



***RNR =
Renewable
Natural
Resources**

**Bhutan-German
Sustainable RNR*-Development Project (BG-SRDP)**

Jointly implemented by

Ministry of Agriculture/Royal Government of Bhutan, and
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

GTZ Project No. 2001.2045.1-001.00

POSTAL ADDRESS: P.O.Box 362; THIMPHU / BHUTAN

TEL. 00975 – 2- 481 356; FAX 00975 – 2- 481 357

EMAIL: gtzrnr@druknet.bt

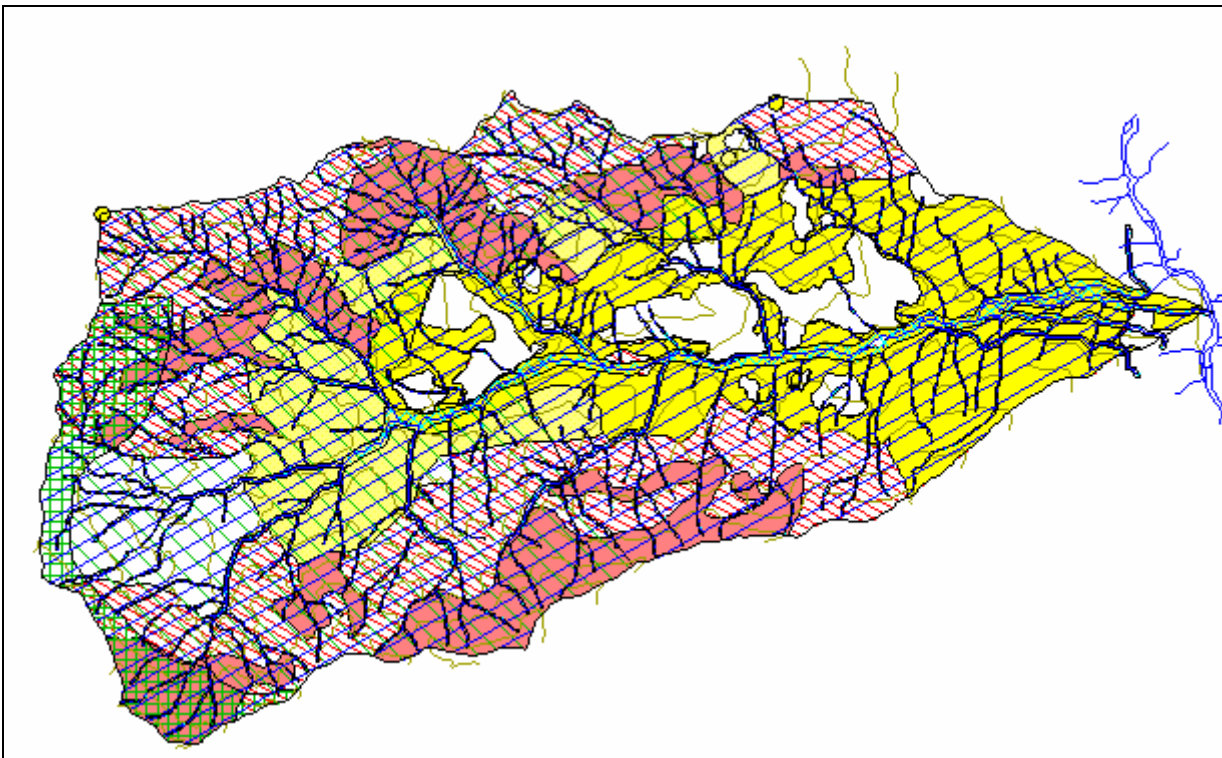


German
Technical
Cooperation

Project Document No. 58

Forest Management Planning Nahi FMU

***Preparation of forest function, forest zonation and
forest management maps***



Prepared by:

Werner Schindele
Forestry Consultant

March 2002

Table of Content

Page

Foreword

1 Forest Function Mapping	2
1.1 Objectives and Definition	2
1.2 Identification and Description of Functions	3
1.2.1 <i>Soil Conservation</i>	3
1.2.2 <i>Water and Watershed Conservation</i>	4
1.2.3 <i>Social Functions</i>	5
1.2.4 <i>Nature Conservation</i>	7
1.2.5 <i>Road Buffer</i>	8
1.3 Required Follow-Up	8
2 Forest Zoning	9
3 Implications on Forest Management	11
3.1 Results of Forest Function Mapping and Zonation	11
3.2 Implications on Commercial Forest Management	13
3.3 AAC Estimation	14
4 Follow-up	15

Annexes

Annex 1: Literature

Annex 2: Definition and Description of Forest Functions

Annex 3: Maps

Annex 4: Inventory Results

List of Tables

Table 1: List of different forest function groups and sub-functions (Source: SCHINDELE and DHITAL, 1997)	2
Table 2: Impact of forest function on commercial forest management and local use (Source: SCHINDELE and DHITAL, 1997)	9
Table 3: Forest zonation	10
Table 4: Distribution of forest functions and zones according to type of management	12
Table 5: Distribution of forest types according to zones and type of management	12

List of Figures

Figure 1: Soil conservation functions	4
Figure 2: Water conservation functions	5
Figure 3: Social functions	7
Figure 4: Nature conservation	8
Figure 5: Distribution of forest zones	10
Figure 6: Distribution of forest types within commercial use forest	13

Abbreviations

AAC	Annual Allowable Cut
BG-SRDP	Bhutan-German Sustainable Renewable Natural Resources Development Project
DEM	Digital Elevation Model
DFO	Divisional Forest Office / Officer (Territorial Division)
FDC	Forest Development Corporation
FMPL	Forest Management Planning
FMU	Forest Management Unit
FNCRB	Forest and Nature Conservation Rules of Bhutan
FRDD	Forest Resources Development Division
FRMD	Forest Resources Management Division (now FRDD)
FRPA	Forest Resources Potential Assessment
GIS	Geographic Information System
GIS-Cell	GIS-Cell of FRDS
GPS	Geographic Positioning System
LUPP	Land Use Planning Project
MOA	Ministry of Agriculture
NTFP	Non Timber Forest Products
RGOB	Royal Government of Bhutan
RS	Reconnaissance Survey
RSPN	Royal Society for the Protection of Nature
STC	Short-term Consultant, Short-term Consultancy
WWF	World Wide Fund for Nature

Abbreviations for Forest Functions

NB	Biodiversity Protection
NCS	Nature Conservation Section
NWC	Wildlife Conservation
NWP	Wildlife Protection
RB	Road Buffer
SC	Soil Conservation
Soc	Social Function
SocL	Social (Local Use Only)
SocLC	Social (Local Cum Commercial Use)
SocRS	Religious Site Protection
SP	Soil Protection
W	Water and Watershed Conservation
WRR	Riparian Reserve Protection
WSMA	Special Management Areas
WLS	Local Water Supply Protection
WSh	Watershed Conservation

Foreword

For Nahi FMU a forest management plan (FMPL) was prepared in 1993. For this purpose a forest management inventory was carried out during 1991/92, aerial photo interpretation of the land-use and forest types was conducted and a logging road was planned. All spatial related information were digitised and stored. However, because of lack of accessibility, the FMPL was never implemented.

In the subsequent years a series of socio-economic assessments were conducted to identify the local peoples needs and interests in forest resource use of Nahi. In 2001, a farm to market road was constructed with financial contribution given through BG-SRDP and Nahi valley is now more easy accessible for commercial timber use.

As the FMPL is only valid till 2002, it was decided to start with preparatory measures for the renewal of the FMPL. As a first activity in December 2001 the short-term consultant (STC) analysed the current situation of Nahi FMU, outlined potential management options and made recommendations for follow-up activities.

During this second assignment in February 2002, the STC supported FRDD in forest function mapping and zonation of Nahi FMU and assisted in the preparation of a forest management map. This was facilitated by the excellent data base which was available for Nahi from the previous activities. The process of forest function mapping, the results and some conclusions are subject of this short report.

1 Forest Function Mapping

The forest function mapping of Nahi FMU followed with some modification the prescriptions specified in SCHINDELE and DHITAL (1997). The Forest Function Map is attached in Annex 3.

1.1 Objectives and Definition

Objective

Forest function mapping is an essential tool for forest management planning. It defines for all the forest areas within a particular area ecological, environmental and social functions and as such allows to balance the some times often diverging interests of commercial logging, local forest use and nature conservation. The forest function map provides the information on the total commercially operable area, identifies which areas have to be reserved for local use and provides the management planner and the implementor with information on management restrictions for particular sites (SCHINDELE and DHITAL, 1997).

Definition and Description of Forest Functions

According to SCHINDELE and DHITAL (1997), there are five main groups of functions (see Table 1). Each one includes a number of subfunctions which are differentiated among each other by their influence on forest management (degree of management prescriptions). For the sub-function the term protection is used if commercial use is prohibited, the term conservation - or a more specific phrase - is used, if the function imposes management restrictions on the commercial use.

Table 1: List of different forest function groups and sub-functions
(Source: SCHINDELE and DHITAL, 1997)

Soil Conservation	Water and Watershed Conservation	Nature Conservation	Social Function	Road Buffer
SP Soil Protection	WRR Riparian Reserve Protection	NWP Wildlife Protection	SocRS Religious Sites Protection	RB Road Buffer
SC Soil Conservation	WLS Local Water Supply Protection	NWC Wildlife Conservation	SocL Social (Local Use Only)	
	WSMA Special Management Areas around Water Courses	NB Biodiversity Protection	SocLC Social (Local cum Commercial Use)	
	WSh Watershed Conservation			

The forest function mapping for Nahi was entirely done based on GIS-analysis of already existing data. Interpretation was verified wherever possible by using stereoscopic aerial photos and latest satellite imagery. For this purpose a base-map was prepared by the GIS-Cell of FRDD at a scale 1:25,000 indicating rivers, roads, settlements, contour lines, inventory plot location and slope classes (< 25, 25-50%, 50-60%, > 60%). Slope classes were derived from satellite DEM with 90m resolution.

In the following chapters, the identification process of the forest functions and the related management restrictions are briefly described. More detailed information on the objective, definition and imposed management restrictions are attached in Annex 2.

1.2 Identification and Description of Functions

1.2.1 Soil Conservation

1.2.1.1 Soil Protection (SP)

All areas having a slope above 60%¹ were classified as soil protection areas. Areas on slopes 50-60% were checked with the help of stereoscopic aerial photos, and if the percentage of steep and inoperable areas was high, they were also classified as soil protection. Soil protection areas are located on both sides of Nahi valley and cover an area of 1583 ha or about 20% of the total area.

Logging is strictly prohibited.

