forests, as many of them remain blissfully ignorant. Awareness building activities should be carried out to promote the understanding of the full values and benefits from forest ecosystems:

- It is not difficult to inspire in more people a strong desire to protect wildlife and feeling that the world would be a poorer place if wild birds and animals disappeared. The middle class individuals in the developed and developing countries want to use whatever influence they have to protect the habitat of wild creatures for their enjoyment of nature and for their children's storybooks (McRare, Hamish, 1994**).**
- Economists are now arguing that we are on the threshold of the Experience Economy, a new economy era in which goods and services are no longer enough. Experiences are the basis for future economic growth (Pine and Gilmore, 1999). Nature can engage people in an inherently personal way, and create memorable experiences for people. The key is to educate people that we are on the verge of loosing their natural heritage. In the words of the late Indian Prime Minister Nehru, to quote "Life would become very dull and colorless if we did not have these magnificent animals and birds to look at and to play with. We should, therefore, encourage as many sanctuaries as possible for the preservation of what yet remains of our wildlife. Our forests are essential from many points of view. Let us preserve them. As it is, we have destroyed them far too much." (Gee, 1964).
- Technological innovation can change the way forests are managed and protected; it provides us with the tools we

need to get reliable and up-to-date information about forests. The use of satellite imagery for regular monitoring of the WRCF and the internet for information dissemination provides an effective tool for raising awareness worldwide about the intrinsic value of the nature. Accurate information in a real time mode will catalyze actions by governments, scientists and conservationists for maximizing forest protection investments and safeguarding these unique and valuable ecosystems for future generations. The key is to harness the potential of information technology tools to inform decision-makers and the public, thereby enabling them to take necessary actions.

- Considering the critical position and importance of the top 15 countries rich in closed forests on the fate of the world's forests, the international community, in cooperation with these 15 national governments, should develop a comprehensive forest strategy for conservation and management of the remaining closed forests.

7.3 Alternatives To Forest Exploitation

Appropriate policies and actions are required to meet the growing demand of people for forest products, for which, followings might be considered:

- With increased agriculture productivity, less land is needed for food production hence it is vital to reduce pressure on forest lands for agriculture through improved productivity in farming (WCFSD, 1999).
- Afforestation and reforestation programs on vacant and degraded land must be undertaken to meet basic needs for production purposes or direct conservation.
- Improved forest planning and silviculture systems to increase productivity of already exploited and disturbed forestlands must be adopted.
- Use of wood substitutes wherever feasible in order to reduce demand should be encouraged.
- All countries in cooperation with the private sector should provide improved technologies for manufacturing forest products by recycling and reducing waste, *inter alia* reducing consumption of wood.
- Within a national and international framework for the protection of the WRCF, timber exporting developed countries, in cooperation with private sector, should provide necessary timber - "timber for forests"- to importing countries, at highly subsidized prices to meet their demand for wood products.
- Methods for valuing benefits of forest ecosystem goods and services should be developed, using a holistic approach that integrates both market and non-market values of forest ecosystems.

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Distribution of the World's Remaining Closed Forests

