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1999 Inventory of Nepal's Forest Resources

A new national forest inventory of Nepal was begun in 1990. The first area covered by the inventory was the plains of Nepal, the flat and narrow belt in the southern part of the country that borders on India. The inventory was extended to the hilly areas in 1994. Fieldwork was completed in 1998 and the results published in 1999. This is the first countrywide forest inventory since the 1960s. The results provide

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essential updated information for national forest policy makers, and realistic figures for forest and shrub areas as well as for growing stock categorized by tree species, which can be utilized by decision makers.

Designing the inventory methodology posed many challenges in Nepal owing to the great diversity of flora and topography. For example, more than 500 possible tree species were mentioned in the inventory field manual. These species grow at different altitudes between 100 and 4000 m above sea level. It was not possible to use a uniform inventory method. Instead, different methods were applied in different parts of the country, as briefly described in the following sections. The national forest inventory is thus a combination of many inventory reports.

Main definitions used

Inventory target area: Forest and shrub area of Nepal. Protected areas (National Parks, Conservation Areas, and Hunting and Wildlife Reserves) were excluded from growing stock measurements.

Forest: Area where trees with well-defined stems are growing and crown coverage is more than 10%. Area must not be used primarily for uses other than forestry (widely understood) and must be at least 100 m wide. Area can include treeless patches not wider than 25 m and not exceeding 1 hectare.

Shrub: Similar to "forest," but well-defined stems cannot be found.

Inaccessible forest: A forest area is inaccessible if it is located on a slope of more than 100% (45°) or if it is surrounded by steep slopes, landslides, or other physical obstacles.

Methods applied for the forest and shrub areas

Satellite image analysis: Satellite image analysis of Landsat Thematic Mapper (TM) data taken in November–December 1990 and 1991 was applied to the forest cover mapping of the 14 *Terai* districts. The total land area of these districts is 23,990 km^2. Normalized Difference Vegetation Index (NDVI) thresholding was applied to distinguish between forested and nonforested land. A distinction between forest and shrub is not possible in satellite image analysis, but according to other inventories in *Terai* country, the amount of shrub in *Terai* is very small or insignificant.

District Forest Inventory: Data on forest and shrub cover were determined for the 7 districts using a traditional method of aerial photo interpretation of photos and forest mapping with field checking. The total land area of the districts is 12,470 km^2. In a district inventory, homogenous sections were delineated in the aerial photos. This delineation was then further processed into maps. Aerial photos (scales 1:25,000 and 1:50,000) from the years 1989 to 1992 were used.

Churia Hills Forest Inventory: Three districts were covered by the Churia Hills Forest Inventory. The total land area of the districts is 4614 km^2. The aerial photos taken in 1992 were enlarged to the scale 1:20,000 and 1:25,000, and the forest and shrub areas were delineated on the photos. The boundaries were then digitized, and corresponding areas were calculated.

Hill Districts: All the other districts that were not covered by the assessments described hitherto were covered by photo point sampling. The area covers the remaining 51 districts, amounting altogether to 106,107 km^2. A grid of 7685 sampling points (4 × 4 km or 3.66 × 3.66 km) for photo interpretation was first drawn on the topographic maps. The points were then manually transferred onto the aerial photos. Location of the points was done with the help of easily recognizable ground features such as river bends and junctions, roads, etc. The photos were taken during the years 1992 or 1996. They were panchromatic black and white contact prints at a scale of about 1:50,000. The photos were inspected with a mirror stereoscope. At all points on the photos, land use was determined.

Methods applied for growing stock in accessible forest

Terai Inventory: The inventory method for the plain areas of 14 *Terai* districts was based on unsupervised classification of Landsat TM satellite imagery and field sample plots. The area of the sample plots varied according to tree diameter, ranging from about 80 m^2 for seedlings to 4800 m^2 for big trees. The sampling intensity was about 0.015%.

District Forest Inventory: Seven districts were assessed by the District Forest Inventory. The inventory method applied in district forest inventories was stratified random sampling using forest types, stand size, and stocking classes as stratification variables. The stratification was based on aerial photographs taken at a scale of 1:25,000 in 1989–1990.

Churia Hills Forest Inventory: The fieldwork for 3 districts was carried out in connection with the Churia Hills Forest Inventory. The inventory method applied was practically the same as in the Hilly Area Inventory (see following method), with some small modifications.

