Chapter III
Forests

General Considerations

Forest Situation

According to Map 2 and Table 4, the forest cover is rather low in each watershed. The high pressure on forest resources due to expansion of agriculture and the increasing domestic as well as industrial needs, both within and outside the region, has resulted in removal and degradation of forests. Degradation of forests not only takes place by cutting the trees but also by collecting litter (nutrient loss for the forest) and grazing.

A detailed assessment of the forest cover is difficult due to the lack of good data. With advanced remote-sensing techniques, it is possible to assess the forest cover of large river basins (Blasco 1986, Myint 1996, National Remote Sensing Agency 1994, Skole and Tucker 1993, Loveland et al. 1997). For the present study, the overall assessment has relied much on the data of the USGS-IGBP Land Cover Classification Project, based on the 1992-93 NOAA imagery and the individual studies commissioned for each watershed.

Importance of Forests

Forests have a multifunctional importance: timber, fuelwood, fodder, fruits, medicinal plants, and many other non-timber forest products. Forests contribute to the stabilisation of the slopes in the uplands and reduce soil loss. According to Hamilton (1987), not only is the forest important, but the condition of the forest is also significant, i.e., density of trees and canopy. A broad-leaved forest without any ground cover or litter can cause more erosion than an area without any forest due to the size and intensity of the raindrops which fall from the leaves during rainfall.

Good forest is important for reducing runoff and soil erosion and to ensure livelihoods and biodiversity in mountain watersheds. Recent studies have shown, however, that on a large scale, the role of forests, e.g., in the reduction of downstream flooding, has usually been overestimated (Hofer and Messerli 1997).

Mangrove forests are important sources of marine biodiversity conservation. They also protect the coastal erosion and prevent siltation of ports, while providing habitats for marine lives.

Trends

Depending on the watershed and on the region, the reduction of forest cover due to overuse or the increase as a result of various initiatives can be observed. For disçussion of trends in forest cover it is necessary to consider individual watersheds.

The Indus River Basin

Forest Situation

According to the USGS-IGBP project, forest cover of the Indus River Basin is 0.5 per cent (Map 4 and Table 5), 2.3 per cent is under farm forestry, shown as cropland and natural vegetation mozaic (Table 5); and this area is in the lowlands (Map 3).

Table 5: **Land Use of the Indus' River Watershed**

No	Land Cover Type	Area	
		'000 sq.km.	%
1	Evergreen needleleaf forest	0.28	0.03
2	Evergreen broadleaf forest	0.19	0.02
3	Deciduous broadleaf forest	3.49	0.37
4	Mixed forest	1.13	0.12
5	Closed shrublands	21.16	2.24
6	Open shrublands	257.11	27.22
7	Woody savannas	2.17	0.23
8	Grasslands	153.40	16.24
9	Permanent wetlands	1.04	0.11
10	Croplands (agricultural lands)	332.49	35.20
11	Urban built-up	1.13	0.12
12	Croplands/natural vegetation mosaic	21.82	2.31
13	Snow and ice	30.60	3.24
14	Barren/ sparsely vegetated	107.30	11.36
15	Waterbodies	11.05	1.17
	Total	**945.00**	**100.00**

Source: USGS-IGBP Land Cover Classification Project June '97, 1992-93 NOAA, (Loveland et al. 1997)

Marjan (1997, background document) estimated the tree cover of the Indus River Basin in Pakistan to be 3.9 per cent (Map 4 and Table 6). The two estimates are quite close. The location of the remaining forest is mainly in the Kashmir area and in the Northwest Frontier Province.

Table 6: **Estimates of Forest/Tree Areas in the Indus Watershed ('000 sq.km.)**

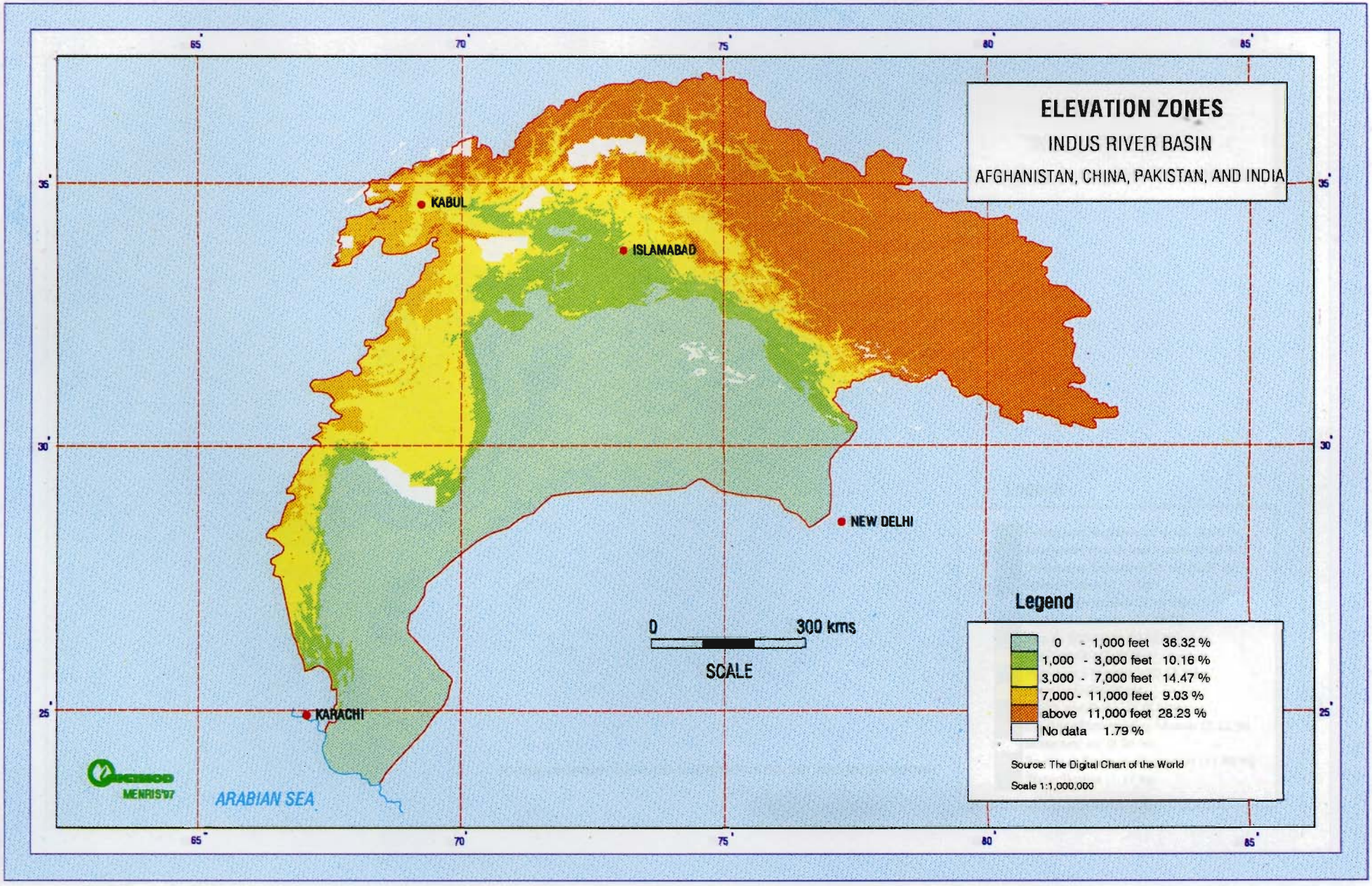
	Azad Jammu & Kashmir	Balochis-tan	Northern Areas	North-west Frot. Pro.	Punjab	Sindh	Afghanis-tan etc. *	Total
Geogr. Area	13.30	155.18	70.40	101.74	206.26	35.51	362.18	944.57
Forest "Area	2.75	2.00	6.66	16.84	6.08	3.39	n.a.	37.72
Forest cover %	20.67	1.28	9.46	16.55	2.94	9.50	4.50	3.99

Source: Adapted from the Forestry Sector Master Plan of Pakistan 1992 (Marjan 1997)

