

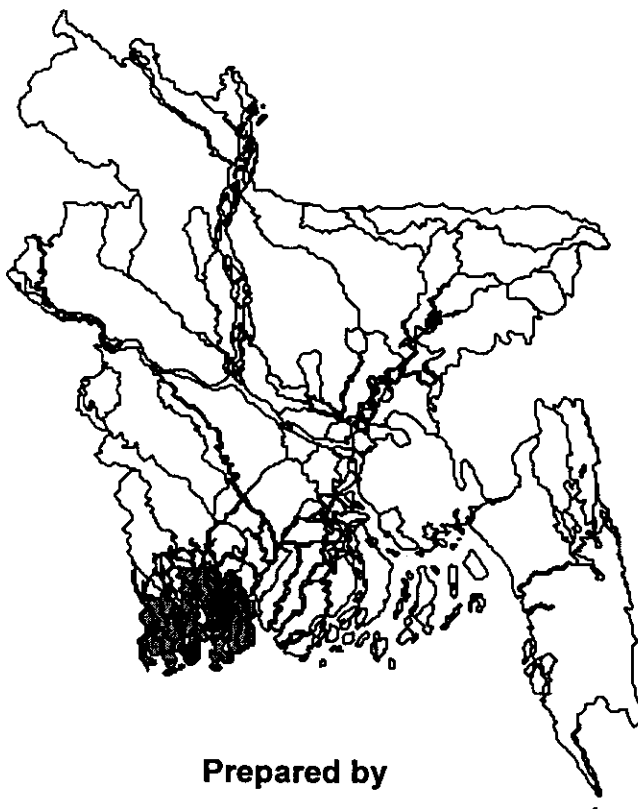
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FOREST RESOURCES MANAGEMENT PROJECT  
*Technical Assistance Component*



**Sundarbans Reserved Forests**  
*Area, Distribution and Status of Forest Types*  
*from 1985 to 1995*



Prepared by


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October 1997

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Martin Runkel and Ishtiaq Uddin Ahmad

October 1997

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## 1. Introduction

The following presents an overview on the area, distribution and status of major forest types and species in the Sundarbans Reserved Forests (SRF). Also included is a comparison of the status given in the years 1985 and 1995, indicating changes within this 10-year-period.

The figures and tables presented are based on an analysis of data available in the Geographic Resource Information Management System (RIMS-GIS) of the Forest Department Bangladesh. RIMS-GIS has been developed within the Forest Resources Management Project (FRMP).

## 2. Available Database: The RIMS-GIS Database of the Sundarbans Reserved Forests

Among others, RIMS-GIS contains maps and associated tabular data on the SRF, which are based on four major data sources:

1. 1985 forest type maps in scale 1:50,000, by Overseas Development Agency (ODA), based on interpretation of airphotos in scale 1:30,000
2. 1989 SPOT multispectral satellite imagery in scale 1:50,000
3. 1995 forest type interpretation of airphotos, scale 1:15,000, done within FRMP
4. Various thematic maps and notifications of the Forest Department Bangladesh, indicating mainly administrative boundaries, location of offices, wildlife sanctuaries, location of sample plots etc. as well as Survey of Bangladesh topographic maps in scale 1:50,000

Geometrically the data is based on the 1989 satellite data, in order to provide a stable and consistent map base. Onto this the photointerpretation results from 1985 and 1995 have been transferred. As result, all data layers are geographically referenced to the same projection system<sup>1</sup>. This allows a direct comparison (overlay) of the forest situations given in 1985 and 1995<sup>2</sup>.

The data discussed in the following focus on the forest status in 1985 and 1995 concerning:

- The forest area of the Sundarbans Reserved Forest
- The area and distribution of forest types respectively vegetation types
- The area and distribution of major species groups.
- The forest density respectively the canopy closure
- The forest stand height respectively the height classes

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<sup>1</sup> A detailed description of all data layers contained in RIMS-GIS is contained in: RUNKEL, M. & F.I. KHAN: "Manual on GIS Database for Sundarbans Reserved Forest" and RUNKEL, M. & F.I. KHAN: "Manual on RIMS-GIS Database" (both available with RIMS Unit of FD Bangladesh)

<sup>2</sup> It should be mentioned here, that the larger photo scale used in 1995 leads to a higher map resolution. This concerns especially the rivers. compared to 1985, in 1995 many more and also smaller rivers could be mapped. As those rivers naturally are considered as water area, the land area of 1995 will be decreased by the same area.

### 3. Area and Forest Status of the Sundarbans Reserved Forests in 1985 and 1995

#### 3.1. Total Area

The total area of the Sundarbans Reserved Forest is about 601,700 ha in 1985 and about 600,400 ha in 1995. The decrease in the total area is caused by the fact, that the boundary of the SRF partly is following river courses, which are changing over the time (see Table 1).

The land area found for the SRF in 1985 is 414,259 ha, whereby in 1995 it is 411,229 ha. This means nominally a decrease of approx. 3,000 ha or 0.7 % of the total land area. However, it can be shown, that this nominal difference is due to the higher resolution of the maps created in 1995 (see footnote 2). Actually there is no considerable change in the overall land area of the Sundarbans Reserved Forests within the period from 1985 to 1995.

The overall balance in the total land area results from comparable amounts of land accretions and land decrections in various locations. Land accretion can be observed mainly at the banks of the big rivers. Some land decrections occur especially in the southern parts of the SRF, which are directly facing the Bay of Bengal. This is obviously due to the effect of strong wave action.

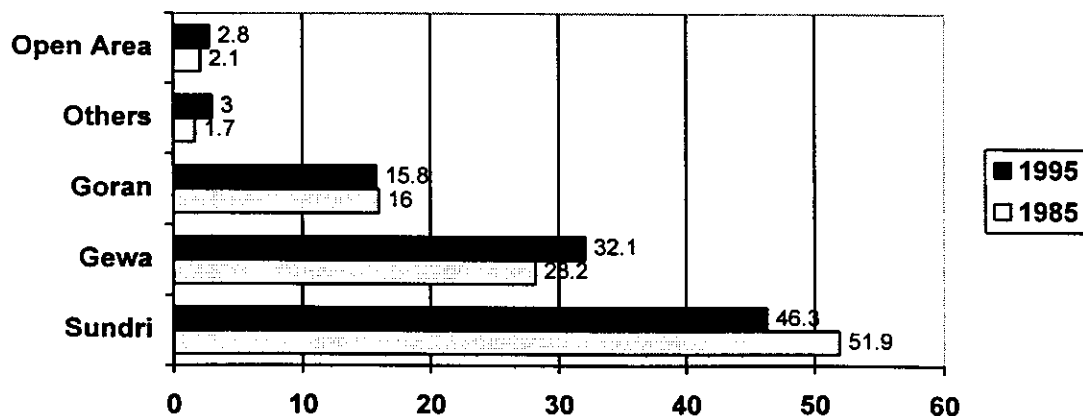
An overview on the area of the different Forest Ranges and Compartments is provided in Table 2 and Table 3.