Area: 1000 hectares

Africa

Country Name	Population 1990	Total Land Area	Closed Forests	% of CF To Total Area
Algeria	24,935,000	231,937.1	177.0	0.1
Angola	9,229,000	125,066.6	17,776.0	14.2
Benin	4,684,000	11,601.0	1,658.6	14.3
Botswana	1,272,000	57,966.9	34.6	0.1
Burkina Faso	9,082,000	27,441.9	734.2	2.7
Burundi	5,487,000	2,708.6	0.5	0.0
Cameroon	11,484,000	46,798.4	16,169.6	34.6
Cape Verde	341,000	403.5	0.0	0.0
Central African Republic	2,929,000	62,285.4	9,774.3	15.7
Chad	5,552,000	127,442.1	78.6	0.1
Comoros	523,000	153.6	42.8	27.9
Cote d'Ivoire (Ivory Coast)	11,682,000	32,231.6	9,054.7	28.1
Democratic Republic of the Congo (Zaire)	37,405,000	233,814.5	116,204.2	49.7
Djibouti	517,000	2,160.5	0.0	0.0
Egypt	56,312,000	98,238.7	0.0	0.0
Equatorial Guinea	352,000	2,677.1	1,791.2	66.9
Eritrea	2,881,000	12,066.7	2.0	0.0
Ethiopia	48,140,000	1,132,22.9	2,826.7	2.5
Gabon	935,000	264,68.1	19,673.8	74.3
Gambia, The	921,000	10,65.6	59.6	5.6
Ghana	15,018,000	239,69.7	3,673.9	15.3
Guinea	5,755,000	245,33.3	5,801.1	23.7
Guinea-Bissau	964,000	33,44.3	1,393.6	41.7
Kenya	23,475,000	5,8805	984.0	1.7
Lesotho	1,783,000	3,049.8	2.1	0.1
Liberia	2,575,000	9,621.5	6,017.9	62.6
Libya	4,545,000	161,801.6	0.0	0.0
Madagascar	12,642,000	59,247.4	8,388.8	14.2
Malawi	9,329,000	11,853.5	388.4	3.3
Maldives	216,000	29.8	no data	no data
Mali	9,212,000	125,569.8	1,915.5	1.5
Mauritania	2,003,000	104,258.8	1.9	0.0
Mauritius	1,057,000	186.5	0.0	0.0
Mayotte	89,983	31.8	9.9	31.1
Morocco	24,043,000	40,434.9	178.1	0.4
Mozambique	14,182,000	78,810.5	5,377.5	6.8
Namibia	1,352,000	82,529.5	15.6	0.0
Niger	7,731,000	118,760.0	0.4	0.0
Nigeria	96,154,000	91,207.1	8,470.9	9.3
Republic of the Congo	2,232,000	34,300.8	20,341.3	59.3
Reunion	604,000	246.7	no data	no data

Rwanda	6,954,000	2,531.8	2.0	0.1
Sao Tome and Principe	119,000	91.2	0.0	0.0
Senegal	7,327,000	19,674.0	1,256.6	6.4
Seychelles	71,494	22.7	no data	no data
Sierra Leone	3,997,000	7,224.4	2,455.4	34.0
Somalia	8,623,000	63,489.7	47.7	0.1
South Africa	37,066,000	122,160.0	1,723.2	1.4
Sudan	24,061,000	250,879.8	615.2	0.3
Swaziland	744,000	1,730.5	86.9	5.0
Tanzania	25,483,000	94,522.3	4,047.8	4.3
Togo	3,524,000	5,726.0	835.1	14.6
Tunisia	8,162,000	15,341.3	48.8	0.3
Uganda	16,649,000	24,235.3	153.7	0.6
Western Sahara	160,000	26,601.7	0.0	0.0
Zambia	7,224,000	75,411.4	6,443.5	8.5
Zimbabwe	9,855,000	39,183.6	465.4	1.2
Total	**629,644,477**	**2,997,168.8**	**277,200.6**	**9.3**

Australia and Pacific

Country Name	Population 1990	Total Land Area	Closed Forests	% of CF To Total Area
Australia	16,888,000	768,639.9	35,548.5	4.6
Brunei	257,000	587.8	476.9	81.1
Guam	145,935	51.1	0.0	0.0
Indonesia	182,812,000	188,748.2	92,753.4	49.1
New Caledonia	168,000	1,794.3	373.1	20.8
New Zealand	3,360,000	26,354.2	7,302.9	27.7
Papua New Guinea	3,839,000	45,929.1	32,422.3	70.6
Philippines	60,779,000	28,,875.2	7,065.8	24.5
Solomon Islands	320,000	2,599.6	2,568.7	98.8
Vanuatu	149,000	1,138.3	371.3	32.6
Total	**268,568,935**	**1,064,717.7**	**178,882.9**	**16.8**