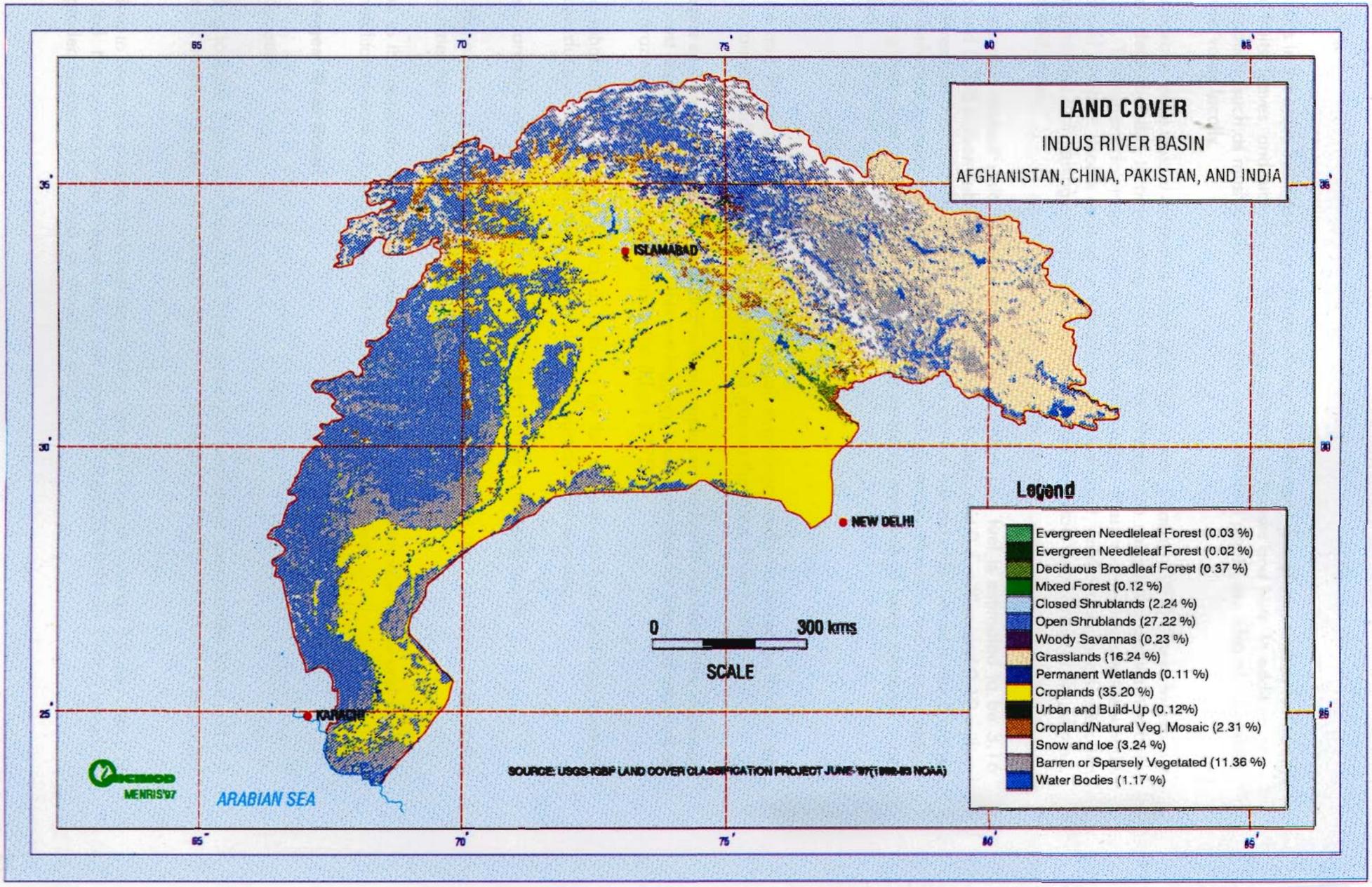
* For Afghanistan, China, and India, the forest and tree areas within the Indus Basin are not available.

** Area under forest (sq.km.) : coniferous forest 1,913 (2.02%), shrub forest 835 (0.88%), riverine forest 112 (0.11%), mangroves 205 (0.21%), irrigated plantations, farmland trees, linear planting, misc. planting

MAP 3 : Elevation Zones of Indus River Basin



MAP 4 : Land Cover Map of Indus River Basin



Significance

The forests in the Indus Basin are of great importance for different types of use: timber, fuelwood, fodder, fruits, leaves, and branches for thatching the roofs of houses and huts. In addition non-forest products, such as mushrooms, tannin, meat, and medicinal plants, are also of substantial economic value locally.

The mangrove forest area is estimated to be 205,000 sq.km. (Marjan 1997). These forests are seriously degraded due to over-cutting and even the *Rhizophora mucronata* species has been wiped out. The current dominant species is *Avicennia marina*. These mangroves are the world's sixth largest in extent. People depend on these forests for fuelwood, small timber, and fodder. Ten thousand families from fishing communities depend on these important mangroves for fish, shrimp, lobster, and crabs.

The sustainable annual yield of forest products for timber and fuel is estimated to be 3.16 million and 0.395 million cubic metres from coniferous forests, and 0.6 million and 0.12 million cubic metres from hardwood forests respectively. The annual harvest of fuelwood is much higher than the fuelwood products available through commercial harvesting. However, local consumption for housing and other infrastructure is not known, as subsistence use of forest products is not recorded.

Trends

- In the mid-9th century, forest management began in an organized way, based on the concept of sustained yields. The focus of these initiatives was on the Indus River Basin.
- In spite of the working plans, exploitation without replacement finally resulted in the depletion of forest resources. The reasons for this are logging, local demands for firewood and timber, and grazing by a dense livestock population (Khan 1995).
- The rehabilitation of degraded lands initiated by the government has been only partially successful due to its locational nature and lack of participatory planning.
- New concepts with pioneer projects (social forestry) show promising results.
- In Afghanistan, it is said that the uncontrolled deforestation in the catchment of the Indus tributaries has had severe ecological consequences.
- Due to the realisation of the importance of mangroves for sustainable fishery and ecology, rehabilitation work is being carried out by Sindh Forest Department.

The Ganges' River Basin

Forest Situation

According to Table 7 (see also Map 6), 8.3 per cent of the catchment area is under forest and 9.9 per cent is mixed cropland and natural vegetation, including shifting cultivation and degraded forests.

According to two other studies, the forest cover of the Ganges' River in India is 13.2 per cent (FSI 1996) and the forest cover in Nepal is 42.2 per cent (HMGN/ADB/FINNIDA 1988), including the degraded forests in both cases, as shown in Table 8.

Table 7: **Land Use in the Ganges' River Watershed**			
No	Land Cover Type	Area	
		'000 sq.km.	%
1	Evergreen broadleaf forest	5.99	0.57
2	Deciduous broadleaf forest	80.12	7.63
3	Mixed forest	1.78	0.17
4	Closed shrublands	20.26	1.93
5	Open shrublands	17.11	1.63
6	Woody savannas	0.10	0.01
7	Grasslands.	69.20	6.59
8	Croplands (agricultural lands)	709.91	67.61
9	Urban built-up	1.89	0.18
10	Croplands/natural vegetation mosaic	104.16	9.92
11	Snow and ice	9.24	0.88
12	Barren/ sparsely vegetated	16.59	1.58
13	Waterbodies	13.65	1.30
	Total	**1050.00**	**100.00**
Source : Loveland et al. 1997			

Table 8: **Forest Cover of the Ganges' Watershed in India and Nepal ('000 sq.km.)**					
Description	India	Nepal	China/ Bangladesh	Total	Per cent
Basin area	852	147	51	1050	100.0
Forest cover	113 (13.2 %)	62 (42.2 %)	n.a.	175	16.7
Densed forest	63	55	n.a.	118	11.2
Open forest	47	7	n.a.	55	5.2
Mangroves	2	0	n.a.	2	0.2
Source : FSI 1996 and HMGN/ADB/FINNIDA 1988					

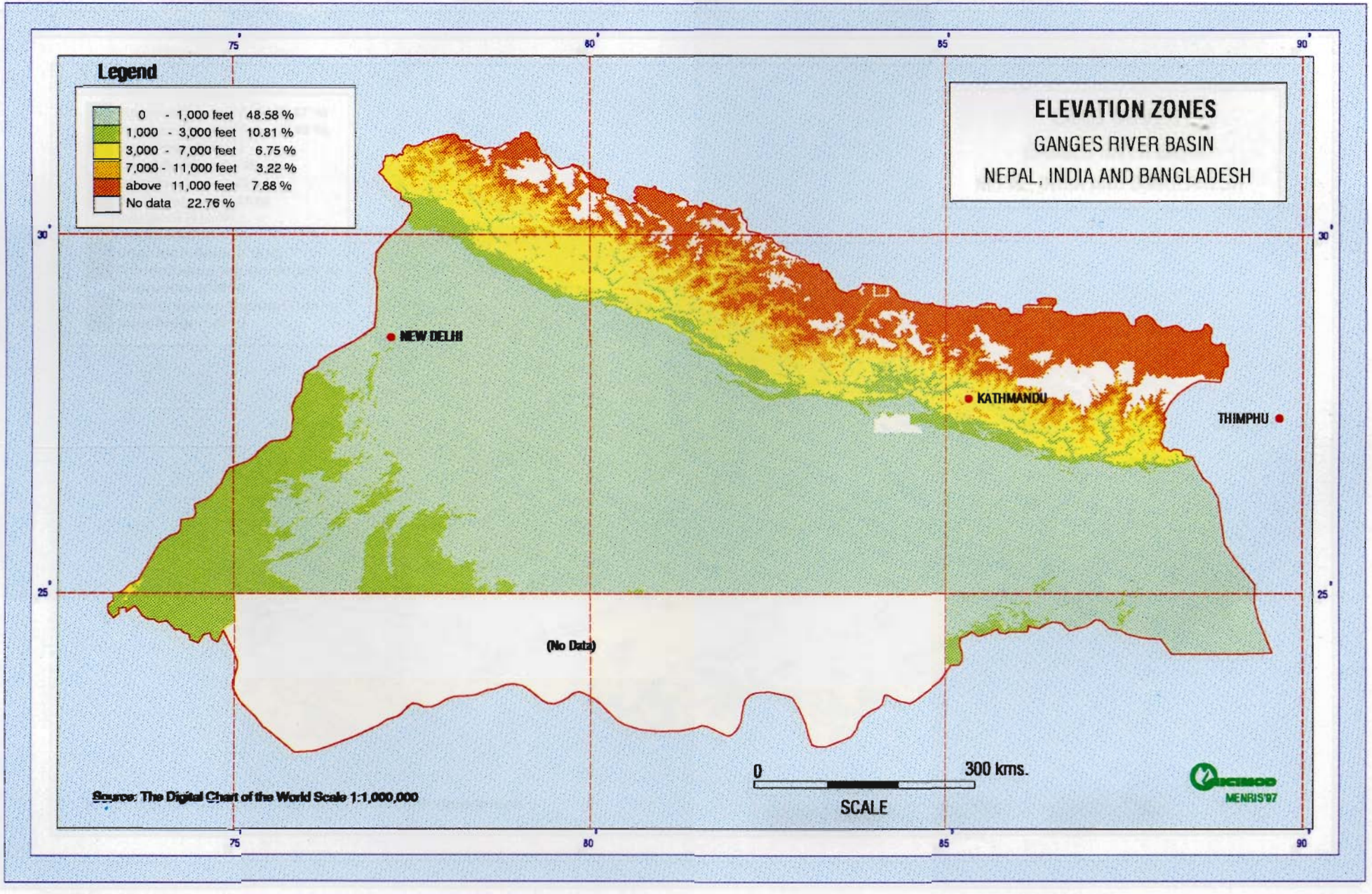
Estimates from these two different sources agree to a large extent that the forest cover of the basin is approximately 16/17 per cent. The areas with more or less dense cover are located in the southern part of the catchment and in the Himalayan ranges, mainly on the first ridges adjacent to the plains. In the middle hills, the forest cover is scattered. In India, below 300m (1,000 feet), there is almost no substantial forest cover left due to the high demand for agricultural land (see Maps 5 and 6).