#### 3.2. Area and Area Change of the different Vegetation Types

The fact, that the RIMS-GIS includes two data layers from the years 1985 and 1995, allows a direct comparison of the respective forest status of these two years. Accordingly also the change over the ten year period is documented in the GIS.

A comparison of the areas occupied by the various forest types in 1985 and 1995 is provided in Table 4 and Table 5. Figure 1 summarizes the areas for the major species. The map in Figure 1 shows the spatial distribution of the major forest types in the Sundarbans Reserved Forests.

**Figure 1: Areas dominated by major species in 1985 and 1995 (in % of total land area)**



Some major findings on the areage of various species can be summarized as follows:

- Sundri (*Heritiera fomes*), Gewa (*Exoecaria agallocha*) and Goran (*eriops decandra*) as the three major species alone occupy approximatly 95 % of the Sundarbans area. Sundri and Gewa together occupy about 80 %. These percentages remained basically unchanged over the period from 1985 to 1995. However, the relation among those species, especially the relation from Sundri to Gewa, changed considerably.
- The Sundri dominated area shows an apparent decrease, especially in the "Sundri" and "Sundri Gewa" forest types. Whereas Sundri dominated areas in 1985 occupied about 215,100 ha, ten years later this area is reduced to about 190,500 ha, which means a decrease of approx. 11.5 % in Sundri area or 5.6 % of the total area.
- On the other side, the second major species of the Sundarbans, Gewa shows an increase from approx. 117,000 ha in 1985 to 131,800 ha in 1995. This corresponds to an increase of approx. 13 % of the Gewa area or 3.9 % of the total area of the SRF. The increase in Gewa dominated area is mainly caused by an increase of "Gewa Sundri". Considering the decrease of "Sundri Gewa" at the same time, it becomes apparent, that Gewa regeneration is rapid in areas where Sundri is being reduced due to Top Dying effects.
- The Goran dominated area does not show a significant difference between 1985 and 1995. The area percentage of Goran remained stable at 15.8 % compared to 16 % in 1985.
- Also no significant changes can be observed in the areas dominated by Passur (*Xylocarpus mekongensis*), Kankra (*Bruguiera gymnorrhiza*) and Baen (*Avicennia officinalis*). Together these species cover only approx. 1 % of the land area in the SRF.
- Keora (*Sonneratio apetala*) shows a significant increase in area from approx. 3,500 ha to approx. 8,300 ha.
- The balance of Open Areas increased over the 10 year period from approx. 8,700 ha to 11,500 ha.

### 3.3. Canopy Closure

The canopy closure has been interpreted 1985 and 1995 in three classes:

- |                          |             |
|--------------------------|-------------|
| a. low canopy closure    | (10% < 30%) |
| b. medium canopy closure | (30% < 70%) |
| c. high canopy closure   | (>= 70%)    |

Detailed listings of the observations on the canopy closure are given in Table 6 for 1985 and Table 7 for 1995. The tables list the respective values for each vegetation type.

The following figures summarize the findings for the three main species Sundri, Gewa and Goran. They show for each of the species the percentage of area falling into different canopy closure classes.

For Sundri there is an obvious difference between 1985 and 1995. Whereas in 1985 80% of the Sundri dominated area had a canopy closure of more than 70%, the corresponding figure in 1995 is 67% only. This means that the percentage of dense Sundri stands decreased by 13%. Accordingly the percentage of Sundri dominated areas with low and medium density increased over the period.

Together with the decrease of the Sundri dominated area as such (see above), this shows

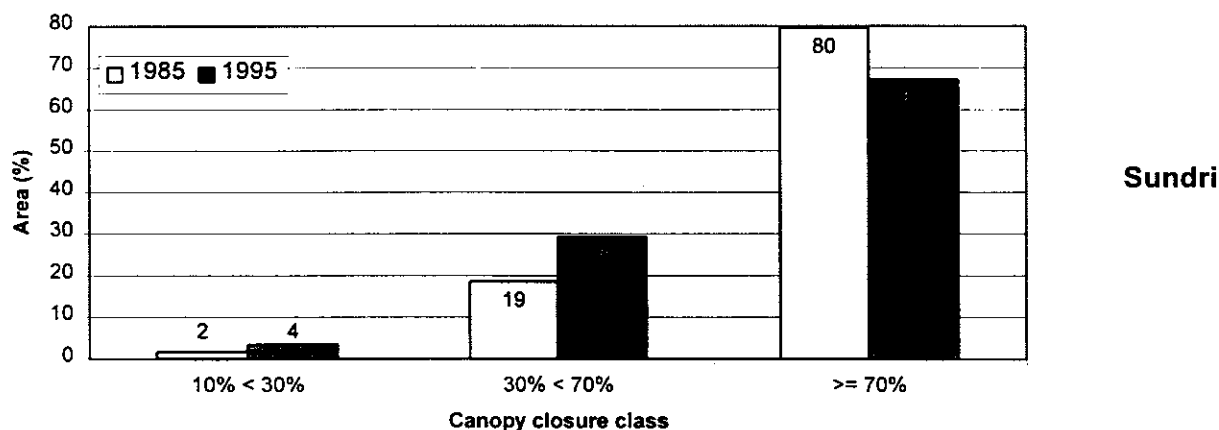
clearly a dynamic reduction of the Sundri in the Sundarbans in quantity (area, canopy closure) as well as in stand quality (canopy closure).

The Gewa dominated areas show basically no difference in their density between 1985 and 1995.

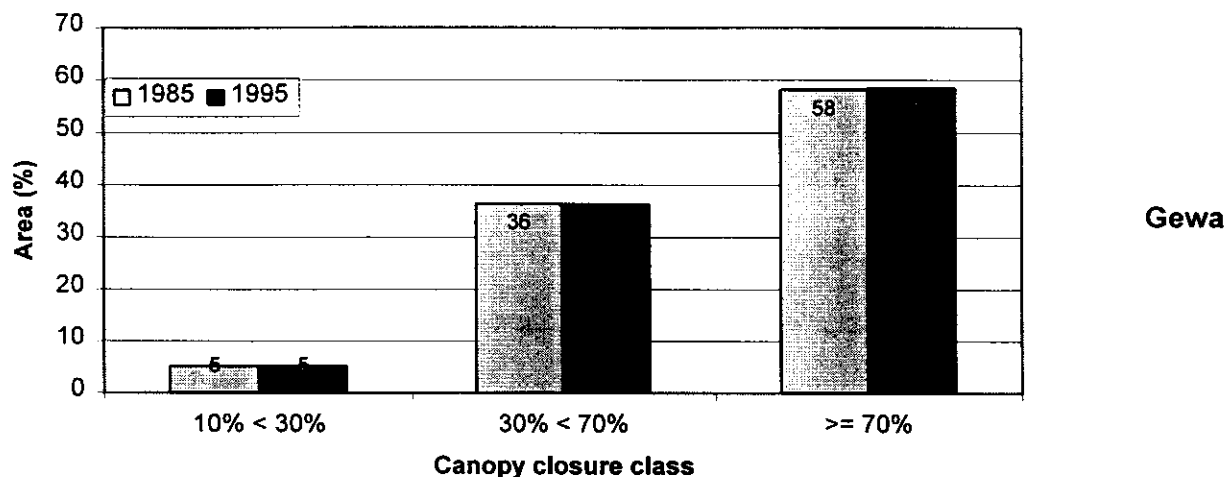
In the Goran dominated area there is a remarkable difference in canopy closure between 1985 and 1995. Whereas in 1985 about 38% of all Goran had a canopy closure of more than 70%, this percentage in 1995 went down to 11%. Parallel to this change, the percentage of the medium dense stands remained almost unchanged, but the percentage of the stands with low density rose from 2% to 31% of the total Goran dominated area.