Europe and Asia

Country Name	Population 1990	Total Land Area	Closed Forests	% of CF To Total Area
Afghanistan	14,754,000	64,160.6	112.7	0.2
Albania	3,289,000	2,857.8	276.3	9.7
Andorra	61,962	47.6	14.3	30.0
Armenia	3,545,000	2,967.0	239.6	8.1
Austria	7,705,000	8,374.9	3,503.3	41.8
Azerbaijan	7,159,000	8,621.8	448.0	5.2
Bahrain	490,000	55.4	0.0	0.0
Bangladesh	109,765,000	13,564.2	1,110.1	8.2
Belarus	10,260,000	20,685.7	7161	34.6
Belgium	9,951,000	3,054.7	408.3	13.4
Bhutan	1,645,000	3,976.1	2,870.2	72.2
Bosnia and Herzegovina	4,308,000	5,063.2	2,189.4	43.2

Bulgaria	8,718,000	11,085.4	2,376.8	21.4
Cambodia	8,695,000	18,181.4	6,709.9	36.9
China	1,176,396,663	940,234.9	111,578.9	11.8
Croatia	4,517,000	5,524.3	1,375.0	24.9
Cyprus	681,000	899.1	3.4	0.4
Czech Republic	10,306,000	7,860.9	1,869.4	23.8
Denmark	5,140,000	4,213.8	207.3	4.9
Estonia	1,571,000	4,462.7	1,743.9	39.1
Finland	4,986,000	33,223.1	18,776.0	56.5
France	56,718,000	54,508.5	9,075.4	16.7
Georgia	5,460,000	6,968.3	2,492.2	35.8
Germany	79,365,000	35,491.1	6,831.2	19.3
Greece	10,220,000	12,870.6	1,840.2	14.3
Hungary	10,365,000	9,284.4	852.5	9.2
Iceland	255,000	9,940.6	56.3	0.6
India	850,793,000	315,440.8	37,952.2	12.0
Iran	59,219,000	162,155.6	1,470.9	0.9
Iraq	18,078,000	43,870.8	1.1	0.0
Ireland	3,503,000	6,780.4	240.3	3.5
Israel	4,660,000	2,822.3	1.0	0.0
Italy	57,023,000	29,834.1	5,157.4	17.3
Japan	123537,000	36,723.3	20,328.7	55.4
Jordan	4,259,000	8,921.7	0.0	0.0
Kazakhstan	16,742,000	268,736.5	1,670.3	0.6
Korea, North	20,363,000	12,144.5	4,761.7	39.2
Korea, South	42,869,000	9,685.7	2,532.8	26.2
Kuwait	2,143,000	1,706.2	0.0	0.0
Kyrgyzstan	4,395,000	19,896.8	109.9	0.6
Laos	4,202,000	23064.4	11,903.2	51.6
Latvia	2,684,000	6,417.7	2,301.8	35.9
Lebanon	2,555,000	1,032.5	0.0	0.0
Liechtenstein	29,894	15.4	3.0	19.5
Lithuania	3,737,000	6,455.6	1,643.9	25.5
Luxembourg	381,000	260.4	31.8	12.2
Macedonia, The Former Yugoslav Republic of	2,046,000	2,546.5	524.8	20.6
Malaysia	17,891,000	32,794.9	16,077.2	49.0
Malta	354,000	27.2	0.0	0.0
Moldova	4,364,000	3,378.5	140.9	4.2
Mongolia	2,216,000	156,203.4	10,077.6	6.5
Montenegro (with Serbia)	708,248	1,396.4	364.9	26.1
Myanmar (Burma)	41,354,000	66,712.6	26,817.7	40.2
Nepal	18,772,000	14,141.5	5,006.1	35.4

