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ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF ENERGY AND NATURAL RESOURCES
DEPARTMENT OF FORESTS AND PARK SERVICES

"Sustaining Forest Resources for Present and Future Generations"

FOREST MANAGEMENT PLAN

FOR

ZONGLELA FOREST MANAGEMENT UNIT

(1st January 2022 – 31st December 2031)

Prepared by:
Sherab Jamtsho
Sr. Forestry Officer
Paro Forest Division

ཀྱལ་ཡོངས་མཐའ་འཁོར་གནས་སྐྱོང་ལྷན་ཚོགས། དཔལ་ལྡན་འབྲུག་གཞུང་།

National Environment Commission

Royal Government of Bhutan

NECS/EACD/Dzo-Paro/4128/2022/2885 November 28, 2022

ENVIRONMENTAL CLEARANCE

In accordance with Section 34.1 of the Environmental Assessment Act 2000, this Environmental Clearance (EC) is hereby issued to Forest Resources Management Division, Department of Forests and Park Services for the **operation of the Fourth Management Plan of Zongkela Forest Management Unit (FMU) along with the installation of ropeways in state reserve forest land measuring 15,803.10 hectares (39,050.25 acres)** under Paro Dzongkhag with the following terms and conditions:

I. General

The holder shall:

1. comply with provisions of the National Environment Protection Act 2007, Environmental Assessment (EA) Act 2000 and Regulation for Environmental Clearance of Projects (RECOP) 2016, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 (Amendment 2016), The Water Act of Bhutan 2011 and its Regulation 2014 and Revised Regulation on the Substances that Deplete the Ozone Layer and HFCs 2022;
2. ensure that the activity is in line with Initial Environmental Examination (IEE) form and project documents submitted for EC;
3. ensure that local communities, properties and any religious, cultural, historic and ecologically important sites are not adversely affected by the activity;
4. restore the damage of any public or private properties caused by the activity;
5. inform NECS and any other relevant authorities of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have economic, cultural, religious, archeological, and/or ecological importance;
6. erect a signboard at the take-off point of the main entry of the FMU stating the name of the FMU and contact address of the unit in-charge;
7. ensure that safety sign boards are posted at strategic locations;
8. ensure that the copy of the environmental clearance is framed and displayed at the workplace.
9. ensure that the Annual Allowable Cut does not exceed 5,118.53 m^3 (3,993.71 m^3 for commercial supply and 1,124.82 m^3 for rural requirements); and
10. ensure that no timber is extracted from the protection management circle and non-production management circle.

II. Environmental standards

The holder shall comply with the Environmental Standards 2020.

III. Import and use of ODS

The holder shall import and use Ozone Depleting Substances and the Hydrofluorocarbons (HFCs) as per the Revised Regulation on the Substances that Deplete the Ozone Layer and HFCs 2022.

IV. Protection and management of water resources

The holder shall:

1. ensure that the activity does not disrupt the water flow and pollute the water bodies; and
2. ensure that 30 meter or 100 feet buffer is maintained from the water resources at all times with the exception of stream/river crossings.

V. Waste prevention and management

The holder shall manage wastes generated from the activity (site office, labour camp, etc.) with the application of 4R (Reduce, Reuse, Recycle, Responsibility) principle and other environmentally friendly methods of waste management.

VI. Management of fugitive dust and run-off

The holder shall:

1. ensure that fugitive dust generated during operation and management of EMU is adequately suppressed by spraying water at regular intervals; and
2. put appropriate measures for management of surface run-off to avoid erosion and landslides.

VII. Monitoring and reporting

The holder shall:

1. ensure that the effective day-to-day monitoring of the EC terms and conditions are carried out by the environmental unit or designated environment focal person; and
2. maintain monthly records on wastes generated and its management – stating types, quantities, and characteristics and submit to NECS annually.

VIII. Implementation plan

The holder shall prepare a detailed implementation plan focusing on the implementation of terms and conditions of this EC and submit to NECS within three (03) months from the date of issue of this EC as per the reporting format attached herewith.

IX. Renewal and modification

The holder shall:

1. ensure that renewal of this EC is processed at least three (03) months prior to its expiry along with a copy of EC, a report on the implementation of its terms and conditions as

per the format attached and payment of prescribed renewal application fee, failing which the applicant shall be liable for penalty as per the RECOP 2016; and

2. obtain prior approval from NECS for any modification to the existing proposal/application including, but not limited to, increase in production capacity, change in location of the project, change in ownerships, etc.

Reservation

1. The NECS may stop the activity or impose additional terms and conditions as may be deemed necessary; and
2. The EC shall be subject to periodic review and modifications as per Article 25 of the EA Act 2000, without any liability on the part of the Royal Government.

The holder may adopt best practices in executing these terms and conditions to avoid adverse environmental impacts.

Failure to comply with any of the above terms and conditions shall constitute an offence and the proponent shall be liable in accordance with the EA Act 2000 and/or existing environmental laws.

Validity:

This EC is issued with validity from **November 28, 2022** until **November 27, 2027** only for the operation of the Fourth Management Plan of Zonglela FMU along with the installation of ropeways.

This EC is issued solely pursuant to the EA Act, 2000 and its Regulations and in no way intends to overrule or alter the provisions of any law or rules in force. The Holder of this EC shall be responsible to adhere to the requirements under other laws and the issuing authority assumes no liability resulting from non-compliance or omission of any laws or rules.

(Sonam P. Wangdi)
SECRETARY

To
Chief Forestry Officer
Forest Resources Management Division
Department of Forests and Park Services
Thimphu

LIST OF ABBREVIATIONS

%	Percent
AAC	Annual Allowable Cut
CF	Community Forest
CFO	Chief Forestry Officer
CGI	Corrugated Galvanized Iron
CM	Centimeter
DBH	Diameter at Breast Height
DFO	Divisional Forest Office
DoFPS	Department of Forests and Park Services
EIA	Environmental Impact Assessment
FMP	Forest Management Plan
FMU	Forest Management Unit
FNCA	Forest and Nature Conservation Act
FNCRR	Forest and Nature Conservation Rules and Regulation of Bhutan
FRMD	Forest Resources Management Division
GIS	Geographic Information System
Ha	Hectare
km	Kilometer
LULC	Land Use and Land Cover
m	Meter
m^3	Cubic Meter
MC	Management Circle
mm	Millimeter
MoENR	Ministry of Energy and Natural Resources
NEC	National Environment Commission
NRDCL	Natural Resources Development Corporation Limited
NWFP	Non-Wood Forest Product(s)
OP	Operational Plan
RGoB	Royal Government of Bhutan
RM	Regional Manager
RME	Reliable Minimum Estimate
RNR	Renewable Natural Resources
sp.	Species
ZFMU	Zonglela Forest Management Unit
TMB	Tree Marking Book
UIC	Unit-In-Charge
UWICER	Ugyen Wangchuck Institute for Conservation and Environmental Research
WC	Working Circle

AUTHORITY FOR PREPARATION, REVISION AND APPROVAL

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from 1st January, 2022 – 31st December, 2031.

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

The authority for preparation of this Plan was given to the Divisional Forest Office (DFO), Paro, Department of Forests and Park Services (DoFPS), Ministry of Energy and Natural Resources, Royal Government of Bhutan.

PROVISION FOR REVISIONS AND CHANGES

This Plan may be revised during the period when it is in effect. The Director, DoFPS has the authority to revise and approve Plan if major changes occur in the Forest Management Unit (FMU), or if new information becomes available that may have significant bearing on the implementation of the Plan. The CFO, Paro Forest Division may be requested to prepare revisions and changes to the Plan for submission to the Director, DoFPS.

APPROVAL

This Plan was examined by a wide section of user groups, clients and organizations. The final version of the Plan was reviewed and technically cleared by the Head, FRPMD and an environmental clearance was obtained from National Environment Commission Secretariat. It was then submitted to the Director, DoFPS, who, after further review and amendments, forwarded with his recommendation for approval to the Secretary, MoENR.

Submitted for Approval:

Chief Forestry Officer
Forest Resources Planning Management Division

Recommended for Approval:

Director
Department of Forests and Park Services

Approved:

Secretary
Ministry of Energy and Natural Resources

ACKNOWLEDGEMENT

This management plan is an outcome of concerted efforts and contribution of many people, without which the plan would not have materialized. The Divisional Forest Office, Paro would like to thank Sonam Tobgay, CFO, FRMD for rendering unwavering support and for being accessible to the planners to provide technical guidance and direction while preparing this plan. An immense appreciation goes to the Unit staffs (both Division and NRDCL counterpart) of Zonglela Forest Management Unit for their assistance and support during data collection and information gathering.

Special thanks to Mr. Lhendup Tharchen, Chief Forestry Officer, Paro for providing immense support and guidance in the process of writing this plan. The technical advices received from the Chief Forestry Officer have helped me make this plan credible and moreover practically applicable in the field.

The author would like to thank the DoFPs, particularly Mr. Arun Rai, Deputy Chief Forestry and Mr. Dawa Zangpo, Deputy Chief Forestry Officer, Mr. Tashi Norbu Waiba, Deputy Chief Forestry Officer, Mr. Dorji Wangdi, Deputy Chief Forestry Officer and Mr. Lhab Tshering, Senior Forestry Officer of FRMD for reviewing the plan and providing valuable comments and feedback during preparation of this management plan.

I would like thank Dzongkhag Administration, Paro and Local Government of respective Geogs and local community people for their support and valuable comments and feedbacks to address concerns and interests of local communities in this management plan

This management plan was possible because of support and valuable comments from many readers and immense gratitude are extended to all who supported in the process to bring this management plan for Zonglela FMU.

EXECUTIVE SUMMARY

This is the 4th Forest Management Plan for Zonglela FMU. The overall structure of this management plan is as per the Forest and Nature Conservation Code of Best Management Practices of Bhutan. It consists of three parts:

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION
PART 2: FUTURE MANAGEMENT
PART 3: IMPLEMENTATION OF THE PLAN

PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

- Paro-Zonglela Forest Management Unit is situated within Wangchang, Shaba, Doga, Lungnyi, and Lamgong Gewog under Paro Dzongkhag. It is located between 27º 26'32.59'' to 27º 16'36.90''N and 89º 31'00.27" to 89º 19'28.82'' E. The total area of the FMU is 15803 hectares. The Pachu forms the eastern boundary and the high ridge which separates Paro and Haa valleys forms the western boundary of the FMU.

- The forest type in Zonglela FMU consists of Mixed conifer (5339.97 ha), Blue pine (6645.66 ha.), Fir (302.18 ha), Broadleaf (34.21 ha), Alpine meadows (165.69 ha), Alpine scrubs (23.2 ha), Shrubs (2103.61 ha), Khamzhing (408 ha) and Build up (146.75 ha) and Rivers and Chuzhing 50.11 ha and 282.41 ha respectively. And as evident, majority of the FMU area has Blue pine forests (42%), followed by Mixed conifer (33%) (LULC,2016)

- The general terrain of FMU ranges from moderate to steep landscape. The elevation of FMU ranges from 2100 m at the bottom valley to 4000 m at the ridge top. The average monthly rainfall is approximately 77 mm. Precipitation in the form of snowfall occurs in the winter.

- The commercial AAC of last Management Plan was fix at 9366 m^3 with local use of 3000 m^3 standing volume and commercial AAC of 6366 m^3. The total commercial timber harvested for last 10 years is 67134.08m^3 against the allotted AAC of 66315 m^3 and rural volume is 34004.47m^3 against AAC of 33179 m^3 in standing Volume. This shows that commercial extraction is over cut by 819 m^3 and rural extraction was overcut by 825 m^3.

- A total of 60 km of forest road has been constructed in FMU during the last three Plan periods. The road network has immensely benefitted the local people for transportation of RHBT timber and forestry officials for patrolling.

PART 2: FUTURE MANAGEMENT

- ***The overall goal of this management plan is to manage the Forest Resources within Zonglela FMU on a multiple use, sustained yield basis for the production of timber, fuel wood& non-wood forest products, conservation of watershed, wildlife and environment.***

- To facilitate the planning, implementation and recording of activities, FMU is divided into blocks and compartments. There are four blocks viz Nabesa, Pombesa, Zonglela, Chelela and Ngobephu which are further divided into compartments. Total of 36 sub-compartments is identified for sustainable utilization of resources and planning

- FMU has been divided into four Management Circles, which allows different areas to be managed and evaluated separately, and increases the ease of management and implementation. The Management Circles has been identified, using forest function mapping and they are **Protection**, **Production** and **Non-Production** Management Circle. The objectives for each Management Circles have been identified and the Production Management Circles have been further divided into Working Circles so that the objectives tailored to the type of stand being harvested and managed. The objectives for each Management Circles have been listed in a logical framework along with the Management Options and responsibility for easy reference by implementers and monitoring agency.

- The total area for Protection Management Circle is 5171 ha, Production Management Circle is 6476 ha and Non-Production Management Circle with 2356 ha.

- The Production Management Circle has been further grouped into Working Circle as Fir Working Circle (87.88 ha), Mixed Conifer Working Circle (2927.13 ha), Blue Pine Working Circles (3438.72 ha) and Broadleaf Working circle (20.35 ha) based on Land Use Land Cover, 2016

- The total AAC for this management plan is fixed at **5118 m^3** in standing form of which **3993 m^3** standing volume or **26 ha** clear cut equivalent, whichever is achieved earlier, for commercial use. For rural use total of **1125 m^3** is allotted for this plan period

- The prescribed Silvicultural System for the commercial harvesting is Group Selection System. Group openings will be created in the stand allowing optimum quantity of light to reach the forest floor and creating conducive micro climatic conditions for seed germination and establishment of seedlings. Criteria for opening the groups and laying out annual coupes are given in detail in the Plan. For Local/Rural use, Single Tree Selection System is prescribed.

- The prescribed Silvicultural System for the commercial harvesting is the Group Selection System with natural regeneration in Mixed Conifer Working Circle and Seed Tree System in Blue Pine Working Circle. Group openings will be created in the stand allowing optimum quantity of light to reach the forest floor and creating conductive micro climatic conditions for seed germination and establishment of seedlings. Criteria for opening the groups and laying out annual coupes are given in detail in the Plan. For local use area, single tree selection system will be used.

  Allocation of AAC

Standing Vol (m^3)	Allotted to
1125 m^3	Local Use: Local villagers and general public for rural house construction
3993 m^3	NRDCL: To meet the commercial timber demand in the market

- In collaboration with NRDCL, the Divisional Forest Office, Paro carried out detailed EIA for FMU. Using a series of environmental criteria outlined in the Environment Assessment Act, 2000 and adopted by the National Environment Commission, the recommended guidelines have examined to ensure that the practice within FMU meets the requirement. The environment statement includes the effects of previous activities within the FMU along with recommended mitigation measures for future actions.
- A ten-year financial forecast has been prepared for the FMU summarizing the total costs, revenue and royalties for NRDCL and treasury (via CFO) for the plan period. The forecast is a projection based on the plan prescriptions and may not reflect the actual workings during the plan period.

PART 3: IMPLEMENTATION OF THE PLAN

- The CFO, Paro will be responsible for the implementation of this management plan and he will be assisted by the Forest Management Planner, Unit In-charge and other Unit staffs.

- FRMD, DoFPS, will be responsible for providing technical support and evaluation of FMUs as per timing prescribed in the Forest and Nature Conservation Code of Best Management Practices of Bhutan

- A rolling biennial Operational Plan will be prepared by the Unit In-charge in consultation with the CFO, Paro and NRDCL counterpart to facilitate the timely implementation of this management plan.

- FMU-level Management Committee chaired by CFO, Paro has been established to assist in objective setting and to ensure the smooth implementation of the Management Plan. The FMU-level Management Committee is comprised of the stakeholders of the FMU and each member has an equal right to say in the recommended management and implementation of the FMP. Planned activities to achieve the FMU management objectives will be discussed in the FMU-level Management Committee meetings.

- Mid-term and Final evaluation should take place within the prescribed timing and completed as per management code.

- The FMU must have adequate technical capability and appropriate institutional set-up to implement this forest management plan

- Unforeseen circumstances may warrant deviation from plan prescriptions and in such an event, the CFO, Paro, must obtain prior written approval from the Head of the Department. The reasons for the deviation must be fully justified by the CFO in writing and such approved deviations updated into the Management Plan during the next scheduled planning period and plan revision

	Action required by FMU plan	Responsibility
	Implementation and Review	
1	CFO Paro will be responsible for the implementation of this Management Plan, assisted by the Unit In-charge and staff.	CFO Paro
2	The FMU Management Committee chaired by CFO Paro will be maintained to ensure the smooth implementation of the Management Plan.	CFO Paro
	Monitoring and Evaluation	
1	CFO Paro will ensure that the monitoring is carried out on regular basis and in accordance to FMCB and guidelines issued by FRMD. The Forest Management Committee at Division level will be responsible for review and address any technical issues which can be address at Division level.	CFO Paro
2	Head, FRMD, will ensure annual monitoring of FMU is carried out and provide advices and recommendations to CFO, Paro for implementation	Head, FRMD
3	Head, FRMD, will ensure that mid-term and final evaluation will be executed by FRMD as per deadline outlined in the FMCB. Policy and technical regulations will be provided by FRMD to CFO, Paro.	Head, FRMD
	Operation Planning (OP)	
1	Biennial OP will be prepared by CFO, Paro, and FMU In-Charge (IC) to facilitate the timely implementation of this Management Plan**.** NRDCL will commit financial and endorse OP by the FMU Level Management Committee. The OP should be completed and submitted to FRMD as per deadline outlined in the FMCB.	CFO Paro FMU IC
2	FMU UIC will identify harvesting area based on production area prescribed by management plan and conduct operational inventory using GIS and GPS. FMU IC will determine the number of location and extend of cable lines in the compartment to be harvested annually based on average standing volume per hectare from operational inventory and NRDCL will lead cable line survey for operational plan	FMU UIC, NRDCL PIC
3	Objective for each Management Circle will be met with the implementation of specific activities	FMU IC

4	Silviculture system for each Working Circle will be adhered to, following cutting cycle guidelines to ensure sustainability	FMU IC
5	The harvesting Plan set out for each Working Circle will be followed unless pests and diseases arise.	FMU IC, NRDCL RM
6	CFO Paro and the Regional Manager, NRDCL will co-operate and co-ordinate to ensure that the logging operation and the log outturn are conducted smoothly and in accordance with local and other demands	CFO Paro, NRDCL RM
7	The FMU IC will ensure that natural regeneration is surveyed as per regeneration guidelines and implement corrective actions as per guidelines.	FMU IC
8	CFO, Paro, will evaluate plantation and recommend corrective actions as per plan prescriptions to NRDCL.	CFO Paro, NRDCL RM
9	Road survey, design and construction will be carried out by NRDCL. NRDCL road engineers must follow the standards, given in Annex 4, during designing and estimating and provide supervision during construction to ensure that the environment standards are met.	NRDCL RM
	Forest Protection (Pests and diseases)	
1	Regular inspection will be conducted by the FMU staff to detect and report any pest and disease outbreaks to enable earliest possible remedial or preventive measures to be initiated	FMU staff
2	FMU IC will seek approval from DoFPS through CFO for sanitation operation of trees/stands affected by forest pests and diseases	FMU IC, CFO Paro
3	FMU IC and CFO Paro will maintain detail records of outbreak of forest pests and diseases and apprise DoFPS through CFO for record and inferences for corrective measures	FMU IC, CFO Paro
	Participatory Forest Management	
1	Records of all tree marked with geo-coordinates by Blocks and Compartments for rural/local use will be maintained by the Unit staff and furnished monthly to CFO Paro	FMU IC
2	Local communities have priority in use of forest products from the area set aside for Local use (Forest Function Socl).	FMU IC

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PART 1

GENERAL DESCRIPTION AND THE CURRENT SITUATION

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location and Extend

Paro-Zonglela Forest Management Unit is situated within Wangchang, Shaba, Doga, Lungnyi, and Lamgong Gewog under Paro Dzongkhag. It is located between 27º 26'32.59'' to 27º 16'36.90''N and 89º 31'00.27" to 89º 19'28.82'' E. The total area of the FMU is 15802.33 hectares. The Pachu forms the eastern boundary and the high ridge which separates Paro and Haa valleys forms the western boundary of the FMU.

Area Statement

As per the Land Use and Land Cover map (LULC,2016) classification, majority of the FMU area is covered by forest (Map 2). Over 42% of the land is covered by Blue pine forest followed by approximately 33% by Mixed conifer forest. The Alpine Scrubs and River has 0.47% of the total land cover (Figure 1).

Land use	Area (Ha)	Percentage (%)
Mixed conifer	5339.97	33.79
Blue pine	6645.66	42.05
Fir	302.18	1.91
Broadleaf	34.21	0.22
Orchards	300.35	1.90
Shrubs	2103.61	13.31
Alpine Scrubs	23.20	0.15
Meadows	165.69	1.05
Built up	146.75	0.93
Rivers	50.11	0.32
Chhuzhing	282.41	1.79
Kamzhing	408.20	2.58
	Total (%)	**100**

Table 1: Area Statement by Land Use

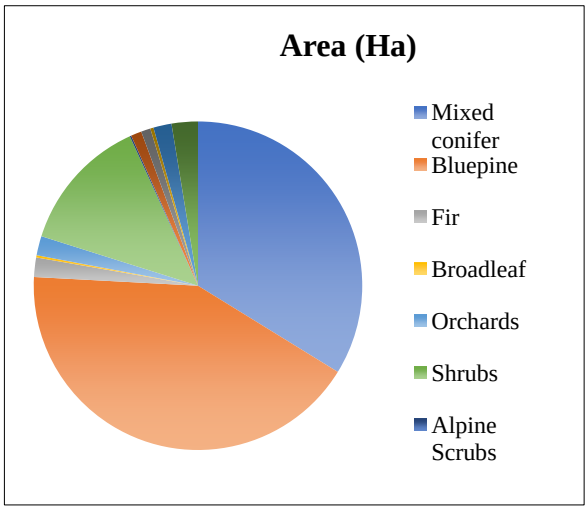


Figure 1: Figure Showing Land use by Percentage

1.2 Historical Background

GENERAL DESCRIPTION AND CURRENT SITUATION

The first scientific management plan for Paro-Zonglela FMU (ZFMU) was implemented in 1st April, 1992-2002. Subsequently the plan was revised in February, 2002 till 31st March 2012 by Gavin Jordan, FRMD/WWMP, with technical assistance from the Commission of the European Communities. Numbers of changes were made in the second plan by Gavin Jordan. The AAC was reduced by more than half using net operable area considering micro-terrain features and production figures, rather than a gross operable area as used in the first plan. Much of the easily accessible, commercially profitable old growth forest has been logged during the implementation of first two plans.

The second management plan for ZFMU was written in 2012 for the duration of ten years (2012-2021). Over the ten-year years of implementation there has been enormous change in production and rural block areas. A total of eight Community Forests has been approved with total area of 2300 ha. This has not only hampered to allot commercial timber areas to NRDCL for extraction but also exacerbated in speedy covering of FMU production areas leading to inadequate areas before the completion of first cutting cycle. According to the last management plan, the ZFMU was divided into five blocks, which was further divided into compartments and sub-compartments, based on natural features. The silvicultural system prescribed was group selection system for the mixed conifer. In areas where opening cannot be created under group selection system single tree. In the first plan period (1992-2000) AAC allocated was 25,000m3 and for rural use AAC allotted was 4485 m^3. In 2nd plan period, total AAC was fix at 11,900m^3 with commercial AAC of 7000m^3 and rural AAC of 4000m^3. The total AAC for 3rd plan (2012 – 2021) was 9366 m^3 with commercial AAC of 6366 m^3 and rural AAC of 3000 m^3. Later in the year 2015-2016 the AAC was reduce to 9021 m^3 since large portion of FMU area was taken by Royal Academy Project, Pombesa.

The total AAC for this plan period is fix at 5118.53 m^3 which is less than 4000 m^3 than the previous plan. Therefore, the AAC for this plan period is fixed at 3993.71 m^3 for Commercial and 1124.82m^3 for Rural use. election system was prescribed.