1.2.1.2 Soil Conservation (SC)

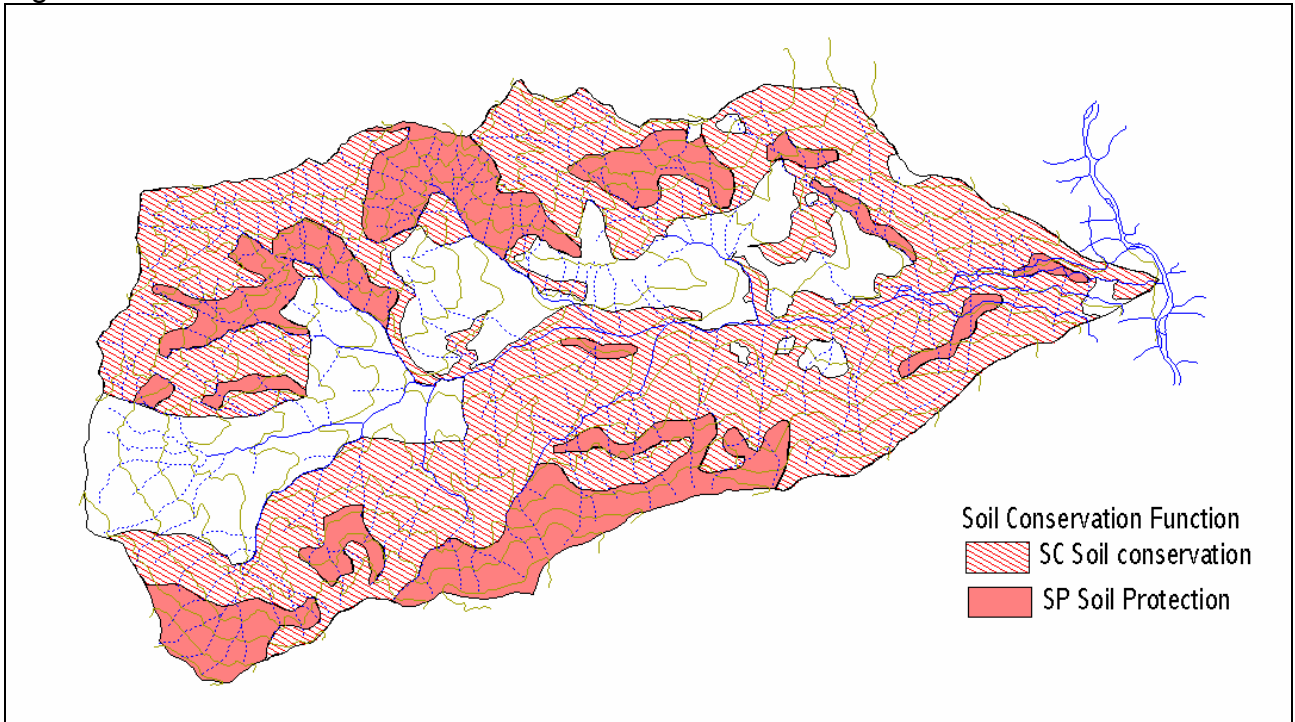
To minimize or prevent negative impacts of forest resource use in order to protect the soil from erosion and other degradation processes and to sustain soil fertility, all steep or heavily intersected areas, exposed sites and sites with high erosion risk were classified as Soil Conservation, altogether 4233 ha or 55% of the total area.

While soils on the lower slope are predominately sandy loam and well drained, the soil in the middle slope is clay to loamy clayey (RGOB/MOA/DOF/FRMD; 1993), sometimes waterlogged and prone to erosion if cleared from vegetation. Therefore, all the middle slopes on steeper terrain were classified as soil conservation areas.

Soil conservation areas are subject to forest management restrictions. Forest harvesting operations shall minimize the disturbances to the under-storey vegetation and damage to residual trees. Clear cuts shall be strictly prohibited. Rejuvenation periods should be rather long in order to promote an uneven-aged and multi-storey structure of the stand. Rejuvenation stands shall be protected from cattle grazing. Silvicultural improvement measures shall be implemented in poorly or inadequately stocked areas.

¹ The legal limit for timber harvesting is 45° or 90% (RGOB/MOA 2000). However slope classes derived from DEM with low resolution tend to underestimate slope considerable. It was experienced, that DEM-based slopes of 50-60% contain already a very high percentage of inoperable and steep areas (>45° in reality) and need to be excluded therefore from timber use.

Figure 1: Soil conservation functions



1.2.2 Water and Watershed Conservation

1.2.2.1 Riparian Reserve Protection (WRR)

Riparian areas occur along the banks of rivers. They include the waterbody itself, areas subject to periodic inundation and flooding. They extend from the actual streambed up to the top of the entrenchment zone. Along alluvial and semi-alluvial rivers, the width of the riparian reserve is 30 m.

The riparian reserves of the Nabe Rongchu and of the other perennial rivers were identified based on stereoscopic aerial photos and topographic map scale 1:50.000. Small and semi-perennial rivers were buffered 10m each side the river bed as it was impossible to determine the width of the entrenchment slopes for each stream. The water-channels in the south-eastern part were buffered individually with a buffers of 10-30m each side depending on topography. The total area of the Riparian Reserves is estimated at 768 ha or almost 10% of the total area².

Riparian reserves are strictly protected. It is not allowed to carry out any forest operation except those required to improve the forest condition and to restore its original natural condition.

1.2.2.2 Local Water Supply (WLS)

Not yet identified (refer to chapter 1.3).

² The area of the riparian reserve is a best estimate, as the real width of the buffer can only be determined when it comes to operation on the ground. The width of the entrenchment slopes can simply not be clearly determined based on topo-maps or aerial photos. However, a proper estimate is required in order to calculate the operable area.

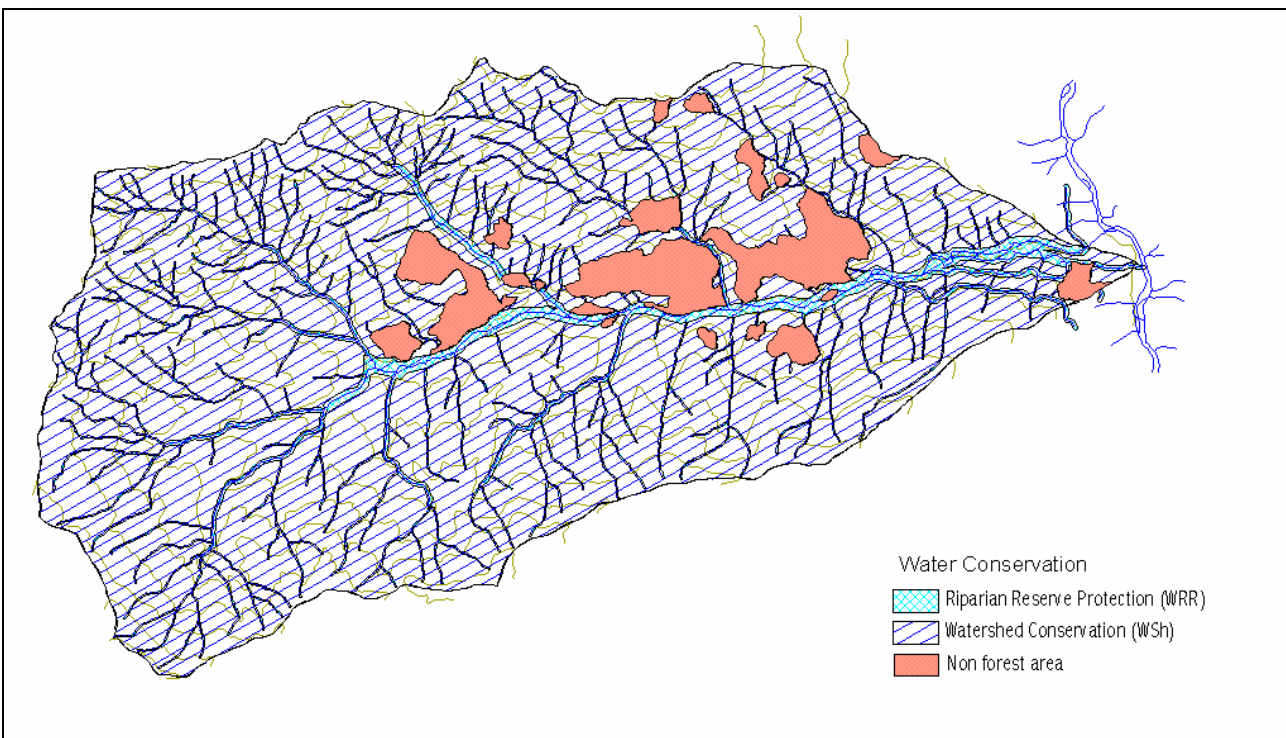
1.2.2.3 Watershed Conservation (WSh)

Upper catchment areas of water courses on steep slopes and poorly drained or permanently waterlogged areas and all other sites serving as water retention or water feeding bodies are classified as Watershed Conservation forests.

Almost the entire Nahi FMU is located on slopes above 25% and qualifies as Watershed Conservation Area.

Water quality can be affected through the fast decomposition of raw humus layers, the wash out of the topsoil, and increased surface run-off of precipitation and intensive cattle grazing. To sustain and maintain continuous water supply the water infiltration rate should be kept as high as possible. Therefore, forest harvesting operations should minimize disturbance to under-storey vegetation and maintain the multi-storey structure of the forests. Clear cuts and conversion of natural forest into plantation is prohibited. Cattle grazing intensity should be kept low and should be prohibited in rejuvenation stands.

Figure 2: Water conservation functions



1.2.3 **Social Functions**

The social functions were identified based on information derived from the socio-economic assessments, land-use data, the forest inventory data and on spatial considerations. They have not yet been verified with the local people (refer to chapter 1.3). The location of the various social function is shown in Figure 3.

1.2.3.1 Local Use Only (SocL)

Local Use Only areas are forests which are, and have been, traditionally used intensively by the local people and which are an integrated and indispensable component of their subsistence. They are excluded from commercial logging in order to ensure the provision of all forest products required for the peoples subsistence needs in a sustainable way. This includes also areas where the objectives of local use and commercial timber production are in conflict.

For this purpose all areas in the immediate vicinity of settlements were classified as Local Use Only. The boundary was determined based on results of the forest inventory (refer to SCHINDELE and DHITAL, 1997) and information derived from the socio-economic studies. Additionally all chirpine forests, which are intensively used by the local people as a silvo-pastoral system were included³.

Altogether, 1931 ha have been set aside for the sole use of the local population which is about 25% of Nahi FMU. This includes 426 ha of protected areas (i.e. mainly Riparian Reserve Protection).

1.2.3.2 Local cum Commercial Use (SocLC)

Forest areas which are used by the local population for the collection of shingleps, firewood and Non Timber Forest Products (NTFP) were classified as Local cum Commercial Use Forests. Sustainable commercial forest management is allowed, but must be carried out in such a way, that continuous and sufficient supply with the above mentioned products is ensured. This requires, that every forest management activity implemented by FDC needs to be done in consensus with the local population.