Netherlands	14,952,000	3,455.5	135.7	3.9
Netherlands Antilles	184,990	80.0	0.0	0.0
Norway	4,241,000	35,614.2	10,461.7	29.4
Oman	1,785,000	31,219.3	0.0	0.0
Pakistan	119,141,000	87,679.9	604.5	0.7
Poland	38,119,000	31,047.2	6,807.7	21.9
Portugal	9,869,000	8,926.3	923.1	10.3
Qatar	485,000	1,099.8	0.0	0.0
Romania	23,207,000	23,737.9	5,425.0	22.9
Russia	148,292,000	1,681,414.4	669,651.8	39.8
Saudi Arabia	16,048,000	195,262.6	1.3	0.0
Serbia (with Montenego)	10,393,585	8,839.8	1,597.1	18.1
Singapore	3,016,000	54.8	0.0	0.0
Slovakia	5,256,000	4,887.4	1,966.7	40.2
Slovenia	1,918,000	2,063.3	876.0	42.5
Spain	39,272,000	50,296.5	5,467.4	10.9
Sri Lanka	17,057,000	6,516.3	1,379.7	21.2
Svalbard	3,209	1,396.5	0.0	0.0
Sweden	8,559,000	44,209.7	27,448.6	62.1
Switzerland	6,834,000	4,115.5	639.8	15.6
Syria	12,388,000	18,670.0	17.5	0.1
Tajikistan	5,303,000	14,196.2	0.7	0.0
Thailand	55,580,000	51,486.7	6,211.9	12.1
Turkey	56,098,000	77,977.3	4,806.0	6.2
Turkmenistan	3,668,000	48,898.6	0.7	0.0
Ukraine	51,891,000	59,827.4	6,559.7	11.0
United Arab Emirates	1,921,000	7,826.1	0.0	0.0
United Kingdom	57,561,000	23,737.9	1,497.1	6.3
Uzbekistan	20,515,000	42,449.5	1.2	0.0
Vietnam	66,689,000	32,617.4	8,707.4	26.7
Yemen	11,592,000	41,630.7	0.0	0.0
Total	**3,736,714,551**	**5,162,654.8**	**1,089,426.0**	**21.1**

North and Central America

Country Name	Population 1990	Total Land Area	Closed Forests	% of CF To Total Area
Anguilla	7006	6	0.3	5.00
Bahamas, The	255,000	890.5	191.3	21.5
Barbados	257,000	41.4	2.3	5.6
Belize	187,000	2,191.8	1,614.0	73.6
Canada	27,791,000	983,400.2	368,650.9	37.5
Costa Rica	3,035,000	5,108.0	2,309.0	45.2
Cuba	10,628,000	10,805.1	3,275.5	30.3
Dominica	86,547	74.7	62.8	84.1
Dominican Republic	7,110,000	4,794.5	2,105.7	43.9

El Salvador	5,031,000	2,057.5	848.3	41.2
Greenland	56,533	214,831.7	0.0	0.0
Grenada	93,830	29.5	25.7	87.1
Guadeloupe	422,114	157.1	73.0	46.5
Guatemala	9,197,000	10,936.1	6,360.9	58.2
Haiti	6,473,000	2,660.0	446.1	16.8
Honduras	4,879,000	11,289.8	6,607.3	58.5
Jamaica	2,366,000	1,086.7	572	52.6
Martinique	360,000	108.9	48.1	44.2
Mexico	83,226,000	195,378.4	60,107.7	30.8
Montserrat	12,661	9.4	5.1	54.3
Nicaragua	3,568,000	12,875.9	5,419.5	42.1
Panama	2,398,000	7,437.1	2,811.7	37.8
Puerto Rico	3,528,000	879.3	310.5	35.3
Saint Kitts and Nevis	407	25.1	7.1	28.3
Saint Lucia	144,337	58.8	36.3	61.7
Saint Pierre and Miquelon	6,652	18.3	6.1	33.3
Saint Vincent and the Grenadines	114,562	39.2	15.2	38.8
Trinidad and Tobago	1,236,000	51.3	0.0	0.0
Turks and Caicos Islands	13,137	297.9	37.1	12.5
United States	254,106,000	940,626.9	236,683.3	25.2
Total	**426,588,786**	**2,408,167.1**	**698,632.8**	**29.0**