The mangrove forests of the Ganges in India, i.e., the state of West Bengal, have an extent of 2,119 sq. km. Mangrove forests in Bangladesh at the mouth of the Ganges and Brahmaputra are also shared by the Meghna River, and area differentiation of mangroves between these rivers is difficult.

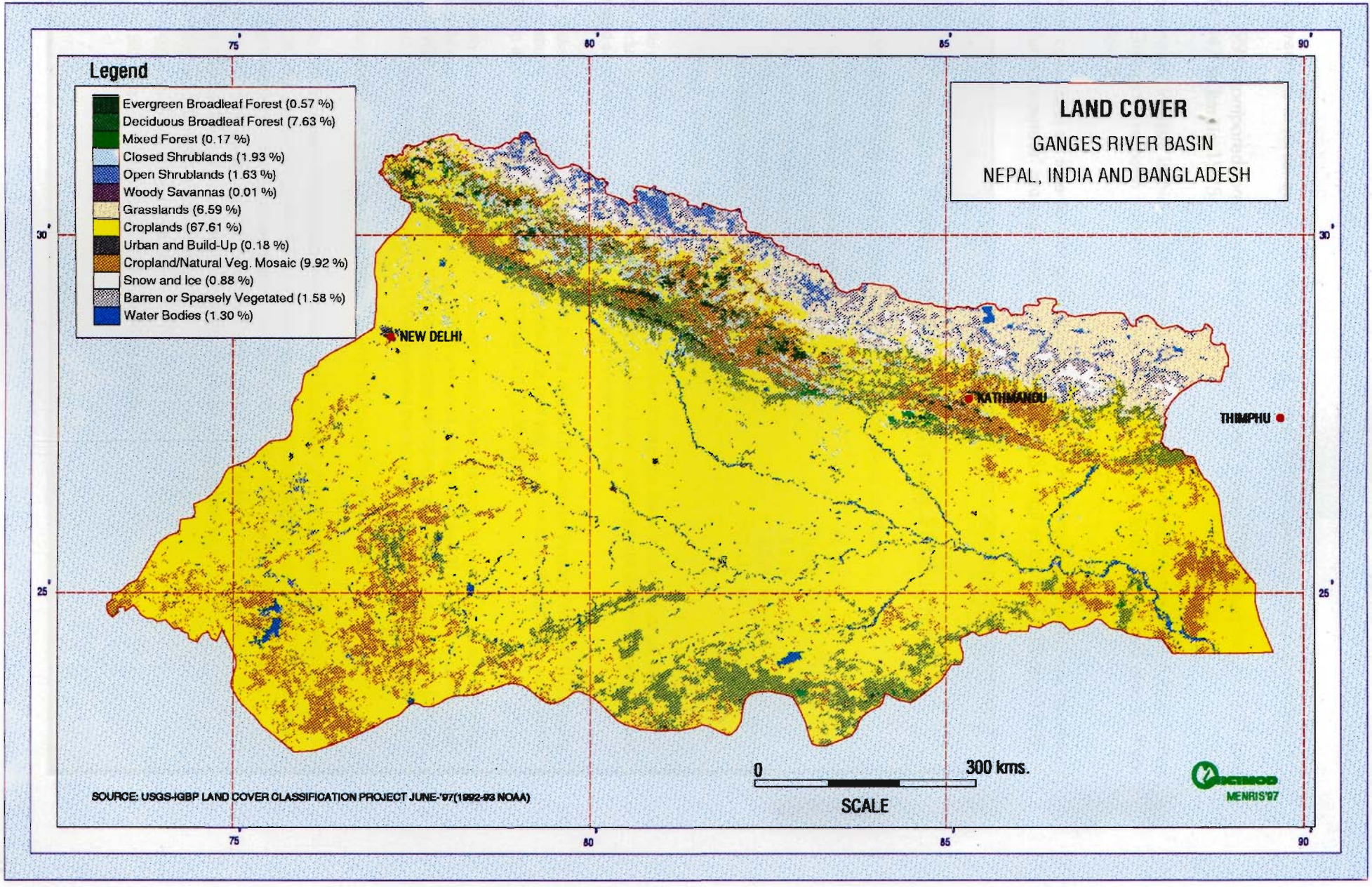
Significance

Forest cover in the Ganges' River Basin is very low and is concentrated mainly in the uplands. In the plains, where population intensity is very high, only degraded forest cover is found in patches. Tremendous problems are already being faced in responding to the needs of households for fuel, fodder, timber, and other forest products. Farm forestry has started to supply some of the wood-based industries. Non-timber forest products are of great significance to local communities. Employment opportunities for local communities are significant in the harvesting of non-timber forest products, forest protection, afforestation, and so on. Forest products are also a source of raw materials to many industries. Non-timber forest products, such as Tendu leaves, Sal seeds, resins, gums, myrobalans, and so on, are important to the community.

MAP 5 : Elevation Zones of Ganges River Basin



MAP 6 : Land Cover Map of Ganges River Basin



Trends

- Improvements in forest cover in both India and Nepal through participatory approaches.
- FSI (1996) compared forest cover in the Ganges' River; it was 138,784 sq.km. in 1991 and 144,047 sq.km. in 1995.
- Community forestry in Nepal has gained momentum and already more than 5,000 Forest User Groups have been formed and more than 300,000 ha formally handed over to them (See Box 3).
- Forest cover and an inventory of growing stock, as well as changes over time, are necessary for natural resources' management in mountain areas (Shengji et al. 1994, Bhatta 1990).

Box 3
Community Forestry with Forest User Groups, FUGS in Nepal

The situation of Community Forestry practices in Nepal can be summarised as follows.

Potential Community Forest Land (Forested)	18,763	sq.km.
Potential Community Forest Land (Non-forested)	15,858	sq.km.
No. of Forest User Groups (FUGs) formed	5,316	No.
Community Forests handed over to FUGs	3,523	sq.km.
Households benefitted	563,434	No.

Source : Shrestha 1997.

Successful rehabilitation had been demonstrated in the Andheri *Khola* of the Jhikhu *Khola* Watershed, 50 km east of Kathmandu, Nepal (ICIMOD 1994, Shengji 1995). Importance of forest cover in a small watershed is stressed and degraded sites can be restored through appropriate agroforestry practices.

Case studies in the Baitadi and Achham districts of the Far Western Development Region (FWDR) of Nepal reveal that community forestry through people's participation is the best way to achieve the sustainable use and effective protection and management of forest resources (Chhetri and Pandey 1992).

There is no general rule for implementation of community forestry due to the vast local diversity of situations. Another successful example in the Begnas *Tal*/Rupa *Tal* (BTRT) watershed management area of the Western Development Region (WDR) in Nepal, which started in 1974, demonstrates participatory approaches (Campbell and Denholm 1993, FAO 1996b, 1996c, 1996d, 1997a). FAO (1996a) outlined the integrated approach and its importance.

The following points concerning development and government policies should be noted.

- Up to 1950 the Government encouraged the maximum exploitation of forests and promoted exports.
- In 1957 the Government introduced the Private Forest Nationalisation Act to protect forests. This resulted in rapid forest degradation, forest degradation rates were 5.7% in 1964-1978 and 3.4% in 1979-1986.
- In the 1970s, the Government introduced the Community Forestry Development Programme (CFDP) to hand back the protection and management of forests to the people and organizations.
- In 1980 regulations were decentralised.
- In 1993 a new forest act was approved.
- In 1995 rules and regulations for the forest act were gazetted.

The Brahmaputra River Basin

Forest Situation

The vertical profile of the forest in the Himalayan part of the watershed is very distinct. Tropical evergreen forests are found in the foothills up to elevations of 800m. Subtropical forests, consisting of a great variety of tree species, some of which are rare and endemic, occur at elevations ranging from 900 to 1,800m. The temperate forests are situated at altitudes ranging from 1,800 to 3,500m and include a great variety of coniferous and non-coniferous species (fir, larch, spruce, oak, chestnut). The sub Alpine zone is found between 3,500 and 4,500m and is dominated by fir-rhododendron, while Alpine forests are found at elevations ranging from 4,500 to 5,500m (see Maps 7 and 8).

According to Loveland et al. (1997) (Map 8 and Table 9), 14.5 per cent of the watershed is forested. Croplands/vegetation mosaic (farm forest), which include shifting cultivation, constitute 12.86 per cent. According to the land-cover map, the areas with relatively high forest cover are located in Bhutan, Arunachal Pradesh, Megalaya, and Nagaland.