Altogether 897 ha (12%) of Local cum Commercial Use Forests were identified based on the results of the forest inventory and on forest type considerations (i.e. for firewood and fodder, the local people depend on the broadleaved forest).

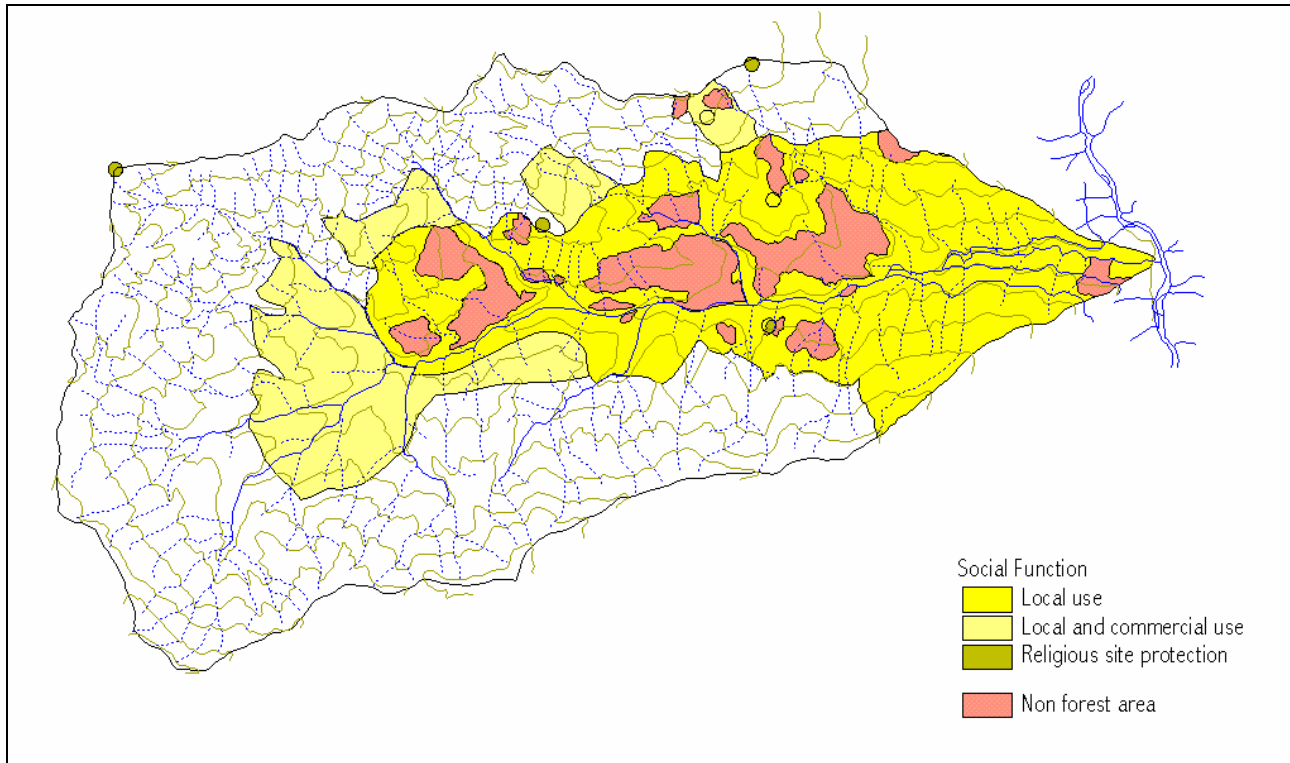
1.2.3.3 Religious Site Protection (SocRS)

Religious sites are lhakhangs/goenbas and all other places of worship or were people practice religion. To respect the sanctity of these places no commercial use shall be permitted within a distance of 100 m, except for silvicultural measures which are necessary to ensure stand stability. Local use shall be restricted to those activities which do not disturb the sanctity of the object.

So far, only the five religious sites indicated on the topographic map have been buffered. If there are any other religious sites within Nahi FMU must be clarified with the local people and/or representatives of the monk body (refer to chapter 1.3).

³ To maintain pasture quality, chirpine forest are burnt periodically, otherwise natural regeneration will take over. This may affect the objective of sustainable timber production.

Figure 3: Social functions



1.2.4 Nature Conservation

It is the objective of the nature conservation functions to balance the diverging interests of commercial logging with that of nature conservation and environment protection. The location of nature conservation areas is shown in Figure 4.

1.2.4.1 *Wildlife Protection (NWP)*

In order to prevent protected and rare animals from human disturbance, their habitats and corridors used for their movement are excluded from commercial use.

In Nahi FMU the fir belt in the west has been classified as Wildlife Protection Area as it is habitat of musk deer, Himalayan black bear and leopards as derived from the results of the forest inventory and field observation made by foresters and the local people. The total area under Wildlife Protection is 487 ha or 6% of the total area.

1.2.4.2 *Wildlife Conservation (NWC)*

The following two areas (altogether 3857 ha or 50% of the total area) were classified as Wildlife Conservation Forest:

- The biological corridor in the western half of Nahi valley.
- All other areas which are very rich in species variety and number of wildlife, especially in mammals and birds.

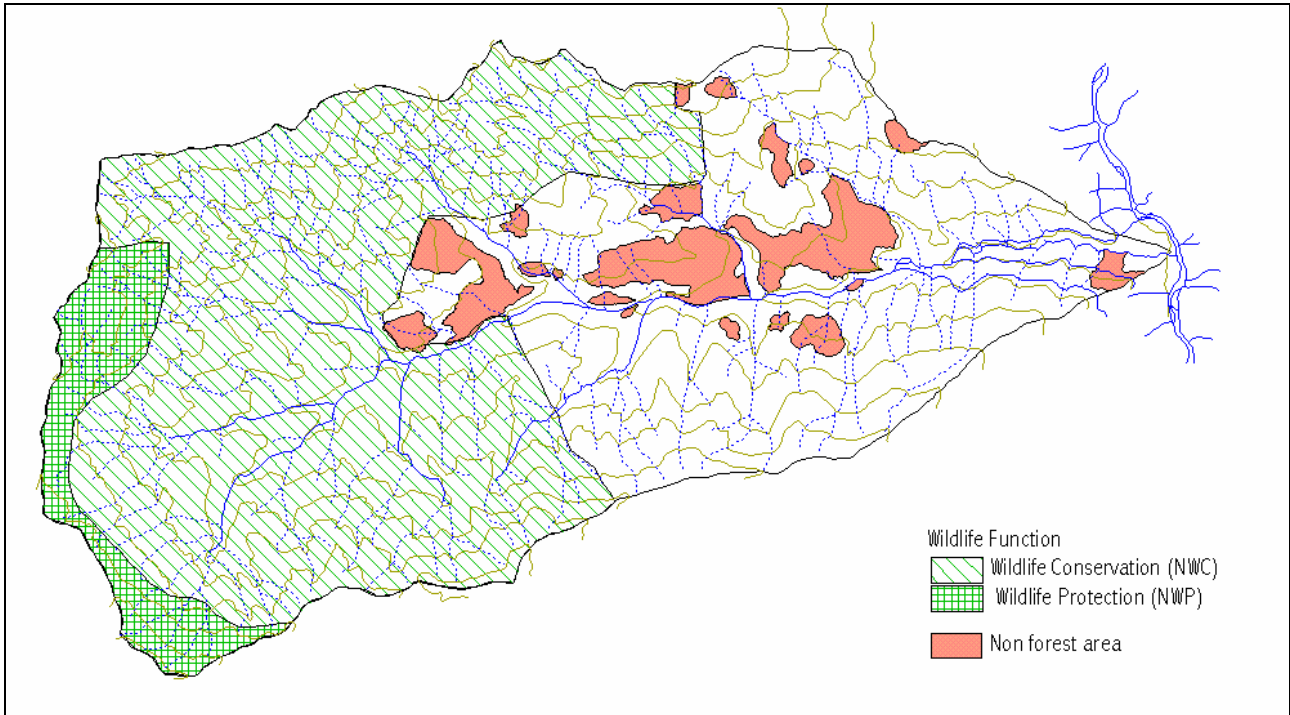
Forest operations shall be planned and executed in such a way, that the multi-storey structure is maintained and the disturbance to the under-storey, especially bamboo is kept to a minimum. Clear cuts are prohibited. Fruit and fodder trees for wild animals shall be exempted from exploitation, snag trees shall be left. Small pasture areas and gaps have to be left open.

1.2.4.3 *Biodiversity Protection (NB)*

It is the objective of Biodiversity Protection to preserve rare and extra-ordinary rich ecosystems and ecological niches. No forest management activities at all shall be permitted within these areas, this includes the collection of NTFP. Also, these areas shall be excluded from cattle grazing.

According to RSPN some very rare ecosystems of the Inner Himalaya region occur in Nahi FMU. Their location and extent still needs to be mapped.

Figure 4: Nature conservation



1.2.5 *Road Buffer*

In 2001, a farm to market road to Nahi school was constructed which shall be buffered 60m uphill and 30m downhill in order to protect the road from falling rock, land slides, surface runoff and erosion each side. The actual transect of the road still needs to be identified with GPS and mapped (refer to chapter 1.3).

1.3 **Required Follow-Up**

The present forest function map has been prepared in the office by using already existing information. What has to be done now, is to complete the map and to field truth the most important boundaries. This shall be done together with the local people and FDC.

What has to be checked or done in particular is listed below:

- Verification of Soil Protection areas.
- Identification of local water supply.
- All religious sites mapped?
- Local Use Only boundaries reasonable?
- Survey of Nahi road with GPS and determination of road buffer.
- Mapping of rare ecosystems with assistance of RSPN.
- Verification of social function with local people.

During the process of forest function mapping of Nahi FMU the need to carry out some minor adjustments in the proposed code on Forest Function Mapping has come up. This refers mainly to the identification of soil protection and conservation areas based on DEM-derived slopes and the classification of biological corridors as Wildlife Conservation.

2 Forest Zoning

Forest functions have different impacts on forest management. Some functions exclude all type of forest management activities, other only commercial timber exploitations, others impose only minor management restrictions. Table 2 ranks the forest functions according to their impact on forest management.

