# 9. Results

The Results chapter is composed by five sections, each one focusing on a specific aspect of the NFA of Bangladesh: Area, Volume, Biodiversity, Social and Economic, Biomass and Carbon. In each section the variables of interest are presented in relation to the Major National Land Use Classes (LUCs) and, in the case of "Forest", the variables are compared among different forest types.

The land area of Bangladesh is described by NFA data according to characteristics such as tree cover, protection level, ownership status, environmental problems and species diversity among others. Information on total and commercial volume is presented over a range of comparative classes. Population characteristics and dynamic is also presented in relation to various forest characteristics, in terms of resource availability and utilization. The contribution of forests of Bangladesh in terms of Biomass and Carbon is also presented.

NFA results with descriptive statistics are presented Annex XI while Results for international reporting (FRA2010) can be found in Annex XIII.

The NFA is not able to present estimates for all variables in all land use classes, as the field data collection did not cover all of the land use classes defined for Bangladesh and in some cases only limited data has been recorded.

## 9.1. Area

Total area of Bangladesh is classified into 28 national land uses (see Table 9) which can be grouped into five Major National LUCs: "Forest", "Cultivated land", "Villages", "Built up areas" and "Inland water". Detailed definitions of the LUCs are presented in Annex I. With regard to "Forest", the definition adopted in this study is the one used by FAO for FRA2005 (FAO 2006):

*"Land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use. Forest is determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 metres (m) in situ. Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10 percent and a tree height of 5 m are included, as are temporarily unstocked areas, resulting from human intervention or natural causes, which are expected to regenerate. Includes: areas with bamboo and palms provided that height and canopy cover criteria are met; forest roads, firebreaks and other small open areas; forest in national parks, nature reserves and other protected areas such as those of specific scientific, historical, cultural or spiritual interest; windbreaks, shelterbelts and corridors of trees with an area of more than 0.5 ha and width of more than 20 m; plantations primarily used for forestry or protective purposes, such as rubber-wood plantations and cork oak stands. Excludes: tree stands in agricultural production systems, for example in fruit plantations and agroforestry systems. The term also excludes trees in urban parks and gardens."*

**Photo 8: Cattle grazing on an agricultural field in the Madhupur Forest Reserve**

### 9.1.1. The area of Bangladesh by Land Use Classes

The land use area statistics have been generated using a combination of findings from the remote sensing survey and the field survey, following a harmonised land use/forest type classification system. The total area of Bangladesh is 14.757 million hectares (Stat. Year Book 2004). In this current NFA, 56% of the area has been classified as "Cultivated land", almost 20% as "Villages", 14% as "Inland water", close to 10% as "Forest" and less than 1% as "Built up areas" as shown in Table 8 and Figure 8. A further subdivision of land classes and respective area contribution to the total is presented in Table 9.

**Table 8: Area of major National LUCs (1000 ha)**

| Forest | Cultivated land | Villages | Built up area | Inland water |
|---|---|---|---|---|
| 1,442 | 8,327 | 2,862 | 104 | 2,022 |

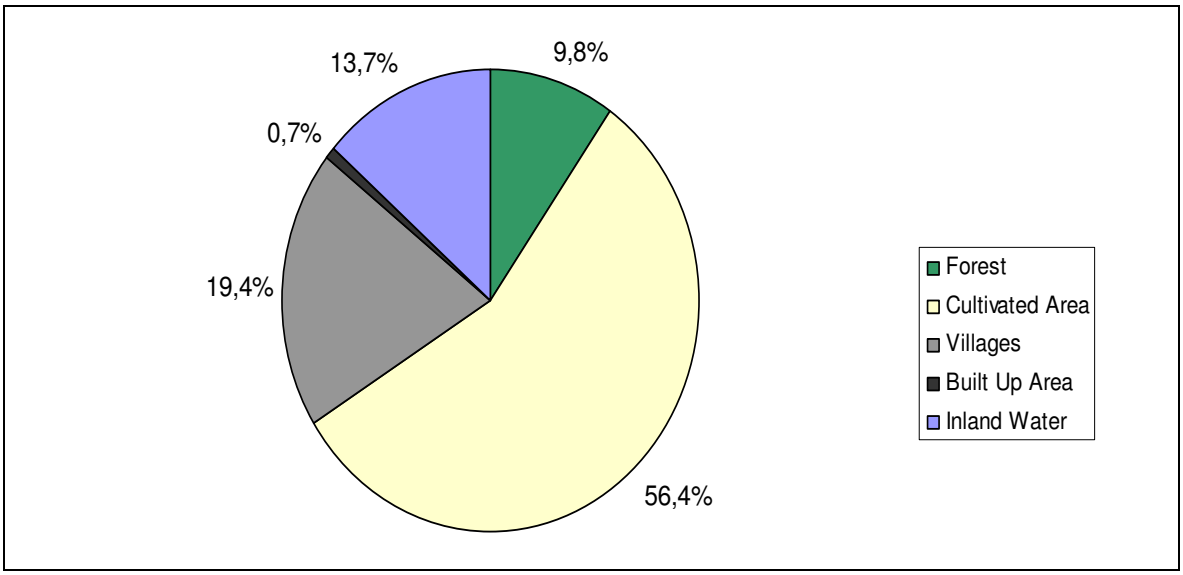


**Figure 8: Total area of Bangladesh divided into major National LUCs**

**Table 9: Total area of Bangladesh by National Land Use Classes**

| International LUCs | National Land Use Classes | | | | Area |
|---|---|---|---|---|---|
| | Level 1 | Level 2 | Level 3 | | 1000 ha |
| Forest (F) 1 442 | **Forest (F) 1 442** | Natural Forest (FN) 1 204 | Hill forest | (FH) | 551[1] |
| | | | Sal forest | (FSa) | 34[1] |
| | | | Mangrove forest (saltwater) | (FM) | 436[1] |
| | | | Bamboo or mixed Bamboo/broad-leaved forest | (FB) | 184[2] |
| | | Forest Plantations (FP) 237 | Long rotation forest plantation | (PL) | 131[2] |
| | | | Short/medium rotation forest plantation | (PS) | 54[2] |
| | | | Mangrove Plantation | (PM) | 45[1] |
| | | | Rubber Plantation | (PR) | 8[1] |
| Other Wooded Land (OWL) 289 | **Cultivated Land (Cult.) 8 327** | Shrubs (S) 289 | Shrubs | (Sh) | 266[3] |
| | | | Swamps with shrubs | (Sw) | 23[1] |
| Other Land (OL) 11 005 | | Barren/Grass Land | | (BG) | 89[4] |
| | | Annual Crops (CA) 7 492 | Annual Crops Without trees | (CA0) | 6,583[4] |
| | | | Annual Crops With trees 0,1 – 0,5 ha | (CA1) | 784[4] |
| | | | Annual Crops With trees >0,5 ha | (CA2) | 126[4] |
| | | Perennial Crops (CP) 106 | Perennial Crops Without trees | (CP0) | 19[4] |
| | | | Perennial Crops With trees 0,1 – 0,5 ha | (CP1) | 8[4] |
| | | | Perennial Crops With trees > 0,5 ha | (CP2) | 79[5] |
| | | Range Land/Pasture | | (RL) | 25[4] |
| | | Wooded land with shifting cultivation (Fallow) | | (Fa) | 327[2] |
| | **Villages (Vill.) 2 862** | Rural settlement without trees | | (SR0) | 95[4] |
| | | Rural settlement With trees 0,1 – 0,5 ha | | (SR1) | 1,090[4] |
| | | Rural settlement With trees > 0,5 ha | | (SR2) | 1,677[4] |
| | **Built-Up Areas (BUA) 104** | Urban settlements | | (SU) | 85[1] |
| | | Highways and other artificial areas | | (HA) | 19[1] |
| Inland Water (W) 2 022 | **Inland Water (W) 2 022** | Lake | | (WL) | 43[1] |
| | | River | | (WR) | 1,070[1] |
| | | Pond | | (WP) | 286[4] |
| | | Haor & Baor | | (WHB) | 622[1] |
| **Total country area of Bangladesh** | | | | | **14,757**[0] |

[0] Data calibrated to official land area of Bangladesh : 13,021,452 ha, and official inland water (WL+WR+WHB) area of Bangladesh : 1,735,548 ha (source SPARRSO)

[1] Data source: Remote Sensing Study, RS (SPARRSO, 2007)

[2] Data source: National Forest Field Inventory, NFI (BFD, 2007)

[3] Data source: RS adjusted by NFI data. Data source: RS adjusted by NFI data. Data correspond to RS(Sh+FB+Fa) - NFI(FB+PL+$PS^{hilltracts}$+Fa)

[4] Data source: NFI calibrated by RS: NFI (BG+CAP+RL+SRT+WP+$PS^{plainland}$) = RS (CAP+SRT+WP)

[5] Data source: Remote Sensing Study, RS (SPARRSO, 2007). Data correspond to RS (Tea and Mango plantations)

### 9.1.2. Forest area divided into natural and plantation forest

Of the total Forest area, 84% has been classified as natural forest and 16% as plantation forest as shown in Figure 9.

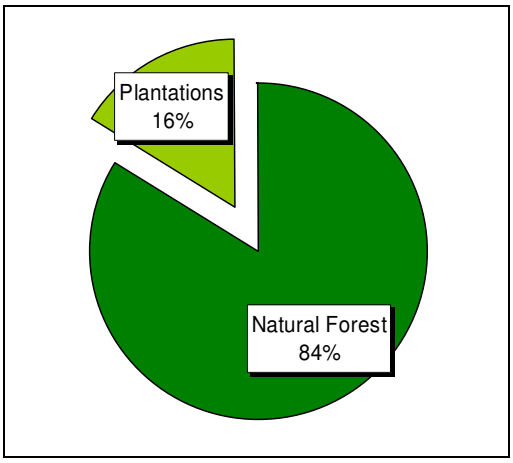


**Figure 9: Proportion of Plantation and Natural forest over Total Forest area**

### 9.1.3. Forest area by Forest Types

The two most common forest types – Hill Forest and Mangrove Forest – cover more than 2/3 of the total forest area. Bamboo Forest covers almost 13% and Long Rotation Plantations almost 10% of the total forest area.