As of 3rd plan a total of 60 km of forest roads has been constructed by NRDCL. Around 60% of FMU area is connected with Forest road and Farm road

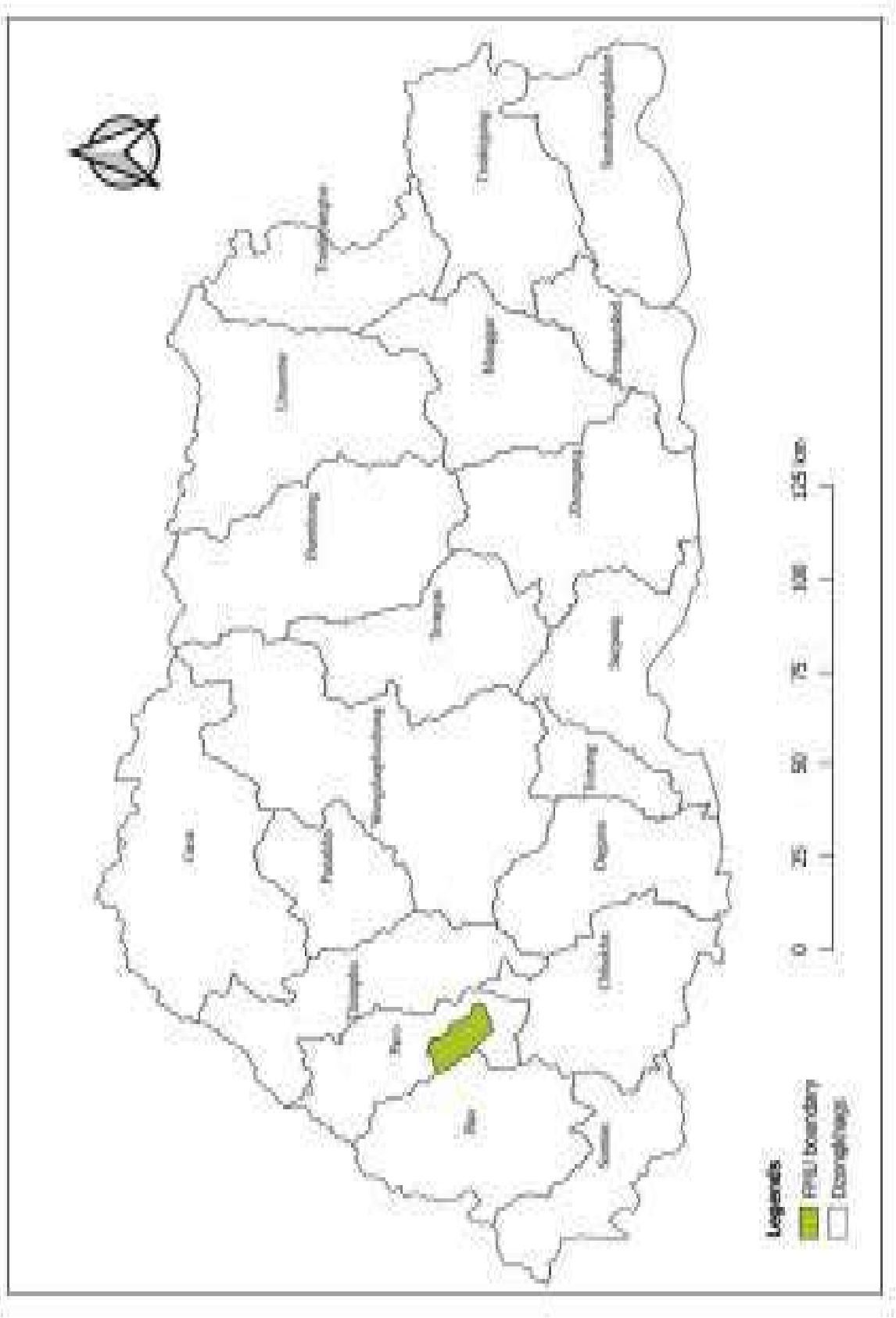


Figure 2: Map showing the location of Selela Forest Management Unit

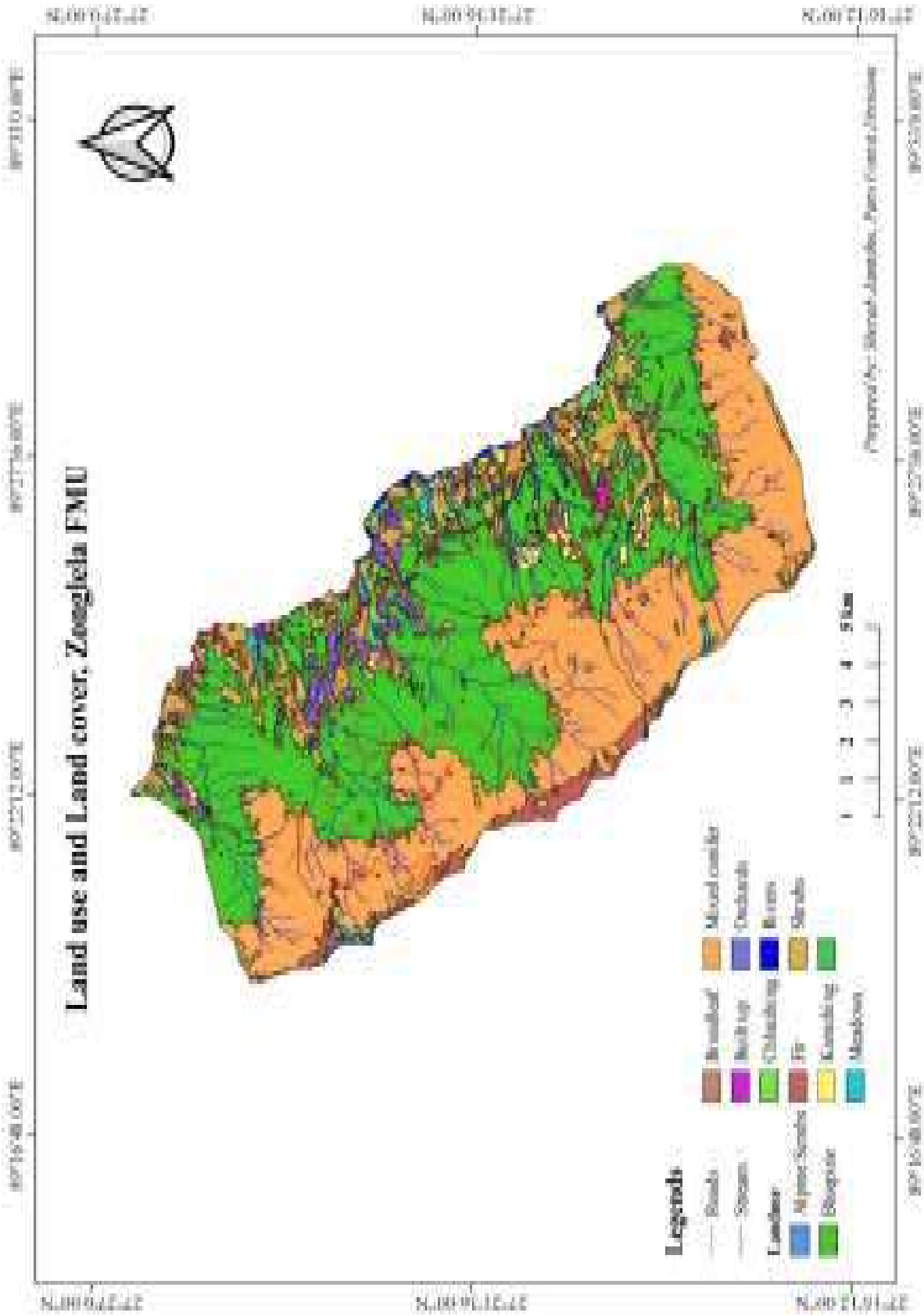


Figure 3: Map showing Land use and Land cover

1.3 Forest Condition

Zonglela FMU was under commercial harvesting for the last twenty years and although scientific silvicultural systems were used, some parts of commercial and rural use areas are over exposed to tree felling. This was mainly happened due to major bark beetle sanitation operation works which was carried out in 2nd and 3rd management plan period. Further, due to road connectivity illegal activities were observed in most commercial and rural; compartments. However, good natural regeneration could be seen in the harvested cable lines and most of the regeneration consists of Blue pine, Spruce and Hemlock species. Bamboo species colonization could also be spotted in the large openings inside commercial blocks.

The altitude of Zonglela FMU ranges from 2100 m to 4000 m amsl and the major forest type found here are Blue pine and Mixed conifer forests. The mixed conifer forest is composed of species like Hemlock (*Tsuga dumosa*), Blue pine (*Pinux wallichaina*), Spruce (*Picea spinulosa*), Juniper (*Juniperus recurva*), and some broadleaf species like Maple (*Acer campbellii*), Rhododendron sp., Oak (*Quercus sp.*), etc. Around 42 % is covered by Blue pine forest, 33 % by Mixed conifer forest

1.4 Legal Status

1.5.1 Ownership

The Forest and Nature Conservation Act, 1995, defines forests as *"any land and water body, whether or not under vegetative cover, in which no person has acquired a permanent and transferable right of use and occupancy, whether such land is located inside or outside the forest boundary pillars, and includes land registered in a person's name as Tsamdrog (grazing land) or Sokshing (woodlot for collection of leaf litter)".*

All such areas are considered as Government Reserved Forest and the entire ZFMU falls within this category of reserved forest, except for a small part of land classified as cultivation which are private.

1.5.2 Rights and Privileges

The right and the privileges of the local inhabitants, concerning the forest use is as per the Forest and Nature Conservation Act of 1995 and the National Forest Policy of 1994. According to the Forest and Nature Conservation Act, grazing, collection of firewood, fodder and leaf mold for the domestic use is allowed either free or on royalty basis. Collection of firewood is permitted from

only dead and fallen trees. Timber trees are issued for *bona fide* domestic use, after they have been marked by a Forest Officer and royalty has been paid. Hunting wild animals is completely prohibited in the forest.

1.5.3 Grazing Rights

The local communities have the traditional rights for grazing their cattle in the forest within the forest management unit. As per the revised act (The Land Act of Bhutan, 2007), it is stated that in section 235 of chapter 10, "All Tsamdro rights maintained in the Thram prior to enactment of this Act shall be deleted from the Thram. Upon deletion, the Tsamdro land shall be reverted and maintained as the Government land in Thromde or the Government Reserved Forest land in reserved areas. "Therefore, all the Tsamdros which has been registered in the name of an individual or community was given back to the Government and deemed as Government Reserved Forest. However, the Tsamdros can be leased for use as per the regulations of the government. The Forest and Nature Conservation Act, 1995, give authority to the Department of Forests, to regulate and restrict grazing anywhere in the country, in order to prevent environmental damages.

1.5.4 Water Rights

The local population within the FMU have traditional rights to use perennial streams for drinking and irrigation etc. Additionally, the FMU is the water source for Bondey town and Pombesa college and law college.

1.5.5 Historical Monuments and Monasteries

There are many important monasteries/lhakhangs situated within Paro-Zonglela Forest Management Unit. Kichu Lhakhang, one of the 108 monasteries that were constructed by king Songtshen Gampo of Tibet in the 7th century, the second monastery constructed by Her Majestry the Royal Grand Mother in 1968, Kila Goempa, Ugyenguru Goempa and the Ugyel Pelri Palace are the most sacred structures located within the FMU

1.5.6 Proximity to Protected Areas

The ZFMU does not lie in any protected areas or share the boundary. The animals may share the areas in FMU as their habitat but we have taken certain measures, by keeping certain areas as Wild life protection strictly prohibiting timber extraction. Still, we have set aside areas of ecologically sensitive as an ecology reserve. The RNR had laid a line transect in the FMU to study forest dynamic. Hence, we kept all these areas as strictly protected zones.

2. PERMANENT SITE FACTORS

2.1 Topography and Slope

In general, the terrain of the ZFMU ranges from the steep to moderate landscape. The lower part along the Paa Chhu is plain. Towards this lower plain, agricultural lands, settlements, schools and the Bondey town can be seen. Paa Chhu is the lower boundary of the FMU

Around 90% of the FMU falls within the slope class of >10^{o} to 25^{o} and remaining 10% of the FMU has slope greater than 35^{o}. Slope classification was done using 30 m resolution ASTER DEM of Bhutan. Surface analysis was carried out and slopes were reclassified as required in Forest code. Areas that were considered over 100% were delineated on the Function Map as SP-Soil Protection where no activities can take place. Slopes that ranged from 76-100% are classified as SC-Soil Conservation where limited activities can take place

2.2 Climate

2.2.1 Meteorological Station

The climate and meteorology information of Zonglela FMU was collected from meteorological station located at Drugyel under Paro Dzongkhag. The station gives the representation climate data as it is located within the Forest Management Unit.

2.2.2 Temperature

The monthly maximum and minimum temperature of Zonglela FMU for last 12 years collected from two different location is given in the following tables and graph.

Table 2: The maximum temperature (Degree Celsius)

Average Maximum Temperature												
Years	J	F	M	A	M	J	J	A	S	O	N	D
2010	15.2	14.3	20.0	22.6	22.9	24.7	24.7	25.1	24.0	20.4	16.6	15.4
2011	11.3	14.2	17.3	20.2	22.2	24.5	23.2	23.8	22.8	20.5	15.9	13.8
2012	9.7	15.0	16.3	19.6	23.1	24.8	23.6	25.0	22.9	20.1	17.4	14.9
2013	12.5	15.0	18.6	18.7	22.6	24.1	25.4	24.5	23.6	19.8	17.3	13.5
2014	14.5	14.6	17.5	20.3	22.2	24.2	24.5	23.2	21.7	20.1	17.0	15.0
2015	13.8	15.0	18.0	18.5	22.5	22.9	23.4	23.1	22.3	21.0	17.6	13.5
2016	11.9	15.6	17.9	22.3	21.5	24.7	22.6	25.5	21.4	19.4	18.5	16.2
2017	13.2	16.1	15.2	20.2	21.3	24.7	24.2	24.5	24.2	22.3	18.6	17.7
2018	13.9	16.0	17.4	19.3	20.5	25.1	25.7	24.9	24.4	20.2	17.5	12.3
2019	11.7	13.5	15.8	19.8	22.5	24.9	25.2	26.1	22.9	20.9	19.8	12.8
2020	10.6	13.8	17.4	18.7	20.3	23.2	22.6	25.1	22.4	22.5	17.3	14.0
Average 11 yrs	**12.6**	**14.8**	**17.4**	**20.0**	**22.0**	**24.3**	**24.1**	**24.6**	**23.0**	**20.6**	**17.6**	**14.5**

Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

Table 3: The minimum temperature (Degree Celsius)

Average Minimum Temperature												
	J	F	M	A	M	J	J	A	S	O	N	D
2010	0.3	-1.6	4.6	8.2	10.6	13.4	15.1	14.9	13.5	9.1	5.0	-3.1
2011	-4.1	-0.3	2.8	5.5	10.2	13.9	14.5	13.9	13.3	9.0	2.8	0.1
2012	-5.3	-1.8	2.0	6.0	8.8	13.8	14.4	14.3	13.3	5.5	-0.4	-3.4
2013	-4.4	-1.3	3.0	6.2	9.9	13.7	14.4	13.5	12.7	8.2	0.5	-2.1
2014	-4.4	-2.4	2.0	4.6	10.0	13.5	14.6	14.0	12.7	6.6	3.0	-0.9
2015	-4.0	-0.6	2.5	5.9	10.2	13.3	13.6	13.7	12.9	7.1	2.7	-3.3
2016	-2.6	0.9	2.9	7.0	9.4	13.2	14.2	13.8	13.0	8.0	1.1	-1.6
2017	-4.7	-0.4	2.3	5.4	9.3	12.9	14.3	14.1	13.6	9.0	0.0	-2.5
2018	-3.4	-0.9	3.0	6.0	9.5	13.1	14.2	14.0	12.7	5.0	-0.1	-3.6
2019	-3.8	-0.5	1.6	6.1	10.1	12.4	13.9	14.2	13.4	7.6	3.5	-3.1
2020	-3.5	0.5	0.0	5.3	9.9	13.6	14.4	14.3	13.9	10.0	-0.1	-1.8
Average 11 yrs	**-3.6**	**-0.8**	**2.4**	**6.0**	**9.8**	**13.3**	**14.3**	**14.1**	**13.2**	**7.7**	**1.6**	**-2.3**

Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

Table 4: The total rainfall

Total Rainfall												
	J	F	M	A	M	J	J	A	S	O	N	D
2010	0.0	0.4	19.0	23.8	69.1	138.5	106.0	99.2	54.9	49.1	0.6	6.4
2011	0.0	33.2	6.8	13.2	18.6	80.6	89.4	144.2	137.5	20.0	1.0	0.0
2012	14.2	15.6	9.8	43.6	16.2	46.2	134.8	122.8	87.0	17.4	0.0	0.0
2013	13.8	42.8	23.2	37.1	81.9	46.0	47.5	3.2	1.9	1.4	0.0	0.0
2014	0.0	3.4	15.8	11.8	106.8	82.6	74.0	125.2	102.2	20.4	0.0	13.4
2015	8.0	12.2	26.2	78.0	42.6	114.0	158.7	80.1	74.0	27.0	3.8	0.0
2016	9.8	0.4	42.6	12.2	85.2	51.5	229.0	65.7	122.1	79.3	0.0	0.0
2017	6.2	0.0	21.7	60.8	51.4	34.1	100.7	68.8	39.2	6.4	0.4	0.0
2018	2.0	0.0	22.6	17.2	41.2	39.6	87.0	71.2	17.2	0.6	0.0	14.4
2019	0.0	34.4	24.2	18.2	28.0	56.4	104.4	69.4	73.8	3.8	0.0	10.4
2020	9.1	10.8	9.8	48.9	57.4	83.6	71.7	96.0	60.8	24.6	0.0	0.0
11 yrs average	**5.7**	**13.9**	**20.2**	**33.2**	**54.4**	**70.3**	**109.4**	**86.0**	**70.1**	**22.7**	**0.5**	**4.1**

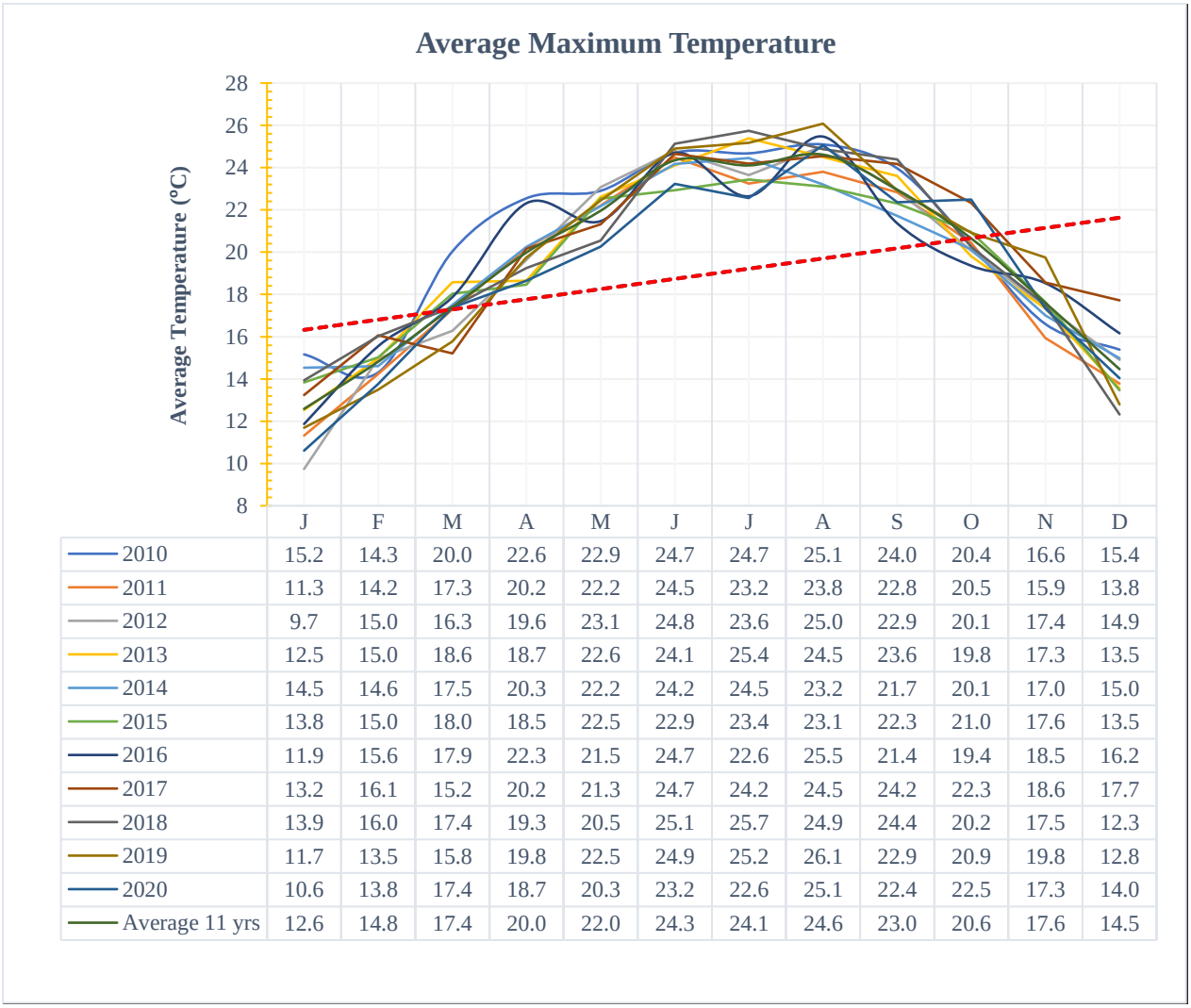
Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

Table 5: Relative Humidity

Relative Humidity (%)												
	J	F	M	A	M	J	J	A	S	O	N	D
2010	70.8	80.2	73.6	70.6	75.5	78.8	88.9	83.4	80.5	80.6	86.9	78.6
2011	85.5	79.7	71.0	67.5	75.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	86.2	95.9	96.3	93.6	88.6	80.8	72.5	69.4	71.6	60.0	55.8	65.8
2013	68.0	74.7	58.0	60.7	56.5	66.4	68.6	71.4	68.6	67.7	63.0	69.2
2014	69.1	62.9	59.7	51.3	56.6	71.0	70.1	74.7	74.3	66.3	68.0	73.6
2015	69.0	66.2	61.5	63.8	59.4	67.4	72.7	76.4	72.7	64.3	59.7	63.2
2016	67.5	62.9	63.9	62.7	66.1	65.7	81.8	68.1	76.2	74.4	59.8	61.4
2017	63.9	56.8	57.3	61.2	60.7	57.8	68.2	72.6	72.4	65.5	58.1	66.2
2018	70.8	64.4	59.2	59.8	68.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019	76.3	78.5	69.3	61.0	55.2	60.6	72.9	69.3	76.8	64.4	60.3	76.1
2020	75.3	71.2	63.4	64.6	66.9	71.2	78.1	75.3	77.3	72.4	67.9	67.4
11yrs average	**72.9**	**72.1**	**66.7**	**65.2**	**66.3**	**56.3**	**61.3**	**60.0**	**60.9**	**56.0**	**52.7**	**56.5**

Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

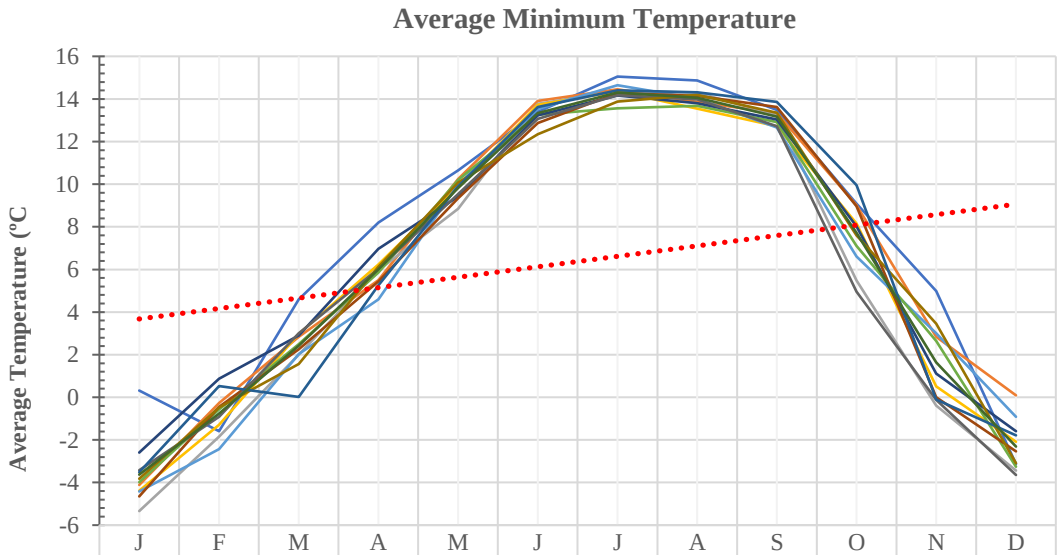
Figure 4: Graph showing Average Maximum temperature



	J	F	M	A	M	J	J	A	S	O	N	D
2010	15.2	14.3	20.0	22.6	22.9	24.7	24.7	25.1	24.0	20.4	16.6	15.4
2011	11.3	14.2	17.3	20.2	22.2	24.5	23.2	23.8	22.8	20.5	15.9	13.8
2012	9.7	15.0	16.3	19.6	23.1	24.8	23.6	25.0	22.9	20.1	17.4	14.9
2013	12.5	15.0	18.6	18.7	22.6	24.1	25.4	24.5	23.6	19.8	17.3	13.5
2014	14.5	14.6	17.5	20.3	22.2	24.2	24.5	23.2	21.7	20.1	17.0	15.0
2015	13.8	15.0	18.0	18.5	22.5	22.9	23.4	23.1	22.3	21.0	17.6	13.5
2016	11.9	15.6	17.9	22.3	21.5	24.7	22.6	25.5	21.4	19.4	18.5	16.2
2017	13.2	16.1	15.2	20.2	21.3	24.7	24.2	24.5	24.2	22.3	18.6	17.7
2018	13.9	16.0	17.4	19.3	20.5	25.1	25.7	24.9	24.4	20.2	17.5	12.3
2019	11.7	13.5	15.8	19.8	22.5	24.9	25.2	26.1	22.9	20.9	19.8	12.8
2020	10.6	13.8	17.4	18.7	20.3	23.2	22.6	25.1	22.4	22.5	17.3	14.0
Average 11 yrs	12.6	14.8	17.4	20.0	22.0	24.3	24.1	24.6	23.0	20.6	17.6	14.5

Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

Figure 5: Graph showing Average Minimum Temperature



	J	F	M	A	M	J	J	A	S	O	N	D
2010	0.3	-1.6	4.6	8.2	10.6	13.4	15.1	14.9	13.5	9.1	5.0	-3.1
2011	-4.1	-0.3	2.8	5.5	10.2	13.9	14.5	13.9	13.3	9.0	2.8	0.1
2012	-5.3	-1.8	2.0	6.0	8.8	13.8	14.4	14.3	13.3	5.5	-0.4	-3.4
2013	-4.4	-1.3	3.0	6.2	9.9	13.7	14.4	13.5	12.7	8.2	0.5	-2.1
2014	-4.4	-2.4	2.0	4.6	10.0	13.5	14.6	14.0	12.7	6.6	3.0	-0.9
2015	-4.0	-0.6	2.5	5.9	10.2	13.3	13.6	13.7	12.9	7.1	2.7	-3.3
2016	-2.6	0.9	2.9	7.0	9.4	13.2	14.2	13.8	13.0	8.0	1.1	-1.6
2017	-4.7	-0.4	2.3	5.4	9.3	12.9	14.3	14.1	13.6	9.0	0.0	-2.5
2018	-3.4	-0.9	3.0	6.0	9.5	13.1	14.2	14.0	12.7	5.0	-0.1	-3.6
2019	-3.8	-0.5	1.6	6.1	10.1	12.4	13.9	14.2	13.4	7.6	3.5	-3.1
2020	-3.5	0.5	0.0	5.3	9.9	13.6	14.4	14.3	13.9	10.0	-0.1	-1.8
Average 11 yrs	-3.6	-0.8	2.4	6.0	9.8	13.3	14.3	14.1	13.2	7.7	1.6	-2.3

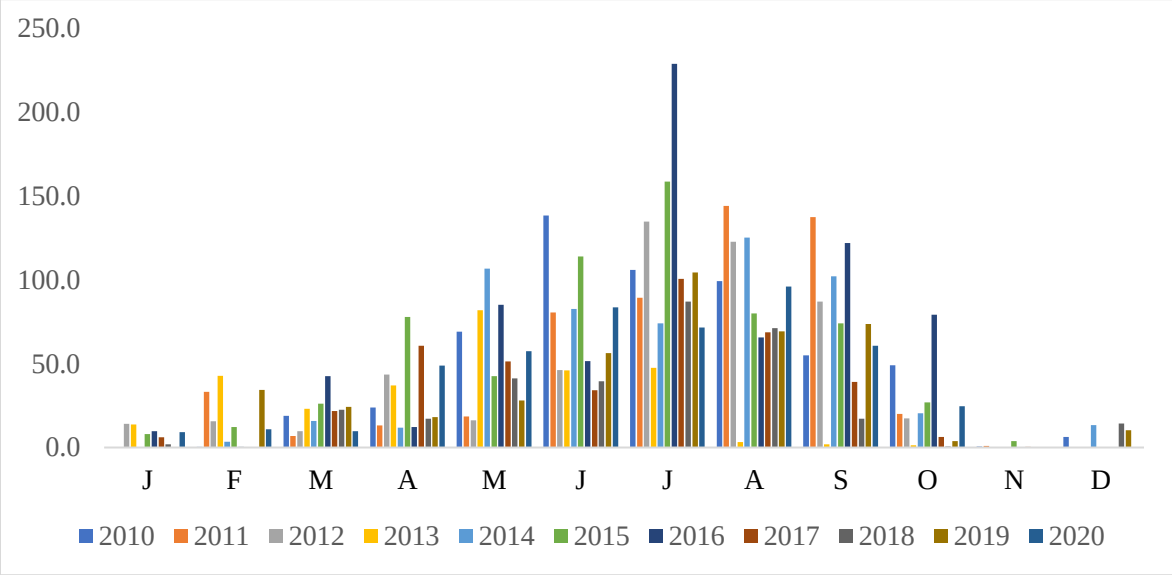
Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

2.2.3 Precipitation

The precipitation of Zonglela FMU is expressed in the following graph for last 12 years. During the monsoon, the rainfall can impact the commercial harvesting and transportation of timber to depot if the road is not maintained properly. Briefly during the months of winter, the area receives

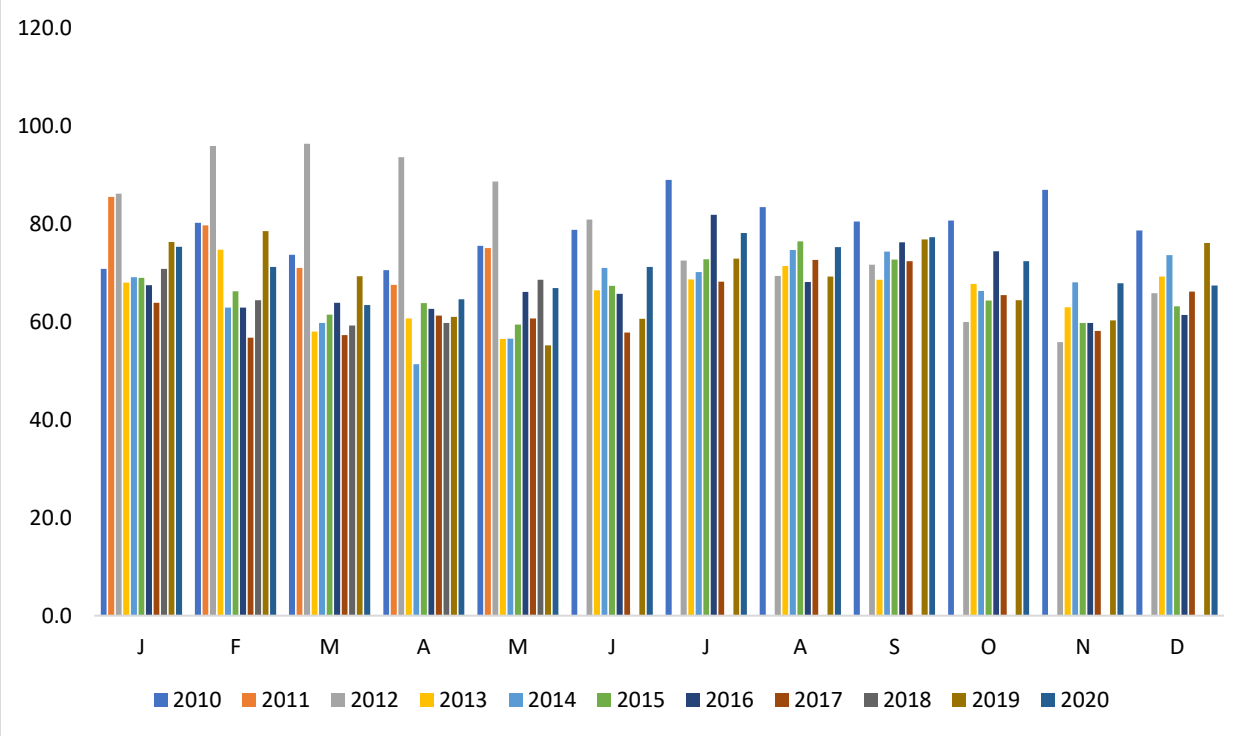
precipitation in the form of snow. Although affecting mainly high elevation sites, but when snow fall is heavy the logging operation are withheld.

Figure 6: Average annual rainfall (mm)



Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

Figure7: Average Relative Humidity (%)



Source: Department of Hydro-Met Services, MEA Thimphu, Bhutan

2.3 Geology and Soil

The FMU is located in the Central Crystalline Zone in the inner reaches of the lesser Himalaya. It is dominated by the pre-cambrian to tertiary series of metasedimentary migmatites and granitoid rocks which are referred to as the Paro and Thimphu formations. These formations are considered as the non-granitised portion of the Thimphu gneissis complex

The main rock formation in the general area of Chelela and Zonglela consists of flaggy quartzites (Quartz-muscovite schists; Calc-silicate rocks of gneissic type; Graphite schists; Quartz-mica schists; Marble crystalline dolomite limestone; interbanded graphite schists; and marble)

The area is characterized by red soils in the lower elevations (associated with the gneissic calc-silicate rocks) and large areas of sandy clay loams on the schist types. In general, the soils are moderately fertile and owing to the clay content retain moisture fairly well. The pH is close to neutral and is buffered by the limestones. The soils tend to be fairly stable and are not prone to large scale or frequent surface erosion or landslides. However, there is a moderate risk of erosion and gullying. The soil type is suitable for forestry activities as long as the silviculture and management are appropriate. These soil types will erode if large areas are exposed or the soils are not looked after.

2.4 Hydrology

The FMU is drained by the Paa chhu via four main tributary streams; the Isuna chhu (South east part of the FMU); Gebjalumi chhu (Gebjaphu valley below the Zonglela road); Jew chhu (Jewphu valley); and the Ngobe chhu (Ngobephu valley). The FMU is generally well-drained. The entire area of the FMU is of special importance as a water supply for Paro, Bondey and surrounding villages. The Ngobephu valley is of particular importance as this is designated as a water supply area for Paro town, Olathang and nearby villages.

The water sources are clean but simultaneously cattle grazing in these watersheds should be regulated to minimize the surface run off. In addition, appropriate silvicultural systems, prescriptions and harvesting methods are implemented in order to ensure that the quality and quantity of water is not affected by forestry operations.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

Paro dzongkhag consists of ten Gewogs of which the Paro-Zonglela FMU falls within Dogar, Lango, Lungney, Shaba and Wangchang gewog. The total population residing in both within and nearby the FMU region is about 20,198. The livestock and their Management Plan for Paro-Zonglela Forest Management Unit 9 products are also one of the main sources of income for the inhabitants. Rural urban migration in this area is not an unusual phenomenon. The probable reasons include better employment opportunities, education and health facilities in the urban towns. The gewog wise distribution of population and the other parameters are as follows;

Sl No	Geogs	Male	Female	Total
1	Dogar	1116	1211	2327
2	Shaba	3258	2683	5941
3	Luyni	2453	2274	4727
4	Wangchang	758	599	1357
5	Lamgong	2972	2874	5846
	Total	**10557**	**9641**	**20198**

Table 6: Geog wise population status

3.2 Agriculture and Farming System

The people are mostly engaged in subsistence farming. Almost all the households own both Kamzhing (dry land) and chhuzhing (wet land) where they grow various agricultural products. The agricultural products from their field are used for family consumption and whatever surplus is left, they sell it. The agricultural crops grown are; Chilli, Potato, Peas, Cabbage, Cauliflower, Sags, etc. Cereals grown are paddy, wheat, sweet and bitter buckwheat. Rice cultivation is in advance stage using mechanized agricultural machines like power tiller and other equipment. Besides agricultural farming, most of the households are engaged in livestock rearing. Cattle are usually reared for dairy products and meat.

3.3 Traditional use of Forest

Ever since the settlement has taken place in and around the Paro-Zonglela FMU, the people have been using the forest for their livelihood. The bond between these people and forest of Paro-Zonglela is very strong, they use the forest to; construct their houses, collect firewood, and fodder, graze their animals, collect fruits and vegetables, collect leaf litters, make farm implements, collect

fencing materials, collect medicinal plants etc. Such practice of forest use has been carried out since time immemorial.

3.4 Grazing

The information about pattern of grazing was mostly obtained from semi structured interviews. Grazing is evident in most areas of the FMU and is going to be one of the main pressures in the ZFMU. The heaviest grazing pressure is in the forest areas close to the settlements, despite the availability of pastures and grazing grounds for the animals. Grazing at current rate will have little impact on soil and water quality, but uncontrolled grazing could lead to poor regeneration and soil compaction in the near future. The nomads mostly practice migratory grazing. The effect on forest regeneration as a result of selective browsing both by resident and migratory cattle can lead to severe impairment of regeneration capacity of the forest in the long run. Future management prescriptions and options should take into account the dynamic and the appropriate regulation of cattle grazing in the forests

3.5 Wildlife

Going across the length and breadth of the FMU we have met with various signs left behind by the wild animals. Fresh footprints of the Himalayan black bear and Leopard pug mark in the vicinity of the cattle sheds and stories of cattle lost to the wild beast shows human wildlife conflict. Sometimes cattle are also lost to the wild dogs. Pellets of sambar and barking deer are also common. Wild boars are considered as wild pest by the local people and even deep inside the forest, soils moved by them were a common sight. During the national Tiger survey in 2021 there was camera trap evidence of Snow leopard presence in FMU. The list of wild animal presence in FMU area:

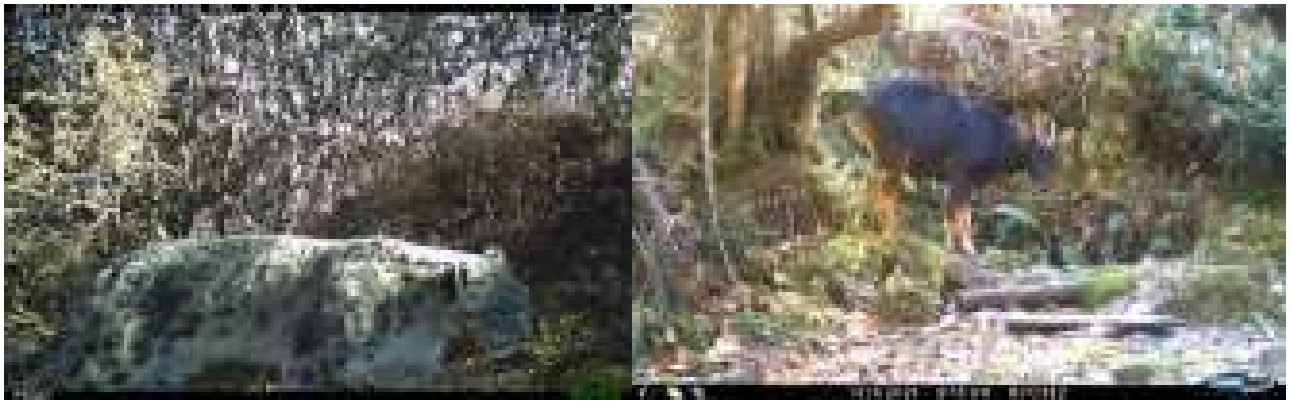


Figure 8: Rare Snow Leopard and Serrow captured in camera trap inside FMU area

SL No	Name of Animal	Scientific Name
1	Snow Leopard	*Panthera uncia*
2	Himalayan black bear	*Selenarctos thibetanus*
3	Leopard	*Panthera pardus*
4	Wild dogs	*Cuon alpinus*
5	Barking deer	*Muntiacus muntjak*
6	Sambar	*Cervus unicolor*
7	Wild boar	*Sus scrofa*
8	Musk Deer	*Moschus moschiferus*
9	Grey Langur	*Presbytis entellus*
	Yellow-throated marten	*Martes flavigula*

Table 7: List of wild animals

3.6 Forest Fire

Forest fire is unpredictable and is main cause of forest depletion in Bhutan. Though forest fire has both positive and negative effect on the ecology of the forest but in Bhutan the negative effect of the fire is more common. The causes of forest fire are both natural and anthropogenic. In the country like Bhutan where major portion of the population depends on agricultural farming, burning of debris in the field is a regular routine for the farmers and forest fire spreading from such burning is very common. The natural cause of forest fire in Bhutan is very negligible; almost 90% of forest fire in Bhutan is manmade. In ZFMU the incidence of major forest fire outbreak occurred at Nabesa block in 2020. Total of 20 ha of forest was damaged by forest fire. Fire is an annual phenomenon in the central region, especially in the conifer areas. Strict vigilance should be in place to prevent forest fire and the local people should be educated on fire safety, fire risk mitigation measures.

3.7 Pest and Diseases

The Eastern Himalayan spruce bark beetle, *Ips schmutzenhoferi*, is a serious pest of *Picea spinulosa* and *Pinus wallichiana* in Bhutan. In Zonglela FMU major chunk of bark beetle sanitation operation was carried out between 2012 and 2021. Total of 88 ha of area was bought under bark beetle sanitation to avoid further spreading. In most of the infested stands, mortality of trees was observed in the patch form and this could be because of root-to-root contact of the fungus. To our understanding, stands would have infested by bark beetles after weakening the trees with damage to the root system by root rot. The other probable causes of beetle outbreak could be because of poor management and harvesting practices. With incidents of outbreak of spruce bark beetle over past years, there are possibility of pest and diseases outbreak any time during this plan period. Therefore, periodic monitoring to detect any outbreak of pest and diseases should be conducted by FMU and NRDCL. Immediate reports should be made to concern CFO and seek approval for immediate sanitation from head of the Department.

Figure 9: Bark beetle sanitation areas in Zonglela block

3.8 Non-wood Forest Product

In Bhutan, non-wood forest products (NWFPs) form the major source of peoples' livelihood in the rural communities. NWFPs play an important role in the daily lives and overall well-being of the Bhutanese people especially among the rural farming community; for instance, they are a major source of off-farm income, food, medicinal and aromatic products, fodder, fiber, and also used for local construction materials. NWFPs often are a safety net for poor people in the off-farm season and/or whenever needed as a food security measure. NWFPs offer a lifeline for many rural Bhutanese households. Bamboos and mushroom are some of the most commonly used NWFPS and used mostly for self and domestic purposes. They also collect *Paris polyphylla* for their medicinal value and very few individuals of Zonglela FMU have now started selling some of the NWFPs like mushroom although the amount is very small. Many varieties of mushrooms are found

and collected by the local population within the FMU, mostly for self-consumption. Matsutake mushroom (Sangay shamu) are also collected from the blue pine forested areas.

Rhododendron species, Junipers and Artemisia were also valued by the local residents to be burned as incense. Pteridophytes like Fern and conifers like Blue Pine needles were said to be used for composting manure to be used in farms. Stones and sands are other useful NWFPs. There are many other NWFP species found within the FMU area which are used as NWFP whose various properties are valued by locals and put into use. Some of the NWFPs found in the FMU are grouped as per their uses and are listed accordingly in the following tables

Particular	**Uses**
Bamboo	Mat, fences
Daphne	Paper making
Mushroom (variety)	Food
Berry *(Rubus spp*)	Fruits eaten
Berbaris spp.	Dye
Holboellia latifolia	Fruits eaten
Rhododendron spp.	Medicinal value
Viscum nepalensis	Medicinal value

Table 8: Non-wood forest product and their uses

3.9 Mineral Extraction

Minerals had not been extracted from the ZFMU till now and should not be allowed even in the future for the aesthetic sensitivity of the area.

4. ECOLOGY

4.1 Floral Association

The altitude of FMU ranges from 2000 m to 4000 m above sea level and vegetation is dominated by conifer forest. The forest type for FMU has been grouped into Blue pine, Mixed conifer, Fir and Broadleaf forest as per land use land cover, 2016.

Blue pine growth is eminent at the lower altitudes either in pure stand or mixed with other species like *Quercus semicarpefolia, Populas ciliate, Betula utalis, Picea spinulosa,* and *Tsuga Dumosa.* Mixed conifer forest mostly comprises of *Picea spinulosa* and *Tsuga dumosa* at the lower altitude.

At the higher altitude, Spruce and Hemlock are mixed with other species like *Taxus baccata*, Juniper species, *Cupressus sps*, *Rhododendron sps*, *Larix graffithiana* and other species. The fir forest is seen at upper portion of the FMU and this forest favor dense under storey where abundant growth of Rhodendron sps and other shrubs are usually seen

Upper canopy: Spruce (*Picea spinulosa*), Hemlock (*Tsuga dumosa*), Fir (*Abies densa*), Blue pine (*Pinus wallichiana*)

Middle canopy: Juniper (*Juniperus recurva*), Rhododendron sps, Oak (*Quercu ssemecarpifolia*), *Acer cambellii*, *Betula alnoides*, *Populus ciliate*, and other species

Shrubs: *Rosa laevigata*, *berberis sps*, etc.

Ground cover: *Aconitum sps, Thalictrum foliolosum, Potentilla sps, Eleagnus parviflora, viola sp, Senecio sp, Aster albescense, Rubus sp, Rumex hastatus, Causiniat homsonii, Gerenium wallichianum* and lot other

4.2 Fauna

During stock inventory, wildlife was also recorded during the first and second management plan periods. During the transect walk in the FMU, some of the animals and birds were directly spotted and many data regarding wildlife was recorded through indirect signs. Some of the animals and birds found in the are listed below

Table 9: List of Wild Animals

Common Name	Scientific name
Himalayan Black Beer	*Selenarctos thibetanus*
Sambar deer	*Cervus unicolor*
Barking deer	*Muntiacus muntjak*
Wild boar	*Sus scrofa*
Wild dog	*Cuon alpines*
Leopard	*Panthera pardus*
Musk deer	*MosChhus chrysogaster*
Jungle cat	*Felis chaus*
Himalayan yellow throated marten	*Martes flavigula*
Three stripped palm squirrels	*Funambulus palmarum*
Pine marten	*Martes martes*
Red Panda	*Ailurus fulgens*

In order to protect the musk deer in ZFMU, detail field survey to identify its main habitat is recommended in near future

Table 10: Common Birds found in Zonglela FMU

Common Name	Scientific Name
Monal Pheasant	*Lophophorus impejanus*
Blood Pheasant	*Ithaginis cruentus*
Spotted Nutcracker	*Nucifraga caryocatactes*
Yellow-billed Blue Magpie	*Urocissa flavirostris*
Kalij pheasant	*Lophura leucophaeus*
Large billed crow	*Corvus macrorhynchos*
Yellow-billed chough	*Phyrrocorax graculus*
Green backed Tits	*Parus monticolus*
Blue-fronted Redstart	*Phoenicurus frontalis*
Blue-whistling Thrush	*Myophonus caeruleus*
Grey-sided Bush Warbler	*Cettia brunnifrons*
White throated laughing Thrush	*Garrulax albogularis*
White tailed nuthatch	*Sitta himalayensis*
White capped redstart	*Chairmarrornis leucocephalus*
Plumbeous redstart	*Rhyacornis fuliginosa*
Alpine swift	*Apus mulba*
Hoopoe	*Upapa epops*

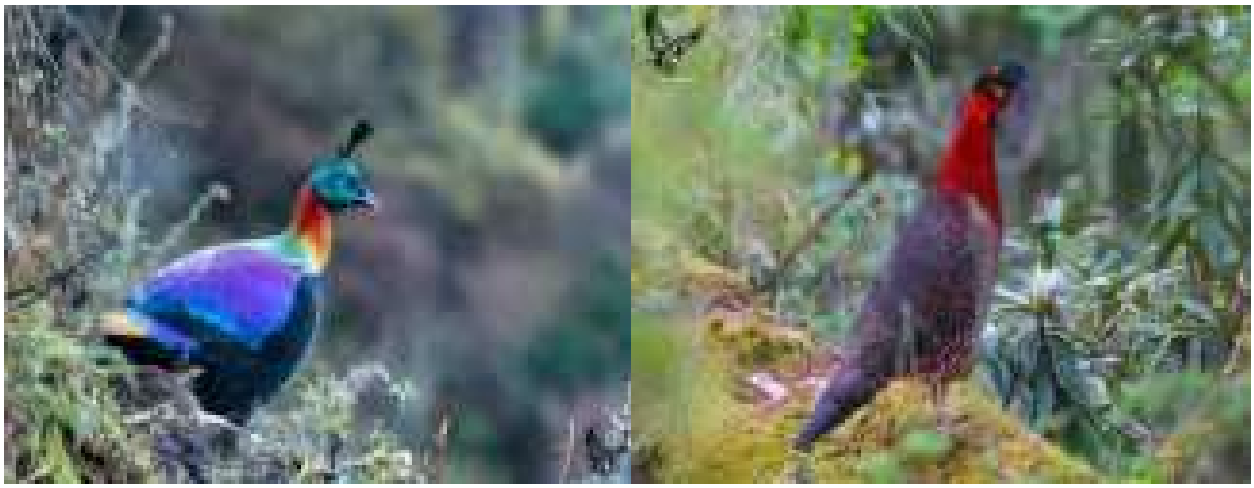


Figure 10: One of the rare bird species Himalayan monal and Satyr tragopan (*Photo PC: Sherab Jamtsho*)

5. SILVICULTURAL ASSESSMENT

5.1 Present Forest Types

The main forest types of Zonglela FMU are;

Blue pine

Blue Pine is mostly found around the settlements and now started invading the open areas. The blue pine stand is at the new stand initiation stage and old growth is only in small patches. It occurs both in pure and mixed with oak, poplar and Acer. In the upper region, it is also found mixed with Hemlock.