Table 2: Impact of forest function on commercial forest management and local use
(Source: SCHINDELE and DHITAL, 1997)

Rank	Code	Function	Restriction on Commercial Use	Restriction on Local Use
1	NB	Biodiversity Protection	no commercial use	no local use
2	SP	Soil Protection	no commercial use	no tree felling; no tsamdo; no shoksing
3	WRR	Riparian Reserve Protection	no commercial use	only collection of NTFP; no tsamdo; no shoksing
4	RB	Road Buffer	no commercial use	no tree felling
5	NWP	Wildlife Protection	no commercial use	restriction to activities that do not change habitat quality and disturb wildlife
6	WLS	Local Water Supply Protection	no commercial use	low impact use only; no cattle grazing
7	SocRS	Religious Site Protection	no commercial use	only uses which do not disturb sanctity of place
8	SocL	Social (Local Use Only)	no commercial use	no restriction
9	SC	Soil Conservation	no clear cutting; no conversion into plantation; extension of rejuvenation periods	low impact local use; no intensive cattle grazing
10	WSMA	Special Management Area around Water Courses	no clear cutting; no conversion into plantation; minimize disturbance to understorey vegetation	low impact local use; no intensive cattle grazing
11	WSh	Watershed Conservation	no clear cutting; no conversion into plantation; minimize disturbance to understorey vegetation	no intensive cattle grazing
12	NWC	Wildlife Conservation	no clear cutting; no conversion into plantation; leave snags; leave some undisturbed patches; minimize disturbance to understorey vegetation (bamboo)	local use should minimize disturbance to wildlife
13	SocLC	Social (Local cum Commercial Use)	depends on type of local use; has to be individually determined from case to case	no restriction
14		Production	no restriction	no restriction

In many cases forest function overlap. In this case all prescribed management restrictions have to be observed.

Based on their impact on commercial forest management the forest functions are classified into the following three zones (see Table 3).

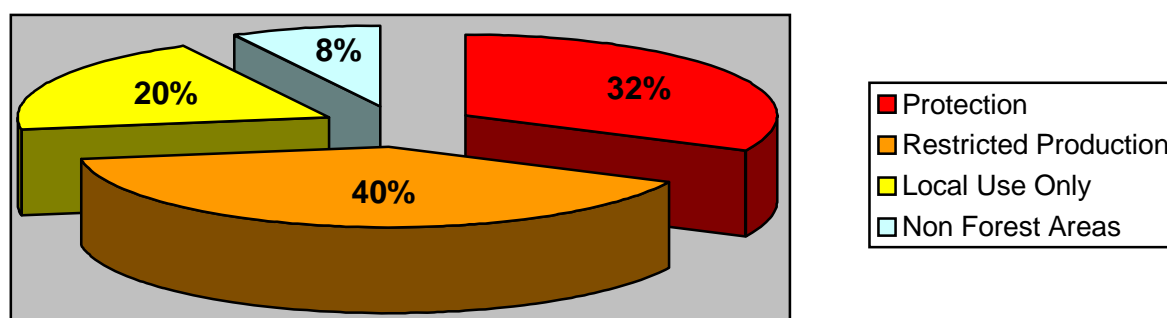
Table 3: Forest zonation

Protection Zone	Restricted Production Zone	Local Use Zone
Biodiversity Protection Soil Protection Riparian Reserve Protection Road Buffer Wildlife Protection Local Water Supply Protection Religious Site Protection	Soil Conservation Special Management Area around Water Courses Watershed Conservation Wildlife Conservation Social (Local cum Commercial Use)	Social (Local Use Only)

All areas which have no defined function are considered as commercial production forests without any particular management restriction except those imposed by the Forest and Nature Conservation Rules of Bhutan (RGOB/MOA, 2000) and relevant rules issued by FSD from time to time.

The distribution of Nahi FMU according to forest zones is shown in Figure 5 below, the forest zonation map is attached in Annex 3.:

Figure 5: Distribution of forest zones



All forest areas within Nahi valley fulfil one or several functions and belong either to Protection Zone or Restricted Production Zone. This is also valid for Local Use Only forests (refer to Table 4: Distribution of forest functions and zones according to type of management

Functions/Zones		Total FMU Area	Commercial Use Area	Local Use Only Area	Non Forest Area
		(ha)	(ha)	(ha)	(ha)
Total FMU		7643,5	5124,3	1931,1	588,1
Forest Functions					
Soil Protection	SP	1583,4	1470,5	112,9	
Soil Conservation	SC	4232,6	2719,3	1513,3	
Local Use Only	SocL	1931,1	0	1931,1	
Local cum Commercial Use	SocLC	896,8	896,8	0	
Religious Site Protection	SocRS	15,6	9,4	6,2	
Wildlife Protection	NWP	486,8	486,8	0	
Wildlife Conservation	NWC	3857,3	3680,4	176,9	
Riparian Reserve Protection	WRR	768,3	389,9	378,4	
Watershed Conservation	WSh	7055,4	5124,3	1931,1	
Forest Zones					
Protection	Prot.	2446,3	2045,5	400,8	
Limited Production	Lim. Prod.	4609,1	3078,8	1530,3	

and Table 5).

3 Implications on Forest Management

3.1 Results of Forest Function Mapping and Zonation

Based on the forest function mapping and zonation, Nahi FMU consists of two sub-units of which:

- one should be managed on a commercial basis by FDC,
- the other one should be managed for local use only.

Table 4: Distribution of forest functions and zones according to type of management

Functions/Zones		Total FMU Area	Commercial Use Area	Local Use Only Area	Non Forest Area
		(ha)	(ha)	(ha)	(ha)
Total FMU		7643,5	5124,3	1931,1	588,1
Forest Functions					
Soil Protection	SP	1583,4	1470,5	112,9	
Soil Conservation	SC	4232,6	2719,3	1513,3	
Local Use Only	SocL	1931,1	0	1931,1	
Local cum Commercial Use	SocLC	896,8	896,8	0	
Religious Site Protection	SocRS	15,6	9,4	6,2	
Wildlife Protection	NWP	486,8	486,8	0	
Wildlife Conservation	NWC	3857,3	3680,4	176,9	
Riparian Reserve Protection	WRR	768,3	389,9	378,4	
Watershed Conservation	WSh	7055,4	5124,3	1931,1	
Forest Zones					
Protection	Prot.	2446,3	2045,5	400,8	
Limited Production	Lim. Prod.	4609,1	3078,8	1530,3	

below shows the distribution of the forest functions and zones according to type of management and Table 5 the distribution of forest types or potential working circles according to zones and type of management.

Table 4: Distribution of forest functions and zones according to type of management

Functions/Zones		Total FMU Area	Commercial Use Area	Local Use Only Area	Non Forest Area
		(ha)	(ha)	(ha)	(ha)
Total FMU		7643,5	5124,3	1931,1	588,1
Forest Functions					
Soil Protection	SP	1583,4	1470,5	112,9	
Soil Conservation	SC	4232,6	2719,3	1513,3	
Local Use Only	SocL	1931,1	0	1931,1	
Local cum Commercial Use	SocLC	896,8	896,8	0	
Religious Site Protection	SocRS	15,6	9,4	6,2	
Wildlife Protection	NWP	486,8	486,8	0	
Wildlife Conservation	NWC	3857,3	3680,4	176,9	
Riparian Reserve Protection	WRR	768,3	389,9	378,4	
Watershed Conservation	WSh	7055,4	5124,3	1931,1	
Forest Zones					
Protection	Prot.	2446,3	2045,5 ⁴	400,8	
Limited Production	Lim. Prod.	4609,1	3078,8	1530,3	

Table 5: Distribution of forest types according to zones and type of management

Forest Types/ Working Group	Limited Production Forest Only			Total Forest Area		
	Commercial	Loc. Only	Total	Commercial	Loc. Only	Total
	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
Broadleaves	1604,4	400,3	2004,7	2267,0	583,6	2850,6

⁴ This Protection zone is located within the part of Nahi which could be managed by FDC for commercial use.

young	15,3	186,3	201,6	48	302,3	350,3
mature	719,1	45,7	764,8	1071,7	49,1	1120,8
old	882,8	155,5	1038,3	1147,3	232,2	1379,5
Mixed Broadl./Conifer	843,3	178,4	1021,7	1337,5	200,0	1537,5
young	174,6	104,7	279,3	270	111,5	381,5
mature	304,3	0,1	304,4	561,7	0,1	561,8
old	364,4	73,6	438,0	505,8	88,4	594,2
Conifers	580,0	797,7	1377,7	1357,9	931,1	2289,0
young	26,2	459,2	485,4	35,2	548,7	583,9
mature	102,0	2,4	104,4	289,8	3	292,8
old	451,8	336,1	787,9	1032,9	379,4	1412,3
unproductive	50,9	153,9	204,8	161,9	216,4	378,3
Total	3078,8	1530,3	4608,9	5124,3	1931,1	7055,4

As all chirpine forests have been classified as Local Use Only (refer to chapter 1.2.3.1), the percentage of conifer forests is over-proportional high in Local Use Only areas.

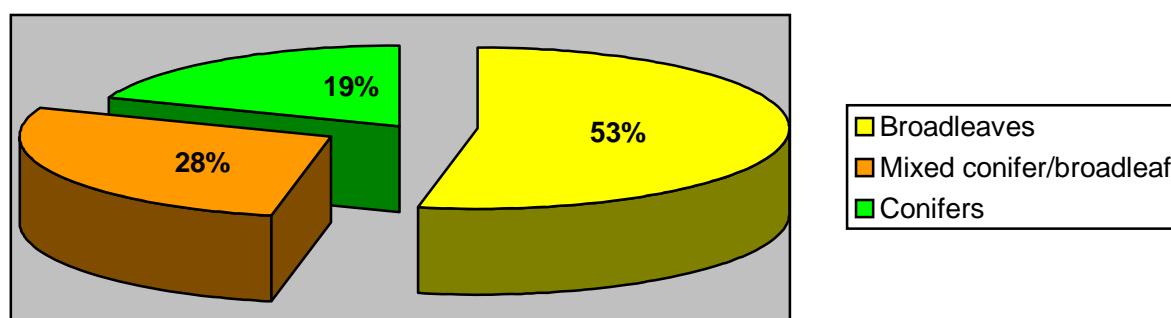
3.2 Implications on Commercial Forest Management

The total area for commercial use is 5124,3 ha of which 2045,5 ha are protection zones and another 50,9 ha are unproductive scrub forests or gaps.

The remaining 3027,9 ha are suitable for commercial timber use, but their management is restricted according to the imposed functions. In most of the forest area clear felling is not permitted.

The percentage of broadleaved or mixed conifer/broadleaved forests (see Figure 6 below) is fairly high (altogether 81%) of which almost 50% are old and over-mature and of poor quality. The appropriate silvicultural system for sustainable broadleaf forest management is the single tree selection system with natural regeneration, which requires a long protection period from cattle grazing.

Figure 6: Distribution of forest types within commercial use forest



The results of forest function mapping in relation to commercial forest management can be summarized as follows:

- The total area of 3027.9 ha of limited production forest is too small for a self-sustainable FMU.
- The percentage of inoperable areas (20%) within the limited production forest is fairly high.