**Table 10: Forest area by forest types (1000 ha)**

| Hill Forest | Sal Forest | Mangrove Forest | Bamboo Forest | Long Rotation Plantation | Short Rotation Plantation | Mangrove Plantation | Rubber Plantation |
|---|---|---|---|---|---|---|---|
| 551 | 34 | 436 | 184 | 131 | 54 | 45 | 8 |

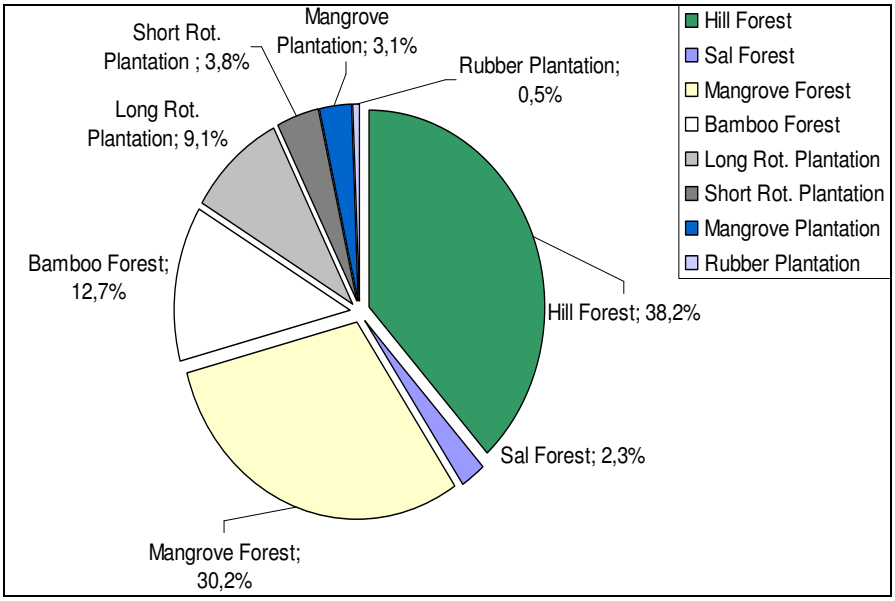


**Figure 10: Forest area by forest types**

### 9.1.4. The area of Bangladesh by Tree Cover Classes

Almost 50% of the area of Bangladesh has some kind of tree cover. Only 2,3% of the area has a very high tree cover (>70%) and roughly 20% has low tree cover (<5%).

**Table 11: Total area of Bangladesh by tree cover classes (1000 ha)**

| No Tree Cover | Tree Cover <5% | Tree Cover 5-10% | Tree Cover 10-30% | Tree Cover 30-70% | Tree Cover >70% |
|---|---|---|---|---|---|
| 7,605 | 2,886 | 1,431 | 1,276 | 1,225 | 334 |

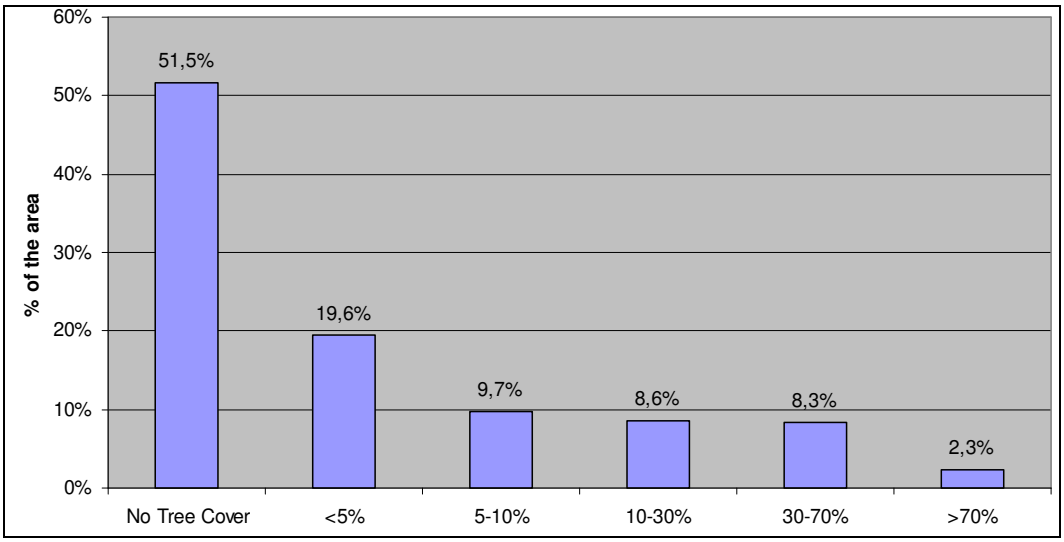


**Figure 11: Total area of Bangladesh by tree cover classes**

### 9.1.5. Forest area by Tree Cover Classes

Less than 25% of the "Forest" area has a very high tree cover (>70%), almost 40% has a tree cover of 30 to 70%, and almost 40% has less than 30% tree cover.

**Table 12: Forest area by tree cover classes**

| No Tree Cover | Tree Cover <5% | Tree Cover 5-10% | Tree Cover 10-30% | Tree Cover 30-70% | Tree Cover >70% |
|---|---|---|---|---|---|
| - | 68 | 30 | 440 | 574 | 330 |

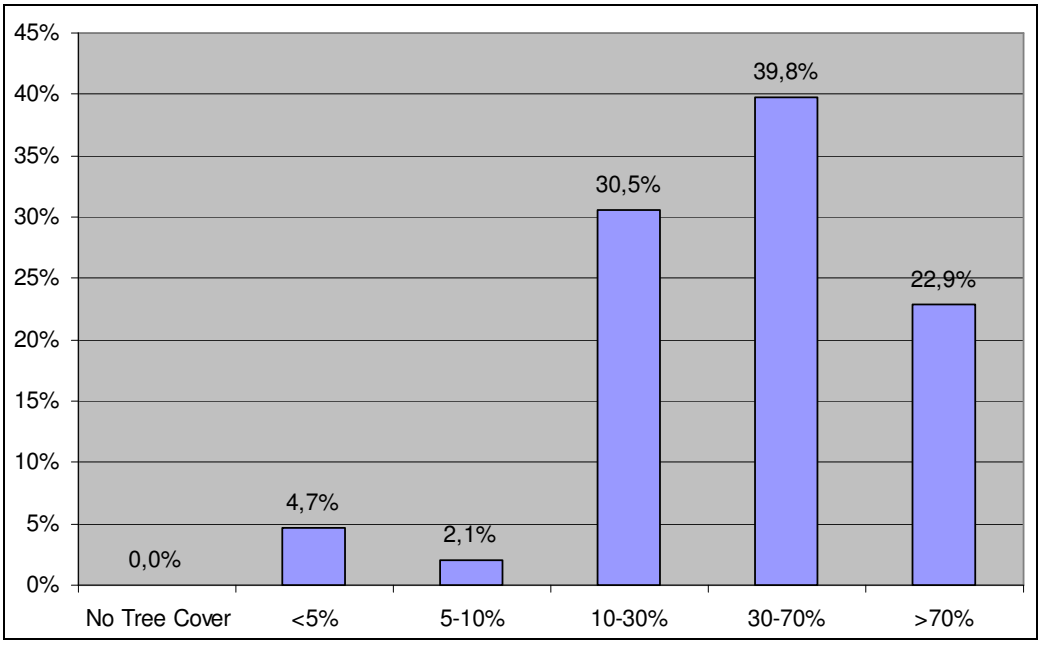


**Figure 12: Forest area by tree cover classes**

### 9.1.6. Cultivated land area by Tree Cover Classes

More than 30% of the Cultivated land area has tree cover, however it is generally low in terms of percentage of cover, with 20% having a cover of less then 5%.

**Table 13: Cultivated land area by tree cover classes (1000 ha)**

| No Tree Cover | Tree Cover <5% | Tree Cover 5-10% | Tree Cover 10-30% | Tree Cover 30-70% | Tree Cover >70% |
|---|---|---|---|---|---|
| 5,553 | 1,866 | 460 | 197 | 227 | 25 |

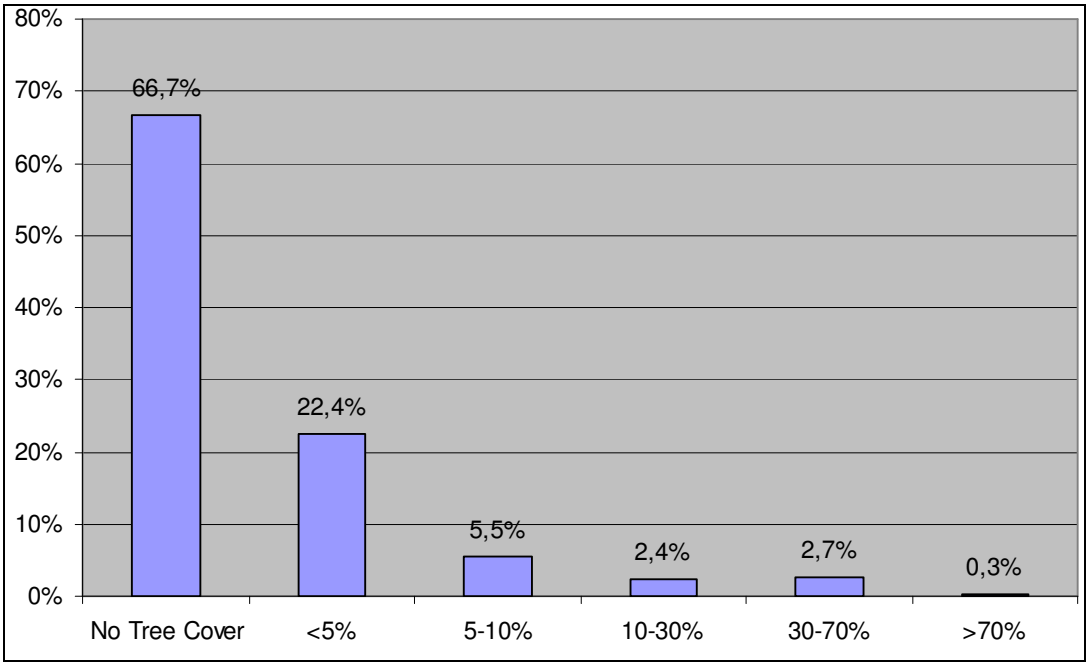


**Figure 13: Cultivated land area by tree cover classes**

### 9.1.7. Village area by Tree Cover Classes

Almost all of the Village area is covered by trees however, only a very small fraction of the Village area has a very high tree cover. Also, a very small area has no tree cover at all.