Mixed conifer

Mixed conifer is found all across the middle portion of the FMU. This forest type is dominated by Hemlock, Spruce and Fir. Hemlock mostly occurs in association with Blue Pine and Spruce.

Fir

Fir forest in Zonglela FMU is confined to the upper ridges up to the tree line and occurs mostly as pure stand, but it is also found mixed with Spruce and Hemlock. The dense canopy provides environment for luxuriant under story of Rhododendron and other shrubs. Most of the Fir at the higher elevations is over matured old growth stand. But protection should be given the first priority as on the steep and high-altitude regions regeneration of Fir is very low hence harvest should be confined to suitable site conditions. And also, invasive nature of the broadleaf species such as rhododendron hampers the regeneration of economically important species like Fir.

5.2 Past Silvicultural Treatment

The Silviculture systems that were to be used were Group Selection System for mixed conifer, Seed Tree System for blue pine and Single Tree Selection System for rural allotment. This was to be carried out using cable crane logging system. Thinning was also to be carried out in the Blue pine stand to improve the individuals. Natural regeneration was to be the main source of stocking supplemented with artificial regeneration in the area absence of natural regeneration for sustainability. Four working circles were established in the previous management plan, four regulars and one overlapping. They were:

Regular Working Circles:

1. Blue Pine Working Circle

2. Mixed Conifer Working Circle

3. Fir Working Circle

Overlapping Working Circle:

1. Non-wood Working Circle

5.3 Plantation

Since 1992, forests in the FMUs have been managed under Management Plans. While the primary objective is sustainable forest management to ensure sustainable production and supply of timber for urban and rural consumers, the FMUs are also mandated to manage the non-timber forest resources as well as the protective functions of forests. From the standpoint of sustainable timber production, the forests cut along the cable line corridors and in the patch, openings are to be reforested through natural regeneration supplemented by artificial planting.

For this plan period a total of 38.03 ha of land was bought under artificial plantation from the total clear-cut area of 56.06 ha (Table 7). This clearly indicates of good natural regeneration in conifer areas and along the cable line corridors and bark beetle sanitation areas. Further, survey to study plantation establishment status were conducted for plantation areas which are more than five years old. The survey was carried out in line with Guidelines for Monitoring and Evaluation of Plantation and Forest Nursery,2019. The average planation survival percentage of five years old of five sites was 70% which falls in very good (VG) category (Picture:1). With this the plantation sites were qualified to evaluated under “Established Plantation” and 10 years regeneration was added for existing rotation period for AAC calculation

Block/Compartment	Geo- coordinates	Year of Plantation	Plantation area planned(ha)	Plantation area implemented (ha)	Plantation Survival Percentage
ChelelaIVa	27°23'44.22" N 89°21'23.95" E	2013	4	4.15	70
NabesaIIIa	27°18'15.87" N 89°26'18.34" E	2016	1.90	1.90	67
Pombesa III	27°20'43.94" N 89°25'17.00" E	2017	5.20	5.20	62
Chelela IV a	27°23'44.22" N 89°21'23.95" E	2017	5.2	5.2	68
Pombesa III	27°20'30.12" N 89°25'22.81" E 27°19'50.80" N 89°25'7.90" E	2018	7	5	60
Nabesa IV (sanitation)	27°19'23.67" N 89°25'23.87" E	2019	5	5	78
Nabesa IV (sanitation)	27°19'16.11" N 89°25'24.79" E	2020	5.5	5.5	80
Nabesa IV (sanitation)	27°19'9.29"N 89°25'27.53"E	2021	8.08	6.08	80
			41.88	38.03	

Table 11: Plantation areas and survival status

6. SOCIO-ECONOMICS

6.1 Common Source of Income

According to the information collected from Geog Agriculture Extension Officer, the main sources of income for the local communities within ZFMU are agriculture and livestock rearing. The majority of local communities are farmers having individual landholdings. The main cash crop grown by the local communities is potato. Other vegetables like Beans, Cabbage, Raddish, etc. are grown in small quantity for family consumption. Selling of Potato and livestock products are the only source of income for the local communities within the ZFMU.

7. CURRENT TIMBER DEMAND AND SUPPLY

The timber needs for the rural communities residing within the FMU is being met from Chelela, Nyobephu, Zonglela, Pombesa and Nabesa blocks. The timber needs are mainly for rural house construction, renovation of rural house, cattle shed construction, fencing of farm lands and flag poles. Even the rural firewood demand for the locals is being met from same area.

For commercial timber use, the total AAC prescribed during the plan period was 6366 m^3 in standing form. The total timber harvested from FMU over period of previous management plan period was 72,646.08 m^3, which is about 81% against prescribed AAC.

Table 12: Commercial timber extracted from the Zonglela FMU 2011-2020

Sl. No.	Year	No of cable lines	Standing Volume (Commercial)	Volume (Road)	Volume (Sanitation)	Volume (Others)	Total Volume (m^3)
1	2012	4	6117.47	0	0	0	6117.47
2	2013	4	5599.45	0	0	0	5599.45
3	2014	2	4579.36	297.5	1755.32	0	6632.18
4	2015	5	7823	0	537.711	0	8360.711
5	2016	6	9232	0	3133.108	122.82	12487.928
6	2017	3	2433	835.14	468.04	46.38	3314.52
7	2018	0	5275	0	91.20	218.00	5584.2
8	2019	7	7938.8	0	0	0	7938.8
9	2020	8	12150	0	5497.04	202.00	17849.04
10	2021	3	0	0	2186	0	2186
Total Volume		**42**	**61148.08**	**1132.64**	**13668.419**	**589.2**	**76070.299**

The overall timber extracted in last ten years from different activities was 76070.29 m^3 of which 13668.41 m^3 was from bark beetle sanitation operation. The commercial AAC allotted was 66,315 m^3 in standing volume and NRDCL have extracted standing volume of 67,134 m^3 which is around 101% achievement from the target volume (Table:11)

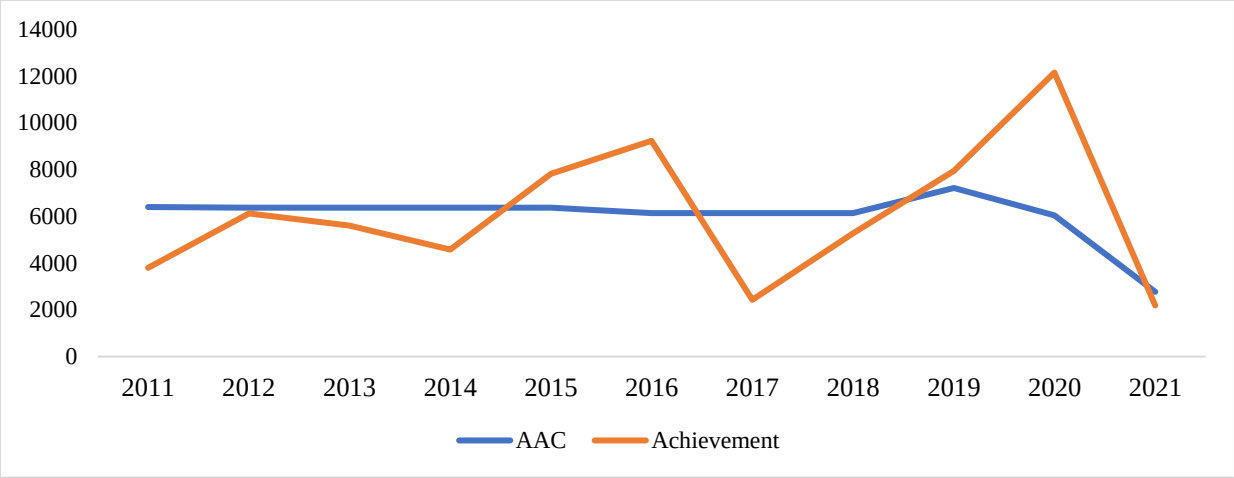


Figure 11: Commercial timber extraction graph

The graph 7 shows the comparative commercial timber extraction of 2nd plan (2002-20211) and 3rd plan period (2012-2021). The figure explicitly shows that timber volume has decrease significantly.

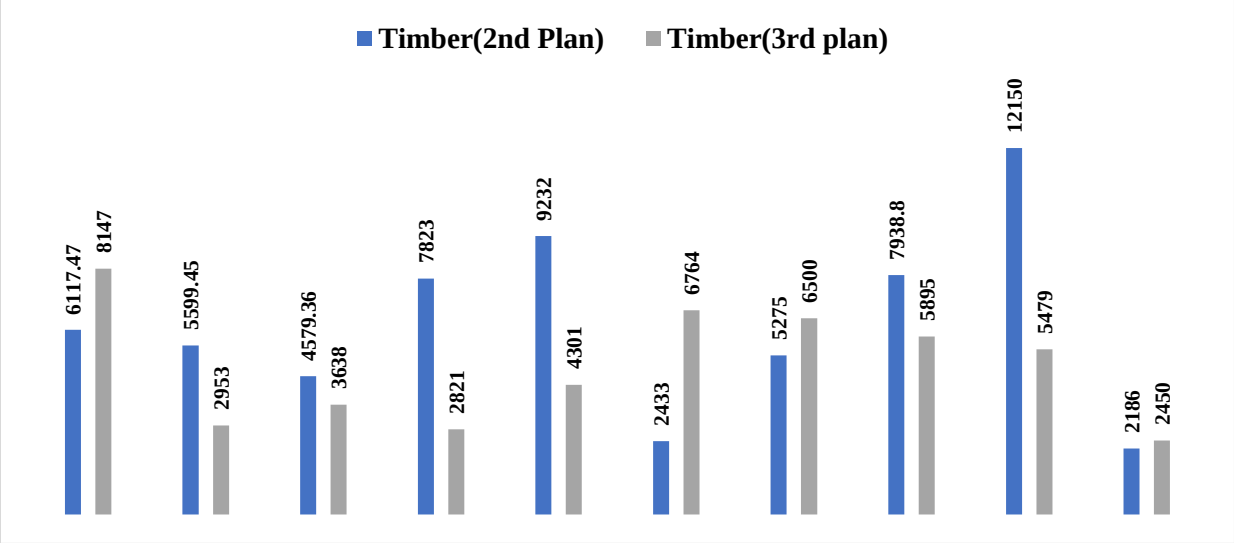


Figure 4: Commercial timber extraction achievement for 2nd and 3rd plan period in m3

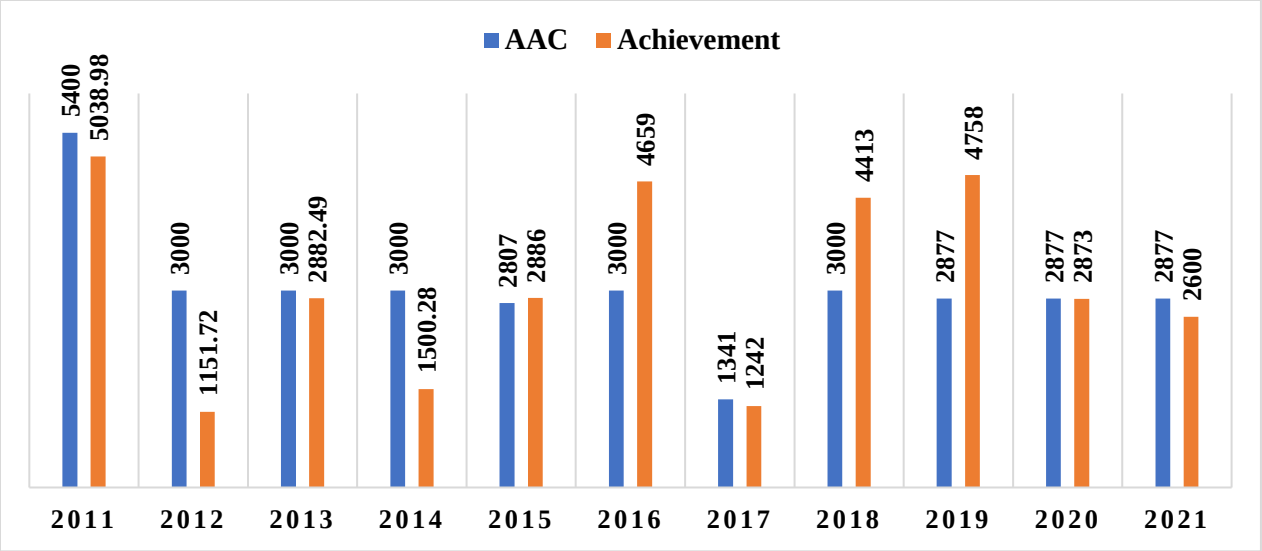


Figure 5: Rural timber demand and supply for last ten years

The total timber allotted to rural use in last ten year is 34004 m^3 against the AAC of 33179 m^3. There is over cut of 825 m^3 in last ten years period.

Table 13: NWFP supplied from the FMU (T/L)

Years	Stone	leaf mould	Bamboo	Forest soil	woodchips	Incense	m/billet	Sand
2013	498	35	500	17	134	134		
2014	500	37			15	5	500	20
2015	87	26	10	47		8	1000	76
2016	139	10		57		2	600	35
2017	265	12		87		5	4000	11
2018	119	27		27			500	16
2019	110	18	500	101		8		6
2020	50	46		11		2	200	5
2021	71	44		90				

8. ORGANIZATION AND ADMINISTRATION

8.1 Organization

Paro-Zonglela FMU is under the jurisdiction of the Paro Forest Division, and is directly administered by the CFO. The CFO is supported by the Unit-In-Charge, who supervises the FMU operations. Operational Plans will be developed and written by the FMU management, with assistance and input from the CFO, Paro. All activities within the FMU will be administered by the Chief Forestry Officer, Paro.

8.2 Health and Safety

In the environmental statement of the National Environmental Commission health and safety had been given a high priority. As stated in the environmental statement and the consultant report of WWMP, Paro, harvesting and extraction method have been identified as the areas of most concern and needs to be addressed.

NRDCL is taking up the implementation part of the forest management; the issue needs to be addressed by the implementers. At present health and safety measures are poor and sometimes absent altogether. Site specific risk assessment seems necessary if not Generic Risk assessment.

The major risk involved in the forestry operations are:

- Harvesting
- Transportation

The safety measures can be initiated with little or no expenditure to ensure the health and safety of the field staffs. Below are the few recommendations to minimize hazards in the field;

- Ensure chain saws equipped with full functioning chain breaks.
- Always ensure feller to keep two tree lengths apart while felling.
- Explain the dangers of falling timbers and overhead cable lines.
- Stack timbers in the same direction stack not too high.
- Never climb or approach the log pile from the bottom of the slope.
- Always dismantle a stack from the top rather than from the bottom.
- Keep two products length while stacking mechanically.

It is recommended that the NRDCL to initiate long term safety measures and its improvement that would one day become a mandatory at any costs.

8.3 Record keeping

Maintenance of record in the FMU office was identified as concern. Some important information was lost, otherwise would be very useful for the planning and management purposes. The Unit Office shall maintain the records of all the activities within the FMU as per the record-keeping format reflected in the Forest and Nature Conservation Code of Best Management Practices of Bhutan and other guidelines issued by the Department. Further, its recommended to develop data

base software to store FMU data so that planners can refers while preparing management plans in future.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENT

9.1 Road

The entire FMU is covered by road network and very minimal road construction will take place during this plan period. Almost all the settlements within the FMU are now connected with forest roads and farm roads. During 3rd management plan total length of 7 km forest road was constructed by NRDCL. The total road length constructed by NRDCL from 1st plan to as of 3rd plan is 43 km and this has immensely helped local people for transportation of timbers.

9.2 Buildings

The FMU has one fully furnished office which was constructed in year 2013.

9.3 Transport

The FMU is provided with Royal Enfield bike through GEF-LDCL, UNDP project to speed up cater public service delivery and for daily patrolling activities. The bike was handed over to UICs in 2020. A total of five bikes were distributed to all FMUs under this division.

9.4 Equipment

The FMU had received many essential office and field equipment in the past. Most of the old office and field equipment are obsolete and some are out of service and thus, impeding the successful implementation of the management plans. The concern agencies must issue office and field equipment from time to time to avoid impediments to the FMU staff. FMU should be equipped with updated equipment and human resources to ensure sustainability of the FMU.

10. EVALUATION OF PREVIOUS PLAN (2012-2021)

It is mandatory to review the last plan to identify areas that are in need of management interventions. This review will comment on the objectives that were set for the last plan period and look at the situation in the field concerning harvesting, roads and regeneration. Since time immemorial, people nearby PZFMU had unlimited access to the forest resources, but records are very minimal. The last management plan by Gavin Jordan (2002 -2012) and Operational Plans are some of the documents available. The past harvesting activities and other associated activities in

Zonglela Forest Management Unit was guided by the Forest Management Plan prepared in line with the Forest Management Code of Bhutan, 2004. It is important to evaluate the past management plan to review and study whether activities are carried out in line with the management plan prescription. Revisiting the areas and the plan would help identify areas for improvement or those aspects which has been overlooked. The required remedial measures can be accordingly incorporated in the new plan. The past plan is reviewed for its goals and objectives and evaluated for the on-field activities carried within the FMU.

10.1 Review of Goals and Objectives

Forest management plan for FMU was written to manage the environment, wildlife, soil, water and timber. This plan tries to tie together all the aspect of sustainable utilization of forests resources, involving stakeholders and the local people in the FMU. A brief review of the Goals and Objectives of the last management plan, to define where activities have been focused are documented below:

Goal

To manage the forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products and for watershed, wildlife and environmental protection

Although, the goal of managing forest on a multiple use, sustained yield basis for the production of timber, fuel wood and other forest products was not achieved completely, however it was observed that, the activities implemented in last plan period has focused towards achieving this. As the goal is usually considered as a long-term objective of the management, it is unlikely to consider that it should be achieved in the short period of time. The sustainability aspect of the goal has been taken care properly while implementing the activities in the FMU.

Objectives

To ensure sustainable supply of timber, fuel wood and other forest resources.

For commercial timber use, the total AAC prescribed for ten years plan period was 66315 m^3 in standing form. The total timber harvested was 67134 m^3, which is about 101% against prescribed AAC. And similarly, for Rural use the total AAC prescribed was 33,179 m^3 and from that total timber allotted was found to be 34004 m^3. Therefore, both commercial and rural timber harvesting was found to be marginally over cut from the ten years AAC allocation.

Other forest resources like sand; NWFPs, Bamboos, etc. were also supplied from the FMU. No annual harvesting limit was fixed for NWFPs. NWFP harvesting in the FMU must be done based on prescribed management prescription in the future management plan for major NWFPs. Management prescription for important NWFP species should be identified and prioritized and management plans must be developed in close consultation with Social Forestry and Extension Division of the Department.

To protect forest from encroachment, fire, grazing and other illegal activities to conserve and enhance wildlife habitats and biodiversity.

This objective has been prescribed under the protection management circle.

As per the field records maintained by FMU Unit In-charge and field observations, there is no evidence of encroachment into FMU area. In the previous plan period, total area of 475.28 ha as soil protection, about 1383.70 ha as local water and stream protection. Although there were some incidents of cable lines being installed inside protected areas but no major disturbance was observed. Therefore, UICs are recommended to strictly prohibit any commercial nor rural marking inside reserve in future.

To involve local people in the management of forest by providing employment opportunities and raising awareness programs.

Although, all the technical works are being contracted to the eligible business firms, the firms hire the local people as laborer to carry out the works within the FMU. This way, it helps in creating employment opportunity for the local people and the social mandate of the FMU is also being achieved. Moreover, two community forests were also established within the FMU which is aimed at giving opportunity to the local people to manage resources for themselves and also to carry out interventions to improve the forest cover and conditions. The local people were also involved in the management of FMU through FMU level meetings in which their opinions and suggestions are being incorporated for proper management of the Unit.

10.2 Review of Harvesting Activities

The management has raised concerned on the considerable damage to environmental which were found resulted from manual timber rolling creating irreparable scare in rural logging areas. To this the FRMD in consultation with department started issuing approval to install cable lines for extraction of rural timber. This has helped to reduce the impact on soil and other environmental impact from road construction.

Figure 6: Impact of manual timber rolling seen in Nabesa block, 2019

There were multiple incidents of bark beetle outbreak on spruce trees in FMU. Total of 88 ha of land were bought under bark beetle sanitation operation to avoid further spreading. Further the total clear-cut equivalent from cable line was 56 ha.

10.3 Review of Road Building Activities

Construction of roads for extraction of timber is very important but at the same time it's very important to minimize the damages to the environment. Around 60 kilometers of forest road have been constructed in the Paro-Zonglela FMU within last 30 years of operation. The road network has covered the entire FMU benefiting the local people residing both within and outside the FMU. The forest road from Chelela to Zonglela requires immediate maintenance and the current amount

for maintenance is not sufficient. The road network in the FMU requires major maintenance in order to carry out harvesting activities.

PART 2

FUTURE MANAGEMENT

THE FUTURE MANAGEMENT

11. Introduction

Bhutan's forest policies have been particularly progressive and invaluable in the protection of the country's rich natural resources. Bhutan nationalized its forests in 1969, then approved a National Forest Policy in 1974 that set a goal of maintaining 60% of the land under forest cover in perpetuity, creating a framework for scientific management of the forests, and providing for the restoration of degraded land.

The Royal Government of Bhutan (RGoB) is committed to the principles and practice of sustainable forest management and to achieve such management, sound policies along with comprehensive approach, appropriate legislative and governance framework is important. The national forest policy, 2011, envisaged sustainable management of Bhutan's forest resources and biodiversity and the RGoB has adapted a firm national policy requiring the preparation and implementation of scientific management plans to produce a wide range of social, economic and environmental goods and services and fulfil social, economic, ecological and cultural needs of the present and future generations. It is important to understand our forest resource dynamics from what has already occurred and useful to take a look at what is likely to occur in near future. The constitution of the kingdom of Bhutan mandated to retain at least 60% of the country under forest cover for all times to come.

11.1 Forest policy

1. From the time immemorial, Forest has been important resource with policy requirement of management plan for State Reserve Forest land focusing on sustainable utilization of forest products and ecosystem services. Several principles have been considered while framing the National Forest Policy and some of these are equity and justice in terms of access, optimal utilization, conservation of forest resources and its ecosystem services.
2. Contribution of forest products and services for poverty reduction through integrated approach.
3. Deregulation and devolution through people centered forest management practices and decision making.
4. Application of good science and indigenous knowledge through integrated research and development in all aspects of forest planning and management
5. Allowing imports of logs and sawn timber to enhance availability of timber materials within the country while export of round logs and sawn timber shall not be allowed to encourage value-addition.

11.2 Goals

The overall goal of Zonglela Forest Management Plan is to:

'*Manage forest on a multiple use, sustained yield basis for the production of timber, fuel wood, non-wood forest products, and conservation of watersheds, wildlife and environment'.*

In order to support this long-term goal, FRMD will have to assess every thematic elements of Sustainable Forest Management (SFM). The elements include extent of forest resources, biological diversity, forest health and vitality, productive and protective functions of forest resources, socio-economic functions and legal, policy and institutional framework through monitoring and evaluation framework for FMUs. The Paro Forest Division will have to process for evaluation of FMU to the DoFPS through FRMD.

11.3 Objectives

The objectives of Zonglela FMU have been divided under the management circles and the working circles set up for the ease of implementation. Three management circles have been identified, **Protection, Production and Non-Production** with objectives listed below. This allows different areas to be managed and evaluated separately. Some of the same objectives may occur under different management circles.:

Protection Management Circle

- To conserve water catchment areas by maintaining buffer zones and not harvesting timber;
- To prevent from forest fire, grazing and other illegal activities
- To allow low-impact collection of Non-Wood Forest Products on sustainable basis through some regulations
- To conserve and protect wildlife habitats and biodiversity areas by not interfering any anthropogenic interventions
- To raise awareness on biodiversity and natural forest to local communities and stakeholders
- To respect sanctity of religious places and to protect historical sites

Non-Production Management Circle

- To maintain and improve the forest condition to retain its multiple value
- To conserve and protect biological diversity by regulating function maps of FMU
- To manage and regulate grazing for livestock

- To conserve the water catchment areas by keeping buffer zone and not harvesting timber;
- To conserve and enhance biodiversity and meet the local demand for NWFPs

Production Management Circle

- To meet local requirements, as priority, for timber, fuel wood and other forest products on a sustainable basis
- To manage the commercial timber production on sustainable basis
- To protect the forest from fire and illegal activities and grazing in regeneration areas
- To create local employment opportunities
- To improve health and safety standard of the workers
- To conserve water catchment function
- To maintain biodiversity within the production area

11.4 Management based on Forest Function

11.4.1 Introduction

Forest function mapping is defined as grouping of different potential uses of forest. The different forest potential includes soil conservation, watershed conservation, habitat for flora and fauna and resource based for many kinds of human needs. Forest function in general are not based only on subjective human demands, they are significantly and objectively limited by site condition of individual forest stand. For this reason, categorization of every forest stand into different forest function is mainly based on the dominant site, forest type, accessibility, slopes, flora and fauna present. However, some forest function represents a certain exception to this rule and these functions are designated on the basis of social or certain group importance.