Table 9: **Land Use of Brahmaputra River Watershed**

No	Land Cover Type	Area	
		'000 sq.km.	%
1	Evergreen needleleaf forest	0.12	0.02
2	Evergreen broadleaf forest	12.12	2.09
3	Deciduous broadleaf forest	67.51	11.64
4	Mixed forest	4.41	0.76
5	Closed shrublands	0.70	0.12
6	Open shrublands	51.62	8.90
7	Woody savannas	3.83	0.66
8	Grasslands	255.20	44.00
9	Permanent wetlands	0.29	0.05
10	Croplands (agricultural lands)	79.58	13.72
11	Urban built-up	0.12	0.02
12	Croplands/natural vegetation mosaic	74.59	12.86
13	Snow and ice	6.32	1.09
14	Barren/ sparsely vegetated	13.17	2.27
15	Waterbodies	10.38	1.79
	Total	**580.00**	**100.00**

Source : Loveland et al. 1997

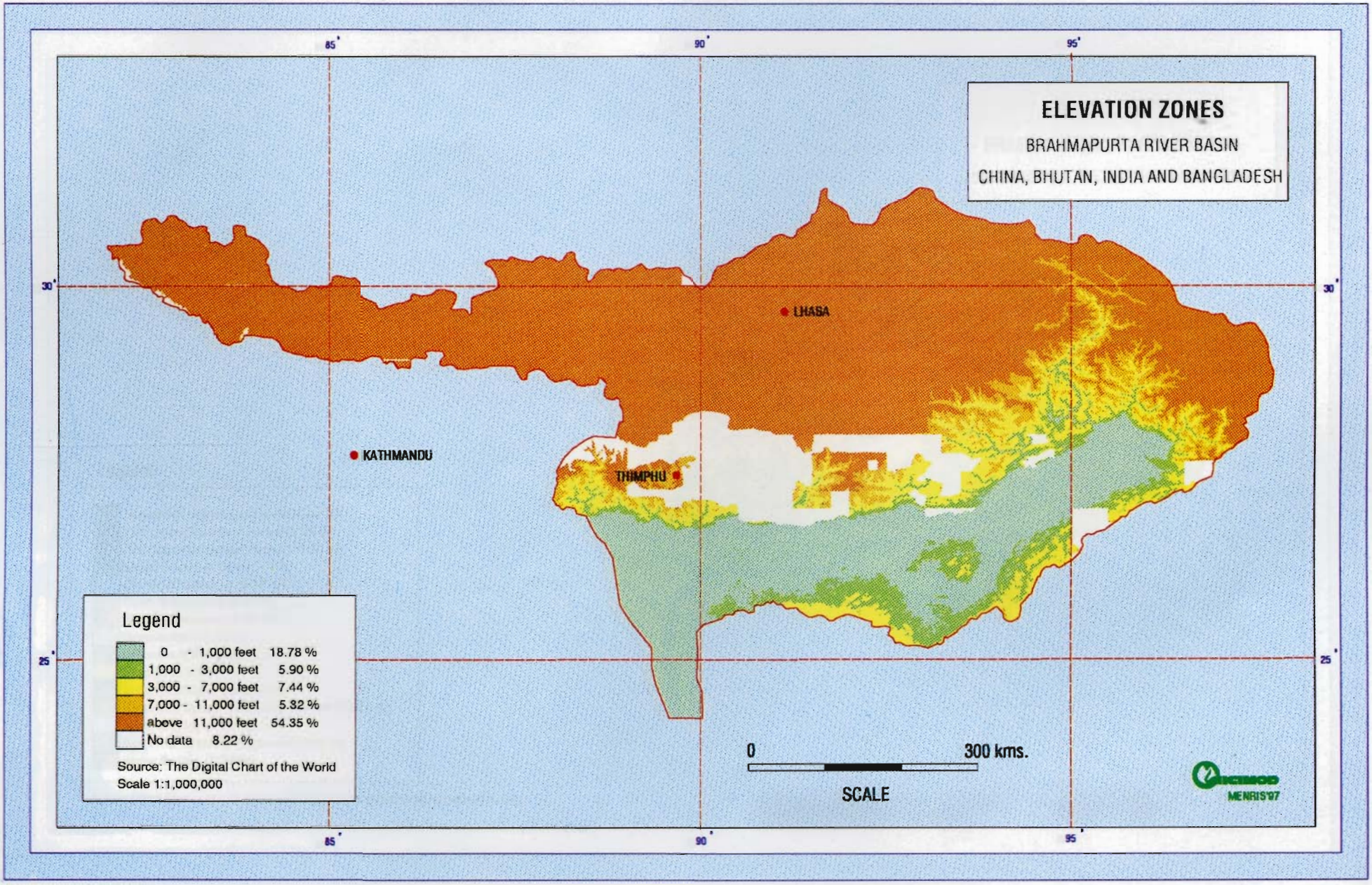
An estimation of the total forest cover of the Brahmaputra Basin had been reported as 55.6 per cent (Goswami 1997) apart from Tibet and Bangladesh (Table 10). The proportion of forest is highest in Arunachal Pradesh, followed by Nagaland, Meghalaya, and Bhutan. It is evident that there are wide regional differences in forest cover. For the whole basin, the forest cover of 14.07 million ha (i.e. 140,700 sq.km.) is about 24.3 per cent - including the shifting cultivated areas.

Table 10: **Estimates of Forest Areas Based on Satellite Data in the Brahmaputra Watershed for India and Bhutan ('000 sq.km.)**

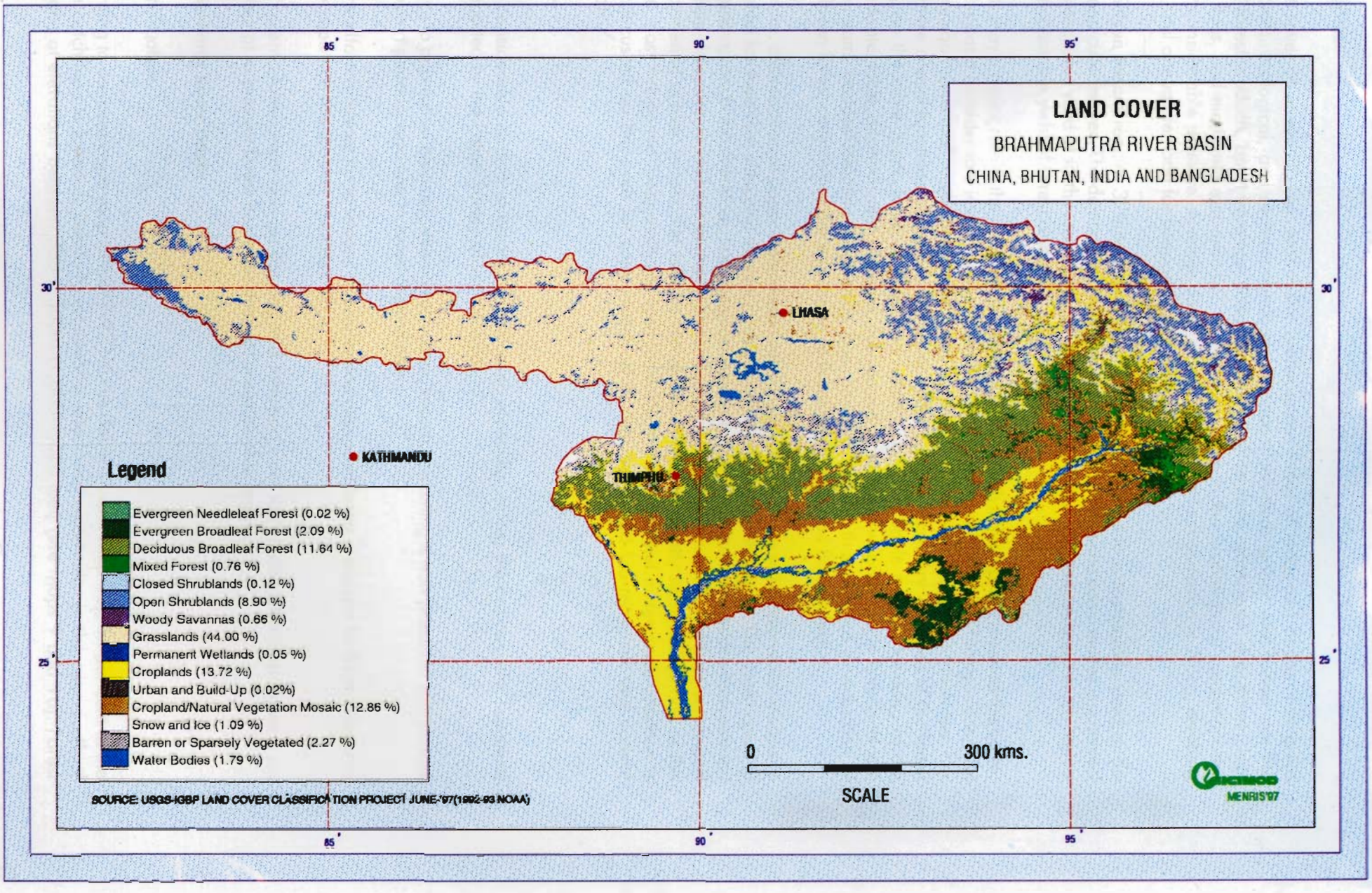
	Arunachal Pradesh	Assam	Meghalaya	Nagaland	Sikkim	West Bengal	Bhutan Bhutan	Total
Geogr. Area	83.7	70.1	22.4	16.5	7.0	12.7	40.0	252.8
Area under forest	69.3	14.4	14.2	11.4	2.8	2.7	25.7	140.7
Percent	82.81	20.56	63.53	68.89	39.52	21.41	64.34	55.67

Source : Goswami (1997, background document), FSI (1996)

MAP 7 : Elevation Zones of Brahmaputra River Basin



MAP 8 : Land Cover Map of Brahmaputra River Basin



Significance

Forest cover of above 50 per cent in the Brahmaputra Basin of India and Bhutan has great economic, ecological, and socioeconomic significance. Fuelwood, timber, and fodder are the major forest products, apart from non-timber products such as cane, gum, resin, dye, tannin, lac, fibre, floss, and medicinal and aromatic plants. The forests in the Brahmaputra catchment are under considerable pressure. Average daily per capita fuelwood consumption is 2.5kg, resulting in an total annual demand for fuelwood of 50 million tons.