**Table 14: Village area by tree cover classes (1000 ha)**

| No Tree Cover | Tree Cover <5% | Tree Cover 5-10% | Tree Cover 10-30% | Tree Cover 30-70% | Tree Cover >70% |
|---|---|---|---|---|---|
| 40 | 752 | 873 | 675 | 491 | 31 |

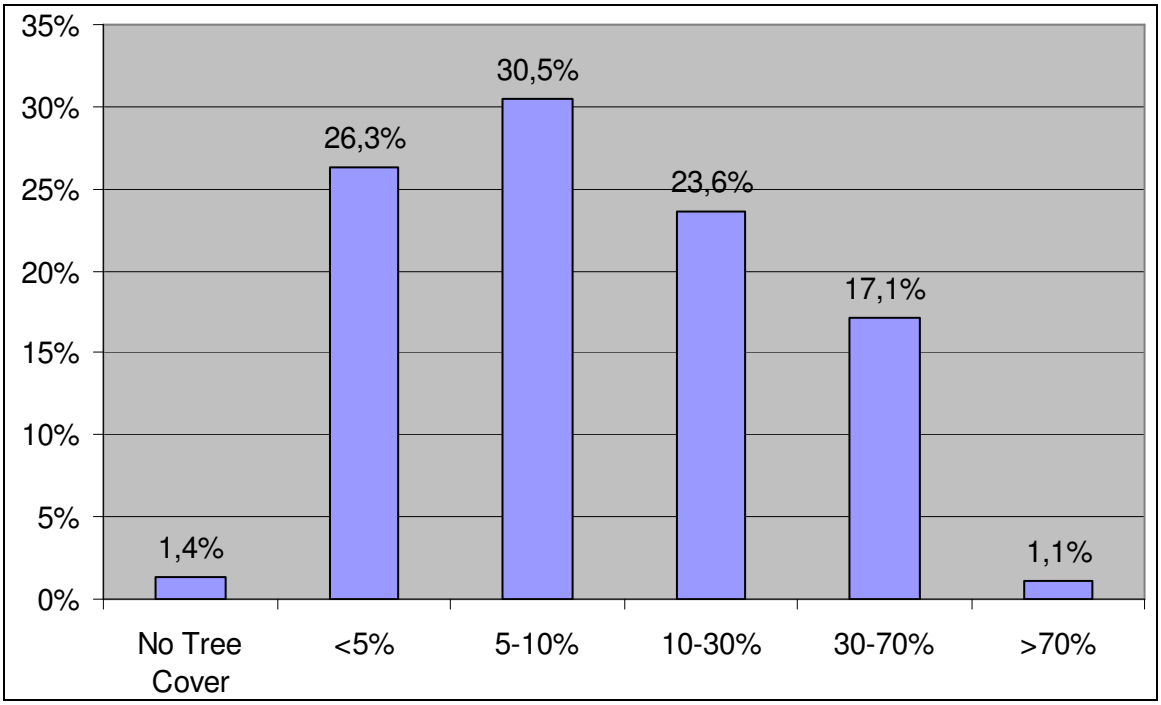


**Figure 14: Village area by tree cover classes (%)**

### 9.1.8. Built-up areas by Tree Cover Classes

The majority of the Built-up area has a low tree cover. Almost 70% has a tree cover of less then 5% while 11% has no tree cover at all.

**Table 15: Built-up area by tree cover classes (1000 ha)**

| No Tree Cover | Tree Cover <5% | Tree Cover 5-10% | Tree Cover 10-30% | Tree Cover 30-70% | Tree Cover >70% |
|---|---|---|---|---|---|
| 12 | 72 | 19 | 0 | 0 | 0 |

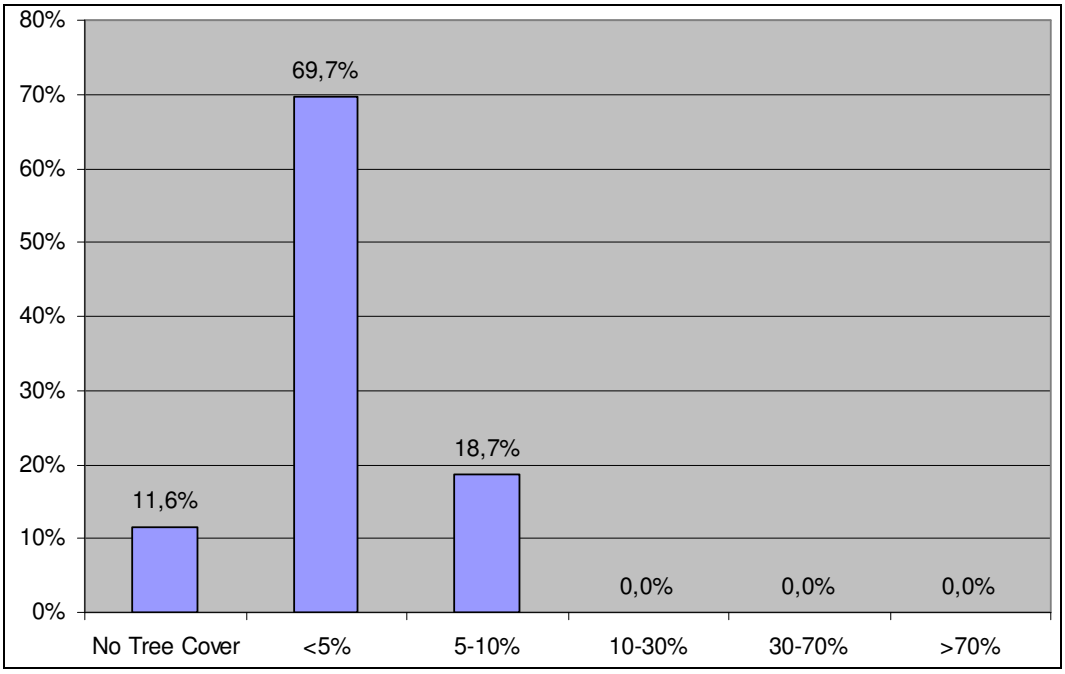


**Figure 15: Built-up area by tree cover classes**

### 9.1.9. Inland water by Tree Cover Classes

Almost 95% of the Inland water area has no tree cover. Only 5% has tree cover of < 5%.

**Table 16: Inland water area by tree cover classes (1000 ha)**

| No Tree Cover | Tree Cover <5% | Tree Cover 5-10% | Tree Cover 10-30% | Tree Cover 30-70% | Tree Cover >70% |
|---|---|---|---|---|---|
| 1,910 | 100 | 12 | 0 | 0 | 0 |

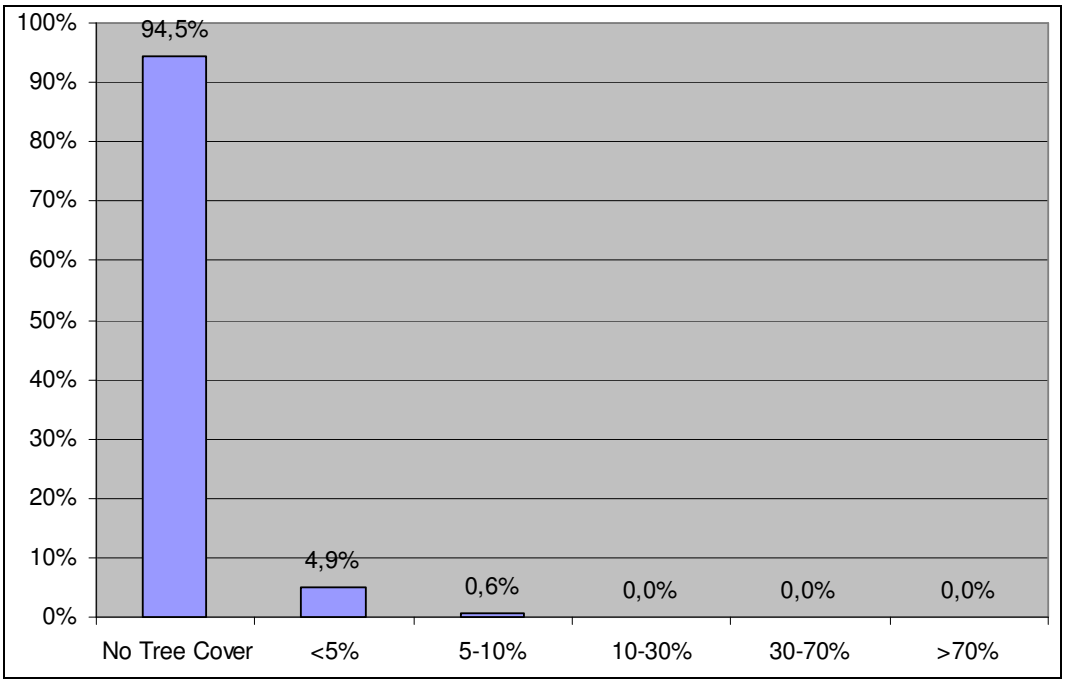


**Figure 16: Inland water area by tree cover classes**

### 9.1.10. Forest types area by Tree Cover Classes

The Hill Forest and Bamboo Forest in general have a tree cover of 10-70%. All the Mangrove forest area has a very high tree cover. The plantations in general have a low tree cover.

**Table 17: Forest types area by tree cover classes (1000 ha)**

| Forest Type | Tree Cover <5% | Tree Cover 5-10% | Tree Cover 10-30% | Tree Cover 30-70% | Tree Cover >70% |
|---|---|---|---|---|---|
| Hill Forest | 0 | 3 | 247 | 297 | 4 |
| Mangrove Forest | 0 | 0 | 0 | 0 | 436 |
| Bamboo Forest | 5 | 3 | 39 | 131 | 6 |
| Long Rotation Pltn. | 39 | 16 | 18 | 31 | 27 |
| Short Rotation Pltn. | 0 | 3 | 48 | 3 | 0 |
| Mangrove Pltn. | 45 | 0 | 0 | 0 | 0 |

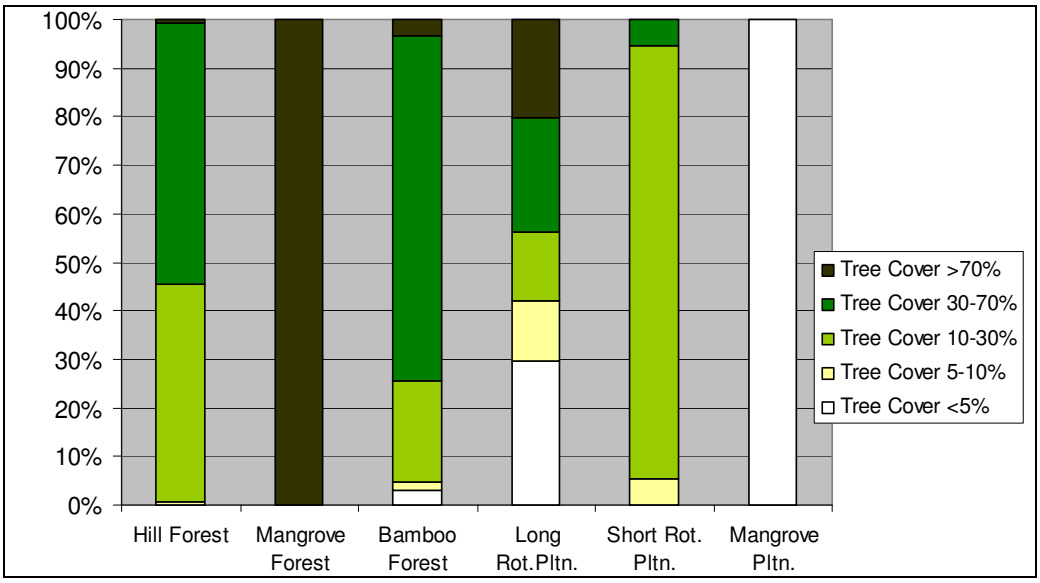


**Figure 17: Forest types area by tree cover classes (%)**

### 9.1.11. Bangladesh total area by classes of protection level

Of the Major Land Use classes (LUCs) “Cultivated land”, “Villages” and “Built up areas” have a low level of protection. Almost 10% of the “Inland water” is protected. For “Forest”, 30% of the area is protected as Strict Nature Reserve or National Park.