Possible reasons for this might be seen in an over-harvesting of Goran. However, this point needs to be evaluated in more detail from the silviculture and management points of view.

**Figure 3: Percentage of Sundri dominated Stands in different Canopy Closure Classes – Comparison of 1985 and 1995**

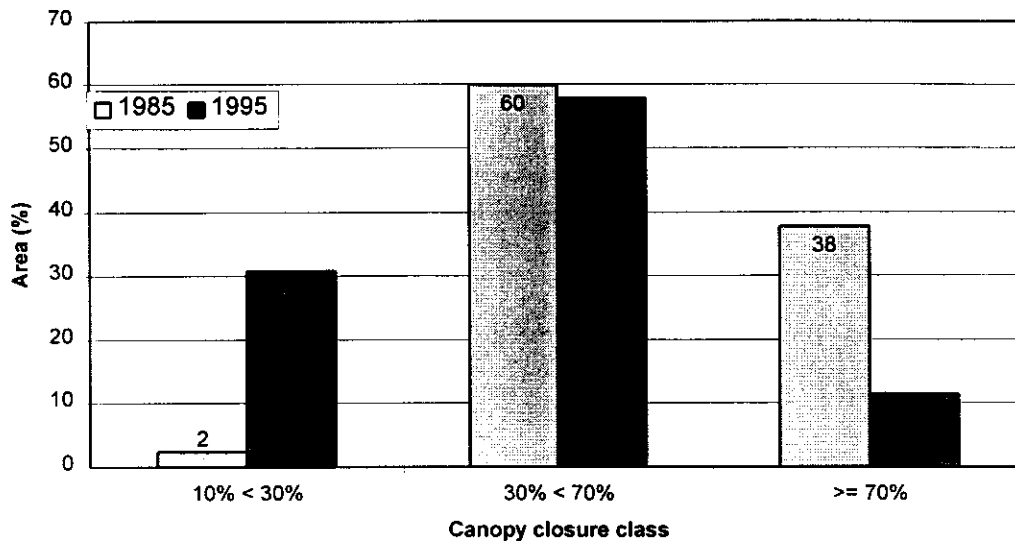


**Figure 4: Percentage of Gewa dominated Stands in different Canopy Closure Classes – Comparison of 1985 and 1995**



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**Figure 5: Percentage of Goran dominated Stands in different Canopy Closure Classes – Comparison of 1985 and 1995**



Goran

### 3.4. Stand Height

The stand height has been described in the following height classes:

- a) very low < 5m
- b) low 5m < 10m
- c) medium 10m < 15m
- d) high >= 15m

The details of the observations on height class development for the various species are given in Tables Table 8 for the year 1985 and Table 9 for 1995. The following figures provide an overview by summarizing the findings for areas dominated by the three main species Sundri, Gewa and Goran. Each column gives the area percentage for a specific species, year and height class.

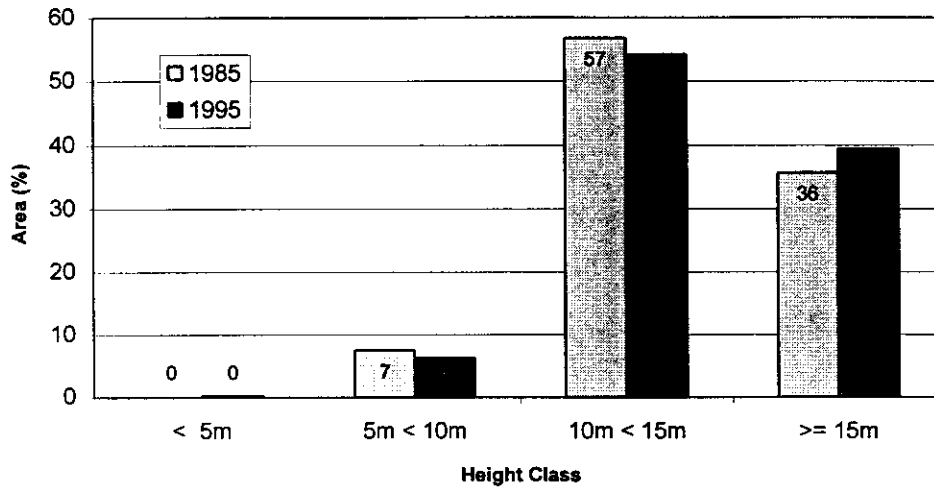
For the Sundri dominated areas, there is a slight nominal increase in the percentage of higher stands over the period from 1985 to 1995. This might be an indicator for a higher age (and thus: height) of the remaining Sundri stands. However, it has to be considered, that the difference between the years is relatively small and might well be influenced by the error rate of the two airphoto interpretations.

The Gewa dominated areas show an obvious increase in stand height. This probably due to the fact, that Gewa following the decrease of Sundri gets better growing possibilities and fills in the space crown space left by the usually dominating Sundri. This is underlined by the fact, that of all "Gewa Sundri" area in 1985 only about 14% had a height of more than 10 m, whereas in 1995 the corresponding value rose to 45%.

Within the Goran dominated areas there is a nominal increase of the areas with a height of more than 5 m. However it has to be considered, that in 1995 for about 13% of the Goran area no height class has been given. Therefore a direct comparison of the values obtained from 1985 and 1995 in this case is not possible.