Hilly Area Inventory: The method based on photo point sampling was applied to the districts that had not been surveyed recently by one of the aforementioned inventories. The photo point sampling described previously (forest and shrub areas—Hill Districts) was the basis for the second phase of sampling. Altogether, 560 clusters in 156 camp units were measured in

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the field. The size of the sample plots varied according to the tree diameter, ranging from about 50 to 3600 m^2. The sampling intensity for accessible forests in the Hilly Area was 0.015% (the target was 0.01%).

Main results

Forest and shrub areas: In Nepal, forest covers about 4.27 million hectares (29%) and shrub covers 1.56 million hectares (10.6%) of a total land area of 14.72 million hectares. Altogether, 39.6% of the total land area is thus covered by forest and shrub. Comparison of these new results with the results of the previous land use study covering the whole country, the 1978–1979 Land Resource Mapping Project (LRMP), led to the following main conclusions about forest and shrub cover change:

1. In the *Terai* plains, the forest area decreased at an annual rate of 1.3% from 1978–1979 to 1990–1991.
2. In the Hilly Area, the forest area decreased at an annual rate of 2.3% from 1978–1979 to 1994, whereas forest and shrub together decreased at an annual rate of 0.2%.
3. In the whole country, from 1978–1979 to 1994, the forest area decreased at an annual rate of 1.7%, whereas forest and shrub together decreased at an annual rate of 0.5%.

Forest and shrub maps based on visual satellite image classification were produced. On the maps, forest and shrub classes are combined.

Growing stock in accessible forest: The accessible forest area in Nepal is 2.18 million hectares (about 52% of the total forest area). The following figures refer only to this surface of accessible forest:

1. About 55% of the total accessible forest area is at altitudes under 1000 m above sea level, about 35% at altitudes between 1000 and 2500 m, and about 10% at altitudes over 2500 m.
2. The total stem volume (over bark) for Nepal is 388 million cubic meters. The total stem volume to 10 cm top (under bark or "ub") is 285 million cubic meters and to 20 cm top (ub) is 240 million cubic meters. About 50% of the total volume is at altitudes under 1000 m, about 30% at altitudes between 1000 and 2500 m, and about 20% at altitudes over 2500 m.
3. The total biomass of stems, branches, and leaves is 429 million tons (air-dry).
4. The mean stem volume (over bark) for Nepal is 178 m^3/ha. The lowest mean volume is at altitudes between 1000 and 1500 m, and the highest mean volume is at altitudes over 3000 m.
5. The average number of stems per hectare is 408. They are divided into the following diameter classes: 10–20 cm (244 stems/ha), 20–50 cm (143 stems/ha), and over 50 cm (21 stems/ha).
6. The main tree species in terms of proportion of total stem volume are Sal (*Shorea robusta*), with 28.2% of total volume, Oak (*Quercus* spp.), with 9.3%, Asna (*Terminalia alata,* previously *T. tomentosa*), with 7.6%, Chir Pine (*Pinus roxburghii*), with 6.3%, *Abies spectabilis,* with 4.4%, *Rhododendron* spp., with 4.2%, and *Alnus nepalensis,* with 2.9%.

If the current NFI results are compared with the results of the inventory carried out in the 1960s, the following are the main findings: mean stem volume (to 10 cm top) has increased from 85 m^3/ha to 131 m^3/ha. Also, the number of stems per hectare has increased from 313 to 408.

In the hilly area of Nepal, observations of human impact and existing nontimber forest products were also conducted. Cattle grazing, fuelwood collection, and lopping were found in almost every field plot regardless of the plot's altitude. Many nontimber product species were observed, although the inventory methodology was designed for a forest inventory rather than a nontimber product inventory.

Open questions

The 1999 Forest Resource Inventory for Nepal leaves many questions unanswered. For example, What are the areas covered by Community Forests, where are they located, and in what condition are they? What happens in the forests outside Community Forests? Are these forest areas degraded more or less than before the establishment of Community Forests? New, more detailed inventories are needed to clarify these very important questions. Without the answers, it is very difficult to assess the effect of current forest policies. Moreover, individual trees and small patches of trees growing mainly on agricultural land were excluded from the inventory. Conclusions about livelihood strategies in relation to use of woody resources cannot be drawn without information on such wood reserves, which are of great importance to local populations. Nevertheless, this new forest inventory is a very important source of data.

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