Sawmills in Assam require 328 thousand cubic metres, compared to a sustainable yield of 56 thousand cubic metres. The demand for timber in Nagaland is 80 thousand cubic metres, compared to a sustainable yield of six thousand cubic metres. It is to be noted that demands are much higher than sustainable yield of forest resources.

Forests play a major role in the maintenance of ecological health in the upland areas of the basin, and this has a considerable impact on the downstream areas. In addition, the Himalayas intercept the monsoon rains and receive the snowfall that sustains the Brahmaputra and its tributaries. For both these crucial functions, a good forest cover in the basin is necessary. Removal of the forest cover, on the other hand, leads to increased runoff, loss of valuable topsoil, lowering of the groundwater table, destabilisation of slopes, accelerated sedimentation, and a rise in flood potential downstream, besides affecting biodiversity. It is, however, argued that removal or reduction of Himalayan forest cover is not the sole cause of flooding in India and Bangladesh.

Therefore, afforestation of upper watersheds and adoption of extensive soil conservation measures are useful for their own sake and may be crucial for the subsistence hill farmer. The forest cover of the Brahmaputra Basin, therefore, has tremendous potential as a biotic resource base with significant upstream-downstream linkages and as a prime factor for conservation of the rich biodiversity and environmental quality. In fact, the eastern Himalayan region is already identified as one of the sixteen most threatened biodiversity hot-spot locations in the world and increasingly attention is being focussed on this area for conservation of its rich and varied bio-resources and natural habitats.

Trends

- A considerable decline in Assam's forest cover, especially during the last decade, has been reported by the Forest Survey of India (1996).
- Due to population pressure, shifting cultivation, known as *jhuming* is now practised with shorter resting periods, resulting in forest degradation.
- The efforts made so far to restore and redevelop degraded forest areas are far from adequate to cope with the problem (see Box 4).
- A recent Government ban on logging and transport from the Northeast Indian states is an attempt to prevent forest depletion through unsustainable logging.

The Mekong River Basin

Forest Situation

According to the land cover map of 1992-93 NOAA (Table 11 and Map 10), 44 per cent of the whole catchment is forested. Dense forest cover is identified in particular in the area north of Vientiane at elevations between 300-2,300m (1,000-7,000 feet) (see Maps 9 and 10). Forest

Box 4
Status of Joint Forest Management (JFM) in India

Policy initiatives by the Government of India include the following.

- The 1980 Forest Conservation Act (FCA) prohibited conversion of forests to non-forestry purposes. Prior to 1980 45,000 sq.km. of forests had been converted. The annual conversion rate is 1,500 sq.km.

- In 1988, the National Forest Policy stipulates 66 per cent of the hills and 33 per cent of the plains to be under forest cover.

- In 1990, the government of India issued a notification on JFM-Joint Forest Management. In the State of West Bengal JFM has commenced and Forest Protection Committees (FPCs) and Village Forest Committees (VFCs) have been formed. It has so far been successful in West Bengal, Haryana, Rajasthan, Jammu & Kashmir, and Uttar Pradesh.

West Bengal	2,350	FPCs	3,500 sq.km.
Haryana	35	Hill Resource Management Societies	150 sq.km.
Rajasthan	447	FPCs	not available
Jammu and Kashmir	1,000	VFDCs	600 sq.km.
Uttar Pradesh hills	4,806	*Van Panchayat*(s)	3,337 sq.km.

The success of the JFM method should be extended further as the impact is still inadequate at national level. Government policy on tenure may need further action to ensure people's participation

The Supreme Court of India decided to ban exploitation of forest products and restrict their transfer out of the north-eastern region in May 1997. The reason for this is the overexploitation of timber beyond the sustainable yield causing deforestation (Goswami 1997, background document). There are many side effects of this ban, apart from conservation. Communities depending on the timber industry are seriously effected, together with the timber and other industries linked to them.

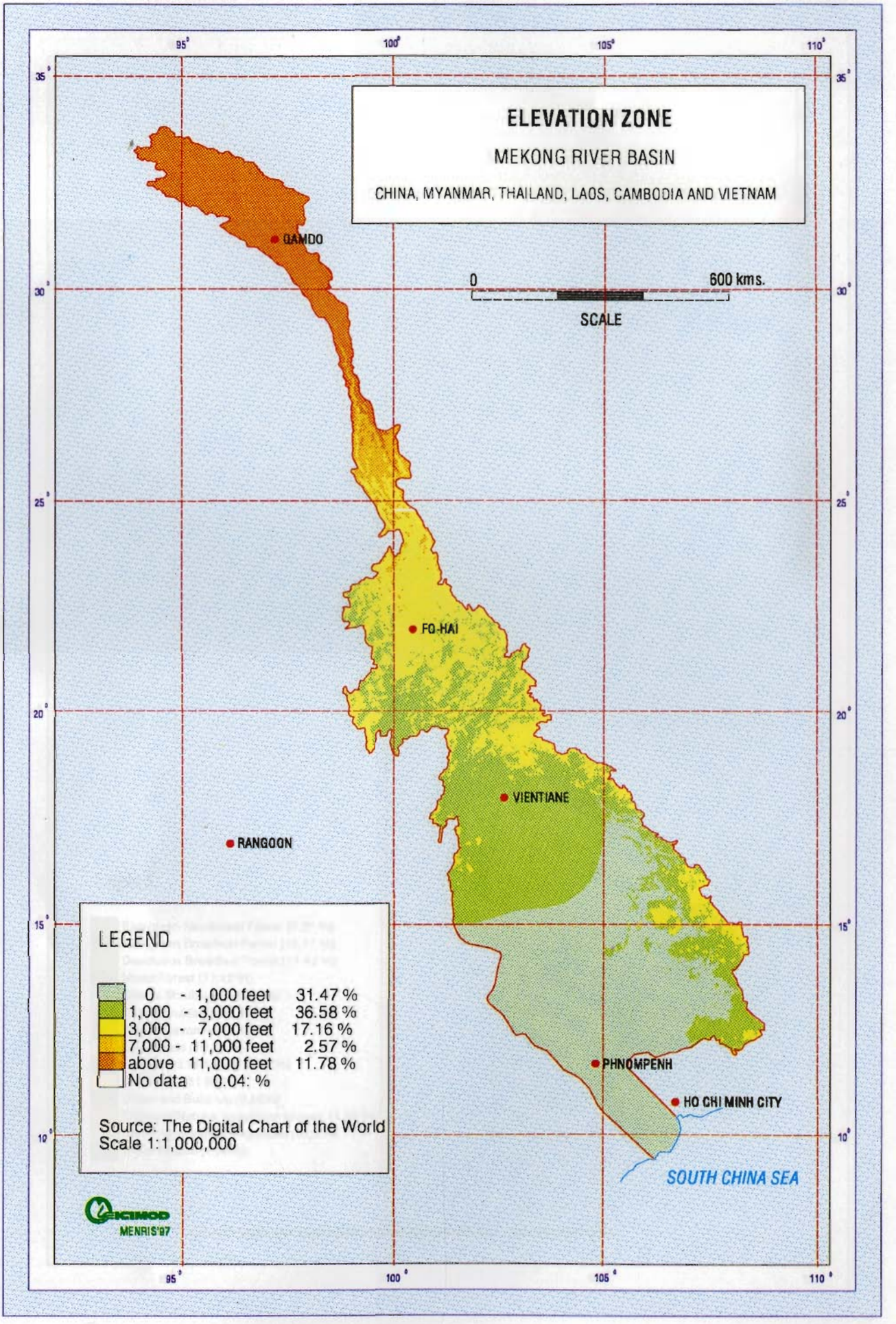
Source : Mr. A. Bhatia, ICIMOD, and Dr. V. N. Pandey, FSI, personal communications