**Table 18: Major LUCs by classes of protection level (1000 ha)**

| Forest Type | Strict Nature Reserve | National Park | National Monument | HM Area | Protected Landscape | Multiple Purposes | Production | Others/ Not known |
|---|---|---|---|---|---|---|---|---|
| Forest | 390 | 43 | 0 | 12 | 0 | 0 | 996 | 0 |
| Cultivated land | 3 | 1 | 0 | 14 | 97 | 0 | 8,212 | 0 |
| Villages | 0 | 0 | 6 | 0 | 0 | 18 | 2,827 | 10 |
| Built up area | 0 | 0 | 0 | 0 | 0 | 2 | 98 | 3 |
| Inland water | 0 | 0 | 0 | 20 | 130 | 6 | 1,746 | 120 |

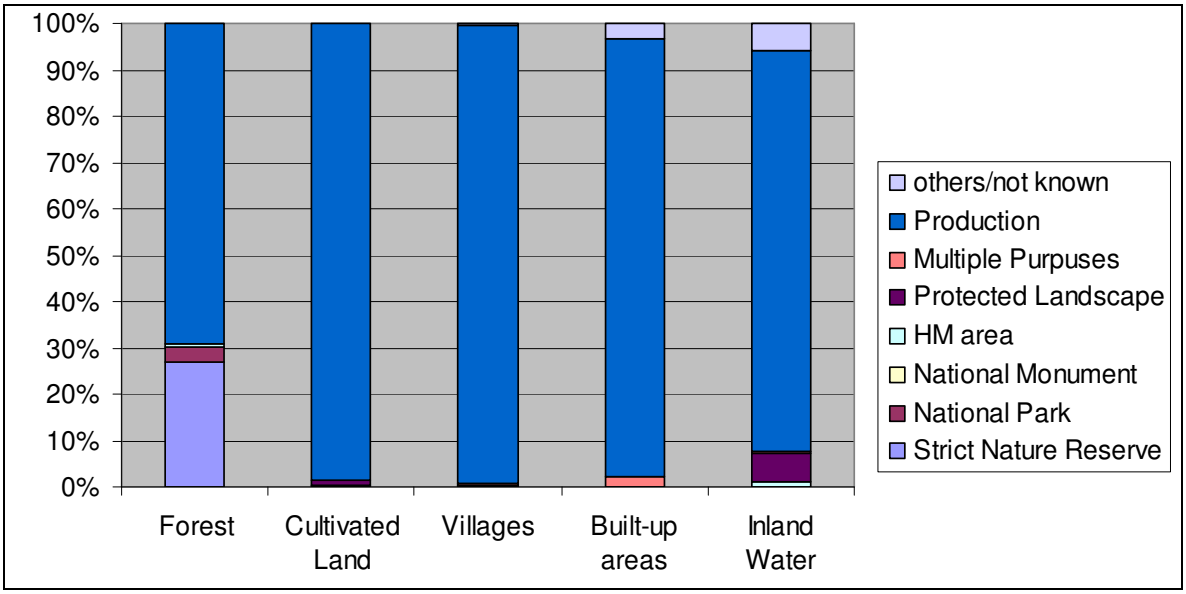


**Figure 18: Major LUCs by classes of protection level (%)**

### 9.1.12. Forest types by classes of protection level

Close to 100% of the Mangrove forest is considered as Strict Nature Reserve. In Hill Forest and Bamboo Forest about 20% of the area is considered Strict Nature Reserve or National Park. The Plantation areas have a very low level of protection.

**Table 19: Forest types by classes of protection level (1000 ha)**

| Forest Type | Strict Nature Reserve | National Park | HM Area | Production |
|---|---|---|---|---|
| Hill Forest | 93 | 4 | 1 | 453 |
| Mangrove Forest | 414 | 0 | 0 | 22 |
| Bamboo Forest | 0 | 30 | 9 | 145 |
| Long Rot. Pltn. | 0 | 2 | 0 | 128 |
| Short Rot. Pltn. | 0 | 0 | 0 | 54 |
| Mangrove Pltn. | 0 | 0 | 0 | 45 |

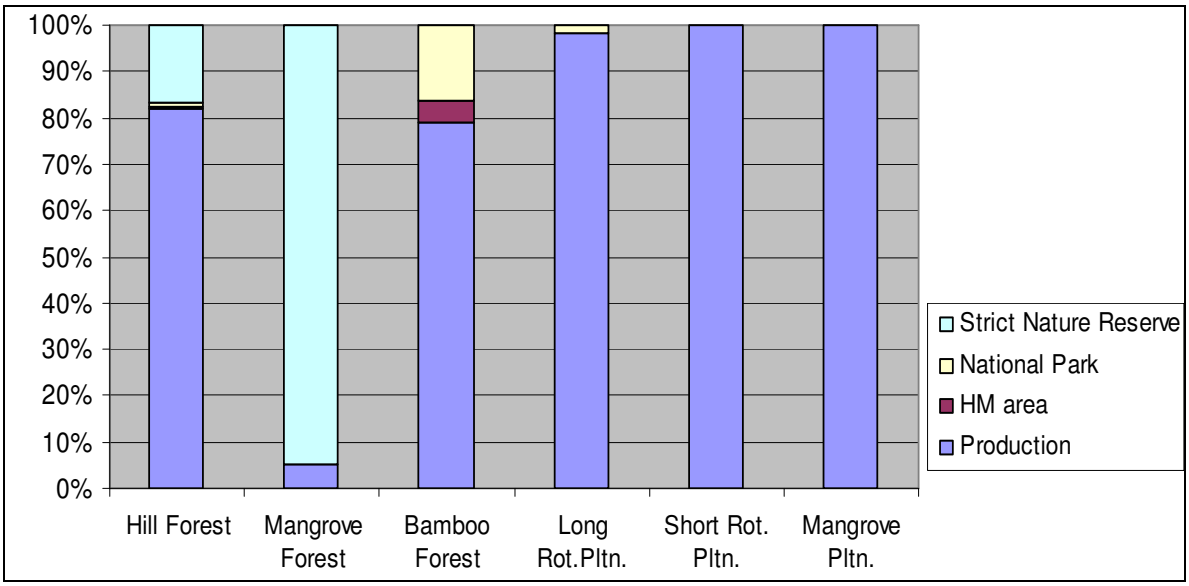


**Figure 19: Forest types by classes of protection level (%)**

### 9.1.13. The area of Bangladesh by type of ownership

More than 95% of the area of Bangladesh is owned by individuals (81%) or by the state (14%). Indigenous ownership constitutes 2,5%. In "Cultivated land" and "Villages" almost 100% of the area is individually owned. In "Forest" and "Inland water" about 50% of the area is state-owned. Approximately 20% of the "Forest" area is owned by indigenous groups.

**Table 20: Major National LUCs by ownership class (1000 ha)**

| Land Use | Individual ownership | Industrial ownership | State ownership | Public ownership Regional | Community ownership | Indigenous ownership | Other/ unknown ownership |
|---|---|---|---|---|---|---|---|
| Forest | 177 | 0 | 860 | 27 | 0 | 344 | 33 |
| Cultivated land | 8,002 | 25 | 213 | 2 | 6 | 28 | 51 |
| Village | 2,828 | 12 | 3 | 0 | 15 | 0 | 4 |
| Built up area | 91 | 0 | 13 | 0 | 0 | 0 | 0 |
| Inland water | 892 | 0 | 1,026 | 29 | 22 | 0 | 53 |
| **TOTAL** | **11,990** | **37** | **2,115** | **58** | **43** | **372** | **141** |
| TOTAL (%) | 81,3% | 0,2% | 14,3% | 0,4% | 0,3% | 2,5% | 1,0% |

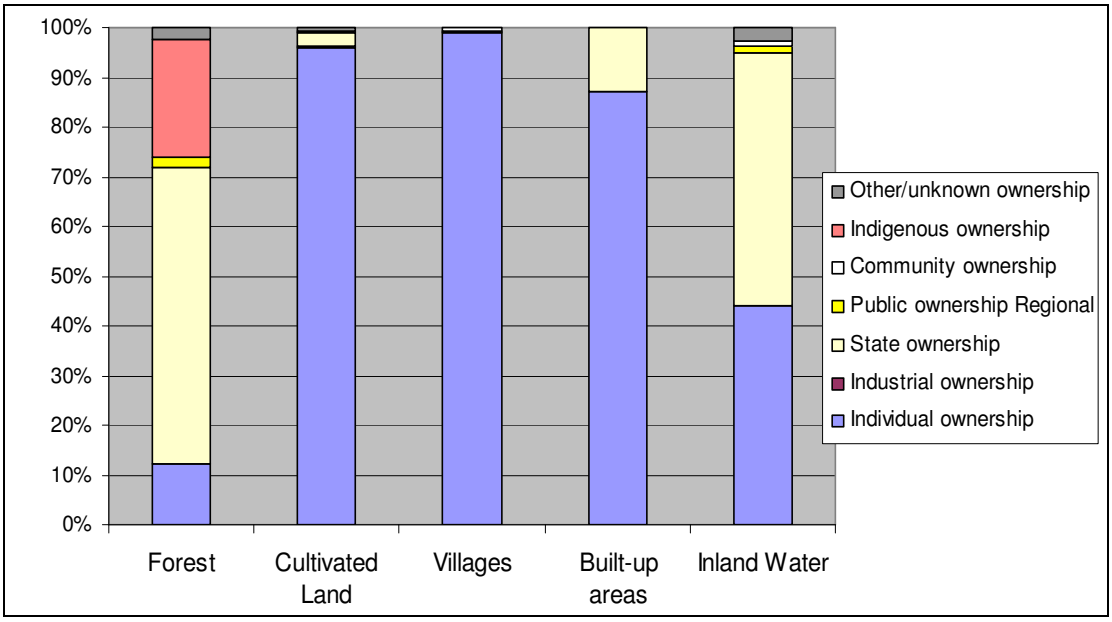


**Figure 20: Major National LUCs by ownership class (%)**

### 9.1.14. The area of state owned and individually owned land by major National LUC

The state owns 860 thousand hectares classified as "Forest", slightly more than 200 thousand hectares of "Cultivated land" and more than 1,000 thousand hectares of "Inland water". Altogether the state owns an area of more than 2,100 thousand hectares. Individuals own 12,500 thousand hectares. This area mainly consists of "Cultivated land" and "Villages".