Forest and Nature Conservation Code of Best Management Practices of Bhutan, describe that forest function defines for all the forest area within the FMU ecological, environmental and social functions and as such serves to balance the often-diverging interest of commercial logging, local forest use and nature conservation. For effective management of forest, it is essential to map all the different forest functions. Forest function map provides the information on the total commercial operable area identifies which areas have to be reserved for local use and provides the

management planner and the implementer with information on management restrictions for particular areas.

Section 5 of Management Plans and Section 21 of establishment of Protected Areas of the Forest and Nature Conservation Act of Bhutan 1995 provides the legal backing for forest function planning. The objectives of forest function planning for this management plan are:

The main objectives of forest function planning for this management plan are:

- To define, for a particular area (FMU), different environmental and social functions of the forest and depict them on the map
- To identify production, non-production and protection forested areas and accordingly implement activities
- To provide a tool for a management planner for balancing the requirement of nature conservation, environment protection, social forestry and commercial timber production and also to provide spatial information required to compute the sustainable AAC.
- To provide the FMU In-charge with information on the location of different forest function in order to specify the required management prescriptions on the ground and to control their implementation.

11.4.2 Function Groups

The functions used in this management plan are listed in the table below. Some of these groups include functions that differ only in the degree of intensity of their management prescriptions.

Table 14: Different Forest Function used in this Plan

Code	Function Group (Bold) and Functions
S	Soil Conservation Functions
SC	**Soil Conservation**
SP	**Soil Protection**
W	Water and Watershed Conservation functions
WRR	**Riparian Reserve Protection**
WSh	**Watershed Conservation**
N	Nature Conservation
Soc	**Social Function**
SocL	**Social (Local Use Only)**
SocRS	**Religious Site Protection**
RB	Road Buffer

11.4.3 Mapping Forest Functions

The criteria used to prepare forest function map for Zonglela FMU is given in the Table 9 below. In this table, information for some criteria is not available or cannot be mapped at the scale used for planning. These criteria are indicated in italics. When Operational Plans are prepared new detail is to be collected and these criteria should be implemented.

Table 4: Criteria for mapping Forest Functions

Function Group and Codes	Criteria for Mapping
Soil Conservation	**SP:** Very steep areas (slopes above 45º), areas unstable and sites prone to landslides and areas with indications of severe erosion. **SC:** Steep areas (slopes of 25-45º), areas with indication of slight to moderate erosion; exposed sites (ridges, etc.)
Water and Watershed Conservation	**WSh:** catchment areas of watercourses on steep slopes and on poorly drained areas; other sites serving as water retention areas or water sources **WRR:** areas within 30m along all perennial streams, water logged area and swamps
Nature Conservation	**WNP:** Alpine areas, Red Panda and Musk Deer territory, ecosystem of high conservation value. **NWC**: Areas identified as biological corridors and all areas rich in wildlife, both in species and in number.
Social Function	**SocL:** area close to or accessible to settlement or village, the areas traditionally used with definite boundaries. **SocRS:** lhakhangs/gornpas, Chortens and other religious sites.
Road Buffer	**RB:** 180 m on either side of Primary National Highway 20 m on either side of Forest road and 30 m on Farm road and access

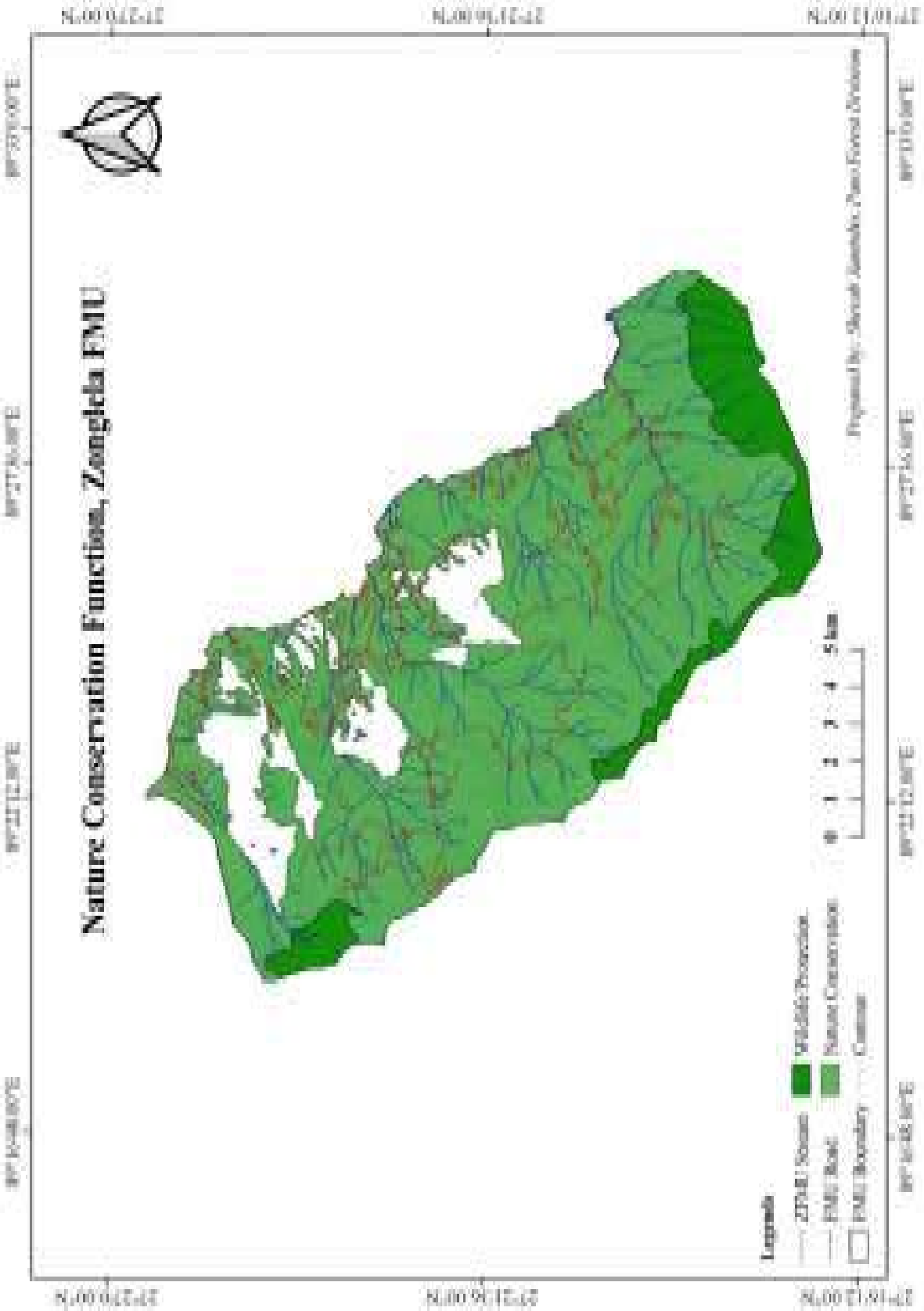


Figure 14: Map showing Nature Conservation Function

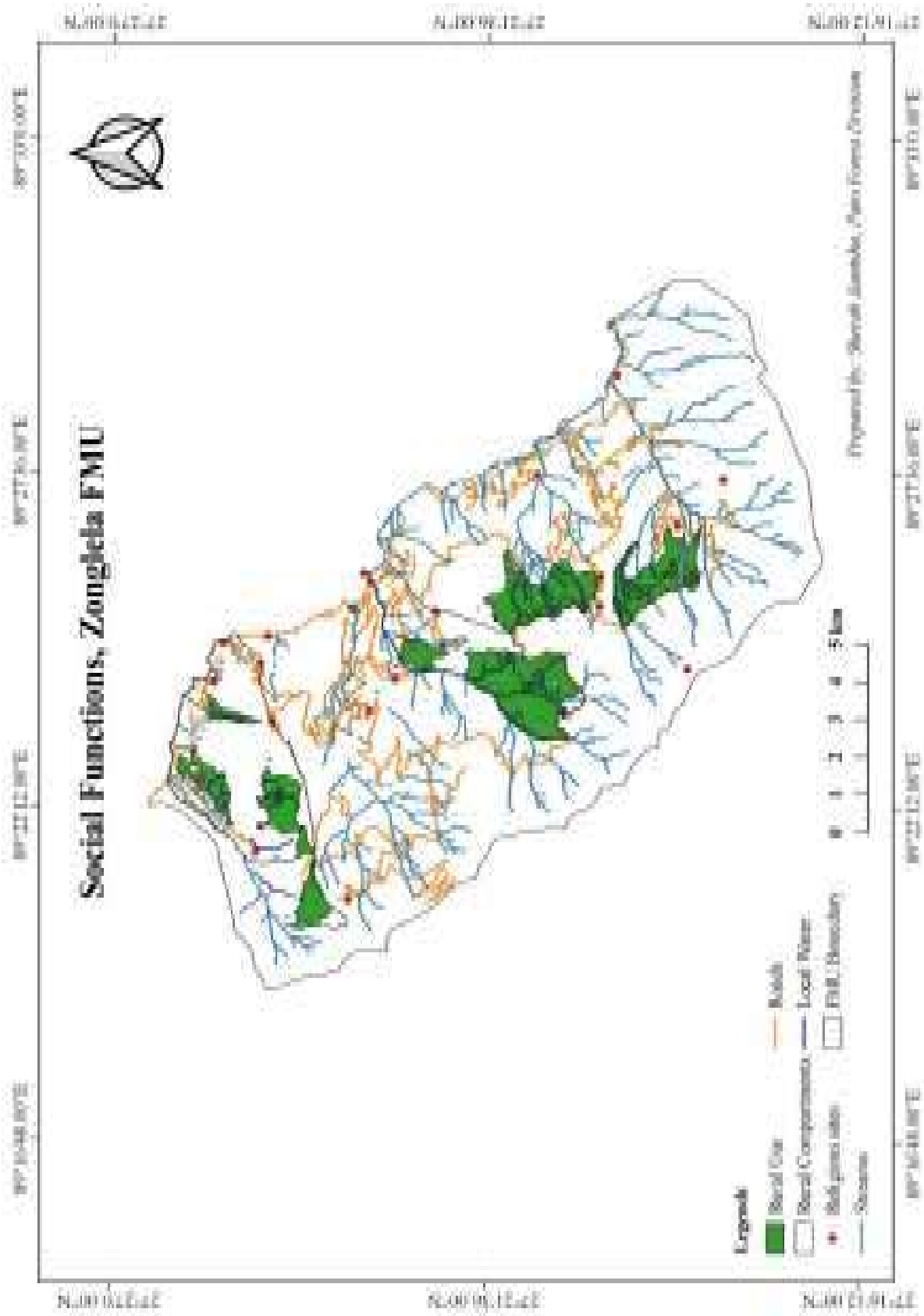


Figure 75: Map Showing social functions

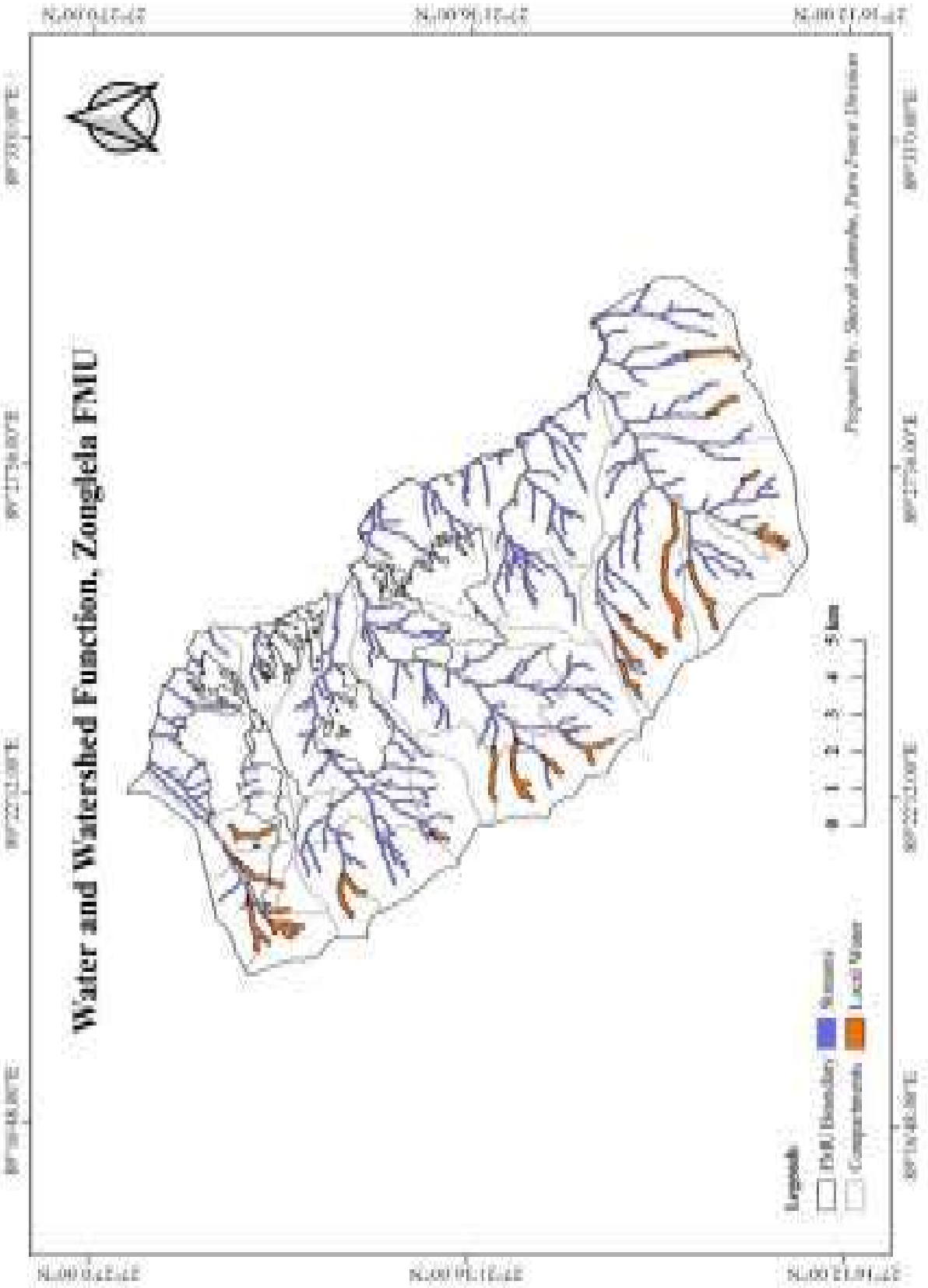


Figure 16: Map showing Water and Watershed Function

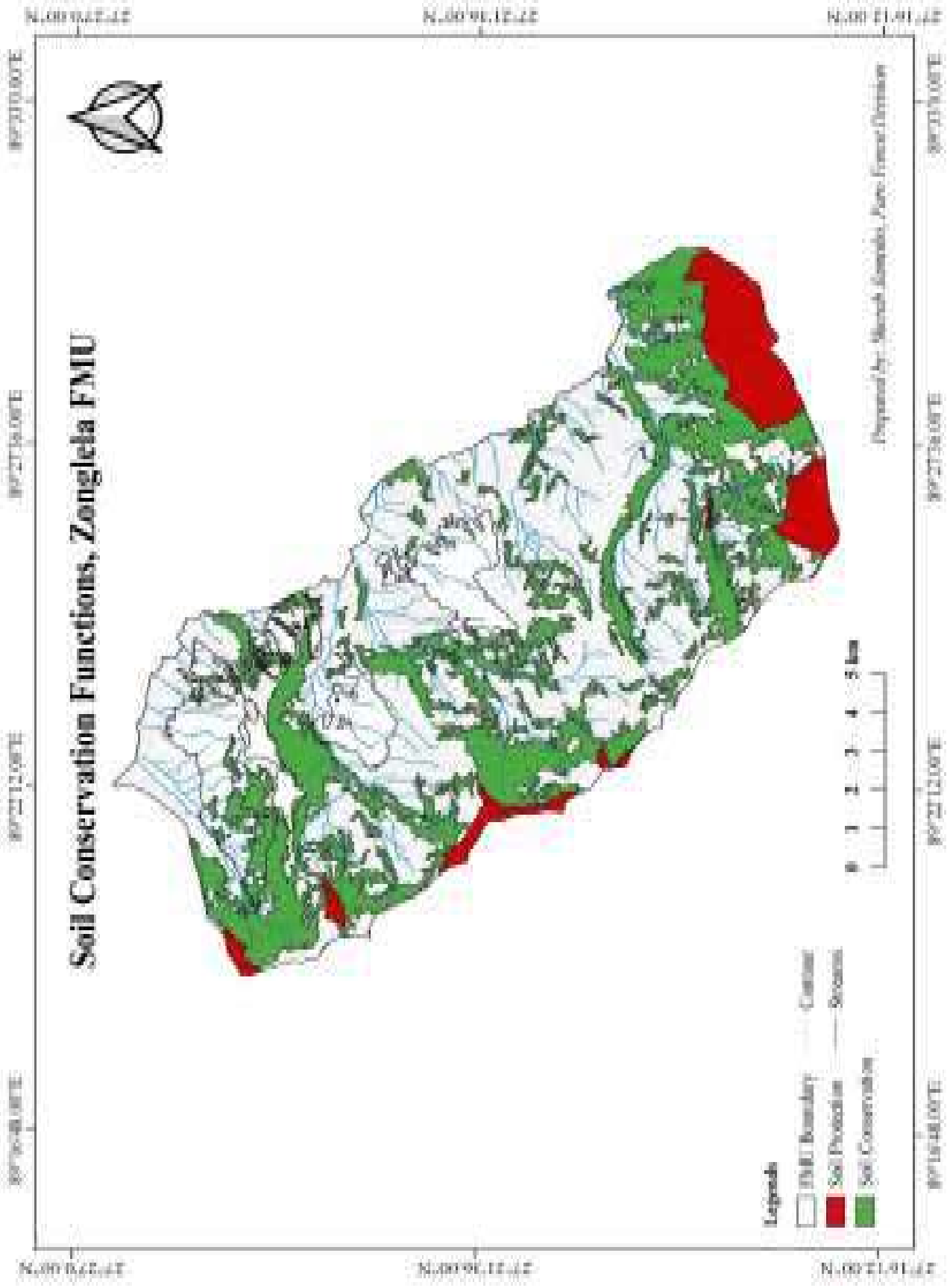


Figure17: Map showing Soil Conservation functions

11.4.4 Restriction of Forest Functions

The specific restrictions to be applied to forest in various categories are summarized in Table 14. These restrictions should be applied in conjunction with the objectives set for each Management Circle.

Table 5: Forest Function Restrictions

Code	Function	Restriction on Commercial Use	Restriction on Local use
SP	Soil Protection	No commercial use	No tree felling, minimize human interference
WRR	Riparian Reserve Protection	No commercial use	Only collection of NWFP; no *tsamdo*; no *sokshing*
RB	Road Buffer	No commercial use	No tree felling
WLS	Local Water Supply Protection	No commercial use	Low impact use only; no cattle grazing
SocRS	Religious Site Protection	No commercial use	Only use which do not disturb sanctity of place
SocL	Social (Local Use Only)	No commercial use	No restriction
SC	Soil Conservation	No clear cutting; no conversion into plantation; extension of rejuvenation periods	Low impact local use; no intensive cattle grazing
WSh	Watershed Conservation	No clear cutting; no conversion into plantation, minimize disturbance to understory vegetation	No intensive cattle grazing; low impact local use
SocLC	Social (Local cum Commercial Use)	Low impact commercial use	No restriction
RB	Road Buffer	No commercial use	No tree felling

12. QUANTITATIVE RESOURCE ASSESSMENT

12.1 Forest Management Inventory

The first scientific management plan for Paro-Zonglela FMU was implemented in 1st April, 1992-2002. Subsequently the plan was revised in February, 2002 till 31st March 2012 by Gavin Jordan, FRMD/WWMP, with technical assistance from the Commission of the European Communities. Numbers of changes were made in the second plan by Gavin Jordan. The AAC was reduced by more than half using net operable area considering micro-terrain features and production figures,

rather than a gross operable area as used in the first plan. Much of the easily accessible, commercially profitable old growth forest has been logged during the implementation of first two plans. The 3rd third management plan was written by FRMD from 1st January, 2012 to 31st December, 2021 was written by FRMD. The standard FMU inventory technique was used with data being collected for the trees >10 cm DBH (OB) from circular plot of 12.62 regeneration from 3.57 m radius. The data obtained from the forest management inventory was analyzed using statistical software called 'R'. A total of 554 plots were laid with plot distance of 500 m throughout FMU area. The inventory was designed with target sampling error of +/- 10 % and the coefficient level of 95%. The general objective of the inventory was to provide essential background information for revising the Zonglela Forest Management Plan. More specifically the objectives of the inventory were:

- To study the changes in growing stock
- To provide relatively accurate overview of the growing stock and regeneration potential of natural forest in the area, according to major forest types
- To give an overview of the general site characteristic of the natural forest, in terms of soil, non-green vegetation and the use by local population
- To provide an indication of timber quality in different forest type
- To furnish essential data on tree height to enable construction of local volume table for main species

12.2 Forest Management Inventory Results

The summary of the inventory results is shown in the table below

Table 6: Summary of Inventory Results for overall FMU area

Parameters	Results	SE %	Reliable Minimum Estimate (RME)
Total Inventory area (Ha)	13587.11	NA	NA
Number of Plots	554	NA	NA
Total number of trees	1742290	17.22	1442267
Number of trees per Hectares	156	17.22	129.13
Total Basal area	213911	10.17	192156.25
Basal Area(m^2) per Hectares	19.16	10.12	17.22
Total growing stock (m3)	2064740	12.07	1816971.2
Volume(m^3) per hectares	185.92	12.07	163.58

***SE= sampling error (95% confidence level)**

13. AREA ORGANIZATION

13.1 Spatial Organization

Zonglela FMU working circle is divided into four blocks and 34 compartments to facilitate field staff on identification of boundaries and make more reliable way of recording information for management purposes. The blocks and compartments have been demarcated according to prominent natural drainage, terrain/ridges, etc. Zonglela FMU has been divided into Five blocks: Ngobephu, Chelela, Zonglela, Nabesa and Pombesa blocks.

Table 7: Block, Compartments and Sub-compartment Information

FID_1	Block_Name	COMPART	SUBCOMPART	Area_ha
0	NGOBEPHU	V	a	**157.221**
1	NGOBEPHU	I	a	**1188.81**
2	NGOBEPHU	II	b	**253.598**
3	NGOBEPHU	III	b	**193.915**
4	NGOBEPHU	V	b	**206.549**
5	NGOBEPHU	I	b	**433.751**
6	CHELELA	VI	a	**523.14**
7	CHELELA	V	b	**136.535**
8	NGOBEPHU	III	c	**0.109**
9	NGOBEPHU	III	a	**109.368**
10	NGOBEPHU	IV	a	**273.338**
12	CHELELA	I	a	**775.955**
13	CHELELA	V	a	**173.424**
14	CHELELA	III	a	**484.701**
15	CHELELA	IV	a	**289.104**
16	ZONGLELA	VI	a	**679.609**
17	ZONGLELA	V	a	**229.189**
18	CHELELA	II	a	**350.01**
19	ZONGLELA	I	a	**726.34**
20	ZONGLELA	III	a	**271.984**
21	ZONGLELA	IV	a	**508.118**
23	POMBESA	I	a	**817.495**
24	POMBESA	IV	a	**465.517**
25	ZONGLELA	II	a	**584.829**
26	POMBESA	II	a	**962.73**
28	NABESA	V	a	**299.989**
29	NABESA	V	b	**174.868**

30	POMBESA	III	a	**410.891**
31	NABESA	I	a	**1533.436**
32	NABESA	II	a	**871.509**
33	NABESA	III	a	**482.424**
34	NABESA	IV	b	**122.389**
35	NABESA	IV	a	**1045.119**
36	NABESA	III	b	**66.264**

The area of Ngobepha compartments has been reduced significantly with the exclusion of Paro town and Druk air area.

13.2 Determining Operable Area

To make sure that the available resources within FMU area are utilized on sustainable way, the Zonglela FMU areas will be managed for multiple purpose. The multiple uses of forests are generally protective, climatic, productive, scientific, recreational, etc. but while managing a unit area of forests, all such purposes cannot be equally harmonized. One purpose has to take precedence over other. The area for commercial and rural forestry activities are those that are left after areas for other critical functions were identified and mapped out, using GIS and inventory information. The functions that take precedence over commercial and rural forestry activities are

- Soil protection areas (slope greater than 100 %)
- Soil conservation
- Riparian buffers and zones
- Religious site protection
- Private registered land
- Road buffers
- Barren areas

13.3 Organization into Management Circles and Working Circles

The function mapping was used to delineate three broad management circles for Zonglela FMU: Protection, Production and Non-Production Management Circles. Management Circles in Zonglela FMU has been divided into Protection, Production and Non-Production. Protection Management Circle includes soil protection, religious areas and streams and road buffers. Production Management Circle includes all potentials timber harvesting areas with exclusion of protection, Non production and Community Forest areas. The Management Circle for Zonglela FMU is categorized into Blue pine, Mixed conifer, Fir and Broadleaf areas. Non-Production area includes all private and cultivated land, non-forest areas mapped out using QGIS & Google map.