Table 11: **Land Use of the Mekong River Watershed**

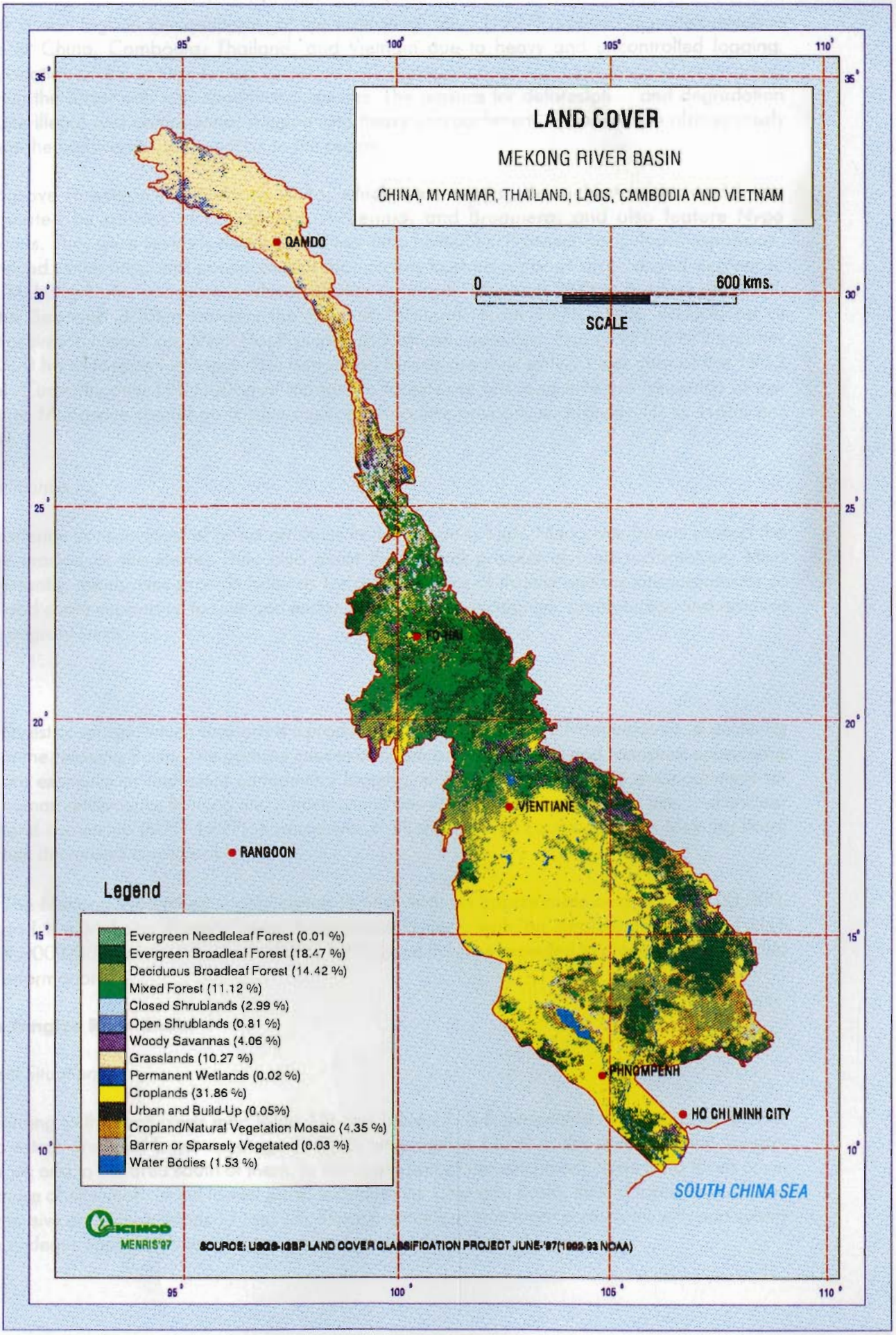
No	Land Cover Type	Area	
		'000 sq. km.	%
1	Evergreen needleleaf forest	0.08	0.01
2	Evergreen broadleaf forest	146.44	18.42
3	Deciduous broadleaf forest	114.16	14.36
4	Mixed forest	89.28	11.23
5	Closed shrublands	24.09	3.03
6	Open shrublands	6.68	0.84
7	Woody savannas	33.15	4.17
8	Grasslands	82.52	10.38
9	Permanent wetlands	0.16	0.02
10	Croplands (agricultural lands)	251.22	31.60
11	Urban built-up	0.32	0.04
12	Croplands/natural vegetation mosaic	34.34	4.32
13	Barren/sparsely vegetated	0.24	0.03
14	Waterbodies	12.32	1.55
	Total	**795.00**	**100.00**

Source : Loveland et al. 1997

MAP 9 : Elevation Zones of Mekong River Basin



MAP 10 : Land Cover Map of Mekong River Basin



cover is also high in the south-east of the watershed. MRC (1997) reported high deforestation rates in China, Cambodia, Thailand, and Vietnam due to heavy and uncontrolled logging. Degradation of the natural forests is caused by logging of commercial species and larger trees, leaving the forest with non-commercial species. The reasons for deforestation and degradation include illegal and unmonitored logging and heavy encroachment. Deforestation also seriously affects the biodiversity conservation in the region.

Mangrove forests in the Mekong Delta, which were among the richest in the world, are dominated by species of *Rhizophora, Avicennia*, and *Bruguiera;* and also feature *Nypa fruticans*. They were severely destroyed by war-time hostilities. Post-war agricultural expansion, fuelwood collection, and conversion of mangroves to shrimp ponds also caused depletion. The Mekong Delta coastline is about 650km in length, of which 350km borders the South China Sea and 300km borders the Gulf of Thailand. From 1978-1988, 40,000 ha of mangroves in Nam Can, Minh Hai Province of Vietnam, were lost. From 1988-1992 another 25,300 ha of forests were lost. The remaining forests are now only 21 per cent of the 1973 level. Currently only 120,000ha of mangrove forests are left, and they are generally of low quality. Mangrove depletion is also causing shoreline erosion, as high as 10 to 100m per year.

Significance

Subsistence consumption of forest products in the region is high. Mangrove forests protect the wave erosion of the shore. They also assist the natural process of land reclamation. Most importantly, mangroves provide habitats for many species of insects and aquatic organisms of the food chain supportive to rare and endangered mammals, reptiles, amphibians, and resident and migrant birds.

Trends

- Forest coverage, which supports the productivity of the watershed catchment area, is declining in the Mekong Basin. The primary causes of degradation of forests and terrestrial ecosystems are excessive or inefficient commercial logging, shifting cultivation, land encroachment for human settlements, farming and infrastructural development, heavy fuelwood use, and unclear land ownership (MRC 1997). Forest cover in all the riparian countries of the Mekong Basin has decreased considerably.

- The Mekong Watershed Classification Project, with an approximate cost of US$ 100,000, and the Mekong Forest Cover Assessment Project, with an approximate cost of US$ 4,000,000, have been initiated (MRC 1995), and they are expected to provide more detailed information.

The Yangtze River Basin

Forest Situation

According to the land cover map (Map 12) and Table 12, 8.5 per cent of the Yangtze watershed is forested. The best forest coverage (>35 % coverage) is found in the area near the Yangtze Gorges and to the area south of them. In the upper part of the catchment, there is no forest cover because of elevation, in the lowest parts, including the Chengdu Basin, lack of forest cover is due to intensive agriculture (Maps 11 and 12). There are many unique forest ecosystems with particularly rich endemic species. Some of them are rare and endangered.

Table 12: **Land Use of the Yangtze River Watershed**			
No	Forest / Land Cover Type	Area	
		'000 sq.km.	%
1	Evergreen needleleaf	0.90	0.05
2	Evergreen broadleaf	3.98	0.22
3	Deciduous needleleaf	3.44	0.19
4	Deciduous broadleaf	117.37	6.49
5	Mixed forest	26.40	1.46
6	Closed shrublands	43.04	2.38
7	Open shrublands	17.90	0.99
8	Woody savannas	17.00	0.94
9	Grasslands	376.17	20.80
10	Permanent wetlands	3.07	0.17
11	Croplands (agricultural lands)	742.21	41.04
12	Urban built-up	1.99	0.11
13	Croplands/natural vegetation mosaic	416.86	23.05
14	Barren/ sparsely vegetated	4.70	0.26
15	Waterbodies	33.28	1.84
	Total	**1,809.00**	**100.00**
Source : Loveland et al. 1997			

Significance

Forests in the Yangtze watershed are highly diverse ecosystems, supporting many species and supplying a wide range of resources. Besides the timber and fuel supplying function, forests in these areas yield large quantities of forage, animals, plant food, medicines, non-wood fibre, furs, skins, essential oils, gums, waxes, latex, and resins as well as a number of other non-wood commodities.

The total volume of these products is difficult to quantify, but they provide substantial amounts of income and employment and are important for the domestic economies of many communities and households. As is evident from scientific research, the forests may have an important influence on the atmosphere and climate.

Forests in this area are concentrated mainly on steep slopes and in the upper reaches of a number of large rivers. Besides supplying timber and other products, forests have vital impacts on the environment. The forest vegetation cover in mountain areas plays an important role, acting as a 'sponge' to regulate and stabilise water runoff and to protect soil. Soil protection by forest vegetation cover and litter can preserve the productive capacity of the reservoirs, prevent landslides and siltation of irrigation channels, and safeguard river banks.