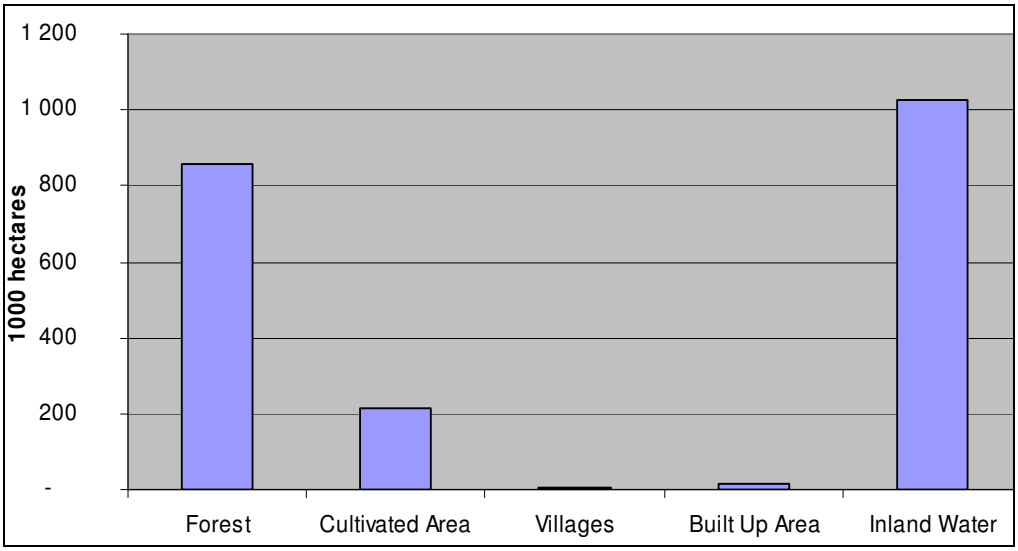


**Figure 21: State owned land by major national LUC (1000 ha)**

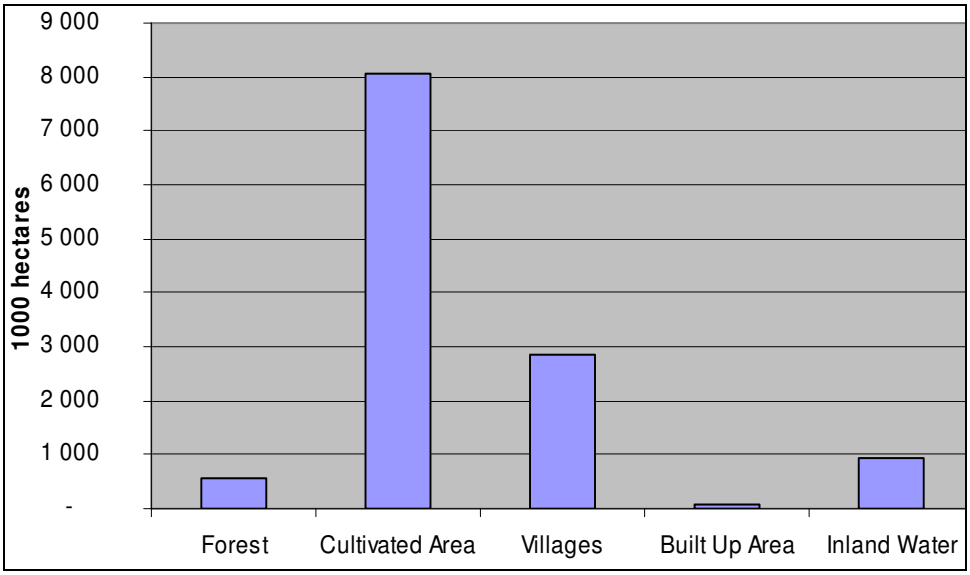


**Figure 22: Individually owned land by major national LUC (1000 ha)**

### 9.1.15. The area of Bangladesh by Global Ecological Zones (GEZ)

The world is divided into 5 Global Ecological Domains (Figure 23) and 20 Global Ecological Zones (Figure 24 and Table 21) (FAO 2001). Two of these zones are present in Bangladesh: Tropical rain forest (TAr) and Tropical moist deciduous forest (TAwa) (Figure 25). The area of Bangladesh and major LUCs belonging to the two GEZ classes is indicated in Table 22.

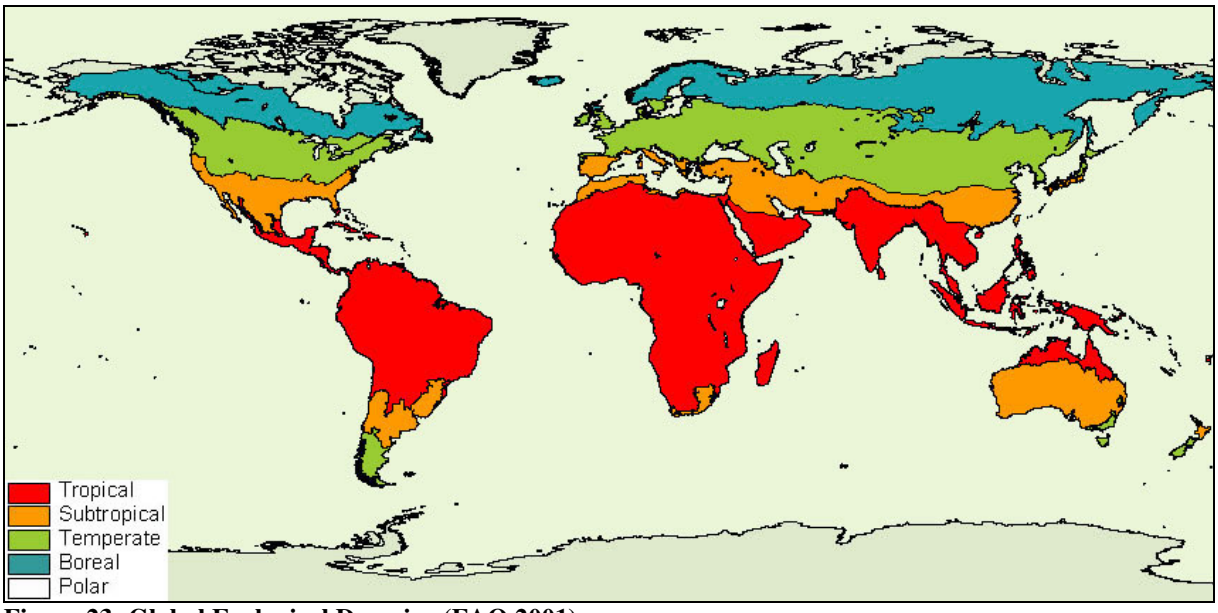


**Figure 23: Global Ecological Domains (FAO 2001)**

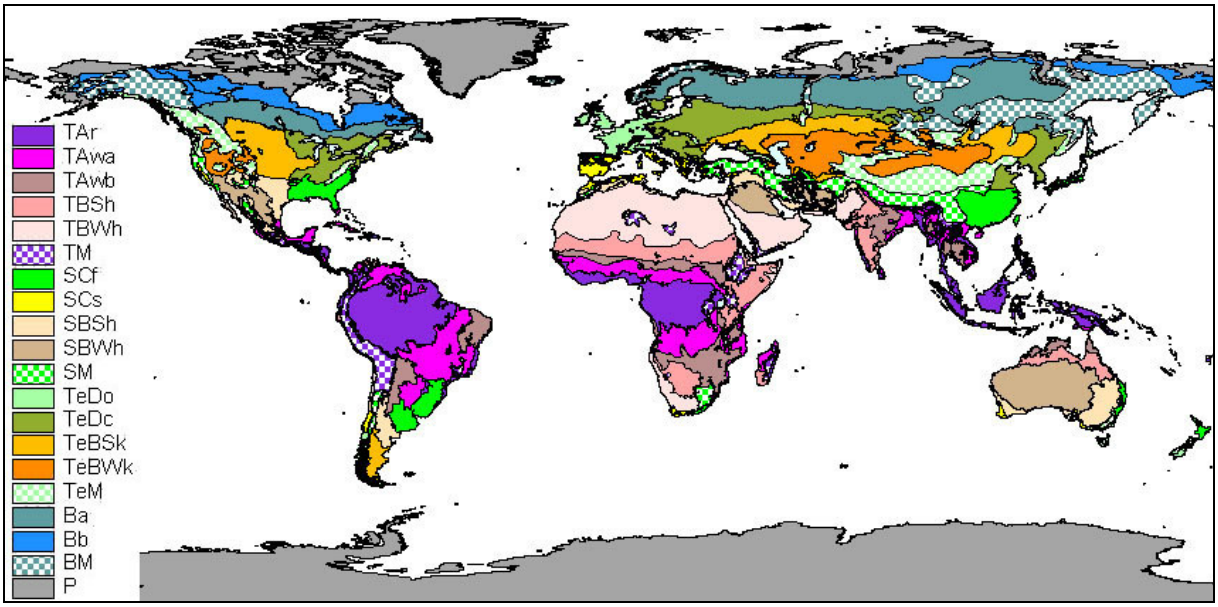


**Figure 24: Global Ecological Zones (FAO 2001)**

**Table 21: Global Ecological Zones (FAO 2001)**

| | |
|---|---|
| Tropical rain forest | TAr |
| Tropical moist deciduous forest | TAwa |
| Tropical dry forest | TAwb |
| Tropical shrubland | TBSh |
| Tropical desert | TBWh |
| Tropical mountain systems | TM |
| Subtropical humid forest | SCf |
| Subtropical dry forest | SCs |
| Subtropical steppe | SBSh |
| Subtropical desert | SBWh |
| Subtropical mountain systems | SM |
| Temperate oceanic forest | TeDo |
| Temperate continental forest | TeDc |
| Temperate steppe | TeBSk |
| Temperate desert | TeBWk |
| Temperate mountain systems | TeM |
| Boreal coniferous forest | Ba |
| Boreal tundra woodland | Bb |
| Boreal mountain systems | BM |
| Polar | P |

**Table 22: Total area of Bangladesh and major LUCs by GEZ classes (1000 ha)**

| Land Use | TAR | Tawa |
|---|---|---|
| Forest | 1,014 | 428 |
| Cultivated land | 2,311 | 6,017 |
| Village | 604 | 2,258 |
| Built up area | 7 | 97 |
| Inland water | 899 | 1,123 |
| **Total** | **4,835** | **9,922** |
| Total (%) | 32,8% | 67,2% |

The geo-ecological zone tropical moist Forest (Tawa) constitutes more than 2/3 of Bangladesh. Less than 1/3 of the area belongs to the Geo-zone Tropical Rain Forest (TAR), see Figure 26. The "Forest" area is mainly situated in the "TAR" zone. One exception is the Mangrove Forest which is found primarily in the "Tawa" zone (see Table 22).