- The economic value of hardwood is at present quite low (remark: hardwoods are currently used mainly for firewood production).
- Clear cuts and patch fellings are not permitted due to silvicultural considerations and imposed forest functions.
- In order to make the harvestable forest area accessible the Nahi road needs to be extended for at least another 6-10 km.

3.3 Estimate of Annual Allowable Cut (AAC)

Based on the area results of forest function mapping and the resource information derived from the forest inventory of 1991-92⁵, the AAC can roughly be estimated as follows:

Assumptions:

- Single tree selection system
- Only usable species considered (i.e. without Rhododendron and other scrub species)

⁵ For a rough estimation of the AAC the inventory results of 1991-1992 can still be used as no commercial logging took place so far. It is assumed, that the local use which took place in the meantime is compensated by the overall increment. For the present AAC calculation only the inventory plots were considered which are located within the commercial use area. The results are attached in Annex 4.

Area = 3000 ha

Cutting period CP: 40 years

Total volume (reliable minimum estimate without Rhododendron) V_{total} : 290 cbm/ha

Extraction Factor (removal of 25% of total volume) $F_{extract} = 0.25$

Factor for inoperable and/or inaccessible areas within limited production forest: $F_{inop} = 0.8$:

$$AAC = ((Area * F_{inop}) * (V_{total} * F_{extract}))/CP$$

$$AAC = (3000 * 0.8) * (290 * 0.25) = (2400 * 72.5)/40 = 4350 \text{ cbm}$$

The annual allowable cut is roughly estimated at 4350 cbm standing volume. It is estimated, that at least 20% of the standing volume will be left on the site and will not be used at all. As such, the merchantable volume is estimated at 3480 cbm per year of which only 10% (i.e. approx. 350 cbm per year) are conifer species according to the results of the forest inventory.

Due to lack of key economic figures it is not possible at this place to provide a brief economic analysis. However taking into account on one hand the high cost for road construction and the high expenses for harvesting (cable crane logging) and on the other hand the comparatively low value of the product makes it very unlikely that under the current management practice Nahi FMU could be managed on a commercial basis as a self-sustainable FMU.

4 Follow-up

After verification, field truthing and finalization of the forest function map, the results and implications on forest management shall be discussed with all stake holders, namely FDC, DFO, FRDD and the local people at the site. A brief cost/benefit analysis shall be prepared for various management options (refer to SCHINDELE, 2001).

After decision has been taken on how to manage Nahi watershed in future, the preparation of a forest management plan shall be initiated.

Annex 1

Literature

Literature

- KLEINE, M.; 1996: Silvicultural Management of Broad-leaved and Chir Pine Forests in the Punakha and Wangdue-Phodrang Districts of Bhutan. Final Report. BG-IFMP, February 1996.
- MAIER, E.J.; 1995 (a): Assessment of the Holistic Approach of Management Plan for FMU Nahi. BG-IFMP Working Paper No. 1.
- NAMGYEL, P.; 1996: Beyond Timber - What Value of the Forest? A Rapid Rural Appraisal Study on Non-Timber Forest Products in the Nahi Gewog, Wangdue-Phodrang Dzongkhag, Western Bhutan. FRC/BG-IFMP Occasional Paper No. 1.
- RGOB/MOA; 2000: Forest and Nature Conservation Rules of Bhutan, 2000. Volume I.
- RGOB/MOA/DOF/FRMD; 1993: Management Plan for Nahi Forest Management Unit, Wangdi Phodrang Dzongkhag. Period of the Plan: 1993 - 2002; Prepared by D.B. Dhital, FRMD.
- RICHTER, M.; 1997: "The Motorable Road of Hope" Resources Management by Rural Households in Nahi Gewog Wangdue-Phodrang Dzongkhag. Working Paper No. 13, BG-SRDP:
- SCHINDELE, W., DHITAL, D.B.; 1997: Forest Function Planning and Mapping. Guidelines for the Preparation of a Forest Function Map and Definition of Management Restrictions. BG-SRDP, Working Paper No. 11.
- SCHINDELE, W.; 2001: Report on a Short-term Consultancy to "Clarify and define the process for the preparation of a Forest Management Plan for Nahi Forest Management Unit (FMU)".

Annex 2

**Definition and Description of Forest Functions
(SCHINDELE and DHITAL, 1997)**

Soil Conservation

The group "Soil Conservation" is one of the most important functions and it is defined in order to prevent land and snow slides, damages caused by falling stones or rocks, protection of arable land, etc. Also, the protection of the topsoil from erosion is an essential measure in order to maintain the fertility and production capacity of the soil in the long run, which is a pre-condition for sustainable forest management and agriculture.

	Soil Protection (SP)	Soil Conservation (SC)
<u>Definition</u>	Soil Protection includes all areas which are extremely sensitive to soil erosion, land and snow slides. These areas include in particular very steep slopes, rocky and stony areas, waterlogged gleys and already eroded areas. Unstable slopes above or near important objects such as villages, settlements, individual houses, roads, agricultural land, etc. are defined for protection reasons as Soil Protection, too.	The function "Soil Conservation" covers all areas which are sensitive to soil erosion, which are, for example, steep slopes, waterlogged areas and exposed sites.
<u>Objective</u>	(1) to prevent damages caused to the environment and infrastructure by land slides, snow slides, falling stones and other physical impacts; (2) to protect the soil from erosion and to sustain soil fertility.	(1) to minimize or prevent negative impacts due to forest resource use in order to protect the soil from erosion and other degradation processes and to sustain soil fertility.
<u>Legal Restrictions</u>	According to § 14 a (iii) of the Forest and Nature Conservation Act (1995) <i>"no permits shall be issued to fell and to take any timber where the slope is greater than 45 degrees (100%) unless authorized under an approved management plan or by the Head of the Department."</i>	None.
<u>Identification</u>	Soil erosion depends largely on geology, site conditions (soil type, water regime, etc.) and slope gradient. In general it can be said, the finer the soil texture, the steeper the slope and the higher the water content (saturation) the more sensitive the soil becomes towards erosion and landslides. Unfortunately, up to date soil map does not exist for Bhutan and soil mapping for entire FMU would definitely over stress the human resources of the Forest Services Division. The only parameters which can be comparatively easily assessed are the slope gradient, the land use type and already existing signs of erosion (gullies, rills, land slides, etc.).	
	The following areas shall be classified as Soil Protection: <ul style="list-style-type: none"> • very steep areas (slope above 100%); • unstable areas and sites prone to landslides and areas with indications of severe erosion. 	The following areas shall be classified as Soil Conservation: <ul style="list-style-type: none"> • steep areas (slopes of 76-100%); • areas with indication of slight to moderate erosion; • exposed sites (ridges, etc.).
<u>Short Description of Management Prescriptions/Restrictions</u>	Strict Protection! No trees shall be felled or removed for commercial purposes. However, if the area is not prone to landslide limited local use may be permitted. In heavily landslipped areas, even collection of leaf litter shall be restricted. Cattle grazing, in such areas, shall also be regulated or restricted. However the collection of minor forest products such as fruits, nuts, medicinal herb, etc. shall be permitted. In case the forest is in such a bad condition that its protective function is no longer valid, silvicultural operations required to restore functionality of the forest cover have to be planned and implemented. Already severely eroded areas which are poorly stocked should be reforested as soon as possible.	Only management restrictions! Forest harvesting operations shall minimize disturbances to understorey vegetation and damage to residual trees. Silvicultural systems shall focus on natural regeneration, with enrichment planting only where necessary. Deep rooting and site adapted species shall be promoted on unstable sites. Rejuvenation periods should be rather long (at least 60-100 years) in order to promote an uneven-aged and multistory structure of the stand. Clear cuts shall be strictly prohibited. Low impact local forest use shall be permitted, however grazing pressure in rejuvenation stands shall be kept to a minimum. Silvicultural improvement measures (i.e. enrichment planting, tending) shall be planned and implemented in poorly or inadequately stocked areas.

Water and Watershed Conservation

Water is one of the most valuable natural resources and clean potable water is an indispensable asset for the human population. The protection of water resources therefore gains highest priority in resources management. The function "Water and Watershed Conservation" focuses on the conservation of the cleanliness of the groundwater and surface water bodies and the maintenance of a continuous water supply. According to the objective of the function and the imposed management prescriptions/restriction different sub-functions are defined.

	Riparian Reserve Protection (WRR)	Special Management Areas (WSMA)				
<u>Definition</u>	<p>Riparian areas occur along the banks of rivers and streams, and around the perimeter of lakes and wetlands. They include the water body itself, areas subject to periodic inundation and flooding, areas with high water tables and immediate adjacent uplands. Streamside vegetation stabilizes stream banks, regulates stream temperatures through shading, and supplies a continual source of coarse woody debris to stabilize stream channels and diversify aquatic habitat. The majority of fish food organisms come from overhanging trees and shrubs, while the nutrients from organic materials that fall or wash into the stream are the basis of aquatic ecosystem productivity.</p> <p>Riparian areas often contain the highest plant and animal diversity, and some of the highest valued non-timber forest resources in the forest landscape. They provide critical habitats, home ranges and travel corridors for many mammal and bird species, and maintain ecologically-important vertical and horizontal linkages throughout the forest landscape.</p>					
<u>Objective</u>	<p>(1) to minimize or prevent negative impacts due to forest resource use on stream channel stability, water quality, and aquatic ecosystem productivity and diversity;</p> <p>(2) to protect and sustain plant diversity associated with riparian areas; and</p> <p>(3) to allow sustainable and environmentally-sound forest uses consistent with objective (1) & (2) above.</p>					
<u>Legal Restrictions</u>	<p>According to § 14 a (ii) of the Forest and Nature Conservation Act (1995) "<i>no permits shall be issued to fell and take timber within 100 feet (30 m) of the bank or edge of any river, stream, water course and or water source.</i></p>					
<u>Identification</u>	<p>Stream courses in mountainous landscapes vary considerably in gradient, cross section, flow, stability and ecological importance. To ensure adequate protection the characteristics of the water courses have to be taken into account.</p>					
	<p>The Riparian Reserve includes the stream bed and extends to the top of the entrenchment slope. Along alluvial and semi-alluvial rivers and streams the width of the Riparian Reserve is 30 m.</p>	<p>The size of the Special Management Area extends to the specified distance from the top of the stream bed.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 70%;">Large non-alluvial rivers:</td> <td style="text-align: right;">100 m</td> </tr> <tr> <td>Alluvial and semi-alluvial rivers and streams:</td> <td style="text-align: right;">to edge of active flood plain</td> </tr> </table>	Large non-alluvial rivers:	100 m	Alluvial and semi-alluvial rivers and streams:	to edge of active flood plain
Large non-alluvial rivers:	100 m					
Alluvial and semi-alluvial rivers and streams:	to edge of active flood plain					
<u>Short Description of Management Prescriptions</u>	<p>Strict Protection!</p> <p>Within buffer zones (riparian reserves) along streams, small rivers and perennials, it is not allowed to carry out any forestry operation except those required to improve the forest condition and to restore its original natural condition. Such rehabilitation activities are: reforestation of cleared sites, beating up, tending, weeding and, if necessary from the silvicultural viewpoint in order to increase stability, thinning. All those activities have to focus on the establishment of multi-structured, uneven-aged mixed forests and they have to be carried out manually only. The use of machines is strictly prohibited. Local use is limited to the collection of NTFP. Cattle grazing and leaf litter collection are not be allowed. The establishment of infrastructure like logging roads, establishment of log ponds, housing, sawmill and other utilization units, camp-sites, log landings etc. is strictly prohibited within these areas. (Note: Removal of trees shall be considered on epidemic out-break & silvicultural reasons.)</p>	<p>Only management restrictions!</p> <p>Forest harvesting operations within the special management zones and 20 m from the top of the entrenchment slopes should minimize disturbance to understorey vegetation and damage to residual trees. Silvicultural systems should focus on natural regeneration, with enrichment planting wherever necessary. Clear cutting is prohibited. Woody debris, occurring in the site, should be maintained and no weeding or burning or slash disposal should take place. The conversion of natural forests into plantations is prohibited. Low impact forest use is permitted, however high cattle densities are to be discouraged.</p>				