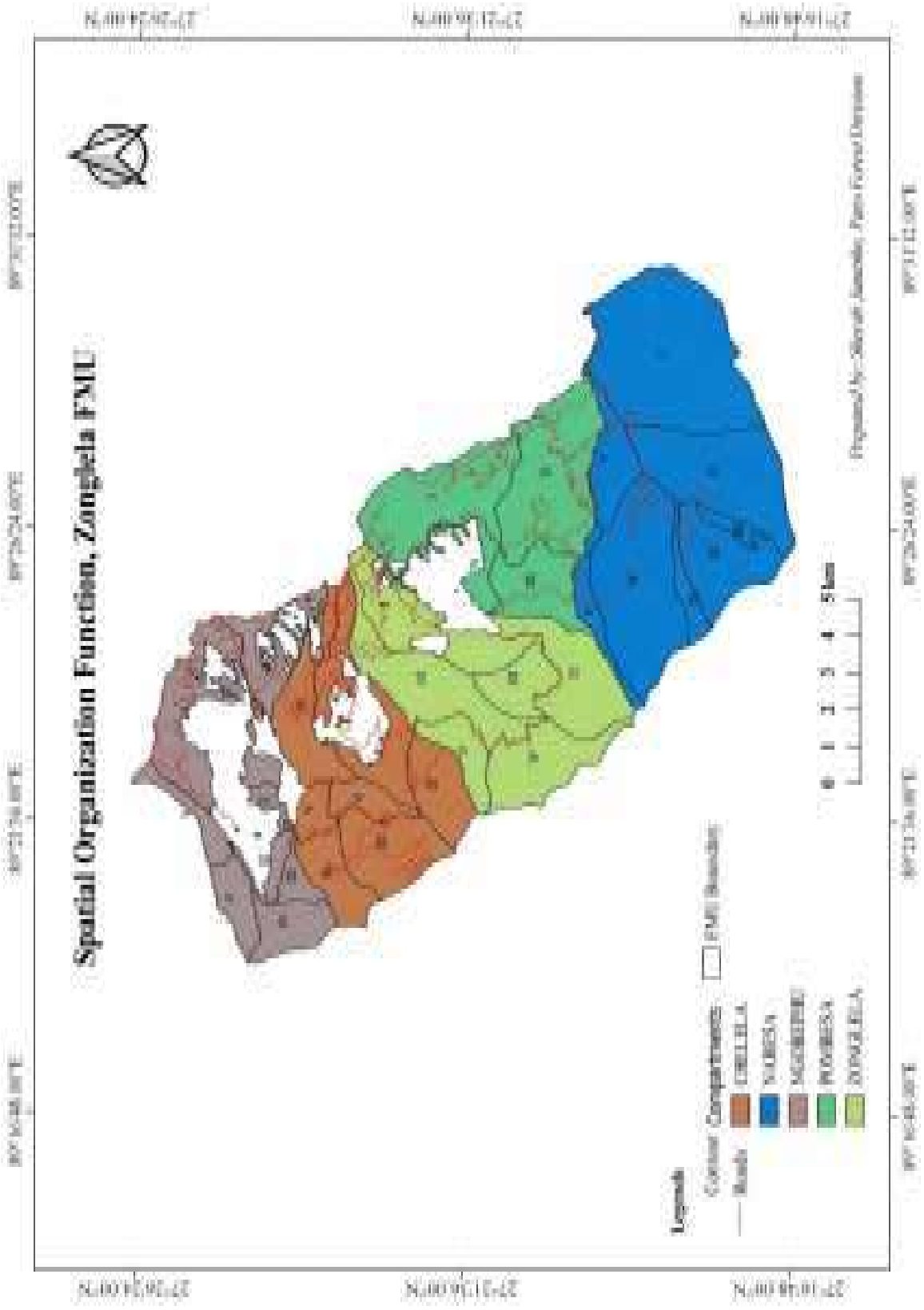


Figure 18: Map showing Spatial Organization Function

Table 198: Area Statement for Management Circles and Working Circles

Management and Working Circles	Area (Ha)
Protection Management Circles	
Soil protection	1148.79
Local Water Supply Protection	414.86
Streams	1288.02
Road buffer	1987.54
Religious sites	54.46
Wildlife protection	1608.28
Non-Production Management Circle	
Private/Cultivated Land	1547.08
Non-forested areas	326.42
Production Management Circle	
Mixed Conifer Working Circle	2927.13
Blue Pine Working Circle	3438.72
Fir Working Circle	87.88
Broadleaf Working Circle	20.35

13.4 Management Circles

13.4.1 Protection Management Circle

The Protection Management Circle is an area where commercial activities are restricted. The Protection Working Circle is the sum of soil protection, religious site, wildlife sites, road and streams and local water supply buffer areas. Total of 6501.95 ha has been identified under the protection management circle which is 41% of total FMU area. In the previous plan, the total area under protection circle was 5371.06 ha. The increase in protection areas for this plan period was resulted from the buffering of multiple road networks and local water sources which were constructed in the last ten-year plan period. Further, additional soil protection areas were added based on the ground truthing. The operation of commercial and other activities shall be considered in the following cases upon technical recommendations from DoFPS:

I. Epidemic out-break
II. On silviculture reasons

Note: *Here function overlaps. Like water protection overlaps with soil protection and major stream buffer which is known as Riparian reserve protection overlaps with local water supply protection*

The management objectives and options for this circle are briefly given below.

Table 9: Protection Management Circle

Management Objectives	Management Options	Responsibility
To conserve water catchment functions and watershed values of FMU	Minimal intervention	All parties
To protect and conserve biodiversity	Involve local people in protection and conservation Avoid disturbance Promote research	All parties Divisional office Divisional office
To meet local needs for NWFP on sustainable basis	Resource assessment Regulate harvesting on sustainable basis	Divisional office
To protect the forest from grazing, fire and illegal activities	Involve local people in participatory planning process	Divisional office
To respect the sanctity of religious places	Non-intervention	All parties

13.4.2 Non-production Management Circle

The Non-production Management circle includes areas where production is not economic or feasible. It generally comprises of non-forest areas, settlements and agricultural/private registered areas. The Non-production areas were mapped using Land use and Land cover (LULC,2016). The total area under non-production management circle is 1873.5 ha which is 57% less than the previous plan. The following points were some of contributing factor for area reduction: The areas which were under Non-production category in LULC 1995 were updated into Fir zone and shrub category in LULC 2016. The production areas were also mapped as Non-production areas and some of SRF land areas were also mapped as non-production in previous plan. After verifying all those nitty gritty errors, the area got reduced for this plan period.

Figure 89: Non-production areas under Zonglela FMU

As principle of equity and justice has been considered as one of the principles for formulation of national forest policy and managing forests responsibly and sustainably requires a balanced approach encompassing economic, social and environment, limited developmental activities may be allowed inside the non-production working circle with less significant impact on the FMU to support local livelihoods. The activity has to pass through the relevant environmental Acts and Rules, and other necessary applicable laws.

Table 21: Non-production Management Circle

Management Objectives	Management Options	Responsibility
To meet local needs for collection of NWFP	Apply management guidelines and involve community for monitoring	Divisional office
To maintain and improve the forest condition	Follow plan prescriptions Silviculture operation	NRDCL & Divisional office
To manage grazing for livestock	People's participation through workshops and sensitization Fodder tree plantation and local involvement	Divisional office /Geog administration Divisional office
Environmental conservation	Environmental concern is to be taken into consideration while activities are implemented	NRDCL/ territorial

Note: Lead agency is the first agency listed

13.4.3 Production Management Circle

The Production management circle are areas which are identified after excluding critical functions like protection and non-production areas from FMU area. The production management circles cover a total area of 6474.10 ha which is 40% of total FMU area.

However, with the assumption that while laying out cable lines in the FMUs, for harvesting timber, there always would be some patches of inoperable areas due to small rock crags running across the main slope or minor ridges that limits gravity system cable lines. The exact operable areas of the FMU would be affected to a great extent, due to the above-mentioned reasons. Therefore, for the Zonglela FMU, it is assumed that 35% of the gross operable area would be inoperable. With the net reduction of 35% from total gross operable area the total net operable area for Zonglela FMU is fixed at 4272.62 ha for this plan period. In the last plan, the total gross operable area was 7919.6 ha. However, with the net reduction of 30% for Mixed conifer and 30% each for Blue pine

and Fir, the net operable reduced to 5543.72 ha. The reason for decrease in production management circle in this plan period is mainly due to addition of protection and non-production areas. The Production management circle is divided into two working circles and management options and objectives are described for each in subsequent sections.

To define, assess, monitor and report progress on sustainable forest management, the sustainability of this working circle should be science-based that would provide measurable evidences. As the management circle also contain rich biodiversity because of stable and good stands, the production forests, therefore, need to be managed for more than just timber production, but also for objectives such as biodiversity conservation, environmental services, including carbon capture and storage. Management perspectives need to embrace the larger landscape, not be focused simply at the stand level. In this working circle. To retain management circle as a unit of sustainability for timber production, developmental activity should not be encouraged for individual vested interest or benefits. This is to sustain working circle for not only perpetual production of timber and conservation of biodiversity, but also for carbon capture and storage by avoiding reduction of production area and safeguard from unwanted disturbances, which may impact social and economic as well as environmental dimensions of forestry. This is also to include the important function of forests and trees outside forests to store carbon and thereby contribute towards the achievement of commitment on climate change. Forest and Nature Conservation Code of Best Management Practices of Bhutan, also recommend that FMUs to be retained as the principal unit for sustained yield.

Figure 20: Production areas under Zonglela FMU

THE FUTURE MANAGEMENT

CFO, Paro, should create an appropriate section with competent forestry officer under Division to look after all the matters related to FMUs and facilitate CFO in reviewing and ground truthing of any proposals of land lease and allotment or for any developmental activities within FMU. In case the proposal area for any developmental activities falls inside the production working circle and it is of national interest and benefits, CFO will apprise the Department for perusal for further action. Any activity within production management circle has to pass through the relevant environmental Acts and Rules, and other necessary applicable laws

Table 22: Production Management Circle

Management Objectives	Management Options	*Responsibility
To meet local need for timber and other forest produce on sustainable basis	Priority must be given to nearby local people and then to other Geogs	Divisional office/FMU UIC
Manage commercial timber production on sustainable basis	Scientific and systematic harvesting	NRDCL/ Division
Enhance and improve forest condition and productivity	Suitable silviculture operation, adapt research findings and re-forest harvested areas	NRDCL/ Division
Create employment	Preference to local people and involve them	NRDCL/ Division
Maintain biodiversity within production area	Document, research and field visit	Divisional office

Note: Lead agency is the first agency listed

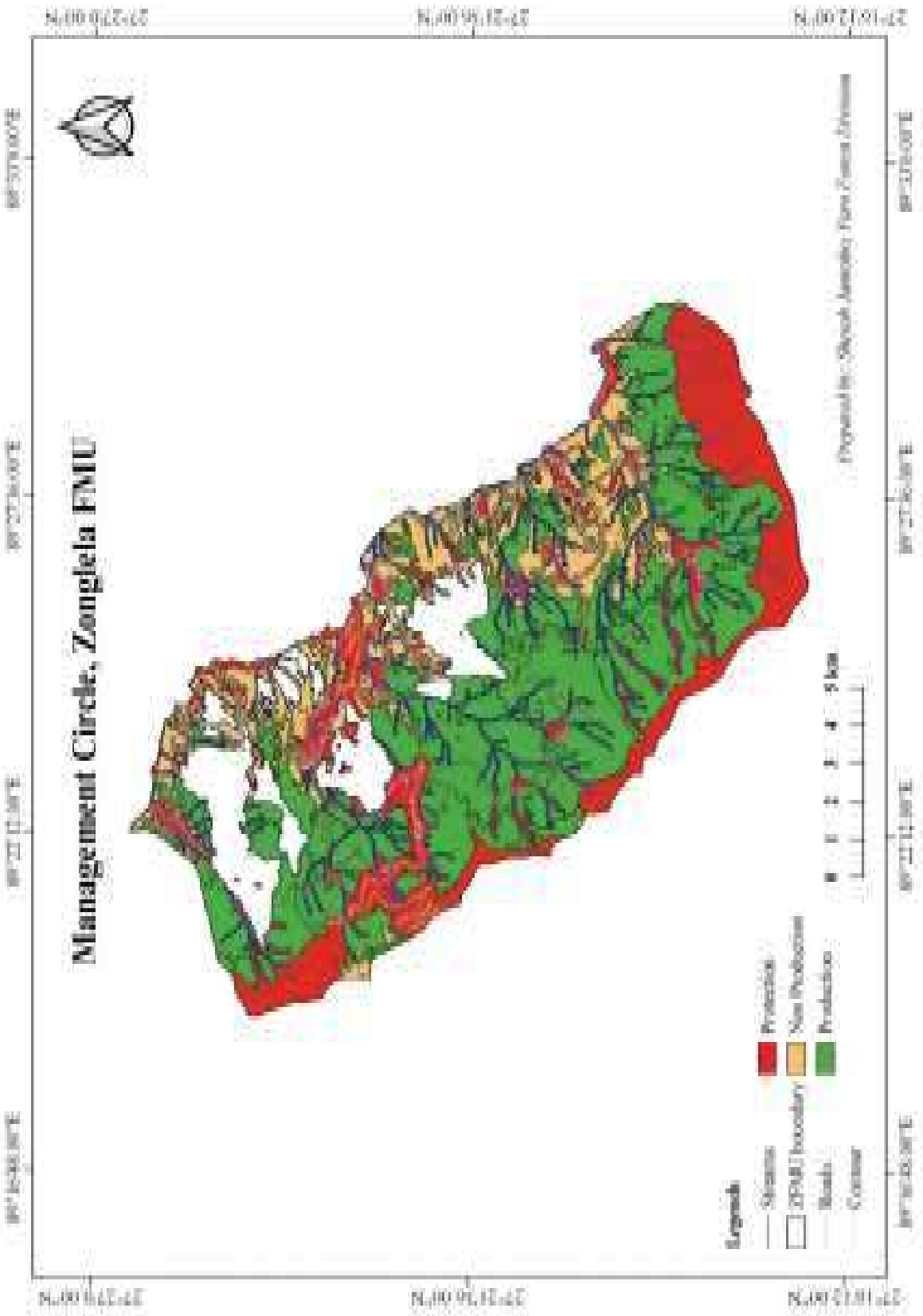


Figure 21: Map showing Management Circle

13.4.4 Non-Wood Forest Products Management Circle (Overlapping)

Non-Wood Forest Products (NWFPs) are important source of income for improvement of rural people's livelihoods. However, unregulated collection of NWFPs may not only surpass the production potential of NWFPs in the forest, but would also cause genetic erosion in the wild in near future. Certain NWFPs would be also serving as food materials for wild animals and unsustainable collection would reduce food materials in the wild and cause wild animals crossing into agriculture field in search of food, thereby causing human-wildlife conflict. NWFPs should be assessed with available guidelines for resource availability and accordingly prescribe for sustainable management. FRMD in collaboration with SFED should look into the possibility of developing methodology for calculating AAC for important NWFPs inside the FMU area. FMU in-charge should make use of available references developed by SFED for assessing NWFPs and then regulate supply during this plan period for sustainability. Removal of NWFPs from Zonglela FMU with intend of research and commercialization utilization by any individual or parties should, in this plan period, be guided by Biodiversity Act of Bhutan to conserve value of genetic materials/resources and ensure there is access and benefit sharing to resource provider.

The Management Circle shall overlap with all other Management Circles, including Protection, Non-Production and Production Management Circles, which constitutes the entire FMU area. The overall objective of this management circle is to manage the NWFPs in Zonglela on sustainable basis, and monitor the impact of collection.

13.5 Management of Production Working Circle

The working circles have been created on the consideration of stands requiring similar silvicultural treatment. For this plan period, the production management circle has been divided into four regular working circles and the working modality of each working circles differs. The three working circles are:

I. Fir Working Circle
II. Mixed Conifer Working Circle
III. Blue pine Working Circle
IV. Broadleaf Working Circle

The objectives, management options, responsibilities, monitoring and evaluation and silvicultural systems specific to each working circle is given in the following table

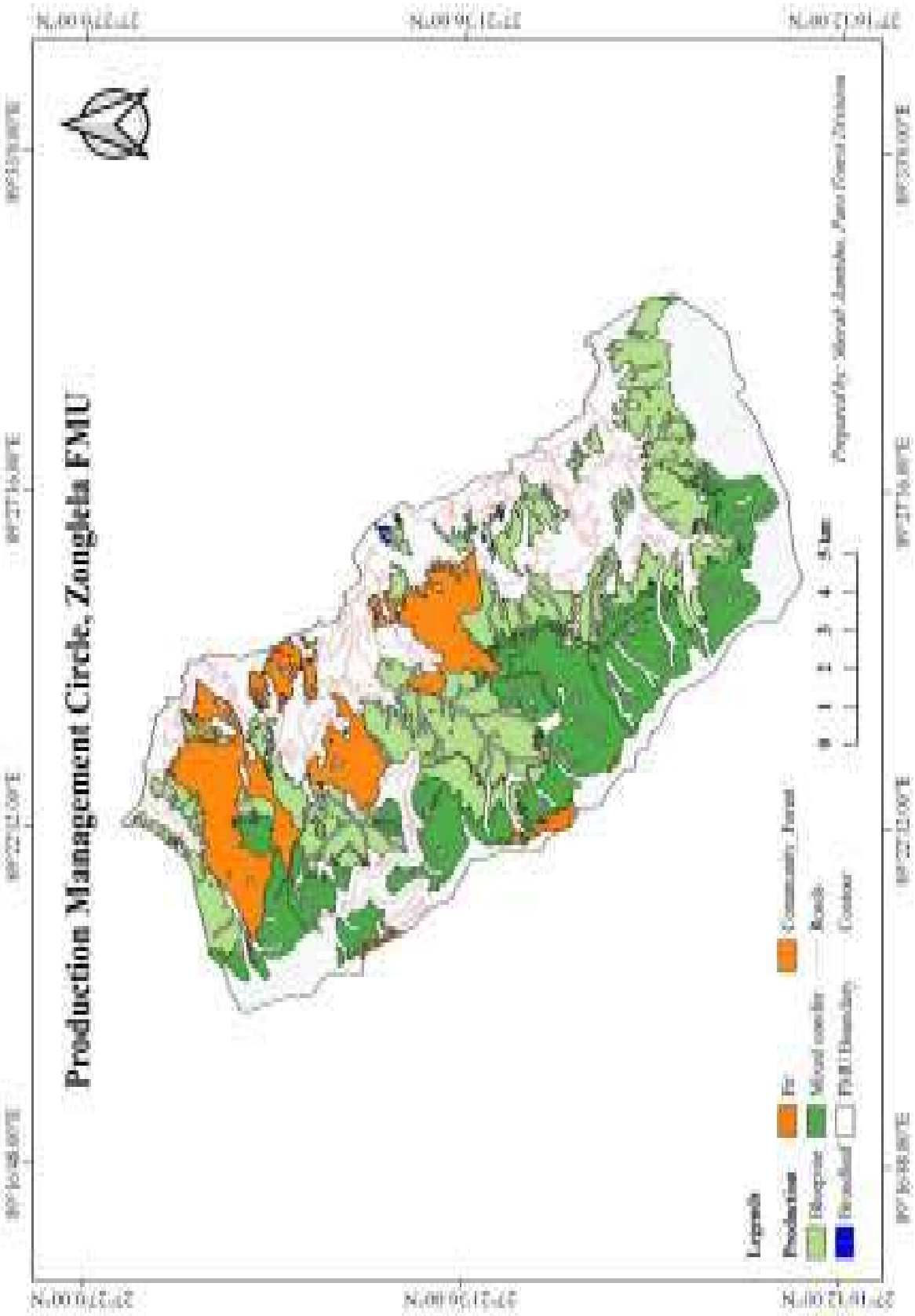


Figure 9: Production Management Circle

Table 23: Mix-conifer Working Circle

WORKING CIRCLE: MIXED CONIFER		**Area: 2927.13 Ha**		
Management Objectives	**Management Options**	***Responsibility**	****Monitoring**	**Silvicultural systems**
To meet local requirement as a priority, for timber, fuel wood and other forest products on a sustainable basis	Allow closely monitored and controlled marking of trees	Division office	Division	Single Tree Selection System Applied for Local Use Only for rural tree marking
To manage the commercial timber production on sustainable basis	Use appropriate logging and Silviculture method Ensure cable-line lay out allows inter line logging Operate entire cable line Encourage cleaning of entire cable lines If natural regeneration fails, area should be reforested	Division/ NRDCL Division/ NRDCL Division/ NRDCL NRDCL	Division Division Division Division	Cable lines will be laid to their full capacity. Cable corridors will be no more than 4m wide. Group opening will not exceed 0. 15ha.The distance between the cable lines will not less than 60m and between groups along cable line will not less than 50m.
To enhance and improve forest condition and productivity	Ensure that all barren and past harvested areas are restock with suitable native species Use appropriate logging and silvicultural method Monitor on the attack of pest and disease	NRDCL/ Division NRDCL/ Division Division	Division Division Division	All merchantable trees >10cm DBH will be felled. Dead, dying, malformed and diseased tree will be felled by priority.

	Involve local communities Use FULL CABLE LINE LENGTH in Beetle attacked areas Create favorable conditions for regeneration and growth	NRDCL/ Division NRDCL/Division NRDCL	NRDCL Division Division	Opening can be irregular shapes and should be based on terrain features and stand condition. Damage to residual tree must be minimized
To protect the forest from overgrazing, fire and other illegal activities	Control over grazing, fire and other illegal activities through participation and dialogue and acceptable fencing	Division	Division	
To create local employment	Encourage contractors to hire worker locally Provide proper training prior	NRDCL/ Division NRDCL	NRDCL NRDCL	
To maintain biodiversity within the production area	Low impact Silviculture system	Division/ NRDCL	Division	
To conserve the water catchment functions	Minimal intervention Abide by stream buffer regulation	Division/NRDCL NRDCL/Division	Division Division	
To continually improve health and safety standards	Provide training to contractors Promote awareness in the local community	NRDCL Division	Division Division	

All objectives will be evaluated annually by the FMU Level Management Committee.
Lead agency for responsibility is the agency listed first.
All objectives and activities will be evaluated during the mid-term and final review.

Table 24: Fir Working Circle

WORKING CIRCLE: Fir	**Area: 87.88 Ha**			
Management Objectives	**Management Options**	***Responsibility**	****Monitoring**	**Silvicultural systems**
To meet local requirement as a priority, for timber, fuel wood and other forest products on a sustainable basis	Allow closely monitored and controlled marking of trees	Division office	Division	Single Tree Selection System Applied for Local Use Only for rural tree marking
To manage the commercial timber production on sustainable basis	Use appropriate logging and Silviculture method Ensure cable-line lay out allows inter line logging Operate entire cable line Encourage cleaning of entire cable lines If natural regeneration fails, area should be reforested	Division/ NRDCL Division/ NRDCL Division/ NRDCL NRDCL	Division Division Division Division	Cable lines will be laid to their full capacity. Cable corridors will be no more than 4m wide. Group opening will not exceed 0. 1ha.The distance between the cable lines will not less than 60m and between groups along cable line will not less than 50m.
To enhance and improve forest condition and productivity	Ensure that all barren and past harvested areas are restock with suitable native species Use appropriate logging and silvicultural method Monitor on the attack of pest and disease Involve local communities	NRDCL/ Division NRDCL/ Division Division NRDCL/ Division	Division Division Division NRDCL	All merchantable trees >10cm DBH will be felled. Dead, dying, malformed and diseased tree will be felled by priority. Opening can be irregular shapes and should be based on terrain features and stand condition.

	Use FULL CABLE LINE LENGTH in Beetle attacked areas Create favorable conditions for regeneration and growth	NRDCL/Division NRDCL	Division Division	Damage to residual tree must be minimized
To protect the forest from overgrazing, fire and other illegal activities	Control over grazing, fire and other illegal activities through participation and dialogue and acceptable fencing	Division	Division	
To create local employment	Encourage contractors to hire worker locally Provide proper training prior	NRDCL/ Division NRDCL	NRDCL NRDCL	
To maintain biodiversity within the production area	Low impact Silviculture system	Division/ NRDCL	Division	
To conserve the water catchment functions	Minimal intervention Abide by stream buffer regulation	Division/NRDCL NRDCL/Division	Division Division	
To continually improve health and safety standards	Provide training to contractors Promote awareness in the local community	NRDCL Division	Division Division	

All objectives will be evaluated annually by the FMU Level Management Committee.
Lead agency for responsibility is the agency listed first.
All objectives and activities will be evaluated during the mid-term and final review.