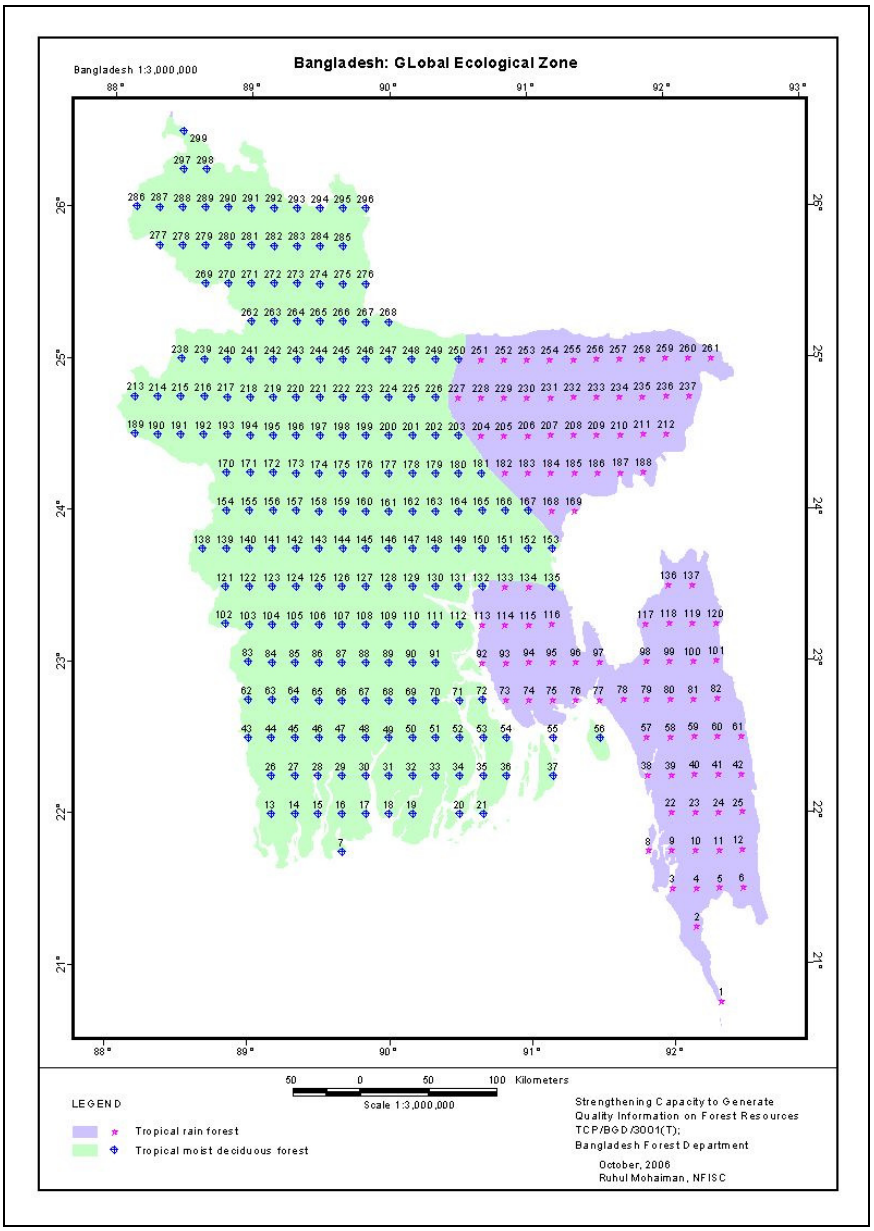


**Figure 25: Global Ecological Zones of Bangladesh (including NFA tracts)**

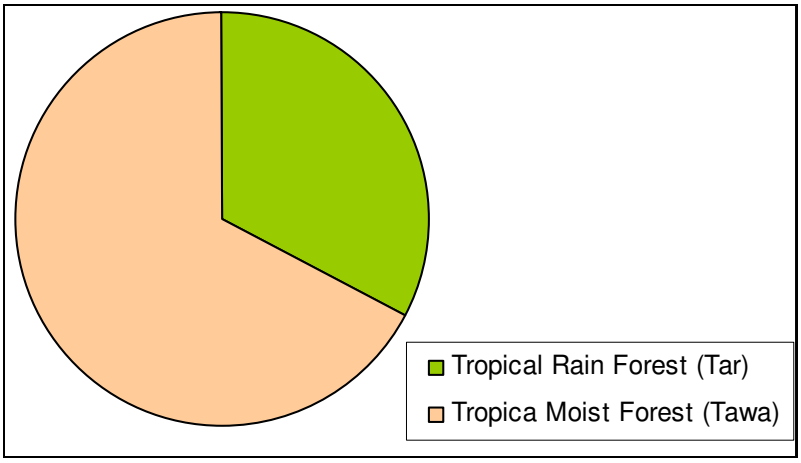


**Figure 26: Area proportions of Global Ecological Zones in Bangladesh**

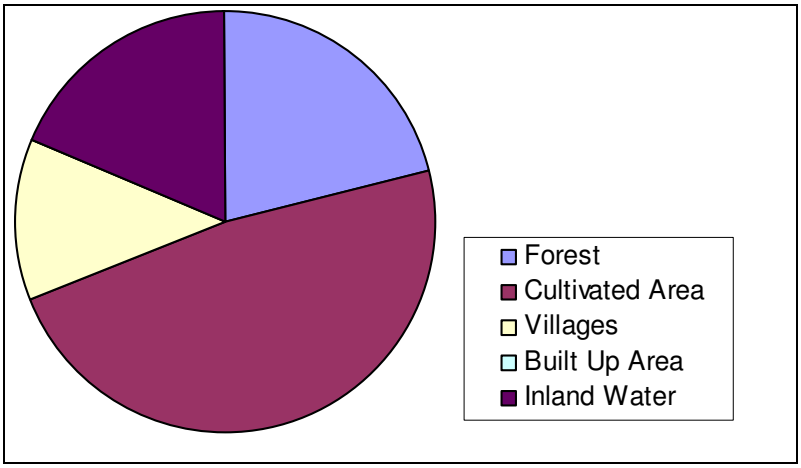


**Figure 27: Distribution of major land uses in the Tropical Rainforest zone**

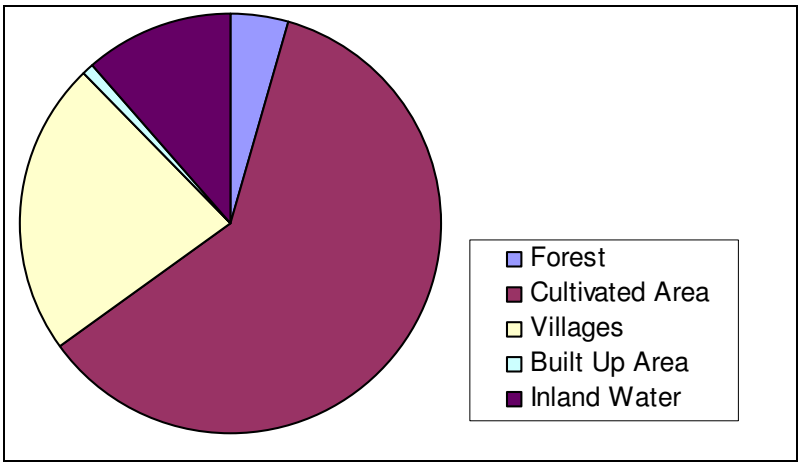


**Figure 28: Distribution of major land uses in the Tropical Moist Forest zone**

### 9.1.16. The area of Bangladesh by Environmental problems

In the NFA-methodology the same area can have several environmental problems. Environmental problems in the major National Land Use Classes are presented below in Table 23.

**Table 23: Environmental problems in major National LUCs (%)**

| | Forest | Cultivated land | Village | Built up area | Inland water | Total |
|---|---|---|---|---|---|---|
| Not existing | 9% | 44% | 40% | 55% | 40% | **39%** |
| Loss of water | - | 2% | 2% | - | 2% | **2%** |
| Drought | - | 9% | 9% | 1% | 2% | **7%** |
| Flooding | - | 18% | 17% | 5% | 16% | **16%** |
| Poor water | 9% | 5% | 11% | - | 16% | **8%** |
| Pests | 10% | 7% | 2% | - | - | **5%** |
| Erosion | 60% | 8% | 2% | - | 20% | **14%** |
| Loss of soil fertility | 24% | 20% | 17% | 14% | 11% | **19%** |
| Burning | 5% | 3% | 2% | - | - | **3%** |
| Landslide | 5% | 4% | - | - | 2% | **3%** |
| Wind throw | 2% | - | - | - | - | **-** |
| Over exploitation | 28% | 4% | - | 1% | - | **5%** |
| Over grazing | 2% | - | - | - | - | **-** |

The most common environmental problems in Bangladesh are loss of soil fertility, erosion and flooding, but also poor water and drought. In “Forest”, the most common environmental problems are erosion, over exploitation and loss of soil fertility. In “Cultivated land” and “Villages” the most common problems are loss of soil fertility, flooding, poor water and drought. In “Inland water” erosion, flooding, poor water and loss of soil fertility are the most common environmental problems.

### 9.1.17. Environmental problems in the different forest types

In Hill Forest the most common environmental problems are erosion, over exploitation and loss of soil fertility. In Mangrove Forest the most common environmental problems are poor water and pests and in the Bamboo Forest erosion and over exploitation. In the plantations the environmental problems are loss of soil fertility, erosion and over grazing.

**Table 24: Environmental problems in different Forest types (%)**

| | Hill Forest | Mangrove Forest | Bamboo Forest | Long rotation plantation | Short rotation plantation |
|---|---|---|---|---|---|
| Not existing | 2% | 10% | - | 50% | - |
| Loss of water | - | - | - | - | - |
| Drought | - | - | - | - | - |
| Flooding | - | - | - | - | - |
| Poor water | - | 44% | - | - | - |
| Pests | 2% | 47% | - | - | - |
| Erosion | 87% | - | 83% | 39% | - |
| Loss of soil fertility | 35% | - | 11% | 34% | 46% |
| Burning | 8% | - | 7% | - | - |
| Landslide | 11% | - | - | - | - |
| Wind throw | - | 10% | - | - | - |
| Over exploitation | 47% | - | 31% | - | - |
| Over grazing | - | - | - | - | 46% |

### 9.1.18. Expected change in tree cover by major National LUC

Almost 3 million hectares of Cultivated land and the same area of Villages are expected to increase its tree cover. Nearly all Forest area is expected to register an increase in its tree cover. The rest of the country area is expected to maintain current tree cover level.

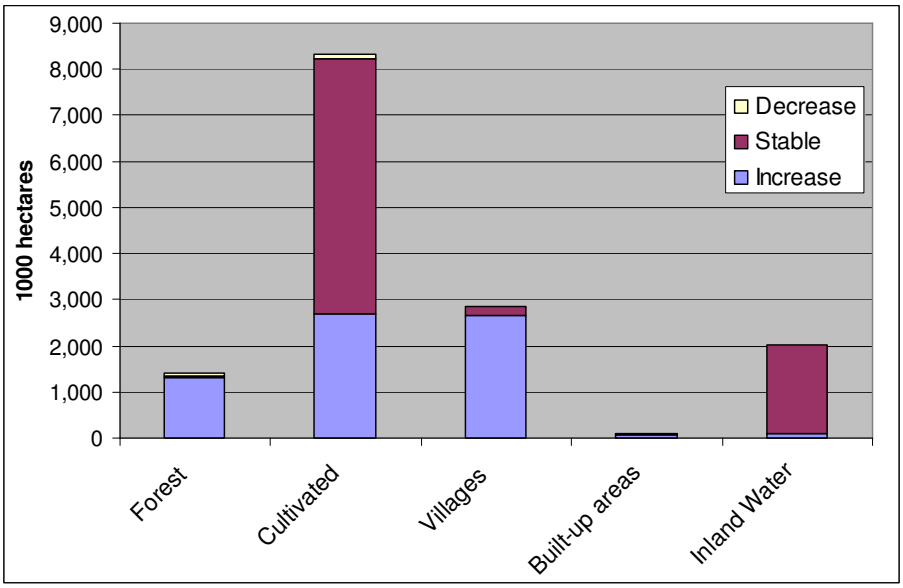


**Figure 29: Expected change in tree cover by major National LUC (1000 ha)**

### 9.1.19. Expected future trees in the different forest types

The major part of all forest types is expected to increase their current tree cover. The only and relatively small decrease in tree cover is expected to occur in Hill Forest and Bamboo forests.