	Local Water Supply Protection (WLS)	Watershed Conservation (WSh)
<u>Definition</u>	Buffer zones have to be defined for all areas in the immediate vicinity of water resources used for the local water supply and includes the water-body itself and swampy or waterlogged catchment areas.	Watershed conservation. Forests cover the upper catchment areas of water courses on steep slopes and poorly drained or permanently waterlogged areas.
<u>Objective</u>	(1) to prevent negative impacts due to forest resource use on water quality and stream channel stability	(1) to maintain the cleanliness of ground and surface water (water quality); (2) to prevent surface run-off of precipitation and to sustain continuous water supply; and (3) to allow sustainable and environmentally-sound forest uses consistent with objective (1) & (2) above.
<u>Legal Restrictions</u>	According to section 14a (ii) of Forest and Nature Conservation Act (1995) " <i>no permits shall be issued to fell and take timber within 100 feet (30 m) of the bank or edge of any river, stream, water course and or water source.</i> "	None!
<u>Identification</u>	The buffer zone consists out of the Riparian Reserve (WRR) and an additional 30 m wide protection zone along the outer edge of the Riparian Reserve. Swampy or waterlogged areas feeding the respective water resource will have to be included.	Water conservation measures are necessary on steep areas (> 25% slope). Also upper catchment areas and poorly drained or waterlogged sites, moist areas and swamps, and all other sites serving as water retention or water feeding bodies, should be classified as Watershed Conservation areas.
<u>Short Description of Management Prescriptions/Restrictions</u>	<p>Strict Protection!</p> <p>No commercial operations shall take place within WLS buffers. Low impact local use shall be permitted, but intensive cattle grazing has to be restricted for hygienic reasons. The establishment of infrastructure, such as, logging camps, log landings and forest roads, is prohibited.</p> <p>Note: Removal of trees shall be considered in the following cases:</p> <ol style="list-style-type: none"> 1. Epidemic out-break. 2. On silvicultural reasons. 	<p>Only management restrictions!</p> <p>Water quality can be affected through the fast decomposition of raw humus layers, the application of chemicals or fertilizers, the wash out of the topsoil and increased surface run-off of precipitation and intensive forest pasture. To sustain and maintain continuous water supply the water infiltration rate should be kept as high as possible.</p> <p>Forest harvesting operations within Watershed Conservation areas should minimize disturbance to understorey vegetation and damage to residual trees. Silvicultural systems should focus on natural regeneration, with enrichment planting only where necessary. Clear cuts and the conversion of natural forests into plantations shall be prohibited. Multi-structured, uneven-aged forests with a high percentage of deep-rooting tree species fulfill the requirements of water conservation in the best way. Local forest use is permitted, however, high cattle densities have to be avoided.</p> <p>The use of heavy machinery, application of chemicals, dumping of waste (i.e. old oil) and the establishment of logging camps, sawmills, etc. are prohibited.</p>

Social Functions

The local population living in and around the FMU largely depend on the forest as a resource for construction timber, firewood and fence posts. They also use the area for collection of NTFP and as cattle grazing ground. To avoid conflicts with commercial logging, the forest area used by the local people must be identified and, if required, a portion of the forest has to be set aside for their exclusive use. It is of greatest importance, that the identification of the areas used by the local people and the decision on "social functions" is made in a participatory way. Therefore, the identification of social functions is subject of the PRA. There is one problem in defining and mapping social functions, they are not consistent and they depend largely from social framework. Therefore, when mapping the social forest functions, future trends and developments need to be appraised.

	Social (SocL) (Local Use Only)	Social (SocLC) (Local cum Commercial Use)
<u>Definition</u>	Forest areas which are, and have been, traditionally used intensively by the local population and which are an integrated and indispensable component of their subsistence should be set aside for Local Use Only.	Forest areas which are used by the local population for the collection of wood (shingleps) and NTFP should be defined as Social (Local cum Commercial Use) forests.
<u>Objective</u>	(1) to provide the local population with sufficient forest products for their subsistence needs in a sustainable way; and (2) to exclude forest areas from commercial logging, where the commercial use of the forest is in contradiction with objective (1).	(1) to provide the local population with sufficient forest products in a sustainable way; and (2) to allow sustainable commercial forest use by FDC in a way that it is consistent with objective (1) above.
<u>Legal Restrictions</u>	None! Remark: if Social (Local Use Only) use is defined as a separate community forest reserves, then the "Social Forestry Rules" and the "Community Forestry Guidelines for Bhutan" provide the legal basis.	None!
<u>Identification</u>	The definition and mapping of social functions is done during the PRA after the decision has been taken to open a FMU. The procedures for identifying the individual functions will be prescribed in the PRA manual. Criteria for the identification are: <ul style="list-style-type: none"> • vicinity to settlement or village; • accessibility; • forest type and condition (can the area provide the required product in a sustainable way?); • site capability (production potential); • traditional use and user (any registered rights?); • visibility of boundaries (natural features); • prospective of future social development (i.e. population growth, market structures) • other functions. 	
<u>Short Description of Management Prescriptions/Restrictions</u>	No commercial exploitation! Note: Removal of trees shall be considered in the following cases: 1. Epidemic out-break. 2. On silvicultural reasons.	There is no standard management restrictions for "Commercial cum Local Use". The prescriptions/restriction for commercial forest depends largely from the type of local use. For example: if the forest area is traditionally used for shinglep production, enough "shinglep"-trees have to be excluded from commercial logging. These will have to be marked by the Beat Officer during tree marking. Another example: thinning of blue pine could be done by the people for the production of tshims, poles, fence posts, etc., the final logging could be done for commercial purpose only or it could be linked with local use (i.e. shingleps). The various management restrictions to be imposed have to be <u>jointly determined by the management planner and the local population during the PRA</u> for different forest areas and have to be specified in the stand or compartment book.

Social Function (Soc) (Religious Sites)

Religion plays an important role in Bhutan. Through out the country, monasteries, gneys, meditation houses and other religious objects are distributed and many of them are located in forested areas. To respect the sanctity of these holy places and in order, not to disturb people in their religious practice, no forestry operations should take place in the immediate vicinity of religious sites.

Religious (SocRS) Site Protection

<u>Definition</u>	Religious sites are lhakhangs/goenbas and gneys and all other places used by people to practice religion.
<u>Objective</u>	(1) not to disturb people in their religious practice and to respect the sanctity of these places.
<u>Legal Restrictions</u>	None!
<u>Identification</u>	Most of the monasteries and religious sites have already been localized on topographic maps or LUPP land use working maps. During the process of RRA and PRA all religious sites which should be buffered will have to be jointly identified and mapped and the size of the buffer zone should be determined. The minimum buffer around a religious site is a circle of 100 m in diameter.
<u>Short Description of Management Prescriptions/Restrictions</u>	<p>Strict protection!</p> <p>Buffer zones around religious sites will have to be exempted from commercial logging. However, silvicultural improvement measures such as planting, weeding, tending and thinning should be planned and implemented if the religious site is located on a Soil Protection area and if the implementation of these measures are required for protecting these objects Only the local forest uses should be permitted which do not disturb the sanctity of the place.</p> <p>Note: Removal of trees shall be considered in the following cases:</p> <ol style="list-style-type: none"> 1. Epidemic out-break. 2. On silvicultural reasons.

Nature Conservation

According to the objective of nature conservation two different types of functions are distinguished:

- Conservation of wildlife and wildlife habitats (in particular rare or endangered species).
- Protection of areas rich in biodiversity and/or of high ecological value.

	Wildlife Protection (NWP)	Wildlife Conservation (NWC)
<u>Definition</u>	This function includes all habitats and other areas where <u>rare or endangered mammals and birds</u> occur and where the protection of these animals gains highest priority.	All forests areas <u>rich in species variety and number of wildlife</u> , in particular, mammals and birds.
<u>Objective</u>	(1) to conserve the habitat of protected wild animals and corridors for their movement; and (2) to prevent the protected animals from human disturbance.	(1) to minimize or prevent negative impacts due to forest resource use on wildlife habitats and to minimize disturbances due to human impacts.
<u>Legal Restrictions</u>	According to § 22 (a) of the Forest and Nature Conservation Act of 1995 altogether 23 wild animals are totally protected in Bhutan (see Annex 3).	None!
<u>Identification</u>	The determination of wildlife protection and conservation areas should be done during EA exercise, which should be carried out in close consultation with NCS, NEC, WWF and RSPN. Useful information can be derived from the RFI and RRA/PRA. Criteria for the identification are: type and number of wildlife species and protection status, actual vegetation and habitat condition, habitat size, and degree of disturbance. Of course these criteria depend largely from the type of wildlife which should be conserved or protected. Details on habitat requirements of various protected animals can be derived from ASTE (1994). All areas where <u>protected wildlife species occur and wildlife corridors</u> . According to Aste (1994) a wildlife corridor is defined as "a <i>linear two-dimensional element that connects two or more patches of wildlife habitat</i> ". If possible wildlife corridors should be aligned in more or less undisturbed areas and areas unsuitable for commercial management which are for example: steep slopes, ridges (i.e. SP or SC), gullies or canyons (i.e. WRR), etc..	All <u>areas rich of wildlife</u> , both in species and in number. Especially breeding areas, watering places, etc..
<u>Short Description of Management Prescriptions/Restrictions</u>	Strict protected! Within wildlife refuge areas and corridors commercial logging is strictly prohibited. Local forest use is only permitted if the habitat quality and structure is not significantly changed (i.e. single tree felling for shingle production) and disturbance to the protected animals is not long lasting and kept to a minimum. Road construction within wildlife refuge areas and corridors should be avoided as much as possible Note: Removal of trees shall be considered in the following cases: 1. Epidemic out-break. 2. On silvicultural reasons.	Only management restrictions! Forest operations within Wildlife Conservation zones should minimize disturbance to understorey vegetation, in particular bamboo, and to residual trees. Fruit and fodder trees for wild animals have to be excluded from exploitation. Small pasture areas or gaps have to be left open and should not be reforested. Logging operations should leave behind some undisturbed forest patches irregularly distributed within a coup. At least one snag tree per ha of a big diameter has to be left in order to provide arboreal living animals with tree cavities. The opening of the forest has to be limited in size to a gap with a maximum diameter of one tree length. The remaining canopy density has to be at least 50% and the maximum standing volume to be removed is 30%.