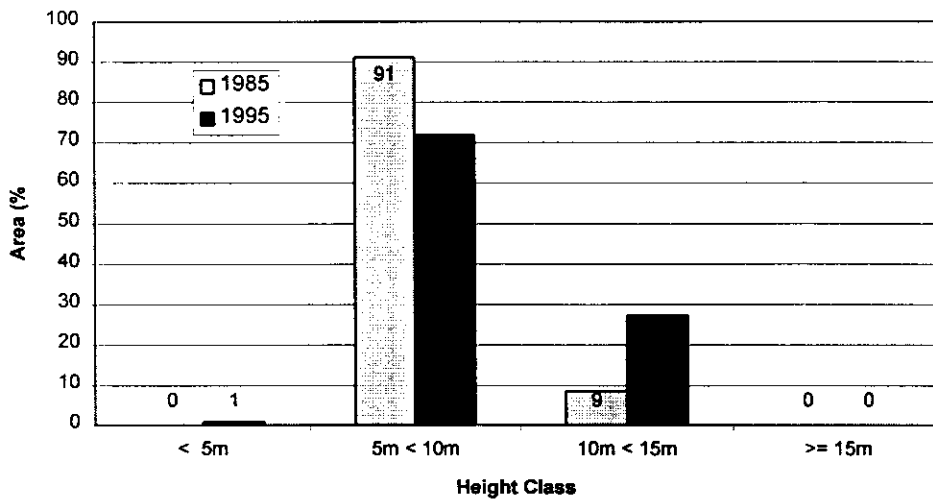


**Figure 6: Distribution of Height Classes in Sundri dominated Areas – Comparison between 1985 and 1995**



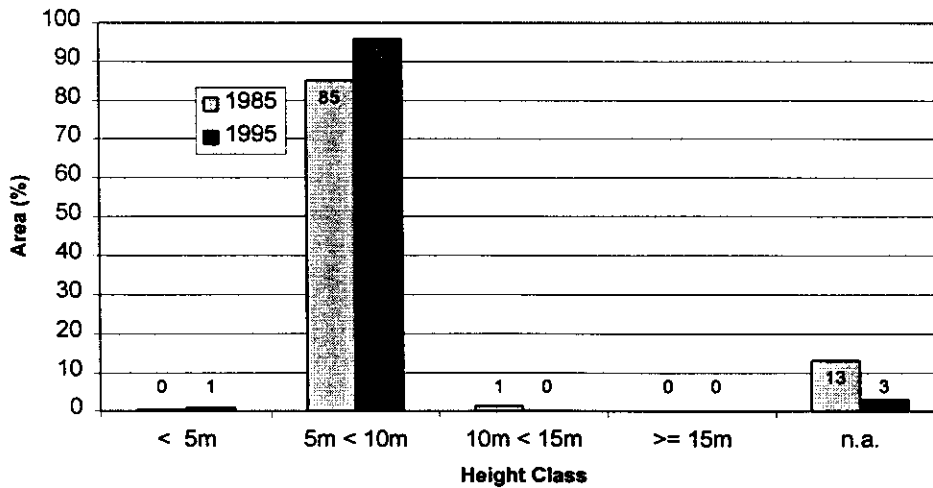
Sundri

**Figure 7: Distribution of Height Classes in Gewa dominated Areas – Comparison between 1985 and 1995**



Gewa

**Figure 8: Distribution of Height Classes in Goran dominated Areas – Comparison between 1985 and 1995**



Goran

### 3.5. *Mixed Species*

Table 8 and Table 9 contain a comparison of the hectareage of mixed species, which are wihtin the area dominated by one vegetaition type.

In 1985, in average about 21% of the area dominated by a certain species respectively species comosition were found to have other mixed-in species. In 1995 the corresponding value was 37%. These findings however should not necessarily be rated as an increase in stand diversification. Moreover, they show that in 1995 the airphoto interpretation obviously has been gone to some more detail compared to 1985.

## 4. Tables

**Table 1: Area of the Sundarbans Reserved Forests in 1985 and 1995  
(in ha, rounded to full hectares)**

| TYPE       | YEAR    |         |
|------------|---------|---------|
|            | 1985    | 1995    |
| Land Area  | 414,259 | 411,227 |
| Waterbody  | 187,413 | 189,159 |
| Total Area | 601,672 | 600,386 |

**Table 2: Area of Ranges in 1995  
(in ha, rounded to full hectares)**

| RANGE            | LAND AREA | WATER AREA | TOTAL AREA |
|------------------|-----------|------------|------------|
| Khulna Range     | 114,444   | 56,166     | 170,610    |
| Chandpai Range   | 82,993    | 14,451     | 97,444     |
| Sarankhola Range | 92,313    | 53,288     | 145,601    |
| Satkhira Range   | 121,477   | 65,254     | 186,731    |
| Total            | 411,227   | 189,159    | 600,386    |

**Table 3: Area of Compartments in 1995  
(in ha, rounded to full hectares)**

| COMPART-MENT | LAND AREA | WATER AREA | TOTAL AREA |
|--------------|-----------|------------|------------|
| 1            | 10,788    | 4,235      | 15,023     |
| 2            | 5,559     | 703        | 6,262      |
| 3            | 5,782     | 613        | 6,395      |
| 4            | 6,523     | 632        | 7,155      |
| 5            | 5,161     | 5,572      | 10,733     |
| 6            | 7,939     | 10,177     | 18,116     |
| 7            | 11,496    | 6,944      | 18,440     |
| 8            | 13,807    | 5,475      | 19,282     |
| 9            | 13,230    | 3,135      | 16,365     |
| 10           | 6,049     | 1,347      | 7,396      |
| 11           | 5,661     | 1,167      | 6,828      |
| 12A          | 2,143     | 365        | 2,508      |
| 12B          | 3,620     | 309        | 3,929      |
| 13           | 5,559     | 850        | 6,409      |
| 14           | 4,306     | 517        | 4,823      |
| 15           | 5,576     | 1,269      | 6,845      |
| 16           | 6,281     | 2,563      | 8,844      |
| 17           | 7,693     | 5,928      | 13,621     |
| 18           | 12,676    | 6,726      | 19,402     |
| 19           | 7,936     | 2,696      | 10,632     |
| 20           | 7,907     | 1,136      | 9,043      |
| 21           | 4,647     | 994        | 5,641      |
| 22           | 4,832     | 929        | 5,761      |
| 23           | 3,823     | 401        | 4,224      |
| 24           | 5,332     | 739        | 6,071      |
| 25           | 4,584     | 405        | 4,989      |
| 26           | 3,826     | 543        | 4,369      |
| 27           | 4,078     | 138        | 4,216      |
| 28           | 4,241     | 372        | 4,613      |
| 29           | 4,427     | 1,173      | 5,600      |
| 30           | 5,231     | 559        | 5,790      |
| 31           | 6,443     | 1,454      | 7,897      |
| 32           | 5,545     | 538        | 6,083      |
| 33           | 5,333     | 1,317      | 6,650      |

| COMPART-MENT | LAND AREA      | WATER AREA     | TOTAL AREA     |
|--------------|----------------|----------------|----------------|
| 34           | 4,785          | 739            | 5,524          |
| 35           | 6,579          | 2,094          | 8,673          |
| 36           | 7,223          | 1,249          | 8,472          |
| 37           | 5,806          | 1,051          | 6,857          |
| 38           | 6,350          | 1,978          | 8,328          |
| 39           | 6,152          | 1,540          | 7,692          |
| 40           | 4,084          | 1,617          | 5,701          |
| 41           | 7,137          | 1,892          | 9,029          |
| 42           | 7,169          | 3,185          | 10,354         |
| 43           | 11,148         | 5,904          | 17,052         |
| 44           | 8,946          | 19,090         | 28,036         |
| 45           | 10,645         | 16,722         | 27,367         |
| 46           | 11,130         | 3,787          | 14,917         |
| 47           | 10,403         | 1,343          | 11,746         |
| 48           | 8,063          | 2,571          | 10,634         |
| 49           | 11,548         | 3,306          | 14,854         |
| 50A          | 1,902          | 1,294          | 3,196          |
| 50B          | 6,049          | 1,535          | 7,584          |
| 51A          | 3,460          | 1,213          | 4,673          |
| 51B          | 6,075          | 2,003          | 8,078          |
| 52           | 11,773         | 4,567          | 16,340         |
| 53           | 8,259          | 2,805          | 11,064         |
| 54           | 12,472         | 17,152         | 29,624         |
| 55           | 16,037         | 18,601         | 34,638         |
| <b>TOTAL</b> | <b>411,230</b> | <b>189,156</b> | <b>600,386</b> |