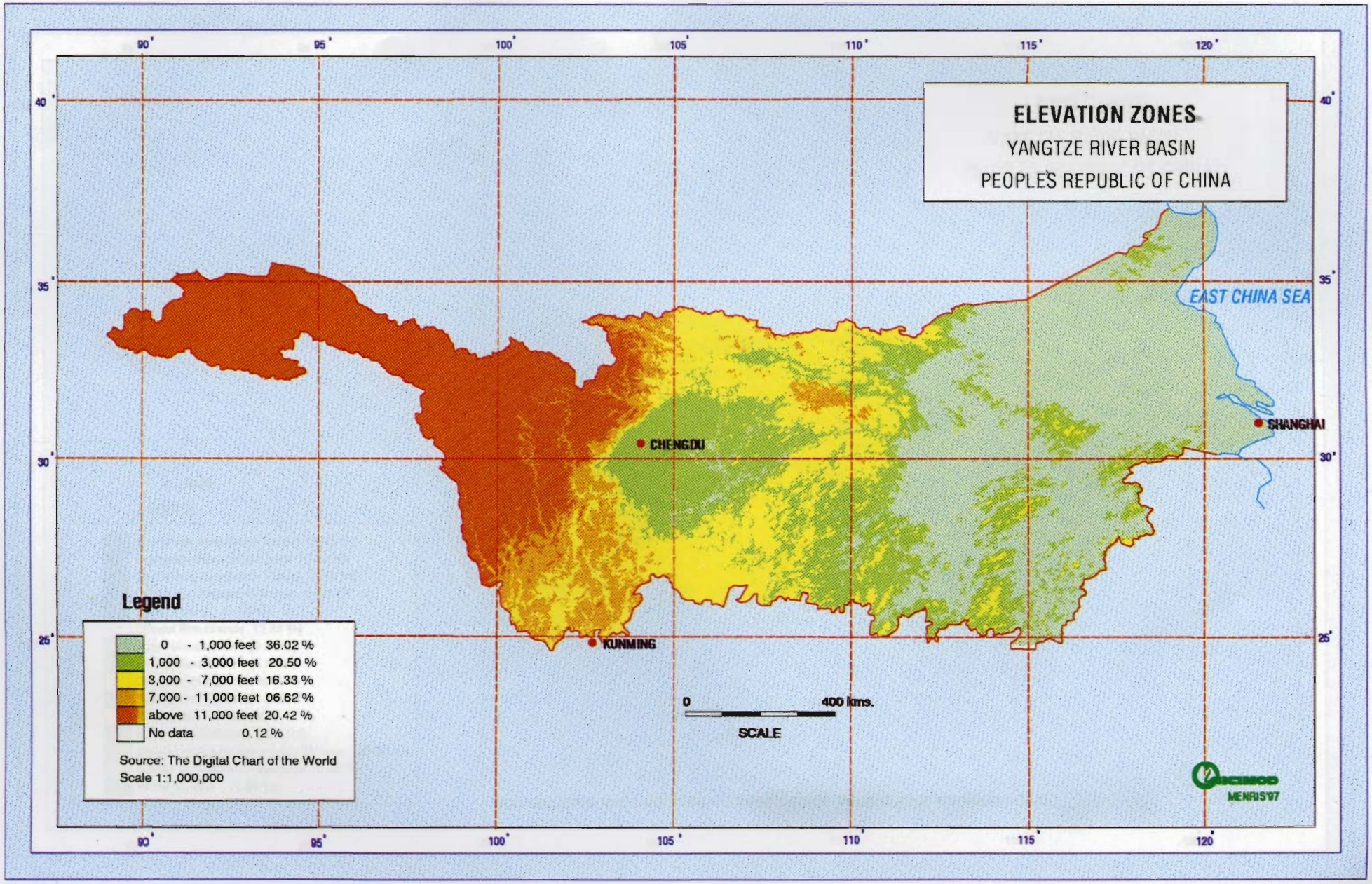
Trends

- In Sichuan Province, the forest cover decreases. The role of the forests in water conservation and regulation in the Yangtze River has decreased significantly.

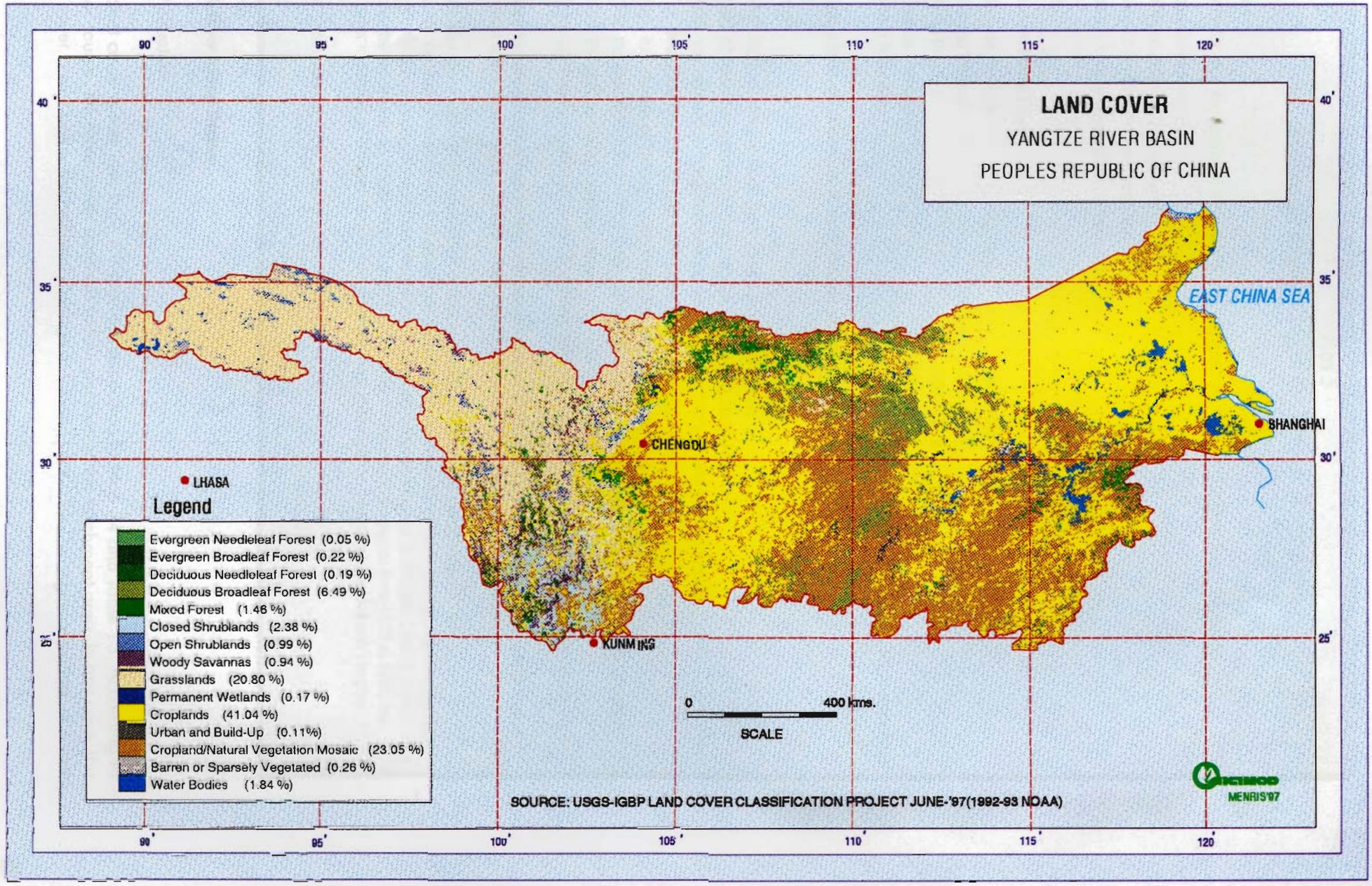
- The degradation in the quality of forests into low-value secondary forests, caused by repeated human disturbance and careless management, is also a serious problem.

- A series of guidelines, directives, laws, and regulations were issued and a Forest Act and Law of Soil and Water Conservation were also adopted. According to these, the existing forests were protected and new protective forests were established and combined with agroforestry practices (see Box 5).

MAP 11 : Elevation Zones of Yangtze River Basin



MAP 12 : Land Cover Map of Yangtze River Basin.



Box 5
Ecological Engineering in the Yangtze River Basin

Causes

Deforestation and degradation in the upper and middle reaches of the Yangtze River Basin are due to:

- population pressure,
- inadequate forest management,
- illegal use of the marginal land, and
- poor economic development of the region.

Effects

Decrease in Forest Cover

• Sichuan Province	1950- 20%	1980- 13%
• Jiangsu Province		1997- 8%
• Anhui Province		1997- 13.5%
• Guizhou Province		1997- 15.1%
• Jialing River Area		1997- 6,000 sq.km. of low density forests (60% of the total forest area)

- Debris flows, landslides, rapid runoff, erosion, and decline in water quality

Measures

- 1979: future of Yangtze River Basin forests received attention
- 1980: afforestation and strengthening of watershed forests carried out
- 1980: a symposium on integrated development of forestry and agriculture held in Sichuan
- The idea of constructing the protective forest system was generated.
- 1981: experiences of Yanting County reveal the great social and economic aspects
- 1986: the Overall Plan for the First Stage Construction Programme was approved by the People's Congress.
- 1989: the State approved the programme.
- The programme integrated protective forest with cash-crop, fuelwood, timber, and other-purpose forests.

This huge forestry ecological engineering programme covered 13 Provinces and 645 counties, with a total area of 4.06 million sq.km. After the year 2050, the total forest cover will be 45 per cent of the land area.

In 1997, after seven years of implementation of the Yangtze River Protective Forest Project, 27,075 sq.km. of protected forest had been improved and stocking became almost double than previously. Overall, the Yangtze River Basin area had an increase of more than five per cent in forest and vegetation cover. In Xingzuo County, Jiangxi Province, the soil erosion area was reduced from 160,000 to 50,000ha and, in the period from 1980 to 1995, the forest cover increased by 20.8 per cent; formerly this area was known as the desert area of southern Yangtze.

Source : Wenhua et al. (1997, background document)

The Yellow River Basin

Forest Situation

The forest cover is very low, only 2.9 per cent according to Map 14 and Table 13. According to another source, the forest cover amounts to four per cent of the catchment area. In any case, the forest cover is well below the national average in China (13.92 %). The regional pattern of forest

Table 13: **Land Use of the Yellow River Watershed**			
No	Forest / Land Cover Type	Area	
		'000 sq.km.	%
1	Evergreen needleleaf	0.08	0.01
2	Evergreen broadleaf	1.91	0.24
3	Deciduous needleleaf	14.45	1.82
4	Mixed forest	6.99	0.88
5	Closed shrublands	0.16	0.02
6	Open shrublands	159.46	20.08
7	Woody savannas	1.27	0.16
8	Grasslands	332.89	41.92
9	Permanent wetlands	0.08	0.01
10	Croplands (agricultural lands)	123.16	15.51
11	Urban built-up	0.87	0.11
12	Croplands/natural vegetation mosaic	98.15	12.36
13	Barren/ sparsely vegetated	45.50	5.73
14	Waterbodies	9.29	1.17
	Total	**794.00**	**100.00**
Source : Loveland et al. 1997			

cover has been documented in Table 14. The highest forest cover is found on the loess plateau where forestry is most important and beneficial (see Maps 13 and 14).