Biodiversity Protection (NB)	
<u>Definition*</u>	<p>Biodiversity can be defined as the diversity of plants, animals and other living organisms in all their forms and level of organization, including genes, species, ecosystems and the evolutionary and functional processes that link them. Biodiversity does not entail merely the preservation of a few rare, endangered or interesting species, but rather the protection and conservation of the diversity of species, genetic materials, biophysical processes and ecosystem structures that together determine biological productivity and stability.</p> <p>The <u>diversity</u> of a given ecosystem is defined by the following three components:</p> <ul style="list-style-type: none"> • Composition: Ecosystems are composed of organisms, species, groups of interacting species, genetic diversity within species, the remains of dead organisms, and various inorganic compounds; • Structure: Ecosystem structure arises from the patterns in which the basic building blocks of composition occur. There are two types of structure: physical structure or spatial pattern (i.e. canopy layer, patchiness in distribution of species, etc.) and social structure (relationship of individuals, species, group of species to each other and to the ecosystem as a whole). • Function: Function refers to the actions or interrelationships between components of composition and structure.
<u>Objective</u>	<ul style="list-style-type: none"> • to preserve rare and extra-ordinary rich ecosystems and ecological niches and to protect them from human interference in order to conserve the biological diversity within the concerned FMU.
<u>Legal Restrictions</u>	<p><u>Legal Restrictions</u></p> <p>According to § 22 of Forest and Nature Conservation Act of 1995 the following plants are totally protected (see Annex 3).</p>
<u>Identification</u>	<p>The following areas should be allocated to forest function "Biodiversity Protection" (NB).</p> <ul style="list-style-type: none"> • ecosystems rich in biological diversity (in particular flora and non-vertebrate animals such as reptiles, insects, amphibians); • rare ecosystems (i.e. swamp forests, gallery forests, alpine shrubs); • ecosystems and areas with a high percentage of protected flora; and • forest areas which should be conserved because of their extra-ordinary composition or structure. <p>NB-areas are generally smaller than Wildlife Conservation areas and may range between 1 and 100 (or more) hectares.</p>
<u>Short Description of Management Restrictions</u>	<p>Strict protection!</p> <p><u>Commercial and local forest use are strictly prohibited.</u> This refers also to the collection of NTFP and other minor forest products. If possible, these areas should be exempted from grazing. No road construction within NB areas.</p>

Road Buffer

Road Buffer (RB)									
<u>Definition</u>	A road buffer is the zone along a road where the implementation of forest activities may have direct negative impact on the road itself or on the security of the traffic.								
<u>Objective</u>	to protect the road from rock fall, land and snow slides, surface runoff of precipitation and erosion and to safeguard traffic.								
<u>Legal Restrictions</u>	According to § 14 a (i) of the Forest and Nature Conservation Act (1995) " <i>no permit to fell or to take any timber within 600 feet (200 m) uphill and 300 feet (100 m) downhill should be issued along motorable roads <u>except for forest roads.</u></i> "								
<u>Identification</u>	<p>The need of determining a road buffer depends mainly on the type of road (i.e. motorable road, forest road etc.) and the terrain. The size of the buffer zone required depends on the terrain stability as specified below:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;">Type of road</th> <th style="text-align: center; border-bottom: 1px solid black;">Unstable terrain</th> <th style="text-align: center; border-bottom: 1px solid black;">Stable terrain</th> </tr> </thead> <tbody> <tr> <td rowspan="2" style="vertical-align: top;">Motorable public road</td> <td style="text-align: center;">200 m uphill</td> <td style="text-align: center;">200 m uphill</td> </tr> <tr> <td style="text-align: center;">100 m downhill</td> <td style="text-align: center;">100 m downhill</td> </tr> </tbody> </table> <p>Main factors influencing terrain stability are steepness, drainage, soil and site type, stoniness and geology. Features indicating unstable terrain are: steep slopes, poor drainage or waterlogged areas, clayish soil texture, high stoniness and fragile geologic formations.</p> <p>The distance specified is the real distance from the edge of the road (not the horizontal distance!)</p>	Type of road	Unstable terrain	Stable terrain	Motorable public road	200 m uphill	200 m uphill	100 m downhill	100 m downhill
Type of road	Unstable terrain	Stable terrain							
Motorable public road	200 m uphill	200 m uphill							
	100 m downhill	100 m downhill							
<u>Short Description of Management Prescriptions/Restrictions</u>	<p><u>Commercial logging within road buffer zones is prohibited, including felling and removal of trees for local use.</u> However, trees which are a source of danger for the road, or the traffic on it, will have to be felled as soon as possible. This refers namely to dead or decayed trees, or exposed single trees which may break or fall during storms or heavy winds. The collection of NTFP such as fruits, medicinal herb, mushrooms etc. for the local use may be permitted. However collection of dead wood and fallen branches for firewood will be permitted.</p> <p>Note: Removal of trees shall be considered in the following cases:</p> <ol style="list-style-type: none"> 1. Epidemic out-break. 2. On silvicultural reasons 								