**Table 4: Vegetation Types in 1985**

| <i>Area of vegetation types</i> |                  |                 |
|---------------------------------|------------------|-----------------|
| <i>Vegetation Type</i>          | <i>Area (ha)</i> | <i>Area (%)</i> |
| Sundri                          | 82,845           | 20.0            |
| Sundri Gewa                     | 123,247          | 29.8            |
| Sundri Passur                   | 2,214            | 0.5             |
| Sundri Passur Kankra            | 6,799            | 1.6             |
| Gewa                            | 18,556           | 4.5             |
| Gewa Sundri                     | 59,973           | 14.5            |
| Gewa Goran                      | 37,593           | 9.1             |
| Gewa Mathal                     | 836              | 0.2             |
| Goran                           | 8,706            | 2.1             |
| Goran Gewa                      | 57,597           | 13.9            |
| Passur Kankra                   | 940              | 0.2             |
| Passur Kankra Baen              | 1,614            | 0.4             |
| Baen                            | 828              | 0.2             |
| Keora                           | 3,509            | 0.8             |
| Tree plantation                 | 351              | 0.1             |
| Agriculture                     | 16               | 0.0             |
| Grass and bare Ground           | 4,614            | 1.1             |
| Sandbar                         | 4,024            | 1.0             |
| <b>Total Land Area</b>          | <b>414,259</b>   | <b>100.0</b>    |

| <i>Summary by dominating species</i> |                  |                 |
|--------------------------------------|------------------|-----------------|
| <i>Dominating Species</i>            | <i>Area (ha)</i> | <i>Area (%)</i> |
| Sundri                               | 215,105          | 51.9            |
| Gewa                                 | 116,957          | 28.2            |
| Goran                                | 66,303           | 16.0            |
| Others                               | 7,242            | 1.7             |
| Open Area                            | 8,653            | 2.1             |
| <b>Total</b>                         | <b>414,259</b>   | <b>100.0</b>    |

**Table 5: Vegetation Types in 1995**

| <i>Area of vegetation types</i> |                  |                 |
|---------------------------------|------------------|-----------------|
| <i>Vegetation Type</i>          | <i>Area (ha)</i> | <i>Area (%)</i> |
| Sundri                          | 74,992           | 18.2            |
| Sundri Gewa                     | 105,967          | 25.8            |
| Sundri Passur                   | 2,413            | 0.6             |
| Sundri Passur Kankra            | 7,143            | 1.7             |
| Gewa                            | 19,909           | 4.8             |
| Gewa Sundri                     | 75,704           | 18.4            |
| Gewa Goran                      | 34,604           | 8.4             |
| Gewa Mathal (coppice)           | 1,611            | 0.4             |
| Goran                           | 8,269            | 2.0             |
| Goran Gewa                      | 56,536           | 13.7            |
| Passur Kankra                   | 284              | 0.1             |
| Passur Kankra Baen              | 2,516            | 0.6             |
| Baen                            | 1,230            | 0.3             |
| Keora                           | 8,287            | 2.0             |
| Tree Plantation                 | 217              | 0.1             |
| Grass and Bare Ground           | 6,931            | 1.7             |
| Sandbar                         | 4,614            | 1.1             |
|                                 | <b>411,227</b>   | <b>100.0</b>    |

| <i>Summary by dominating species</i> |                  |                 |
|--------------------------------------|------------------|-----------------|
| <i>Dominating Species</i>            | <i>Area (ha)</i> | <i>Area (%)</i> |
| Sundri                               | 190,514          | 46.3            |
| Gewa                                 | 131,828          | 32.1            |
| Goran                                | 64,805           | 15.8            |
| Others                               | 12,534           | 3.0             |
| Open Area                            | 11,545           | 2.8             |
| <b>Total</b>                         | <b>411,227</b>   | <b>100.0</b>    |

**Table 6: Main Vegetation Type and Canopy Closure in 1985**

| VEGETATION TYPE       | AREA (IN HA) COVERED BY CANOPY CLOSURE CLASS |                |                |              |                |              |
|-----------------------|--|----------------|----------------|--------------|----------------|--------------|
|                       | 10% < 30%                                    | 30% < 70%      | >= 70%         | n.a.         | Total          | %            |
| Sundri                | 1,491  | 15,435         | 65,868         | 51           | 82,845         | 20.0         |
| Sundri Gewa           | 1,979  | 19,763         | 101,501        | 4            | 123,247        | 29.8         |
| Sundri Passur         | 38   | 1,666          | 510            | 0            | 2,214          | 0.5          |
| Sundri Passur Kankra  | 261  | 3,161          | 3,377          | 0            | 6,799          | 1.6          |
| Gewa                  | 2,047  | 3,064          | 13,207         | 238          | 18,556         | 4.5          |
| Gewa Sundri           | 2,464  | 15,341         | 42,150         | 17           | 59,973         | 14.5         |
| Gewa Goran            | 1,487  | 23,381         | 12,724         | 0            | 37,593         | 9.1          |
| Gewa Mathal           | 0  | 836            | 0              | 0            | 836            | 0.2          |
| Goran                 | 506  | 2,696          | 5,504          | 0            | 8,706          | 2.1          |
| Goran Gewa            | 1,075  | 37,025         | 19,498         | 0            | 57,597         | 13.9         |
| Passur Kankra         | 232  | 708            | 0              | 0            | 940            | 0.2          |
| Passur Kankra Baen    | 234  | 387            | 993            | 0            | 1,614          | 0.4          |
| Baen                  | 122  | 574            | 131            | 0            | 828            | 0.2          |
| Keora                 | 0  | 2,006          | 1,504          | 0            | 3,509          | 0.8          |
| Tree plantation       | 0  | 0              | 0              | 351          | 351            | 0.1          |
| Agriculture           | 0  | 0              | 0              | 16           | 16             | 0.0          |
| Grass and bare Ground | 0  | 0              | 30             | 4,584        | 4,614          | 1.1          |
| Sandbar               | 0.0  | 0.0            | 0.0            | 4023.5       | 4023.5         | 1.0          |
| <b>Total (ha)</b>     | <b>11,938</b>                                | <b>126,041</b> | <b>266,997</b> | <b>9,283</b> | <b>414,259</b> | <b>100.0</b> |
| <b>Total (%)</b>      | <b>2.9</b>                                   | <b>30.4</b>    | <b>64.5</b>    | <b>2.2</b>   | <b>100.0</b>   |              |