South America

Country Name	Population 1990	Total Land Area	Closed Forests	% of CF To Total Area
Argentina	32,527,000	277,679.3	10,027.2	3.6
Bolivia	6,573,000	108,868.2	41,942.9	38.5
Brazil	148,002,000	850,063.3	361,597.2	42.5
Chile	13,099,000	73,076.3	8,435.1	11.5
Colombia	32,596,000	114,115.9	51,931.9	45.5
Ecuador	10,264,000	24,855.7	12,721.3	51.2
French Guinea	117,000	8,320.5	8,092.8	97.3
Guyana	795,000	21,059.3	17,393.9	82.6
Paraguay	4,219,000	40,033.7	2,814.1	7.0
Peru	21,569,000	129,554.8	59,312.2	45.8
Suriname	400,000	14,622.9	13,240.3	90.5
Uruguay	3,094,000	17,801.2	3.6	0.0
Venezuela	19,502,000	91,408.4	40,709.0	44.5
Total	**294,963,000**	**1,772,654.3**	**628,221.5**	**35.4**
World	**5,356,479,749**	**13,405,362.7**	**2,872,364.0**	**21.4**

Appendix 2

Countries Having More Than 30% of Area Under WRCF to Total Land Area

Area: 1000 hectares

Africa

Country Name	Population	Total Land Area	Area Under Closed Forest	% to Closed Forest To Total Area	Population Density (people/1000 ha)
Cameroon	11,484,000	46,798.4	16,169.6	34.6	245
Democratic Republic of the Congo (Zaire)	37,405,000	233,814.5	116,204.2	49.7	160
Equatorial Guinea	352,000	2,677.1	1,791.2	66.9	131
Gabon	935,000	26,468.1	19,673.8	74.3	35
Guinea-Bissau	964,000	3,344.3	1,393.6	41.7	288
Liberia	2,575,000	9,621.5	6,017.9	62.5	268
Republic of the Congo	2,232,000	34,300.8	20,341.3	59.3	65
Sierra Leone	3,997,000	7,224.4	2,455.4	34.0	553

Australia and Pacific

Country Name	Population	Total Land Area	Area Under Closed Forest	% to Closed Forest To Total Area	Population Density (people/1000 ha)
Brunei	257,000	587.8	476.9	81.1	437
Indonesia	182,812,000	188,748.2	92,753.4	49.1	969
Papua New Guinea	3,839,000	45,929.1	32,422.3	70.6	84
Solomon Islands	320,000	2,599.6	2,568.7	98.8	123
Vanuatu	149,000	1,138.3	371.3	32.6	131

Europe and Asia

Country Name	Population	Total Land Area	Area Under Closed Forest	% to Closed Forest To Total Area	Population Density (people/1000 ha)
Austria	7,705,000	8,374.9	3,503.3	41.8	920
Belarus	10,260,000	20,685.7	7,161.0	34.6	496
Bhutan	1,645,000	3,976.1	2,870.2	72.2	414
Bosnia and Herzegovina	4,308,000	5,063.2	2,189.4	43.2	851
Cambodia	8,695,000	18,181.4	6,709.9	36.9	478
Estonia	1,571,000	4,462.7	1,743.9	39.1	352
Finland	4,986,000	33,223.1	18,776.0	56.5	150
Georgia	5,460,000	6,968.3	2,492.2	35.8	784
Japan	1,23,537,000	36,723.3	20,328.7	55.4	3,364
Korea, North	20,363,000	12,144.5	4,761.7	39.2	1,677
Laos	4,202,000	23,064.4	11,903.2	51.6	182
Latvia	2,684,000	6,417.7	2,301.8	35.9	418