Annex 3

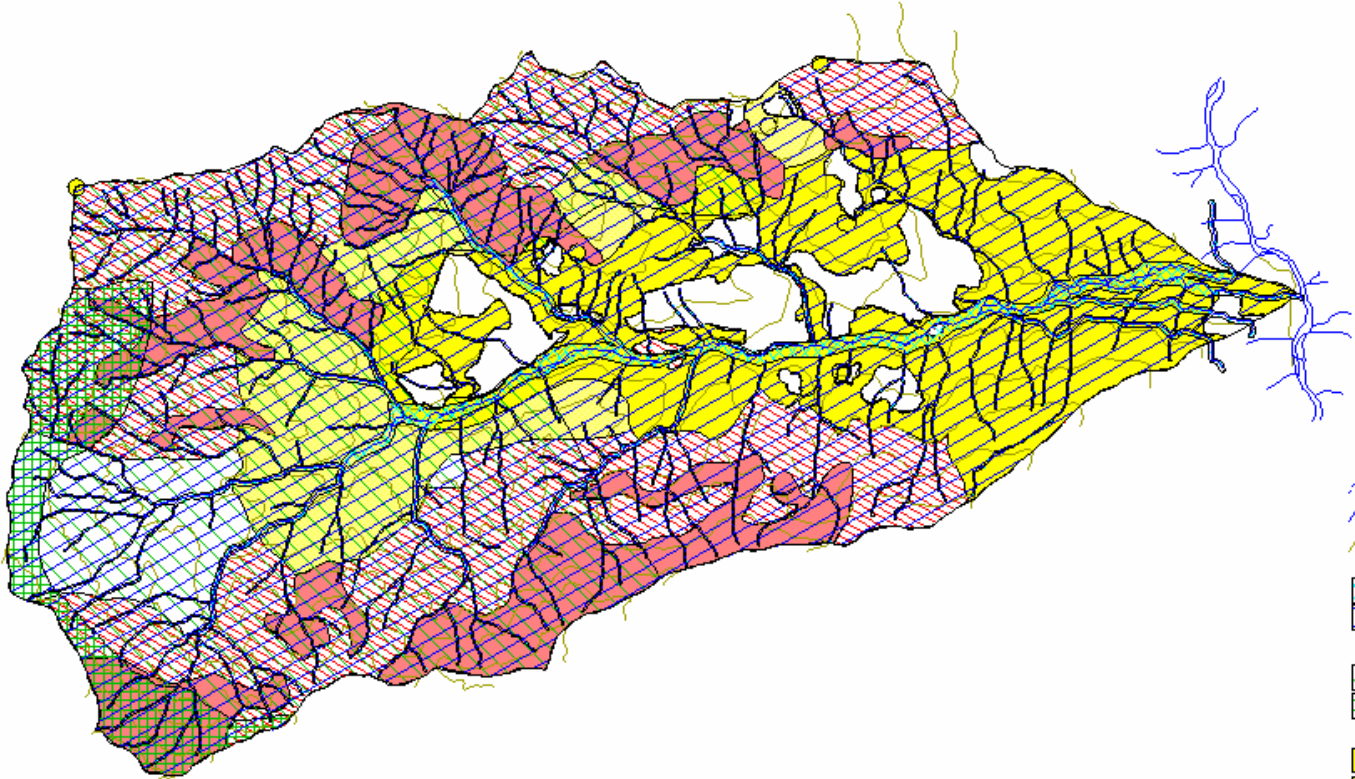
Maps

Forest Function Map
Forest Zonation Map
Forest Management Map

Forest Function Map of Nahi



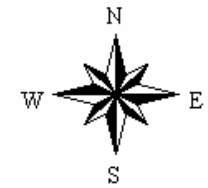
Scale 1:75,000



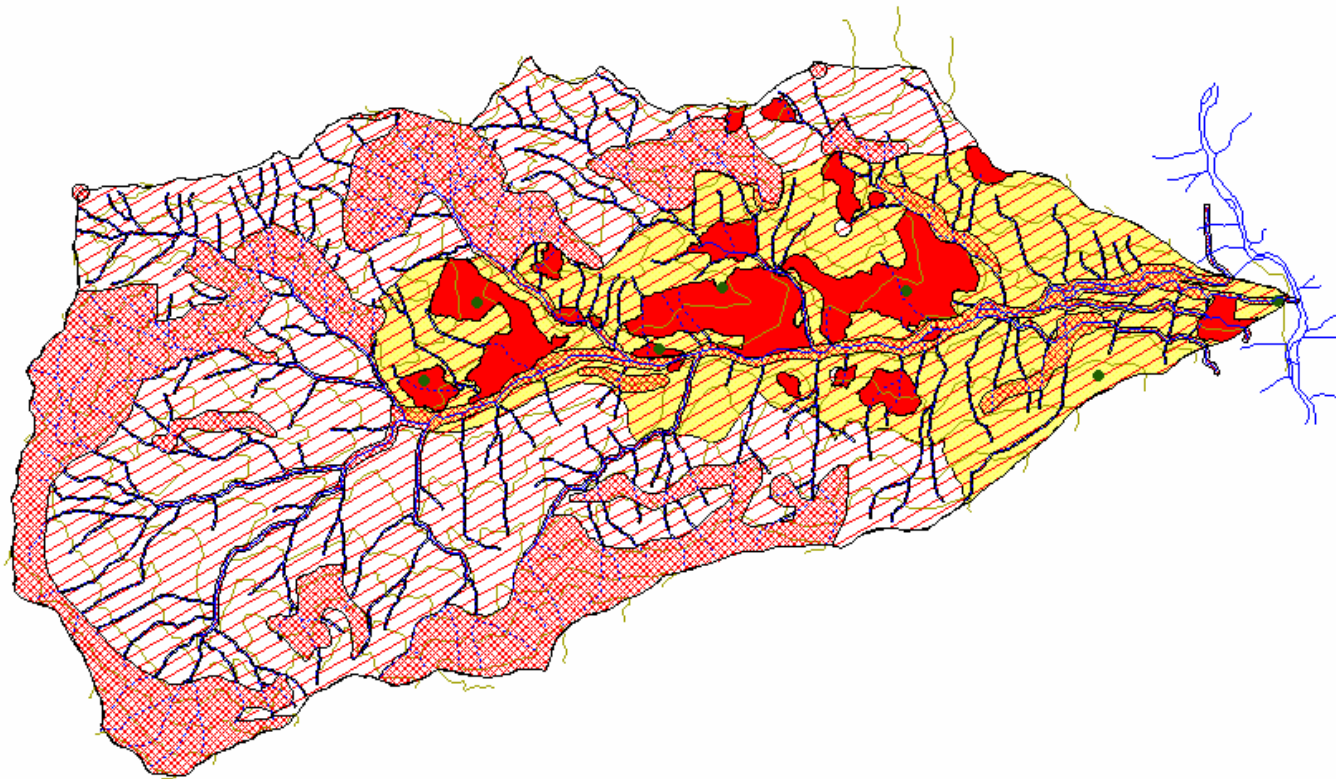
Legend

- small streams
- rivers
- 200 m contour lines
- WRR Riparian Reserve
- WSh Watershed conservation
- NWC Wildlife conservation
- NWP Wildlife protection
- Local use
- Local and commercial use
- Religious site protection
- SC Soil conservation
- SP Soil Protection

Forest Zonation Map Total Nahi FMU



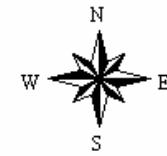
Scale 1:75,000



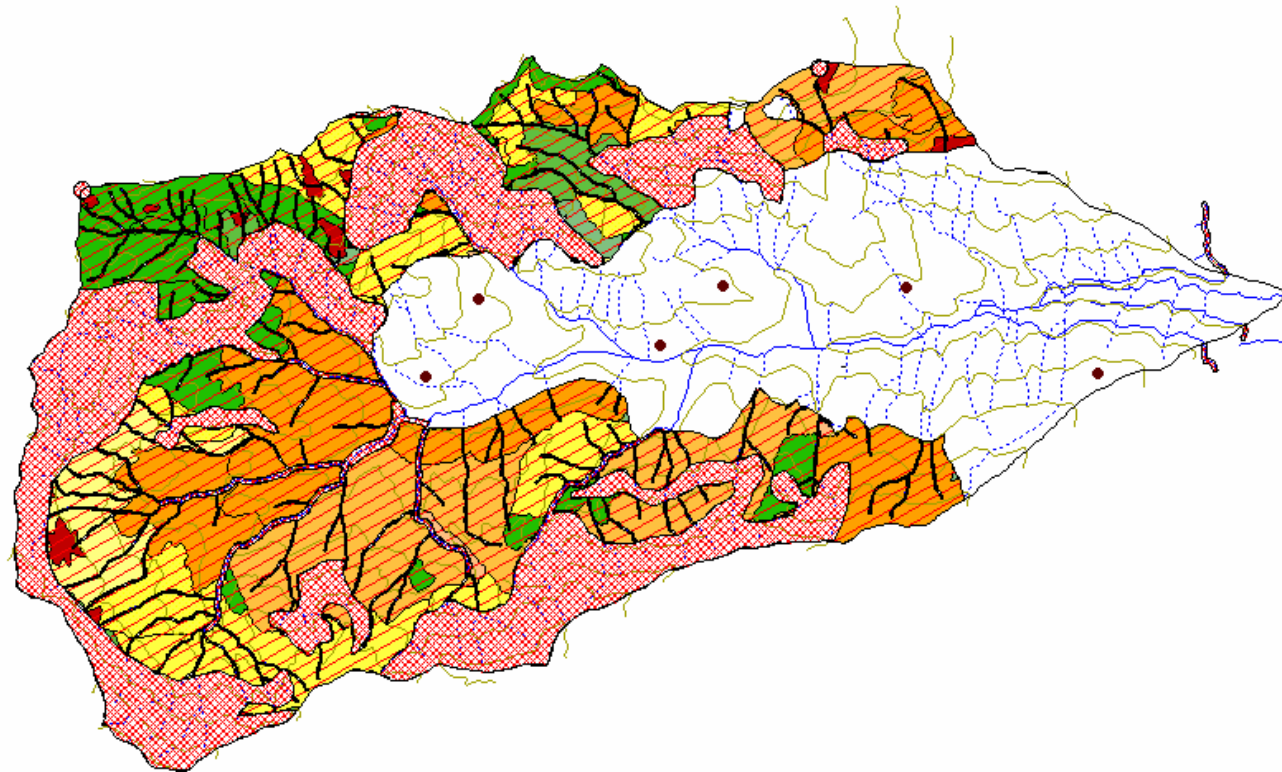
Legend

- 200 m contour lines
- small streams
- rivers
- villages
- Limited production
- Protection
- Local use only
- Non forest area

Forest Management Map, Commercial Use



Scale 1:75000



Legend

- 200m contour lines
- small streams
- rivers
- villages
- Limited production
- Protection
- Broadleaved Forest
 - young
 - mature
 - old
- Mixed Forest
 - young
 - mature
 - old
- Conifer Forest
 - young
 - mature
 - old
- unproductive

Annex 4

Inventory Results

Additional Statistics for Main Table 5.

INVENTORY UNIT	:	Nahi
Size of Sampling Unit (ha)	:	0.05000000
Number of Strata	:	2
ESTIMATED PARAMETER	:	AVERAGE GROSS VOLUME PER HA (m ³ /ha)
Tree Status	:	Survivor
Timber Quality	:	All (Dbh 10+ cm)
STRATUM	:	Broadleaf Forests
Area (ha)	:	2460.00000000
Stratum Weight	:	0.80921053
Number of Sampling Units	:	109
Degrees of Freedom	:	108
Sampling Intensity	:	0.00221545
Finite Population Correction	:	0.99778455
t (0.975,108)	:	1.98300000
t (0.950,108)	:	1.65900000
Estimate	:	352.72033045
Standard Deviation	:	267.24889489
Coefficient of Variation %	:	75.76793051
Standard Error	:	25.56943057
Sampling Error (P=0.95)	:	50.70418083
Sampling Error %	:	14.37517956
Reliable Minimum Estimate (P=0.95)	:	310.30064513
STRATUM	:	Conifer Forests
Area (ha)	:	580.00000000
Stratum Weight	:	0.19078947
Number of Sampling Units	:	25
Degrees of Freedom	:	24
Sampling Intensity	:	0.00215517
Finite Population Correction	:	0.99784483
t (0.975, 24)	:	2.06500000
t (0.950, 24)	:	1.71000000
Estimate	:	335.92986501
Standard Deviation	:	269.64913489
Coefficient of Variation %	:	80.26947377
Standard Error	:	53.87168166
Sampling Error (P=0.95)	:	111.24502263
Sampling Error %	:	33.11555007
Reliable Minimum Estimate (P=0.95)	:	243.80928937
STRATUM	:	Combined
Area (ha)	:	3040.00000000
Number of Sampling Units	:	134
Degrees of Freedom	:	132
t (0.975,132)	:	1.97900000
t (0.950,132)	:	1.65600000
Estimate	:	349.51688645
Standard Error	:	23.10324677
Sampling Error (P=0.95)	:	45.72132535
Sampling Error %	:	13.08129224
Reliable Minimum Estimate (P=0.95)	:	311.25790980

Inventory Unit : Nahi
 Stratum : Combined
 Area (ha) : 3040.0
 Period : 26/07/90 to 13/04/91
 Tree Status : Survivor
 Timber Quality : All (Dbh 10+ cm)
 Number of Strata : 2
 Number of Sampling Units : 134
 Estimate of Total : 349.517
 t (0.975, 132) : 1.979
 Sampling Error% for Estimate (at P=0.95) : 13.08

Estimated Parameter : AVERAGE GROSS VOLUME PER HA (m³/ha)

Species Group	Dbh class: (cm)											total	%		
	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	109	120+				
Picea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pinus	0.55	0.66	0.64	1.06	0.81	2.10	1.83	0.00	0.65	1.62	0.00	3.53	13.45	3.85	
Tsuga	0.00	0.00	0.45	0.24	0.66	0.41	1.44	2.83	1.62	0.00	5.27	1.88	14.80	4.23	
Fir	0.00	0.00	0.00	0.00	0.00	0.39	0.60	1.00	0.00	0.00	0.00	0.00	1.38	0.40	
other conifer	0.10	0.76	0.45	1.01	1.29	2.19	1.62	0.66	0.00	0.00	0.00	0.00	8.08	2.31	
total conifer	0.65	1.42	1.54	2.32	2.76	5.09	4.89	4.48	2.27	1.62	5.27	5.41	37.71	10.79	
Acer	0.22	0.16	0.63	0.00	1.14	0.85	0.54	0.76	0.00	0.00	0.00	0.00	4.30	1.23	
Betula	0.12	0.17	0.85	1.53	1.88	0.00	2.28	2.95	0.78	0.00	0.00	3.16	13.73	3.93	
Quercus	0.73	1.77	3.18	4.78	10.75	8.27	6.44	2.78	11.07	7.00	0.00	15.79	72.55	20.76	
Rhododendron	2.29	9.35	4.66	3.24	2.40	0.67	0.48	0.00	0.63	0.00	0.00	0.00	23.72	6.79	
other broadl.	8.37	17.55	14.69	19.53	16.14	13.09	19.33	23.09	14.78	13.45	15.41	22.08	197.50	56.51	
total broadl.	11.73	28.99	24.01	29.08	32.32	22.88	29.07	29.58	27.25	20.45	15.41	41.02	311.81	89.21	
total	12.38	30.41	25.55	31.39	35.08	27.97	33.96	34.06	29.52	22.07	20.68	46.43	349.52	100.00	
%	3.54	8.70	7.31	8.98	10.04	8.00	9.72	9.75	8.45	6.31	5.92	13.28	100.00		