**Table 7: Main Vegetation Type and Canopy Closure in 1995**

| VEGETATION TYPE       | AREA (IN HA) COVERED BY CANOPY CLOSURE CLASS |                |                |               |                |              |
|-----------------------|--|----------------|----------------|---------------|----------------|--------------|
|                       | 10% < 30%                                    | 30% < 70%      | >= 70%         | n.a.          | Total          | %            |
| Sundri                | 2,626  | 19,759         | 52,596         | 11            | 74,992         | 18.2         |
| Sundri Gewa           | 3,577  | 32,611         | 69,779         | 0             | 105,967        | 25.8         |
| Sundri Passur         | 238  | 1,342          | 833            | 0             | 2,413          | 0.6          |
| Sundri Passur Kankra  | 152  | 3,230          | 3,746          | 15            | 7,143          | 1.7          |
| Gewa                  | 897  | 3,981          | 15,028         | 3             | 19,909         | 4.8          |
| Gewa Sundri           | 3,352  | 18,983         | 53,369         | 0             | 75,704         | 18.4         |
| Gewa Goran            | 2,657  | 23,717         | 8,230          | 0             | 34,604         | 8.4          |
| Gewa Mathal (coppice) | 1,535  | 76             | 0              | 0             | 1,611          | 0.4          |
| Goran                 | 1,508  | 5,631          | 1,131          | 0             | 8,269          | 2.0          |
| Goran Gewa            | 6,041  | 41,294         | 9,201          | 0             | 56,536         | 13.7         |
| Passur Kankra         | 134  | 80             | 51             | 19            | 284            | 0.1          |
| Passur Kankra Baen    | 665  | 1,455          | 395            | 0             | 2,516          | 0.6          |
| Baen                  | 603  | 351            | 276            | 0             | 1,230          | 0.3          |
| Keora                 | 1,760  | 4,423          | 2,104          | 0             | 8,287          | 2.0          |
| Tree Plantation       | 11   | 49             | 157            | 0             | 217            | 0.1          |
| Grass and Bare Ground | 0  | 0              | 0              | 6,931         | 6,931          | 1.7          |
| Sandbar               | 0  | 0              | 0              | 4,614         | 4,614          | 1.1          |
| <b>Total (ha)</b>     | <b>25,757</b>                                | <b>156,982</b> | <b>216,895</b> | <b>11,593</b> | <b>411,227</b> | <b>100.0</b> |
| <b>Total (%)</b>      | <b>6.3</b>                                   | <b>38.2</b>    | <b>52.7</b>    | <b>2.8</b>    | <b>100.0</b>   |              |

**Table 8: Main Vegetation Type and Height Class in 1985**

| VEGETATION TYPE       | AREA (IN HA) COVERED BY HEIGHT CLASS |                |                |               |               |                |              |
|-----------------------|--------------------------------------|----------------|----------------|---------------|---------------|----------------|--------------|
|                       | < 5m                                 | 5m < 10m       | 10m < 15m      | >= 15m        | n.a.          | Total          | %            |
| Sundri                | 0                                    | 599            | 19,983         | 62,212        | 51            | 82,845         | 20.0         |
| Sundri Gewa           | 0                                    | 15,113         | 98,834         | 9,297         | 4             | 123,247        | 29.8         |
| Sundri Passur         | 0                                    | 245            | 1,342          | 626           | 0             | 2,214          | 0.5          |
| Sundri Passur Kankra  | 0                                    | 24             | 1,934          | 4,841         | 0             | 6,799          | 1.6          |
| Gewa                  | 0                                    | 17,450         | 891            | 0             | 216           | 18,556         | 4.5          |
| Gewa Sundri           | 0                                    | 51,286         | 8,658          | 12            | 17            | 59,973         | 14.5         |
| Gewa Goran            | 21                                   | 37,114         | 458            | 0             | 0             | 37,593         | 9.1          |
| Gewa Mathal           | 0                                    | 836            | 0              | 0             | 0             | 836            | 0.2          |
| Goran                 | 0                                    | 35             | 0              | 0             | 8,671         | 8,706          | 2.1          |
| Goran Gewa            | 272                                  | 56,397         | 910            | 0             | 19            | 57,597         | 13.9         |
| Passur Kankra         | 0                                    | 0              | 0              | 0             | 940           | 940            | 0.2          |
| Passur Kankra Baen    | 0                                    | 0              | 0              | 0             | 1,614         | 1,614          | 0.4          |
| Baen                  | 0                                    | 0              | 0              | 0             | 828           | 828            | 0.2          |
| Keora                 | 0                                    | 0              | 0              | 0             | 3,509         | 3,509          | 0.8          |
| Tree plantation       | 0                                    | 0              | 0              | 0             | 351           | 351            | 0.1          |
| Agriculture           | 0                                    | 0              | 0              | 0             | 16            | 16             | 0.0          |
| Grass and bare Ground | 0                                    | 0              | 0              | 0             | 4,614         | 4,614          | 1.1          |
| Sandbar               | 0                                    | 0              | 0              | 0             | 4,024         | 4,024          | 1.0          |
| <b>Total</b>          | <b>293</b>                           | <b>179,097</b> | <b>133,009</b> | <b>76,988</b> | <b>24,872</b> | <b>414,259</b> | <b>100.0</b> |
| <b>Total (%)</b>      | <b>0.1</b>                           | <b>43.2</b>    | <b>32.1</b>    | <b>18.6</b>   | <b>6.0</b>    | <b>100.0</b>   |              |