Malaysia	17,891,000	32,794.9	16,077.2	49.0	546
Myanmar (Burma)	41,354,000	66,712.6	26,817.7	40.2	620
Russia	148,292,000	1,681,414.4	669,651.8	39.8	88
Nepal	18,772,000	14,141.5	5,006.1	35.4	1,327
Slovakia	5,256,000	4,887.4	1,966.7	40.2	1,075
Slovenia	1,918,000	2,063.3	876.0	42.5	930
Sweden	8,559,000	44,209.7	27,448.6	62.1	194

North and Central America

Country Name	Population	Total Land Area	Area Under Closed Forest	% to Closed Forest To Total Area	Population Density (people/1000 ha)
Belize	187,000	2,191.8	1,614.0	73.6	85
Canada	27,791,000	983,400.2	368,650.9	37.5	28
Costa Rica	3,035,000	5,108.0	2,309.0	45.2	594
Cuba	10,628,000	10,805.1	3,275.5	30.3	984
Dominican Republic	7,110,000	4,794.5	2,105.7	43.9	1,483
El Salvador	5,031,000	2,057.5	848.3	41.2	2,445
Guatemala	9,197,000	10,936.1	6,360.9	58.2	841
Honduras	4,879,000	11,289.8	6,607.3	58.5	432
Jamaica	2,366,000	1,086.7	572.0	52.6	2,177
Mexico	83,226,000	195,378.4	60,107.7	30.8	426
Nicaragua	3,568,000	12,875.9	5,419.5	42.1	277
Panama	2,398,000	7,437.1	2,811.7	37.8	322
Puerto Rico	3,528,000	879.3	310.5	35.3	4,012

South America

Country Name	Population	Total Land Area	Area Under Closed Forest	% to Closed Forest To Total Area	Population Density (people/1000 ha)
Bolivia	6,573,000	108,868.2	41,942.9	38.5	60
Brazil	148,002,000	850,063.3	361,597.2	42.5	174
Colombia	32,596,000	114,115.9	51,931.9	45.5	286
Ecuador	10,264,000	24,855.7	12,721.3	51.2	413
French Guinea	117,000	8,320.5	8,092.8	97.3	14
Guyana	795,000	21,059.3	17,393.9	82.6	38
Peru	21,569,000	129,554.8	59,312.2	45.8	166
Suriname	400,000	14,622.9	13,240.3	90.5	27
Venezuela	19,502,000	91,408.4	40,709.0	44.5	213

MEMORANDUM FOR THE SECRETARY OF AGRICULTURE

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release October 13, 1999

SUBJECT: Protection of Forest "Roadless" Areas

At the start of this century, President Theodore Roosevelt dedicated this Nation to the conservation of natural resources — our land, our water, our wildlife, and all the other precious gifts nature had bestowed upon us. One of America's great central tasks, he declared, is "leaving this land even a better land for our descendants than it is for us."

In pursuit of that goal, President Roosevelt established new protections for millions upon millions of acres across America. His remarkable legacy includes 5 national parks, 18 national monuments, and dozens of wildlife refuges. Among his most notable conservation achievements were the consolidation of 65 million acres of Federal forest reserves into the National Forest System, and the creation of the United States Forest Service to ensure wise stewardship of these lands for future generations. In this effort, he was guided by Gifford Pinchot, the first Chief of the Forest Service and a founder of America's conservation movement.

Today, the National Forest System has grown to 192 million acres of forests and grasslands in 46 States and territories. These lands provide a broad array of benefits to the American people. They support rural industries, sustain fish and wildlife, generate drinking water for 60 million Americans, and provide important recreation opportunities to an increasingly urban population.

Over the years, unfortunately, our Nation has not always honored President Roosevelt's vision. Too often, we have favored resource extraction over conservation, degrading our forests and the critical natural values they sustain. As the consequences of these actions have become more apparent, the American people have expressed growing concern and have called on us to restore balance to their forests.