Table 25: Blue Pine Working Circle

WORKING CIRCLE: Blue pine		**Area: 3438.72 Ha**		
Management Objectives	**Management Options**	***Responsibility**	****Monitoring**	**Silvicultural systems**
To meet local requirement as a priority, for timber, fuel wood and other forest products on a sustainable basis	Controlled marking of trees Systematic thinning	Division Division	Division Division	Thinning/single tree selection The young Blue pine stands will be worked under thinning/selection in rural blocks. Marking trees will depend on the number of stems per hector, age or size class and spatial distribution. Dead, dying, malformed and diseased trees will be thinned on priority basis
To manage the commercial timber production on sustainable basis	Encourage use of small diameter wood Promote commercial harvesting	NRDCL NRDCL/Division	NRDCL Division	**Seed Tree System** For cable harvesting, felling areas of 1000m x 30m can be logged, leaving 20-25 trees/ha as a seed source.
To enhance and improve forest condition and productivity	Mark trees for rural use as planned thinning exercise NRDCL to commercially thin stand Use appropriate logging and silvicultural methods Restock logged or barren areas	Division NRDCL/Division Division/NRDCL NRDCL NRDCL/Division	Division Division Division Division	Harvesting line must not run directly downhill. Lines must be 90m apart to allow 2 interlines operation. On exposed or sensitive sites harvesting must leave 40-50 trees/ha & all understory vegetation.

	Create favorable condition for regeneration and growth Involve local communities for planting and restocking activities Use stand tending techniques, such as bush clearing and spacing Harvest all areas regardless of financial return	NRDCL/Division NRDCL NRDCL/Division	Regeneration survey Division Division Division	Seed tree must of good form, not over matured & representative of existing stand. In mixed stand equal distribution of seed tree must be left
To protect the forest from overgrazing, fire and other illegal activities	Control over grazing, fire and other illegal activities through participation and dialogue and acceptable fencing	Division	Division	
To create local employment	Encourage contractors to hire worker locally Provide proper training prior	NRDCL/ Division NRDCL	NRDCL NRDCL	
To maintain biodiversity within the production area	Low impact Silviculture system	Division/ NRDCL	Division	
To conserve the water catchment functions	Minimal intervention Abide by stream buffer regulation	Division/NRDCL NRDCL/Division	Division Division	
To continually improve health and safety standards	Provide training to contractors Promote awareness in the local community	NRDCL Division	Division Division	

All objectives will be evaluated annually by the FMU Level Management Committee.
Lead agency for responsibility is the agency listed first.
All objectives and activities will be evaluated during the mid-term and final review

Table 10: Broadleaf Working Circle

WORKING CIRCLE: BROADLEAF		**Area: 20.35 Ha**		
Management Objectives	**Management Options**	***Responsibility**	****Monitoring**	**Silvicultural systems**
To meet local requirement as a priority, for timber, fuel wood and other forest products on a sustainable basis	Allow closely monitored and controlled marking of trees Promote use of discarded timber	Division Division	Division Division	**Single Trees Selection: For Rural Tree Marking** There is only small chunk of Broad leaf species distributed inside the local use area and contributes only minimum percentage to the overall local AAC. Moreover, as per recent trend of commercializing blue pine trees from private registered land, most of blue pine stands seems to be inside local use area. There is less demand on broadleaf species for timber by local people and merging broad leaf with conifer stratum would not only compromise sustainability of blue pine and other conifer species inside Government Reserved Forest Land of FMU, but would also surpass from the actual availability of blue pine and
To enhance and improve forest condition and productivity	Use stand tending techniques Work with local communities for planting/restocking activities Harvest dead, dying, dried and diseased trees to ensure creation of space for natural regeneration, by creating favorable conditions for regeneration and growth	Division Division Division	Division Division Division	
To protect the forest from overgrazing, fire and other illegal activities	Control over grazing, fire and other illegal activities through participation and dialogue and acceptable fencing	Division	Division	
To maintain biodiversity within the production area	Low impact Silviculture system	Division/ NRDCL	Division	
To conserve the water catchment functions	Minimal intervention Abide by stream buffer regulation	Division/NRDCL NRDCL/Division	Division Division	

				other conifer timber in the plan period.
To continually improve health and safety standards	Provide training to contractors Promote awareness in the local community	NRDCL Division	Division Division	

Note: All objectives will be evaluated annually by the FMU Level Management Committee during the Mid-term and final Evaluation

13.6 Implementing Management Working Circle

To implement the principle of sustainable forest management and to make resources available and affordable to general public, the concept of Forest Function Mapping has been used in this Plan to delineate between forest and different land use inside Zonglela FMU. This will be supplemented further through annual operational planning process whereby information will be collected in detailed through inventory and discussions with stakeholders, local communities and NRDCL. The concerned UICs must take extra cautious to locate individual forest function on the ground so that the prescription and the objectives can be implemented. Everywhere possible the function maps have been prepared indicating the boundaries of the Forest Functions to facilitate FMU while overseeing implementation of management plan.

Therefore, the Unit In-charge have to use shape files of FMU using GIS and Google Earth besides attached maps to the best of his/her ability. Areas should be observed using various means prior to going to the field. Once in the field visual observation within the operable areas should be able to provide the needed information. For example, stream buffer will occur in all the perennial streams and steep slopes should be measured and observed for soil protection or conservation. The forest function maps have to update accordingly as per the field observations if there are any deviation in the field.

14. YIELD REGULATION AND HARVESTING

14.1 Determining of Annual Allowable Cut (AAC)

14.1.1 Introduction

Principle of sustainability is widely accepted as one of back-bone of forest management in which management mainly focus on sustainable utilization of forest resources in perpetual. The concept has evolved from the basic consideration that the later generation may derive forest resource benefits same as present generation. The principle of sustained yield ensures the stability and continuous supply of raw materials to the industries, and meets the social and domestic needs of the people.

Sustained Yield management allows harvesting of forest resources in a way by which annual cut and other losses of timber do not exceed the average annual growth and assures continuity of harvest, indefinitely, without impairment of the productivity of the soil. Sustain Yield Calculation is expressed as Annual Allowable Cut (AAC).

14.1.1 Increment Based AAC

In a perfectly structured normal forest, it should be possible to sustainably cut annual increment each year. Unfortunately, this method relies heavily on the growth data for which in Bhutan we do not have permanent sample plots to ascertain the data. Further, currently forest growth in Bhutan is not perfectly structured and there is so much varied in natural growing stock. Example at present in Fir zone the increment trend is in negative this is mainly due to over exceeded rate of decay over growth. In long term, increment should increase as over mature stands are replaced by younger stocks, but it will be many decades before this second growth is available for harvest. In the meantime, there is an over-mature growing stock and too little and unreliable increment data to use in determining AAC, therefore increment based AAC's is not suitable for Bhutan.

14.1.2 Area based AAC

Area based AAC requires less inventory data but this can be implemented in an even distribution of volume over the forest, which is not the case in the natural forests of Bhutan. An area based AAC would indicate difficulties for NRDCL in practical planning and operational viability as actual volume brought to market would vary dramatically year to year.

14.1.3 The Most Appropriate AAC Method

A wide range of formulae and calculation approaches are available with both advantages and disadvantages which can be argued. Whilst it is difficult to define a clear best method for country, there is a strong believe for standardization around a fairly simple and robust single methodology. The method which is used for the calculation of AAC in Zonglela FMU is based on combination of area, volume and rotational age of species.

The method has been applied to calculate AAC in all Working Circle added together to calculate total AAC of the FMU. The AAC is calculated for different working circle since there is different rotation age used for different working circle, it is necessary to calculate AAC for each working circle first and add up to obtain total AAC of FMU. However, it should be noted that AAC for each working circle should not be the basis for annual harvest in the field due to the fact that one cable line may cross more than one working circle if it is laid to the maximum length. This will also enable the implementer to lay the cable lines to the maximum length and make the best use of available production area

The following method is used for calculating the AAC:

$$\textbf{AAC per Working Circle} = \frac{\textbf{Net Operable Area}}{\textbf{Rotation}} * \textbf{Average Standing Volume per Ha}$$

14.1.4 The Calculation of AAC for Zonglela FMU

Net Operable Area

The total operable area was identified using QGIS 3.0.0 with GRASS 7.4.0. All areas having a slope > 45º has been classified as Soil Protection, which accounts about 1148.79 ha. In addition, prescribed buffer areas for rivers and streams, forest road and religious sites have also been included within the Protection Management Circle. Further those production forest areas which are not likely to be harvested for timber production owning to its remoteness and located on top of the ridges have also been excluded from Gross Operable Area. In previous plan, 30% of gross area was reduced from gross operable areas to produce final commercial net operable area for commercial production. However, in this plan period 35% of gross area was reduced to calculate net operable areas for commercial and 30% for rural use. This is because it has been observed that in most of the FMUs, the total operable area cannot be always subjected to harvesting and major

chunk of production areas has been harvested long time before the operation FMU. Further within the mapped area we assumed that there will be small rocky terrain, water bodies and other conservation areas which often prevent harvesting operations. This occurs mainly when the cable lines are being laid out. Beside this, Group Selection System almost inevitably leads to some patches of mature timber being left in later phases due to the presence of new regeneration and the damage that total removal of that over-story would cause, thus, losing more areas for harvesting. In such challenging terrains of Bhutan, exact geometric-shape group layout is rarely possible. Due to the above inevitable fact, around 35% of area for commercial use was reduced to calculate net operable area and 30% for Rural use. This prescription mandates the Unit In-charge and NRDCL to properly utilize the available production areas so that the area can be sustained for future harvesting operations. Any deviations from the prescribed cable line layout should be approved by the Department prior to implementation

Table 27: Calculation of Net Production Area

Forest Types	Gross Operable Area (Ha)	Calculation	Net Production Area (ha)
Commercial			
Mixed conifer	2507.73	In order to calculate the net production area, 35% from commercial gross operable area was reduced	1630.02
Blue pine	2570.59		1670.70
Fir	87.88		57.12
Broadleaf	18.64		12.11
Total	**5184.84**		**3369.95**
Rural use			
Mixed conifer	419.4	In order to calculate the net production area, 30% from Rural use gross operable area was reduced	293.58
Blue pine	868.13		607.69
Broadleaf	1.7		1.19
Total	**1289.23**		**902.46**

Grand total	**6474.07**		**4272.41**

*** Therefore, the Net operable Area for Zonglela FMU for this plan period is at 4272.41 ha.*

Rotation and Regeneration Period

Species rotation is an imprecise concept in silvicultural system other than clear cutting and replanting. Since reliable increment data is still very limited for Bhutan, assumed rotation lengths need to be cautious. For Group Selection System, the objective is to have more or less even aged regeneration in areas. The assumed rotation length for mixed conifer like Hemlock and Spruce is 140 years and for fir is 160 years. The assumed rotation length for Blue pine which grows at relatively lower altitude is 110 years. Consideration of regeneration period while calculating rotation lengths is a crucial factor. Therefore, while calculating AAC for Zonglela FMU a 20 years of regeneration period has been added to the rotation age for Mixed conifer and Fir, while for Blue pine, 10 years of regeneration period has been added. The rotation period for Broadleaf forest is 100 years and 10 years of regeneration had been added. The assumed rotation period for the calculation of AAC in Zonglela FMU is tabulated below:

Table 28: Rotation period for different tree species

Forest Types	***Assumed Rotation period (Years)***	***Regeneration period (Years)***	***Total Rotation period (Years)***
Mix conifer working circle	140	20	160
Blue pine working circle	110	10	120
Fir working circle	160	20	180
Broadleaf working circle	100	10	110

Average Standing Volume

The mature average standing volume is derived from management forest inventory data statistically analyzed using "R". The sampling error and RME for each stratum is given below. The forest management inventory of Zonglela FMU is designed based on the entire forest type and not based on individual stratum. Therefore, the average standing volume obtained from the

analyzed data is kept same irrespective of stratum. Hence, the average standing volume for all the strata for Zonglela FMU is 185.02m^3/ha with a standard error of 12%. The Reliable Minimum Estimate of standing volume obtained is 162.81 m^3/ha for all stratum at confidence level of 95%.

Table 119: Average result of the forest management inventory

Result types	Average measures	Sampling Error %	Reliable Minimum Estimate (m^3/ha)
Tree volume	185.02	12	162.81
Tree counts	156.13	17.22	129.24
Tree basal Area	19.16	10.12	17.22

AAC for each Working Circle

The AAC for each working circle is calculated on basis of whole production area and the assumed rotation period of each working circle. The AAC for each working circle is given in the following table (Table 28). The AAC for each stratum has been calculated due to different rotation period for each stratum, However, while implementing practically in the field, it is essential to consider that one cable line may pass through more than one stratum and therefore, total AAC (sum total of AAC for each stratum) should be considered instead of relying on individual stratum.

Table 30: AAC for the Working Circles (Standing volume)

Strata	Net Operable Area (ha)	Rotation	RME of mature standing volume (m^3/ha)	AAC (m^3/year)	Clear cut Equivalent (ha)
A. Commercial Use					
Mixed conifer	1630.02	160	162.81	1658.65	10
Blue pine	1670.88	120	162.81	2266.97	14
Fir	57.122	180	162.81	51.66	1
Broadleaf	12.11	110	162.81	16.43	1
Total	**3370.132**			**3993.71**	**26**
B. Local Use					
Mix conifer	293.58	160	162.81	298.73	
Blue pine	607.69	120	162.81	824.48	

Fir	1.19	180	162.81	1.61	
Total	**902.46**			**1124.82**	
Grand Total	**4272.59**			**5118.53**	

Therefore, the total workable AAC for Zonglela FMU is fixed at **5118.53 m^3** in standing volume. It is permissible to vary the AAC area by + - of 10% in individual years, but the volume cut in each five-year period must be no more than five times the AAC. The AAC prescribed is not solely to be met from the cable lines but also volume obtained from ad-hoc logging, sanitation operations, illegal sized/felled timbers and thinning should be incorporated and accounted to annual AAC.

There has been substantial decrease in AAC allocation for last three consecutive plan periods. During first plan period (1992-2000) AAC allocated was 25,000m^3 and for rural use AAC allotted was 4485 m^3. In 2nd plan revision, total AAC was fix at 11,900m^3 with commercial AAC of 7000m^3 and rural AAC of 4000m^3. The total AAC for 3rd plan (2012 – 2021) was 9366 m^3 with commercial AAC of 6366 m^3 and rural AAC of 3000 m^3. Later in the year 2015-2016 the AAC was reduce to 9021 m^3 since large portion of FMU area was taken by Royal Academy Project, Pombesa.

The total AAC for this plan period is fix at **5118.53 *m^3*** which is less than 4000 m^3 than the previous plan. Therefore, the commercial AAC for this plan period is fixed at **3993.71 *m^3*** and ***1124.82m^3*** for ***Rural use.***

14.2 Recording and Accounting for AAC

Annual Allowable Cut will be monitored through records of tree marked (Tree Marking Register) for both commercial and local use in all the Working Circles. AAC has been calculated as gross volume and this is the measure that should be added on annual basis from Tree Marking Register. AAC for FMU has been calculated on the basis of the whole production area and the expected rotation period. Thus, all material removed from of Production Working Circle, including the volumes that is extracted from group and cable corridor, must be accounted in the AAC. This includes timber cut for rural use, timber from normal cable lines, sanitation of pests and disease infested trees, fire burnt areas, ad hoc removal, wind-thrown& uprooted trees, fire burnt areas, illegally harvested timbers, road construction, etc. It is also crucial that all material felled but not removed is included in the 'actual cut'.

The preference for allocation of Rural timber will be first given to local residents and followed by near-by local villages and then to other Geogs and Dzongkhag. The Unit In-charge must maintain separate registers for recording rural timber allocation to local residents and for applicants from

other Geogs and Dzongkhag. This will help future planner Unit In-Charge in getting accurate picture of demand of the local residents and others separately which ultimately will planners during next plan revision.

14.3 Allocation of AAC

The allocation of AAC has taken into account the needs of both rural people (living within and near Zonglela FMU) and commercial demands. The AAC for rural use has been allotted based on demand and the Local Use Area.

Table 31: Allocation of AAC

Standing Vol (m^3)	Allotted to
1124.82(m^3)	Local Use: Local villagers and general public for rural house construction
3993.71 (m^3)	NRDCL: To meet the commercial timber demand in the market

14.3.1 Allocation of AAC for Rural use

The areas for rural timber allocation have been identified in Ngobephu, Chelela, Pombesa and Nabesa blocks. In the previous plan there was no as such rural blocks mentioned in the plan and rural allotment were found allotted below forest roads from Chelela timber depot to Ugyen guru Lhakhang. For this plan period a total of 8 compartments are identified for rural use. The allocated AAC for rural was 3000 m^3 in previous plan however, with no separated areas allotted blocks, it was observed that rural timber allotment was made from all blocks located below forest roads. Such allotment practices could be one factor that has contributed to shortfall of areas for commercial extraction before plan periods.

Therefore, to avoid such management lapses in future, for this plan period the UICs must marked trees equally in all eight rural blocks considering area and timber quantity. The allotment from eight blocks should not excess prescribed annual rural AAC.

The rural blocks are mostly adjoined with Community Forest areas and UICs and marking officers should make sure that strict boundary demarcation is maintained with reference to shapefiles. In case of Rural block (Ngobephu block, compartment 1(a) and II (b)) major portion of areas shares boundary with Ngobephu, Druk Tshenden and Nemjo community Forest area. Therefore, rural marking to be made from areas which are located outside the CF areas.

In case of Ngobephu block compartment III (a) rural area, there are few water source areas which need to be protected during the marking. Further, the rural timber allotment has been carried out in previous plan, so to make sure that timber from this particular area is not over harvest, the UICs must strictly follow single tree selection system marking in previously unmark areas.

Similarly, rural blocks of Zonglela block, compartment I(a) and Zonglela block, compartment IV(a) share boundary with Jari Phuensum, Druk ding and Jamling Community Forest. Therefore, UICs and concerned site In-charge should make sure that boundary is cross check prior to rural marking. The installation of K500/sky cable line is recommended to extract timber from accessible areas.

Timber allotment modality

Preference of allotment will be first given to the local community residing within and near FMU and then to the people of near-by gewogs of Paro. However, if there is balance AAC after meeting all the demand within and near-by FMU community, the Rural allotment to the people of Paro and Haa Dzongkhag will be make available.

14.4 Distribution of the cut

AAC has been calculated by Working Circles. However, during the implementation, it should be noted that the distribution of cut will be considered as the entire FMU and not as individual working circle. If the operation area for a particular area falls completely under one working circle, the sum total of AAC for that year will be removed from this working circle. Therefore, the AAC for each stratum is mentioned purely for calculation purposes and not to be read as individual cut for each working circle. The number of cable lines to be harvested annually should be mentioned in the Annual Operational Plan.

Further, calculation of AAC is based on **AREA** and **VOLUME**. To this, AAC should also be regulated either through volume or through clear-cut area equivalent for each year. In this plan period, the total permissible clear-cut area per year for FMU is ***26 ha***, meaning area cut through cable corridors, group openings, road construction, sanitation operation etc. should not surpass more than 26 ha per year. If AAC achieved through clear-cut area is equivalent to 26 ha and even if there are remaining cable lines, FMU should immediately stop harvesting timber from cable lines. Remaining cable lines should be earmarked for next operational year.

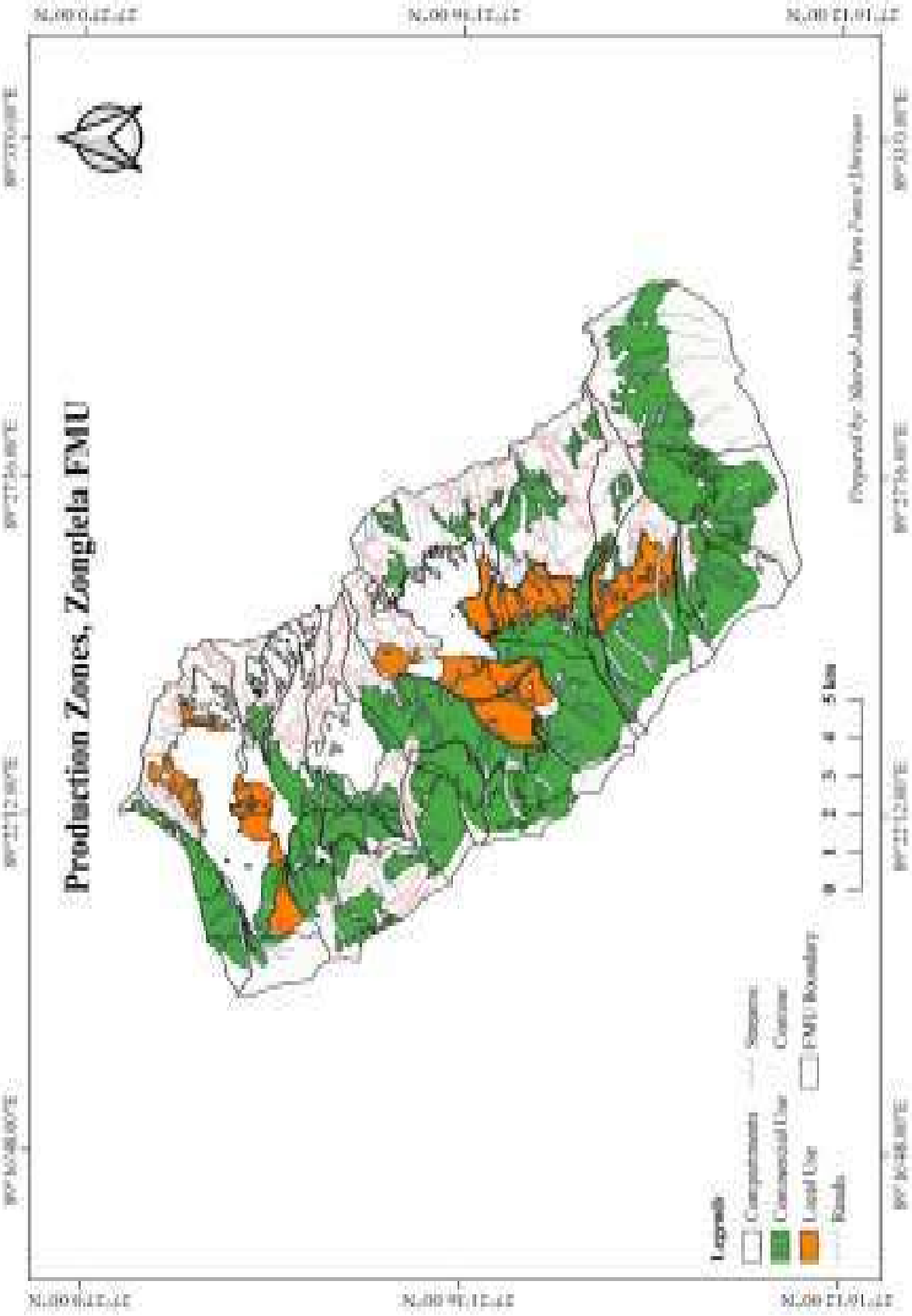


Figure23: Map showing Production Zone

15. SILVICULTURAL SYSTEM

15.1 Group Selection System

Group selection system is considered to be appropriate silviculture system for managing temperate conifer forest as per a study of silvicultural system conducted in mixed conifer forest (Thimphu and Bumthang). The system promotes natural regeneration and requires no treatment of the forest floor to induce natural regeneration (Moktan, 2003). This system suits a range of species, ranging from light demanders, through moderate shade bearers to shade enduring species (Mathews, 1999). The group size can vary according to the light requirements. The forest in Zonglela FMU is dominantly composed of mixed conifer (Blue Pine, Hemlock, Fir and Spruce) and small patches of broad-leaved forest towards the southern boundary. Considering vegetation types and the natural course of growth in natural forest, group selection system is the most appropriate silvicultural system for the area. Diebacks, bark beetle attacks, fire etc. are common occurrences, which create gaps in natural forest. The regeneration therefore, occurs in patches or groups and thus, justifies group selection system as it would imitate the natural pattern.

15.1.1 Working Pattern

Under group selection system small opening will be created in the stand allowing light to reach the forest floor and creating conducive micro climate for seed germination and establishment of seedlings. The opening will be no longer than one and half tree length in Hemlock, Spruce and Fir Stand. The groups will be open along cable lines. The distance between cable lines will be not less than 60 meters, and between groups along cable line not less than 50 meters. The corridors should not exceed four-meter widths. The effective area within the limit of standard cable length is 6 hectares (1000 m x 60 m), less the area of the corridor 0.40 hectares (1000 m x 4 m), thus the one-third removal would be equivalent to (1.87 ha) which is the area available for opening groups. Thus, it would be possible to open up about 9 to 10 groups along the standard cable lines, if the average tree height is taken about 35 m and further the diameter of any opening will not exceed 50 m.

The individual openings need not be uniform in shape or size and systematically located along cable lines. In most cases, the openings will be irregular in shape and systematic location of groups will be almost impossible. Aspect, slope and silvicultural requirement would influence the actual size of the groups. An average of 0.15 ha opening is recommended. However, group opening in

fir working circle will not exceed 0.1 ha if the understory conditions is with bamboo/large rhododendron understory and 0.25 ha is the understory conditions is herbaceous/moss understory, no major competitors.