**Table 9: Main Vegetation Type and Height Class in 1995**

| VEGETATION TYPE       | AREA (IN HA) COVERED BY HEIGHT CLASS |                |                |               |               |                |              |
|-----------------------|--------------------------------------|----------------|----------------|---------------|---------------|----------------|--------------|
|                       | < 5m                                 | 5m < 10m       | 10m < 15m      | >= 15m        | n.a.          | Total          | %            |
| Sundri                | 200                                  | 775            | 15,211         | 58,796        | 11            | 74,992         | 18.2         |
| Sundri Gewa           | 217                                  | 10,665         | 85,121         | 9,964         | 0             | 105,967        | 25.8         |
| Sundri Passur         | 8                                    | 295            | 798            | 1,312         | 0             | 2,413          | 0.6          |
| Sundri Passur Kankra  | 0                                    | 113            | 2,017          | 5,013         | 0             | 7,143          | 1.7          |
| Gewa                  | 28                                   | 18,744         | 1,134          | 0             | 3             | 19,909         | 4.8          |
| Gewa Sundri           | 364                                  | 40,838         | 34,487         | 15            | 0             | 75,704         | 18.4         |
| Gewa Goran            | 12                                   | 34,172         | 420            | 0             | 0             | 34,604         | 8.4          |
| Gewa Mathal (coppice) | 765                                  | 846            | 0              | 0             | 0             | 1,611          | 0.4          |
| Goran                 | 149                                  | 6,143          | 0              | 0             | 1,977         | 8,269          | 2.0          |
| Goran Gewa            | 457                                  | 55,971         | 92             | 16            | 0             | 56,536         | 13.7         |
| Passur Kankra         | 20                                   | 115            | 51             | 99            | 0             | 284            | 0.1          |
| Passur Kankra Baen    | 0                                    | 8              | 1,703          | 739           | 67            | 2,516          | 0.6          |
| Baen                  | 0                                    | 38             | 67             | 936           | 189           | 1,230          | 0.3          |
| Keora                 | 9                                    | 48             | 1,189          | 7,012         | 29            | 8,287          | 2.0          |
| Tree Plantation       | 9                                    | 3              | 124            | 81            | 0             | 217            | 0.1          |
| Grass and Bare Ground | 0                                    | 0              | 0              | 0             | 6,931         | 6,931          | 1.7          |
| Sandbar               | 0                                    | 0              | 0              | 0             | 4,614         | 4,614          | 1.1          |
| <b>Total (ha)</b>     | <b>2,236</b>                         | <b>168,773</b> | <b>142,413</b> | <b>83,982</b> | <b>13,822</b> | <b>411,227</b> | <b>100.0</b> |
| <b>Total (%)</b>      | <b>0.5</b>                           | <b>41.0</b>    | <b>34.6</b>    | <b>20.4</b>   | <b>3.4</b>    | <b>100.0</b>   |              |

**Table 10: Main Vegetation Type and Stand Mixture in 1985**

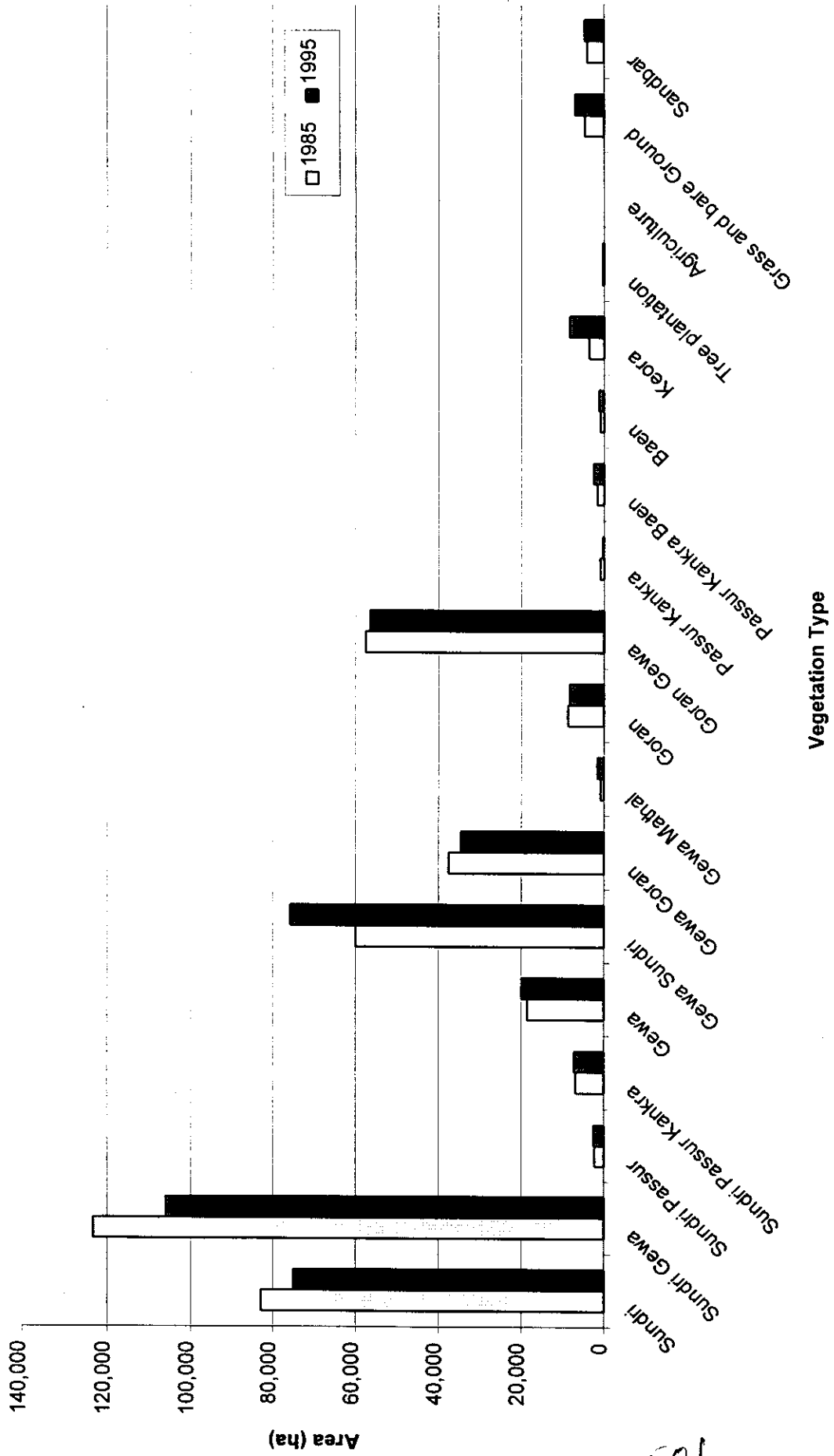
| VEGETATION TYPE       | MIXED SPECIES  |                 |                |                          |                        |                              |                 |                        |                           |              |                | Total (%)    |
|-----------------------|----------------|-----------------|----------------|--------------------------|------------------------|------------------------------|-----------------|------------------------|---------------------------|--------------|----------------|--------------|
|                       | No mixture     | Dhundul & Scrub | Scattered Baen | Scattered Baen & Dhundul | Scattered Baen & Keora | Scatt. Baen, Keora & Dhundul | Scattered Keora | Scatt. Keora & Dhundul | Scattered Passur/ Dhundul | Scrub        | Total (ha)     |              |
| Sundri                | 72,477         | 40              | 443            | 2,377                    | 157                    | 88                           | 49              | 119                    | 4,327                     | 2,768        | 82,845         | 20.0         |
| Sundri Gewa           | 110,715        | 54              | 919            | 3,735                    | 67                     | 0                            | 847             | 294                    | 5,450                     | 1,168        | 123,247        | 29.8         |
| Sundri Passur         | 1,748          | 0               | 466            | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 2,214          | 0.5          |
| Sundri Passur Kankra  | 4,921          | 0               | 1,878          | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 6,799          | 1.6          |
| Gewa                  | 15,302         | 0               | 691            | 71                       | 120                    | 0                            | 2,015           | 0                      | 358                       | 0            | 18,556         | 4.5          |
| Gewa Sundri           | 47,795         | 0               | 288            | 3,797                    | 75                     | 66                           | 910             | 218                    | 6,719                     | 104          | 59,973         | 14.5         |
| Gewa Goran            | 33,068         | 0               | 497            | 976                      | 179                    | 66                           | 699             | 0                      | 2,107                     | 0            | 37,593         | 9.1          |
| Gewa MATHAL           | 732            | 0               | 0              | 0                        | 0                      | 0                            | 0               | 0                      | 104                       | 0            | 836            | 0.2          |
| Goran                 | 3,600          | 0               | 149            | 170                      | 338                    | 239                          | 334             | 42                     | 3,756                     | 78           | 8,706          | 2.1          |
| Goran Gewa            | 27,977         | 0               | 712            | 839                      | 290                    | 1,459                        | 447             | 337                    | 25,325                    | 212          | 57,597         | 13.9         |
| Passur Kankra         | 366            | 0               | 574            | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 940            | 0.2          |
| Passur Kankra Baen    | 1,614          | 0               | 0              | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 1,614          | 0.4          |
| Baen                  | 333            | 0               | 0              | 0                        | 0                      | 0                            | 348             | 0                      | 147                       | 0            | 828            | 0.2          |
| Keora                 | 3,030          | 0               | 479            | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 3,509          | 0.8          |
| Tree plantation       | 351            | 0               | 0              | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 351            | 0.1          |
| Agriculture           | 16             | 0               | 0              | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 16             | 0.0          |
| Grass and bare Ground | 2,879          | 0               | 90             | 15                       | 60                     | 0                            | 674             | 0                      | 107                       | 789          | 4,614          | 1.1          |
| Sandbar               | 4,024          | 0               | 0              | 0                        | 0                      | 0                            | 0               | 0                      | 0                         | 0            | 4,024          | 1.0          |
| <b>Total (ha)</b>     | <b>330,947</b> | <b>94</b>       | <b>7,185</b>   | <b>11,979</b>            | <b>1,286</b>           | <b>1,918</b>                 | <b>6,322</b>    | <b>1,009</b>           | <b>48,400</b>             | <b>5,120</b> | <b>414,259</b> | <b>100.0</b> |
| <b>Total (%)</b>      | <b>79.9</b>    | <b>0.0</b>      | <b>1.7</b>     | <b>2.9</b>               | <b>0.3</b>             | <b>0.5</b>                   | <b>1.5</b>      | <b>0.2</b>             | <b>11.7</b>               | <b>1.2</b>   | <b>100.0</b>   |              |