My Administration has made significant strides in improving the management of our Federal forestlands. Beginning with the adoption of a comprehensive, science-based forest plan for the Pacific Northwest, we have sought to strengthen protections for wildlife, water quality, and other vital ecological values, while ensuring a steady, sustainable supply of timber and other commodities to support stable rural economies. The new forest planning regulation proposed last month represents another major step in that direction.

It is time now, I believe, to address our next challenge — the fate of those lands within the National Forest System that remain largely untouched by human interven-

tion. A principal defining characteristic of these lands is that they do not have, and in most cases never have had, roads across them. We know from earlier inventories that there are more than 40 million acres of "roadless" area within the National Forest System, generally in parcels of 5,000 acres or more. A temporary moratorium on road building in most of these areas has allowed us time to assess their ecological, economic, and social values and to evaluate long-term options for their management.

In weighing the future of these lands, we are presented with a unique historic opportunity. From the Appalachian Mountains to the Sierra Nevada, these are some of the last, best unprotected wildlands in America. They are vital havens for wildlife — indeed, some are absolutely critical to the survival of endangered species. They are a source of clean, fresh water for countless communities. They offer unparalleled opportunities for hikers, campers, hunters, anglers, and others to experience unspoiled nature. In short, these lands bestow upon us unique and irreplaceable benefits. They are a treasured inheritance enduring remnants of an untrammeled wilderness that once stretched from ocean to ocean.

Accordingly, I have determined that it is in the best interest of our Nation, and of future generations, to provide strong and lasting protection for these forests, and I am directing you to initiate administrative proceedings to that end.

Specifically, I direct the Forest Service to develop, and propose for public comment, regulations to provide appropriate long-term protection for most or all of these currently inventoried "roadless" areas, and to determine whether such protection is warranted for any smaller "roadless" areas not yet inventoried. The public, and all interested parties, should have the opportunity to review and comment on the proposed regulations. In the final regulations, the nature and degree of protections afforded should reflect the best available science and a careful consideration of the full range of ecological, economic, and social values inherent in these lands.

I commend you, along with the Undersecretary for Natural Resources and the Environment, Jim Lyons, the Chief of the Forest Service, Michael Dombeck, and the entire Forest Service for your leadership in strengthening and modernizing the management of our Federal forests — lands held by us in trust for all Americans and for future generations. With the new effort we launch today, we can feel confident that we have helped to fulfill and extend the conservation legacy of Theodore Roosevelt and Gifford Pinchot, and to ensure that the 21st century is indeed a new century for America's forests.

WILLIAM J. CLINTON

(Source: http://www.roadless.fs.fed.us)

An Assessment of the Status of the World's Remaining Closed Forests: Addendum/Errata*

Page 1: paragraph 2: Fifty-three should be Fifty-four

Page 3: right column: "FAO (1993) estimated total deforestation in the tropics during 1960-1990 to be 450 million ha; while the forest area in developed countries during 1979-2000 was" should be "FAO (1993) estimated annual deforestation in the tropics during 1980-1990 to be 15.4 million ha; while the forest area in developed countries was"

Page 6: in Definition box after first paragraph the following should be added:
See http://www.fao.org/forestry/fo/fra/index.jsp for the updated definition used in the Global Forest Resources Assessment 2000 (FRA 2000).

Page 14: right column, second paragraph: 53 countries should be 54

Page 38: 1) delete left column, third paragraph: FAO, 1999. *Challenges* …
2) change right column, third paragraph: "Forest Survey of India, 1987." should be "Forest Survey of India, 1997."

Page 43: delete Jan Mayen and Man, Isle of

Page 45: delete Falkland Islands (Isles Malvinas)

Page 47: add one line between Myanmar and Russia for Nepal:

Country	Population	Total Land Area	Area Under Closed Forests	% To Closed Forest To Total Area	Population Density (people/1000ha)
Nepal	18,772,000	14,141.5	5,006.1	35.4	1,327

Pictures: ground photographs courtesy of FAO

* These changes have been made in the current .pdf file.