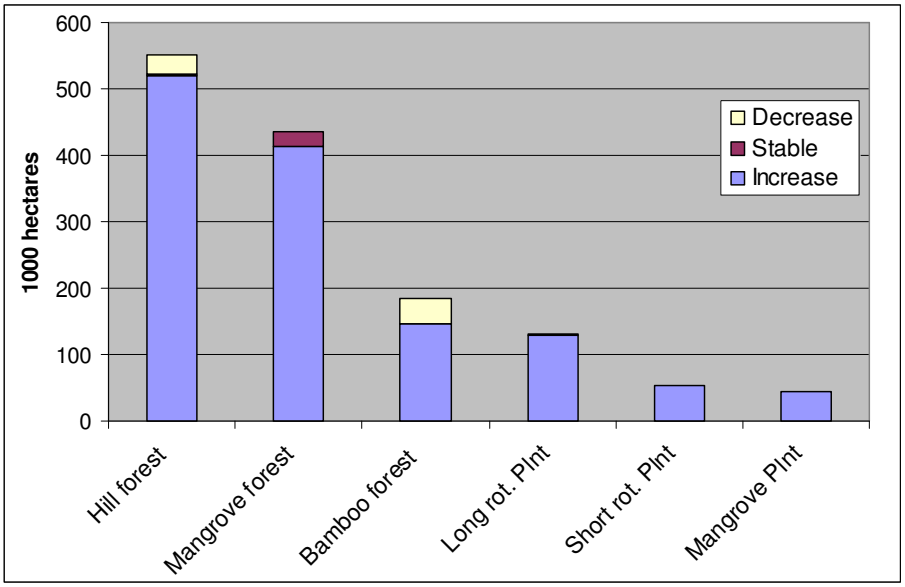


**Figure 30: Expected change in tree cover by forest type (1000 ha)**

### 9.1.20. Forest area – management agreements and management plans

In the NFA Project, the management plan is categorized into "Formal" and "Traditional". An area is said to be managed under "Formal management plan" when a "formal management plan was formulated and implemented". On the other hand, an area is said to be under "Traditional management plan" when "no formal management plan was formulated or when a formal management plan was formulated but not implemented".

For all the different forest types, where the management agreement is known, the forest is exclusively managed by the owner. Thus, in some of the Hill forest the management agreement is unknown.

Based on the results of the forest assessment 46% of the country's total "Forest" are under "Formal management plan" and 50% are under "Traditional management plan". Of the different forest types, only "Mangrove Forest" is totally covered by a "Formal management plan". Most of the areas in "Hill Forest" and "Bamboo or mixed Bamboo/Broad-leaved Forest" are under "Traditional management plan".

**Table 25: Forest area by type of Management and by forest types (1000 ha)**

| Forest Type | Formal | Traditional | Not Known | Total |
|---|---|---|---|---|
| Hill Forest | 63 | 453 | 35 | 551 |
| Mangrove Forest | 436 | 0 | 0 | 436 |
| Bamboo Forest | 7 | 162 | 14 | 184 |
| Long Rotation Pltn. | 104 | 27 | 0 | 131 |
| Short Rotation Pltn. | 37 | 14 | 3 | 54 |
| Mangrove Plantation | 0 | 45 | 0 | 45 |
| **Forest*** | **648** | **700** | **52** | **1,400** |
| **Forest* (%)** | 46% | 50% | 4% | 100% |

* Total Forest area only inclusive of inventoried forest types

### 9.1.21. Forest area – stand origin

Stand origin refers to the apparent source of the vegetation on the area. Stand origin can vary from one stand to another, even though the stands are of the same forest type. It may either be natural, plantation or coppice. "Natural stand" refers to natural regeneration of stand by seed; "Plantation stand" refers to the artificial regeneration of stand by seeding or planting; and "Coppice stand" refers to regeneration by shoots from stumps or roots.

82% of the total "Forest" area consists of natural stands and 18% are man-made forests. The results also show that there are patches of established plantations within the "Hill Forest" and "Bamboo or mixed Bamboo/Broad-leaved Forest".

**Table 26: Forest area by forest type and stand origin (1000 ha)**

| | Natural | Plantation |
|---|---|---|
| Hill Forest | 528 | 23 |
| Mangrove Forest | 436 | 0 |
| Bamboo Forest | 180 | 4 |
| Long Rotation Pltn. | 0 | 131 |
| Short Rotation Pltn. | 0 | 54 |
| Mangrove Pltn. | 0 | 45 |
| **Forest*** | **1,143** | **257** |
| Forest* (%) | 82% | 18% |

* Total Forest area only inclusive of inventoried forest types

### 9.1.22. Forest area – stand structure

Tree canopies can be categorized into single layer, two-layer, three-layer, or more than three-layer. "Single layer vegetation" refers to a stand with only one well-defined layer formed by the tree canopies; "two-layer vegetation" refers to a stand with two distinct canopy layers: an upper layer (a dominant canopy layer with two thirds above the lower layer, forming a clearly defined layer with at least 20% canopy cover), and a lower layer; "three-layer vegetation" refers to a stand with three distinct canopy layers, each with at least 20% canopy cover; and "more than three-layer" refers to a stand with more than three distinct layers of tree canopies. Out of the total "Forest" area in Bangladesh 33% of the tree canopies have single layer, 25% two-layers and 42% three-layers. Hill forest and Bamboo forest have tree canopies ranging from single layer to three layers, whereas the tree canopy of "Mangrove Forest" is completely in three layers. Plantations generally have one layer.

**Table 27: Forest and forest type by classes of stand structure (1000 ha)**

| Forest Type | 1-Layer | 2-Layer | 3-Layer |
|---|---|---|---|
| Hill Forest | 234 | 237 | 78 |
| Mangrove Forest | - | - | 435 |
| Bamboo Forest | 9 | 107 | 68 |
| Long Rotation Pltn. | 124 | 7 | - |
| Short Rotation Pltn. | 53 | 1 | - |
| Mangrove Pltn. | 45 | - | - |
| **Forest** | **465** | **352** | **581** |
| Forest (%) | 33% | 25% | 42% |

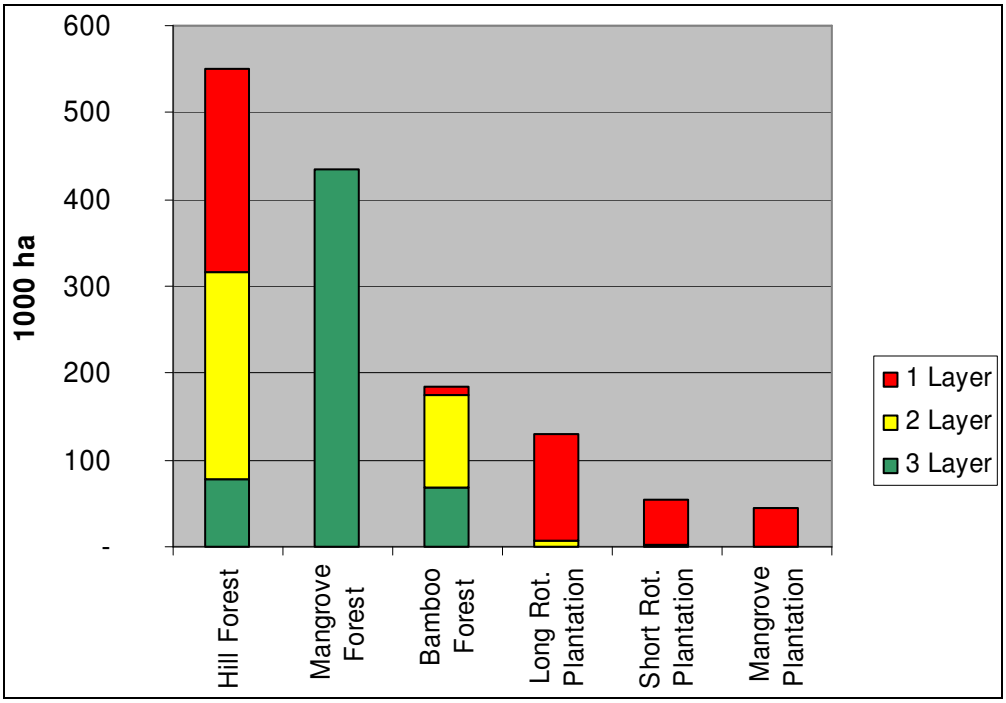


**Figure 31: Forest types by classes of stand structure (1000 ha)**

### 9.1.23. Forest area – shrub coverage

Shrubs are multi-stemmed, woody perennial plants of more than 0.5 meters and less than 5 meters in height at maturity and without a definite crown. Shrubs dominate most of the forest understory and are generally found where the trees are more widely spaced and along the forest edges. The opening of a "light gap" in the forest canopy in general stimulates the growth of pioneer tree species including shrubby plants that colonize clearings.

Mangrove forests have less than 10% shrub coverage. This may imply that mangrove areas are not suitable site for the growth of shrubs because these areas are under water most of the time or the forest stands have closed tree canopy that help suppress understory growth.

On the other hand almost 60% of the Hill forest and almost 70% of the Long rotation plantations have more than 40% shrub coverage. This may be an indication that the forest stands in these forest types have experienced either moderate or heavy ecological disturbances. Less than 25% of the Bamboo forest has shrub coverage of more than 40%.