**Table 11: Main Vegetation Type and Stand Mixture in 1995**

| VEGETATION TYPE       | MIXED SPECIES         |                 |                |                          |                        |                           |                 |                        |                           |        |            |           |  | Total (ha) | Total (%) |
|-----------------------|-----------------------|-----------------|----------------|--------------------------|------------------------|---------------------------|-----------------|------------------------|---------------------------|--------|------------|-----------|--|------------|-----------|
|                       | No mixture resp. n.a. | Dhundul & Scrub | Scattered Baen | Scattered Baen & Dhundul | Scattered Baen & Keora | Scatt. Baen, Keora & Dhun | Scattered Keora | Scatt. Keora & Dhundul | Scattered Passur/ Dhundul | Scrub  | Total (ha) | Total (%) |  |            |           |
| Sundri                | 49,588                | 211             | 4,480          | 15,488                   | 207                    | 135                       | 89              | 0                      | 1,433                     | 3,362  | 74,992     | 18.2      |  |            |           |
| Sundri Gewa           | 76,373                | 47              | 5,042          | 8,754                    | 1,875                  | 0                         | 968             | 367                    | 8,738                     | 3,802  | 105,967    | 25.8      |  |            |           |
| Sundri Passur         | 551                   | 0               | 150            | 1,692                    | 0                      | 0                         | 5               | 0                      | 0                         | 15     | 2,413      | 0.6       |  |            |           |
| Sundri Passur Kankra  | 4,661                 | 0               | 1,435          | 835                      | 41                     | 0                         | 11              | 0                      | 32                        | 128    | 7,143      | 1.7       |  |            |           |
| Gewa                  | 14,768                | 0               | 535            | 88                       | 727                    | 0                         | 2,996           | 0                      | 405                       | 390    | 19,909     | 4.8       |  |            |           |
| Gewa Sundri           | 54,285                | 0               | 3,031          | 7,519                    | 2,284                  | 88                        | 1,412           | 69                     | 4,535                     | 2,480  | 75,704     | 18.4      |  |            |           |
| Gewa Goran            | 22,913                | 0               | 613            | 2,511                    | 419                    | 69                        | 1,535           | 0                      | 4,608                     | 1,936  | 34,604     | 8.4       |  |            |           |
| Gewa Mathal (coppice) | 111                   | 0               | 137            | 267                      | 16                     | 18                        | 93              | 0                      | 176                       | 792    | 1,611      | 0.4       |  |            |           |
| Goran                 | 1,830                 | 0               | 91             | 607                      | 404                    | 148                       | 277             | 40                     | 4,271                     | 601    | 8,269      | 2.0       |  |            |           |
| Goran Gewa            | 19,763                | 0               | 871            | 8,766                    | 308                    | 853                       | 638             | 326                    | 21,275                    | 3,736  | 56,536     | 13.7      |  |            |           |
| Passur Kankra         | 16                    | 17              | 67             | 164                      | 0                      | 0                         | 0               | 0                      | 0                         | 20     | 284        | 0.1       |  |            |           |
| Passur Kankra Baen    | 1,823                 | 0               | 39             | 0                        | 0                      | 0                         | 0               | 0                      | 0                         | 654    | 2,516      | 0.6       |  |            |           |
| Baen                  | 276                   | 0               | 0              | 7                        | 0                      | 0                         | 354             | 0                      | 219                       | 375    | 1,230      | 0.3       |  |            |           |
| Keora                 | 4,448                 | 0               | 779            | 0                        | 0                      | 0                         | 0               | 0                      | 0                         | 3,061  | 8,287      | 2.0       |  |            |           |
| Tree Plantation       | 195                   | 0               | 0              | 0                        | 0                      | 0                         | 0               | 0                      | 0                         | 22     | 217        | 0.1       |  |            |           |
| Grass and Bare Ground | 3,268                 | 0               | 131            | 48                       | 131                    | 0                         | 1,629           | 0                      | 139                       | 1,586  | 6,931      | 1.7       |  |            |           |
| Sandar                | 4,614                 | 0               | 0              | 0                        | 0                      | 0                         | 0               | 0                      | 0                         | 0      | 4,614      | 1.1       |  |            |           |
| Total (ha)            | 259,485               | 275             | 17,400         | 46,745                   | 6,412                  | 1,311                     | 10,006          | 802                    | 45,832                    | 22,959 | 411,227    | 100.0     |  |            |           |
| Total (%)             | 63.1                  | 0.1             | 4.2            | 11.4                     | 1.6                    | 0.3                       | 2.4             | 0.2                    | 11.1                      | 5.6    | 100.0      |           |  |            |           |



Figure 9: Area of different Vegetation Types in 1985 and 1995



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