Significance

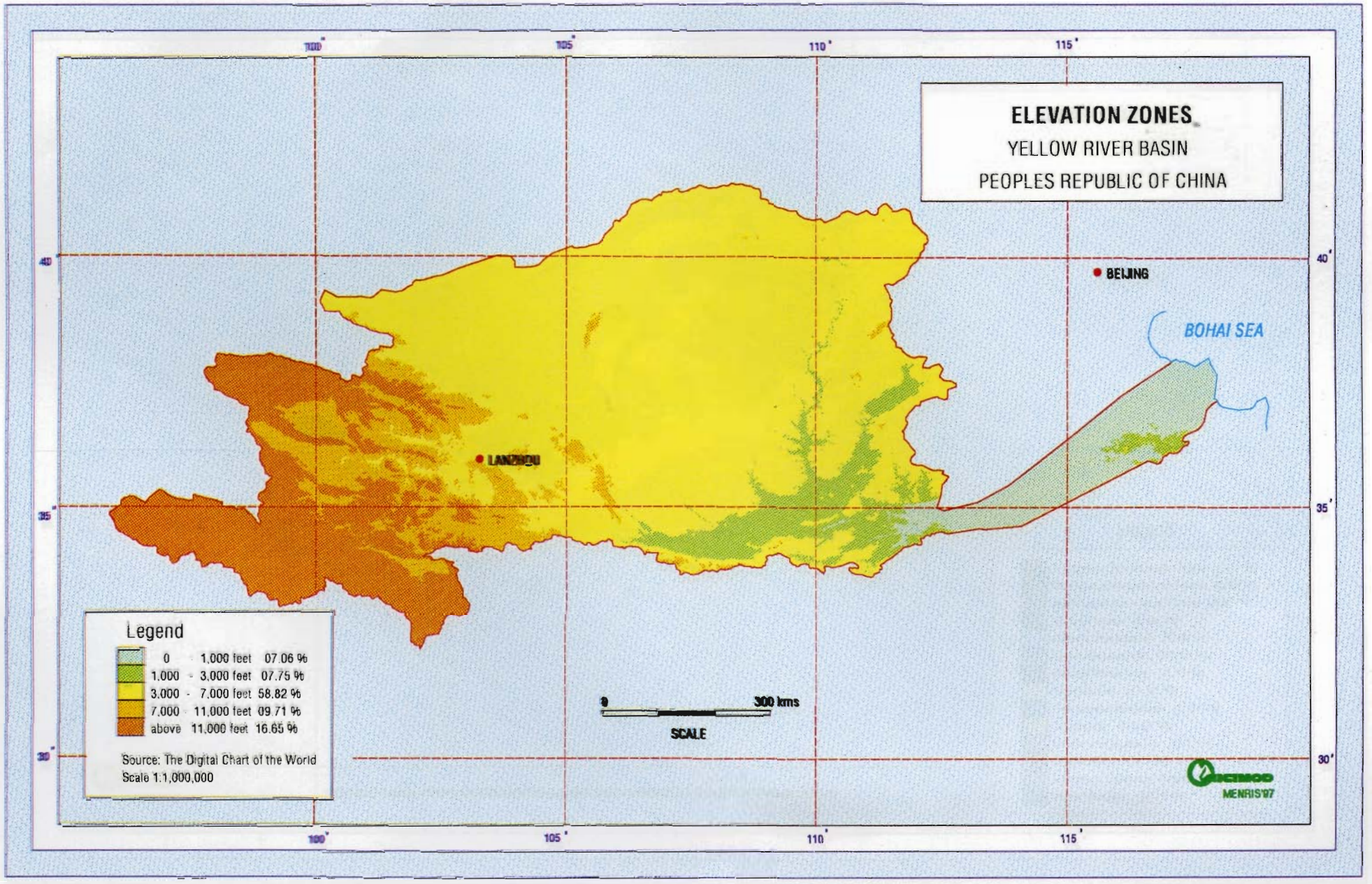
The Loess Plateau is the key area for fruit production. Water and soil conservation measures (biological measures) are very common. Fruit production totalled 1,059,700 tons on the Loess Plateau, and this corresponds to 9.1 per cent of the total production of China.

Trends

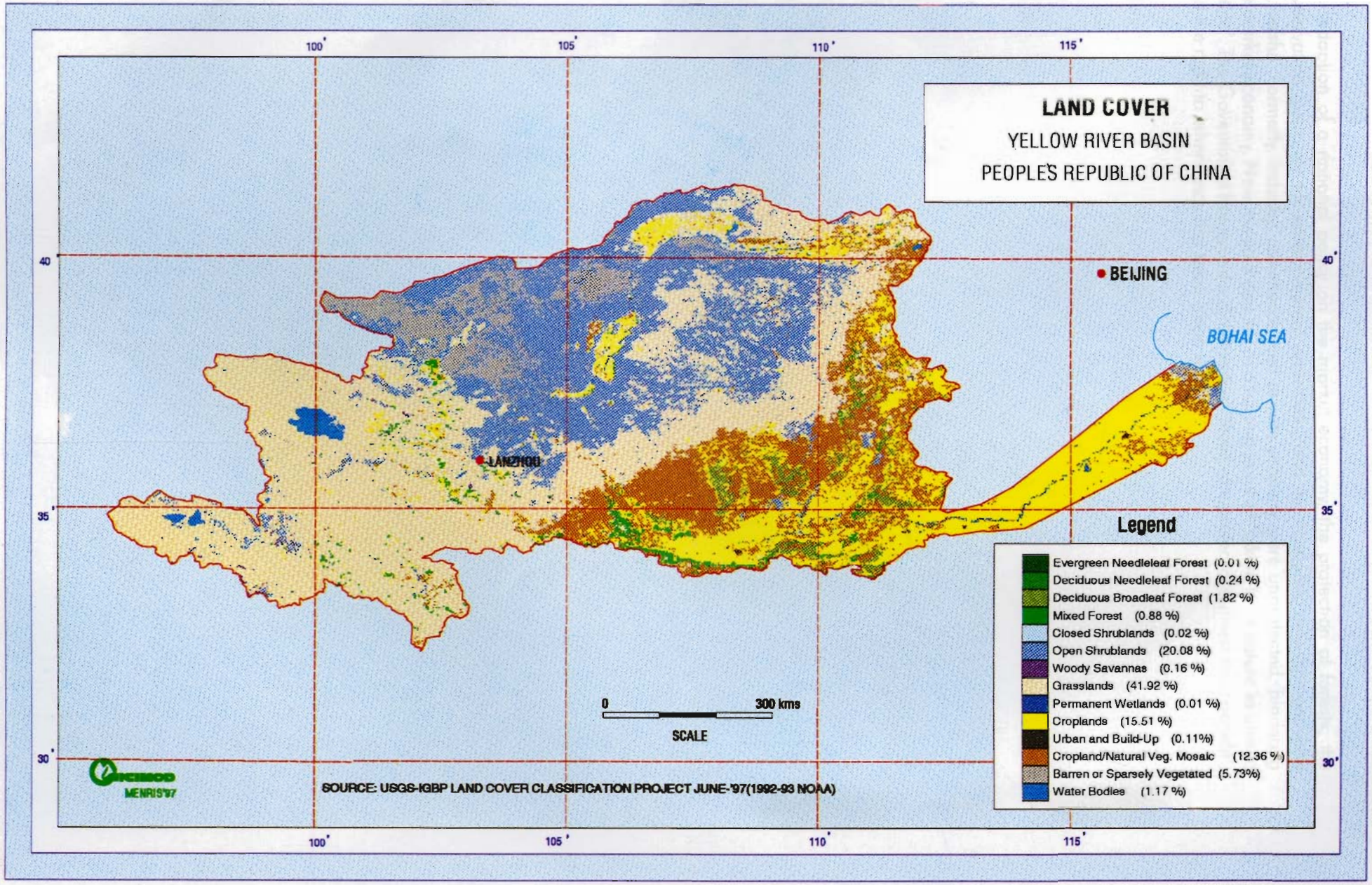
- There are several afforestation projects in the Yellow River Basin. As an example, in the 'three north protection forest project', 61,830 sq.km. were planted from 1978-85 out of which 39,784 sq.km. are located in the Loess Plateau.

Table 14: **Forest Regions of the Yellow River Basin**			
Region	Precipitation (mm)	Climatic zone	Forest Cover (per cent)
Agroforestry Region of Huang-Huai-Hai alluvial plain	500-800	Warm and semi-humid temperate zone	4.4
Agroforestry Region of Fen-Wei alluvial plain	600-800	Warm and semi-humid temperate zone	3.2
Water - Soil Conservation Forestry Region of the Loess Plateau	400-600	Semi-arid temperate zone	8.3
Windy Sandy, Arid Land Forestry Region	200-400	Arid temperate zone, high frequency of drought, strong wind	2.4
The Irrigated Forestry Region of Ningxia and Hetao Alluvial Plain	100-250	Arid temperate zone, dry and sunny, dry and hot wind	4.2
East Qinghai High Plateau and Mountain Forestry Region	300-600	Semi-arid Mountain Temperate Zone, with sharp vertical changes	2.9
Bush Forestry/ Non-Forest Region in the river originating region and upper reaches	400-800	Humid cold mountain climate, with sharp vertical changes	0.0
Source : Wenhua et al. (1997, background document)			

MAP 13 : Elevation Zones of Yellow River Basin.



MAP 14 : Land Cover Map of Yellow River Basin



- The adoption of a national policy on the market economy, the protection of forests, the conservation measures for environmental protection, and the economic development were successful. Formerly, industry, commerce, and private property were unprotected, hindering the market economy. Now it is said that it is at a turning point of 'taking from nature to give to nature'. The Government has issued a directive that 'those who protect and invest must benefit', and the right to inheritance has been given also.