**Table 28: Forest and forest types by classes of shrub coverage (1000 ha)**

| Forest Type | <10% | 10-40% | 40-70% | >70% |
|---|---|---|---|---|
| Hill Forest | 44 | 184 | 136 | 186 |
| Mangrove Forest | 435 | - | - | - |
| Bamboo Forest | 9 | 132 | 32 | 10 |
| Long Rotation Pltn. | 22 | 19 | 12 | 77 |
| Short Rotation Pltn. | 50 | - | 4 | - |
| Mangrove Pltn. | 45 | - | - | - |
| **Forest** | **605** | **335** | **184** | **273** |
| Forest (%) | 43% | 24% | 13% | 20% |

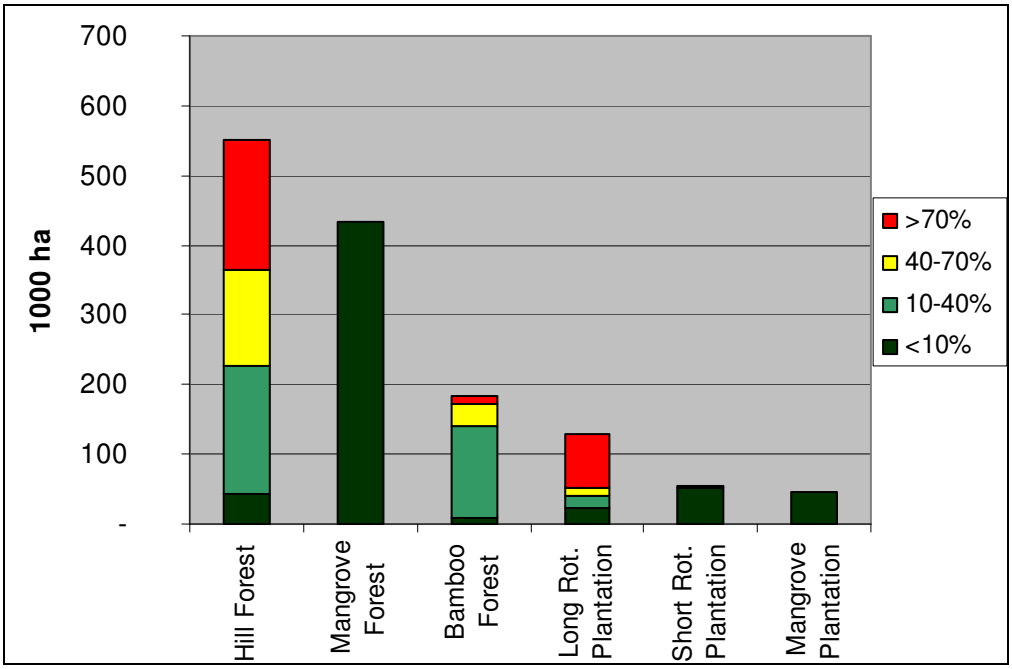


**Figure 32: Forest types by classes of shrub coverage (1000 ha)**

### 9.1.24. Forest area – degree of disturbance

In NFA, "forest disturbance" refers to the "impact level of human activity in the forest". A forest stand is categorized as "slightly disturbed" when the exploitation of goods and services is carried out according to management plans; "moderately disturbed" when many products are collected without conforming to management plans, and the notion of sustainability is not respected; and "heavily disturbed" when the rate of removal of products is higher than the Mean Annual Increment (MAI), additionally, biodiversity degradation is caused by high pressure on selected species and encroachment of agriculture leads to high rate of deforestation.

Table 29 and Figure 33 show the degree of distubance in "Forest" and in the different forest types. It can be noticed that 78% of the total Forest area is disturbed. More than 1/3 of the "Forest" area is moderately or heavily disturbed. Only slightly more than 1/5 of the "Forest" area is classified as not disturbed. Almost 60% of the Hill Forest is heavily or moderately disturbed. None of the Mangrove forest is moderately or heavily disturbed, but the major part of is slightly disturbed. Less than 40% of the Bamboo forest is moderately or heavily disturbed.

**Table 29: Forest and forest types by degree of disturbance (1000 ha)**

| Forest Type | Not Disturbed | Slightly Disturbed | Moderately Disturbed | Heavily Disturbed |
|---|---|---|---|---|
| Hill Forest | 130 | 101 | 268 | 51 |
| Mangrove Forest | 62 | 373 | 0 | 0 |
| Bamboo Forest | 82 | 34 | 64 | 3 |
| Long Rotation Pltn. | 23 | 37 | 70 | 0 |
| Short Rotation Pltn. | 9 | 43 | 0 | 1 |
| Mangrove Pltn. | 0 | 0 | 0 | 45 |
| **Forest** | **307** | **588** | **402** | **100** |
| Forest (%) | 22% | 42% | 29% | 7% |

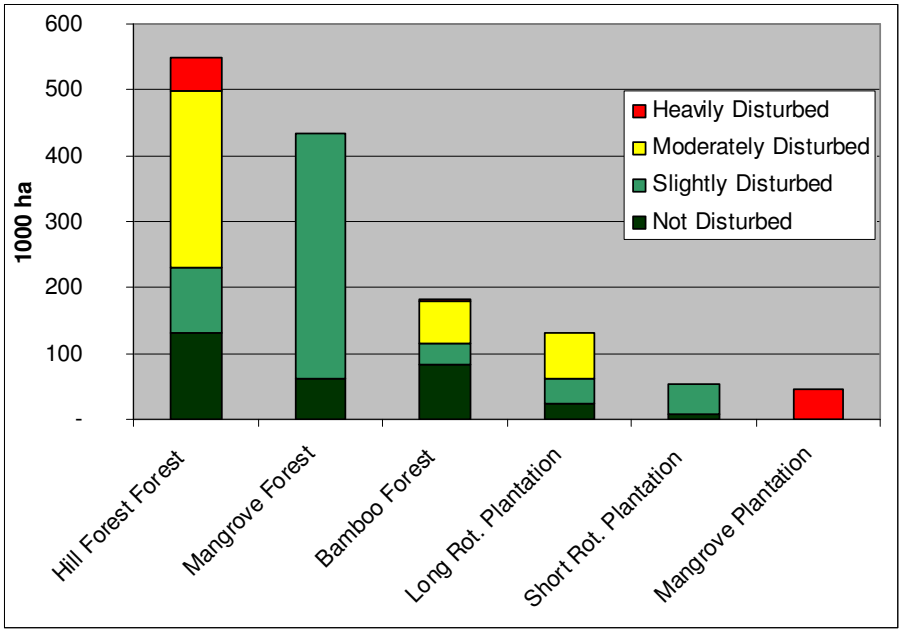


**Figure 33: Forest types by degree of disturbance (1000 ha)**

### 9.1.25. Forest area – fire occurrence

In NFA, fire occurrence is categorized as "recent fire" when the evidence of fire shows that it occurred during the current season/year; "old fire" when the evidence of fire shows that it occurred during the previous years but not during the current season. Table 30 indicates that in most of the forest area in Bangladesh there is no evidence of burning. Only 6% of the total "Forest" area has experienced burning. The major part of the burned area can be found in the Hill forest.

**Table 30: Forest and forest types by classes of fire occurrence (1000 ha)**

| Forest Type | No Evidence of Fire | Recent Fire | Old Fire |
|---|---|---|---|
| Hill Forest | 468 | 56 | 28 |
| Mangrove Forest | 436 | 0 | 0 |
| Bamboo Forest | 181 | 0 | 3 |
| Long Rotation Pltn. | 131 | 0 | 0 |
| Short Rotation Pltn. | 54 | 0 | 0 |
| Mangrove Pltn. | 45 | 0 | 0 |
| **Forest*** | **1,314** | **56** | **31** |
| Forest* (%) | 94% | 4% | 2% |

* Total Forest area only inclusive of inventoried forest types

### 9.1.26. Forest area – timber exploitation

In Bangladesh, selective felling is practiced in natural forest stands and clear felling in plantation forest. NFA defines "selective felling" as extracting only trees of certain species, dimensions, value, etc., not taking into account silvicultural needs; and "clear cutting" refers to the felling of most commercial-sized trees in a stand.

Table 31 shows that timber exploitation was carried out in 63% of the total "Forest" area. Out of the exploited area, 82% was selectivelt felled (Table 32). The clear felling was carried out mainly in the "Hill Forest", which may imply that these are either clear-cut plantations or potential areas for shifting cultivation.

**Table 31: Timber exploitation area by forest types (1000 ha)**

| Forest Type | No Felling | With Timber exploitation |
|---|---|---|
| Hill Forest | 161 | 390 |
| Mangrove Forest | 182 | 254 |
| Bamboo Forest | 30 | 154 |
| Long Rotation Pltn. | 97 | 33 |
| Short Rotation Pltn. | 50 | 4 |
| Mangrove Pltn. | 0 | 45 |
| **Forest*** | **520** | **880** |
| Forest* (%) | 37% | 63% |

* Total Forest area only inclusive of inventoried forest types

**Table 32: Area by forest types and type of timber exploitation technique (1000 ha)**

| Forest Type | Clear Felling | Selective Felling | Total area with Timber exploitation |
|---|---|---|---|
| Hill Forest | 111 | 279 | 390 |
| Mangrove Forest | 0 | 254 | 254 |
| Bamboo Forest | 0 | 154 | 154 |
| Long Rotation Pltn. | 0 | 33 | 33 |
| Short Rotation Pltn. | 0 | 4 | 4 |
| Mangrove Pltn. | 45 | 0 | 45 |
| **Forest*** | **155** | **724** | **880** |
| Forest* (%) | 18% | 82% | 100% |

* Total Forest area only inclusive of inventoried forest types

### 9.1.27. Forest area – silviculture

Table 33 shows that 35% of the total "Forest" area has been subjected to different silvicultural practices. In

Table 34 it is indicated that Enrichment planting has been the most commonly practiced treatment, covering 72% of the total area treated.

Analyses also show that two or more silvicultural practices have been applied in some forest types. This explains why in some forest types the data under "Any practice" is not equal to the sum of the different silvicultural practices.

**Table 33: Area with silviculture practices by forest types (1000 ha)**

| Forest Type | No Practice | With Practice | Total |
|---|---|---|---|
| Hill Forest | 384 | 167 | 551 |
| Mangrove Forest | 325 | 111 | 436 |
| Bamboo Forest | 90 | 93 | 184 |
| Long Rotation Pltn. | 15 | 116 | 131 |
| Short Rotation Pltn. | 45 | 9 | 54 |
| Mangrove Pltn. | 45 | 0 | 45 |
| **Forest*** | **904** | **496** | **1,400** |
| Forest* (%) | 65% | 35% | 100% |

* Represented by inventoried forest types

**Table 34: Area by forest types and type of silviculture (1000 ha)**

| Forest Type | Improvement | Release of desirable trees | Removal of undesirable vegetation layer | Enrichment | Total area with Practice |
|---|---|---|---|---|---|
| Hill Forest | 0 | 9 | 1 | 163 | 167 |
| Mangrove Forest | 111 | 0 | 0 | 0 | 111 |
| Bamboo Forest | 0 | 35 | 35 | 69 | 93 |
| Long Rotation Pltn. | 0 | 0 | 3 | 116 | 116 |
| Short Rotation Pltn. | 0 | 0 | 0 | 9 | 9 |
| Mangrove Pltn. | | | | | 0 |
| **Forest*** | **111** | **44** | **39** | **358** | **496** |
| Forest* (%) | 22% | 9% | 8% | 72% | >100% |

* Represented by inventoried forest types

### 9.1.28. Forest area – technology for tree exploitation

Technology for tree exploitation refers broadly to the equipment and techniques employed in the felling of trees and the extraction of their stems or other usable parts for subsequent processing into industrial products.

Table 35 indicates that tree exploitation was exclusively carried out with the aid of non-motorized hand tools, such as axes and manual saws.

**Table 35: Area by forest type and type of technology used (1000 ha)**

| Forest Type | Manual | Chainsaw | Mechanized | Total |
|---|---|---|---|---|
| Hill Forest | 390 | 0 | 0 | 390 |
| Mangrove Forest | 254 | 0 | 0 | 254 |
| Bamboo Forest | 154 | 0 | 0 | 154 |
| Long Rotation Pltn. | 33 | 0 | 0 | 33 |
| Short Rotation Pltn. | 4 | 0 | 0 | 4 |
| Mangrove Pltn. | 45 | 0 | 0 | 45 |
| **Forest*** | **880** | **-** | **-** | 880 |
| Forest* (%) | 100% | - | - | 100% |

* Represented by inventoried forest types

**Photo 9: Local timber market close to the Madhupur Forest Reserve**