Group openings should be created in already opened up/barren/blank areas and opening area of 0.15 ha for mixed conifer and 0.1 ha for fir if the understory conditions are with bamboo/large rhododendron understory and 0.25 ha if understory conditions is herbaceous/moss understory, no major competitors should be calculated for clear felled area in the operational plan.

Figure 24: Cable line corridor of past operated areas inside FMU

The tree should be felled towards center of group opening whenever possible to avoid damage to the unmarked trees. Terrain with steep slope and exposed South and South-West aspects should be avoided, or the opening should be smaller to match with the terrain and site conditions or the selection system should be applied.

In areas where opening cannot be created under group selection system (in between two cable lines) such areas should be operated under Single Tree Selection System. However, care should be taken that spatial distribution of the trees are strictly followed and should match with openings created under Group Selection System.

The Group Selection System has the following advantages:

- Regeneration in the small groups under even-aged condition gives better stem form;
- Larger openings in comparison to that under single tree selection system permit the establishment of intolerant species;

- Harvesting is more concentrated, so the logging cost is lower;
- Harvesting in group lower damages to residual stands;
- Intermediate cuts may be made less frequently;
- Aesthetically and environmentally more acceptable than clear cutting system.

15.1.2 Calculating Number of Cable Lines Annually

Mixed Conifer: Commercial use

Assuming, the standard cable line length to be 1,000 meters with 10 numbers of group opening of 0.15 ha each in mixed conifer working circle, the approximate number of cable lines that can be installed to achieve the annual allowable cut is worked out below:

Length of the cable line = 1,000 meters

Clear-felled area of cable line corridor = 4 m x 1,000 m = 4,000 m

=4,000/10,000ha = 0.4ha

Clear-felled area of groups = 10 x 0.15ha = 1.5ha

Total clear-felled area per line (in Mixed Conifer WC) = 0.4ha + 1.5ha = 1.9ha

AAC for commercial harvesting of Mixed conifer = 1658.65m^3/year

Volume = 162.81m^3/ha

Clear cut area equivalent = 1658.65/162.81 = 10 ha

Therefore, total cable lines that can be installed annually to achieve the AAC is

= (10 ha / 1.9 ha)

= 5cable lines/year

Fir: Commercial use

Length of the cable line = 1,000 meters

Clear-felled area of cable line corridor = 4 m x 1,000 m = 4,000 m

=4,000/10,000ha = 0.4ha

Clear-felled area of groups = 10 x 0.1ha = 1 ha

Total clear-felled area per line (in Mixed Conifer WC) = 0.4ha + 1ha = 1.4ha

AAC for commercial harvesting of Fir = 51.66m^3/year

Volume = 162.81m^3/ha

Clear cut area equivalent = 51.66/162.81 = 0.31 ha

Therefore, total cable lines that can be installed annually to achieve the AAC is

= (0.31 ha / 1.4 ha)

= 1cable lines/year

Note: Group opening for Blue pine and broadleaf is 0.15ha

Considering average cable length of 1000 m, about 14 cable lines can be tentatively harvested annually from the production area by NRDCL from FMU.

Table 32: Showing number of cable lines and clear-cut areas

Stratum	AAC	Volume	Clear cut area equivalent	Clear cut equivalent area of one cable line	Numbers of cable lines
Mix conifer	1630.02	162.82	12.08	1.9	10
Blue pine	1670.88	162.82	8.75	1.9	14
Fir	57.122	162.82	1.63	1.4	1
Broadleaf	12.11	162.82	1.07	1.9	1
				Total	**12**

Although, the above projection is done considering the length of the cable line to be 1,000 meters, the length of the cable line while practically planning in the field may vary based on the topography and site conditions. Therefore, this projection should only be used to initially plan the field work during operational plan preparation. The actual number of cable lines to be installed annually will be guided by the operational inventory and cable line survey carried out during preparation of operational plan.

Figure 25: Map showing Past Operated Cable lines

15.1.3 Prescribed Silvicultural System in Broadleaf Forests - Patch Cut with Artificial Regeneration

On 17th of January 2005, Silvicultural Systems Consultative Workshop was held at the DoFPS's Conference Hall. During the workshop, the participants agreed to prescribe Patch Cut System with artificial regeneration as the silvicultural system in broadleaf forests in Bhutan.

The following considerations should be made before the application of the silvicultural system.

1. **Factors of Locality**

Factors of locality include micro-climate, slope aspects, soil, humidity, rainfall, and geology of the locality which affect the growth of plant. The nutrient contain of soil is also very important for regeneration of the area. Biotic factors like grazing should be considered before clear felling.

2. **Potential Productivity of the Site**

Potential Productivity of site should be assessed and silvicultural technique should be suitably modified to ensure rapid growth of new plants in the clear-felled areas. In Bhutan there is a lack

of information on potential productivity of sites. It is also imperative that inputs are applied judiciously. In other countries, people have even irrigated as well as applied fertilizers to the site.

3. Species and composition

Clear felling system is suited to light demanding species. The composition of the species can be changed to ensure the best financial results. But there are trees that can't withstand wind throws. So, clear cutting is going to expose them, causing uprooting and other damages. Some species can't stand the frosts during winter. Clear cutting exposes them to such adverse condition. Choice for species and composition should be made taking into consideration these characteristics of different species.

4. Regeneration

The success of any system depends entirely on the success of the regeneration of the logged areas. Artificial regeneration is the only option if there is no natural regeneration. The practice of keeping the area barren for a year allowing firewood contractors to collect lop and tops from the cable line could mean extended exposure of the area to soil erosion. But in sub-tropical conditions of Bhutan, grasses and shrubs cover the soil soon after the clear cutting. Thus, even with the canopy gone, the cover provided by grasses and shrubs are enough safeguards against soil erosion or soil deterioration. However, the invasion by grasses and shrubs can mean danger of fire for other inter-cable line stands. Once the area is about to be planted, the weeds and shrubs should be weeded out. Weeding should take place as per Norms and Standard of Plantation 2019 issued by SFED.

To ensure the survival of artificial regeneration created by the NRDCL the UIC should carry out plantation survival survey by doing total count in the planted areas annually. If the survival percentage is less than 70% the NRDCL should be apprised to carry out beating up and other necessary maintenance work to improve the status of regeneration

Group Selection System has been prescribed for broadleaf forests. The group selection system has been prescribed in preference to Strip Clear Cutting system that was in operation in previous plan basically because the latter is seen as environmentally riskier. The large tracts of land being clear felled would open the area to hazards of monsoonal rain and soil erosions. Even aesthetically, the large openings would be an eye sore. In group selection system, trees develop in clearly defined

even-aged aggregations; this is of substantial advantage in developing good form especially in hardwoods.

Under the group selection system, small openings will be created in the stand allowing light to reach the forest floor and creating microclimatic conditions conducive for seed germination and establishment of seedlings. There are important unresolved problems with sub-tropical and warm broadleaved silviculture in Bhutan; particularly the poorly understood regeneration dynamics of commercial species. Good regeneration has proved extremely difficult. There are also still considerable doubts regarding the best silvicultural systems for managing broadleaved forest. It is likely to be some time before research results are available and it is quite possible that stand succession towards commercially useful species is naturally a very long process (Whitfield, 2001).

Since one of the main reasons for failing of silvicultural systems is the lack of regeneration, it has been proposed during the Consultative Workshop that the group selection system should be combined with artificial regeneration. The Group Selection System with artificial regeneration is synonymous to the Patch Cutting.

System as recommended by the RNR-RC Yuispang as per the *Forest Research Findings and Recommendations during the 8th FYP, RNR RC Yusipang (2003)*. The "patch" in patch cutting system would mean smaller groups (as compared to groups Group Selection System in Conifers) in Group Selection System. As per their research findings, the patch cutting system with fencing is proven to be the best option in terms of fostering biodiversity, mitigating grazing impact and safeguarding financial viability for sustainable management of mixed broadleaf forests in Eastern Bhutan

General guidelines for Patch-cutting system (group selection system) in broadleaf forest. *(vide the Forest Research Findings and Recommendations during the 8th FYP, RNR RC Yusipang, 2003)*

- ✓ Patches of mature and over-mature trees under which there is existing regeneration or which are most likely to regenerate successfully should be given first preference. This would include large trees with spreading crowns, which absorb sunlight if permitted to reach the forest floor would enhance seedling development.
- ✓ In selecting patches, ridge tops are preferred over depressions, up slope positions over down slope in order to minimize damage to regeneration in subsequent felling operations.

- ✓ The size of openings should depend on stand composition and condition. In general, the size of opening should vary from 0.15 to 0.5 ha. It should not be too large, as it will favor growth of other species, which have less timber value.
- ✓ Distance between the patches retained should be such that patches of trees retained will form a wind firm group of trees and appear as a uniform patch.
- ✓ In mature broad-leaved forests with many mature and over-mature trees it is expected that 75% of the standing volume would be harvested by felling 40 to 60 % of the area.
- ✓ The direction of the tree lean, and the topography should be taken into account to prevent large trees being felled on nearby advanced growth.
- ✓ Dead or dying trees or those showing symptoms of decay or damage (snags, scars conk, mistletoe, etc.) should be retained to safeguard flora and fauna niches or
- ✓ Sufficient seed trees in the interline spaces adjacent to the cable lines opened up should be retained as potential seed sources for seedling regeneration in patch-cuts.

The Group Selection System has following advantages:

- ✓ Regeneration in the small groups under even aged conditions, which gives better stem form
- ✓ Larger openings in comparison to single tree selection system permit the establishment of intolerant species
- ✓ Harvesting is more concentrated, so logging cost is lower
- ✓ Harvesting in groups lower damages to residual stands
- ✓ Immediate cuts may be made less frequently
- ✓ Aesthetically and environmentally more acceptable than clear cutting

15.2 Single Tree Selection System

The Single Tree Selection System will be applied to Local Use areas in case of rural marking for extraction of rural house building timber and firewood. Single tree selection system follows principles of nature that matured trees are selected and removed to enable regeneration to replace them. The felling should be scattered all over the operational area instead of confining to certain parts of forest. Felling should involve removing of trees or small groups of trees. This system helps to maintain uneven-aged character of the forest crop. This system is applicable to stands in need of thinning as well.

THE FUTURE MANAGEMENT

In single tree selection system, sustained yield must be maintained by making thinning among the various age classes to ensure that:

- ✓ Stands are maintained in their correct proportions
- ✓ A suitable mixture of species is maintained
- ✓ Young saplings are freed from suppression
- ✓ Defective stands are removed wherever they are hampering better ones

It is observed in most cases that the trees of best economic interest are selected and felled. Instead of following this, Unit In-charge of the particular FMU should judge and familiarize with the forest condition and silvicultural requirement of the species and do the selection with the interest of meeting the objectives of the system. As far as possible, selection of trees to be felled should be done for following categories first especially in young and immature stands.

- ✓ Dead, dying, diseased, misshapen or otherwise defective trees which interferes with the growth of neighboring vegetation.
- ✓ Trees of undesirable species.
- ✓ Immature tree which can be removed by judicious thinning.
- ✓ Mature trees above the exploitable diameter, which will leave gaps for regeneration to come up.

15.3 Seed Tree System

Blue Pine Working Circle will be worked under Seed Tree System, if in case the identified harvesting area is pure blue pine stratum as Blue Pine regenerates very easily under Seed Tree System. This system involves retaining certain number of trees to supply seed for regeneration after rest of the trees are harvested. These trees must be of good health and vigorous in growth which would truly serve as good seed source. Slope characteristics, wind firmness and aesthetic value have to be taken into consideration while utilizing this system. Blue pine regenerates easily when light is ample and ground vegetation is sparse. In applying this system, site condition like aspect must be considered as Seed Tree System is not suitable on steep and exposed south and southwest sites; rather group selection system should be preferred on such condition

15.3.1 Working Pattern

For cable line harvesting, the felling area of 1000 x 30 m can be logged, if the felling is confined only to Blue pine stand stratum with the retention of about 20-25 trees/ha that are phenotypically superior. Harvesting lines must not run directly downhill. Lines must be 90m apart, allowing 2 interline operations. Dead, dying, malformed and diseased tree will be cut on priority basis. On exposed or sensitive site harvesting must leave 40 to 50 trees / ha. The distance between the seed bearers should not be more than one crown length as it can be easily colonized by weeds and/or regeneration of unwanted species

Seed Tree System has the Following Advantages;

- ✓ Compared to artificial sowing, the seed from seed trees is gradually released over the time and this can increase the probability of seed being on the ground when the desired germination conditions occur.
- ✓ The expense of collecting and sowing of seed is avoided where there is suitable on-site seed
- ✓ The local gene pool is more closely reproduced, leading to better adaptation to the site
- ✓ Harvesting is more concentrated, so logging cost is reduced
- ✓ Aesthetically and environmentally more acceptable than clear cutting

15.4. Thinning

Thinning is an important silviculture activity. It is particularly important where there is dense stocking of young trees of similar age and size. The objective of thinning is primarily for improvement (of stand increment and quality) although poles and fuel wood will also be produced. The young Blue Pine stands (Blue Pine Working Circle) will be worked under thinning. Thinning will be done by positive selection with due consideration to stabilize the structure of the stands. This type of thinning will be to direct the growth potential of the stand and site to the most promising individuals of the tree populations to maximize volume and quality production. The stand to be thinned will be identified from the treatment map and field visit. Pruning in the appropriate stands will also improve the value of the forests. Marking of trees will depend on the number of stems per hectare, age or size class and spatial distribution. Dead, dying, malformed and diseased tree will be thinned on priority basis. Large opening must not be created. Thinning

area should be identified as per this plan and should be carried out annually in order to improve the existing stand.

The marking guidelines for thinning are as under;

- ✓ Mark 20% of the standing volume for thinning
- ✓ Marking of trees will depend on number of trees per ha, age or size class and spatial distribution
- ✓ Only low thinning will be done in most stands, where only dead, dying, suppressed, diseased and defective trees will be marked first.
- ✓ In stands less than 20 m average height, the target spacing should be approximately 4.5m x 4.5m or about 500 trees per ha.
- ✓ In stands with pole crop (average height 10-20m), the spacing of trees after the thinning should be no more than 5-6m, or approximately, 300-400 trees per ha
- ✓ In stands which at present have less than desired tree density and spacing, only tree that grows in cluster, very close together and competing for light and nutrients can be removed, diseased trees, especially those infected with mistletoe can be removed
- ✓ Care must be taken not to create large opening in the thinned stands.

15.5 Coupe Clearance

Divisional Forest, Paro and Zonglela FMU should follow the following procedure for issuance of coupe clearance for execution of timber extraction from planned cable lines in this plan period. The following procedure was recommended by FRMD on issuance of coupe clearance certificate in FMUs vide No.FRMD/MPS/2(1)2018-2019/708 dated 17/01/2019.

1. The concern Territorial Division through Unit office must issue coupe clearances to NRDCL prior to execution of timber extraction works from planned cable lines. The operation of cable lines by NRDCL must commence only upon obtaining the coupe clearance issued by the division.
2. Coupe clearance for the 1st cable line to be issued prior to installation of cable cranes. Further the cable crane in the 1stline will be removed only upon complete extraction of lops and tops from the cable corridor and are brought to the landing site.

3. Coupe clearance for the 2nd cable line to be issued while 1st cable line is still under Operation so as to enable marking of trees and installation of cable crane in the end cable line.
4. Coupe clearance for the 3rd line to be issued only after lops and tops extracted from 1st cable line is completely disposed from the landing site. The same procedure must be followed for the operation of following consecutive lines.

16. FOREST PROTECTION

16.1 Forest fire

Zonglela FMU consist of coniferous forest mostly which is very much prone to forest fires. Although very few incidences of forest fires have been recorded in Zonglela. The major forest fire outbreak was in 2020 in Nabesa block. A total of 30 ha of forest area was burnt by fire. It cannot be overlooked because a single incidence of uncontrolled fire can destroy extensive forest areas. It causes damages to trees, regeneration, soil (exposing it to elements of nature that can lead to erosion), and productive power of the forest, protective power of the forest, wild animals and the recreational and scenic value of the forest.

Forest fires in Bhutan are mostly caused by human activities and are due to either carelessness/ accidental or deliberate. Therefore, it is of utmost importance to educate the people and to garner their goodwill and corporation to not just to prevent forest fire but also gain support during such outbreaks. Fire management covers all activities concerned with prevention, control and use of fire in forests.

Therefore, the Unit In-charge and the Production In-charge of NRDCL will need to review forest fire protection programs at regular interval in close consultation with the local communities and forest workers in the FMU. The danger of forest fire outbreak from the burning of field debris should be well informed to the local people, as it is the common practiced followed by the local people. When the local people are going to burn their property, the information must reach to territorial staff so that monitoring can be taken.

Fire Management Procedures:

- ✓ Obtain the necessary permit or authority to conduct prescribed burn,
- ✓ Observe weather conditions to determine when to carry out the prescribed burn,
- ✓ Always extinguish the fire before leaving,

- ✓ Use ground fires to reduce the amount of inflammable fuel in forests (dead branches and leaf litter),
- ✓ Create fire breaks around forest fringes and in sensitive areas to stop fires spreading. Establish and maintain these in October-November (before the fire season). Fire breaks (Fire line) width may depend on the slope.
- ✓ Reduce fuel loads inside high-risk forest stands. This means removing dry woody material that is likely to burn. This can be done by controlled burning or physical removal.

16.2 Pest and Diseases Management

The Eastern Himalayan spruce bark beetle, *Ips schmutzenhoferi*, is a serious pest of *Picea spinulosa* and *Pinus wallichiana* in Bhutan. In Zonglela FMU major bark beetle sanitation operation was carried out between 2014 and 2016 (Figure 19). Total of 3754 number of trees equivalent to 13631.96 m^3 in standing volume (Figure 20) were operated to avoid further spreading.

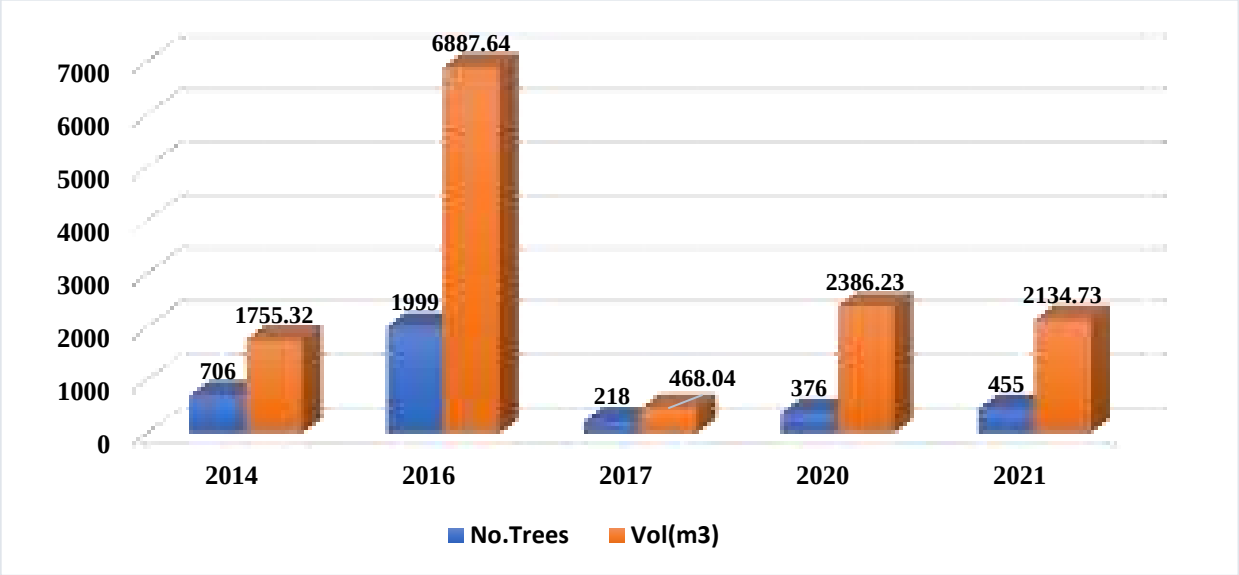


Figure 106: Graph showing Bark beetle sanitation areas under ZFMU

In most of the infested stands, mortality of trees was observed in the patch form and this could be because of root-to-root contact of the fungus. To our understanding, stands would have infested by bark beetles after weakening the trees with damage to the root system by root rot. The other probable causes of beetle outbreak could be because of poor management and harvesting practices.

THE FUTURE MANAGEMENT

With incidents of outbreak of spruce bark beetle over past years, there are possibility of pest and diseases outbreak any time during this plan period. Therefore, periodic monitoring to detect any outbreak of pest and diseases should be conducted by FMU and NRDCL. Immediate reports should be made to concern CFO and seek approval for immediate sanitation from head of the Department.

The following are the control measures suggested:

- ✓ Regular periodic survey of the forest and removal of deformed trees.
- ✓ Regular survey of regenerated areas and burning of infected plants after slashing and debarking.
- ✓ Education extension program for the people and the workers in the forest to report symptoms of the disease will be part of the pest and disease management program within the FMU.
- ✓ The planting stock at any nursery, which will be supplied to the Unit for further plantation, will need to be monitored for pest and diseases. The infected seedlings should not be supplied, instead destroy by burning at the nursery itself.

Figure 27: Map showing Bark beetle sanitation areas

16.3 Grazing

In line with the multiple-use of the forest and traditional rights of grazing within the FMU, grazing will be allowed to continue in some part of the Unit.

However, grazing will be excluded from Protection functions and light grazing will be permitted in Conservation functions. Grazing in planted areas along the cable corridors and any other areas where plantation has been taken up by NRDCL should be avoided. In this plan period, FMU should focus more on educating people regarding impact of grazing and their participation in managing FMU and other ecosystem services. FMU should collaborate with livestock sector of Dzongkhag or gewogs to develop appropriate methods and approaches to avoid impact on natural regeneration and plantation within FMU during plan period. More importantly, a participatory approach to secure the cooperation of local villagers in keeping their cattle out of environmentally sensitive areas and away from regeneration coupes will be adopted with high priority.

NRDCL should provide adequate support with available local materials to support and protect planted seedlings until its establishment. Regular maintenance should carry out as per maintenance schedule reflected in the annual operational plan to prevent damage of seedlings from grazing.

17. ENVIRONMENTAL IMPACT ASSESSMENT

All developmental proposals in Bhutan have to fulfill certain environmental criteria as per the provision of the Environmental Assessment Act, 2000. The Chapter III, Section 18 of the Environmental Assessment Act necessitates obtaining environmental clearance prior to the commencement of the proposed developmental activity. To carry out any forestry activities, the National Environment Commission Secretariat has developed Regulation for Environmental Clearance of Projects in 2002, the procedures of which the applicant should meet. This section of the plan provides all necessary information required for environmental clearance which includes the perceived threats of the proposed project to the environment and necessary mitigation measures to minimize the impacts resulting from the planned activities. This section, altogether, meets the requirement of the Act to be fulfilled by the applicant concerned.

This section of Zonglela Forest Management Unit Plan provides information how the forestry activity will be carried out and controlled so that the proposed activity meets the requirements of the Act.

THE FUTURE MANAGEMENT

17.1 Project Description

17.1.1 Introduction

Bhutan Forest Act, 1969 provided the first legal framework for regulating forest resources in the country than National Forest Policy of 1974 provided focused and objective to the directives with regards to forest and its management. The revised policy of 1991 has four main objectives for which the forest is to be managed, one of it being, to meet the long-term needs of all the people for woods and other forest product by placing the country's productive forest areas under sustainable forest management. Numerous forest management units were identified across the country to manage the forest scientifically and sustainably.

Zonglela FMU is under commercial harvesting for last 29 years since the forest was brought under scientific management in 1992. The harvesting operations were carried out generously during its first plan period with AAC of 25,000m^3 huge volume of timber was extracted on a sustainable harvesting principle. However, during second plan period, the harvesting of timber was drastically brought down. This was done in order to protect the sustainability principle of the forest management. Zonglela FMU will be worked on principle of sustainability to meet timber for commercial as well as bona fide rural requirements. The FMU will be managed on the basis of sustainability principles which will ultimately improve the forest stands.

A total FMU area of 15803.65 ha will be managed under the principle of sustainable forest management. From the gross production area of 6474.03 ha, the net production area allotted for timber extraction operation is fixed at 4646.41 ha. The broad objective of this project is to harvest the over matured and matured trees to improve the forest stands and also to make timber available in the market along with generation of revenue for the government.

17.1.2 Objectives

- ✓ To maintain and improve the present vegetation cover to protect the environment, soil and water conservation and as well as biodiversity;
- ✓ To ensure sustain supply of timber, construction poles and posts, fuel wood and other non-wood forest products for local supply through regulated harvesting and collection;
- ✓ To strengthen the awareness of the communities within the Forest Management Unit to participate in forest protection and conservation;

- ✓ To ensure that multiple use of forest does not result in unacceptable level of ecological and environmental disturbances;
- ✓ To generate local employment opportunities in the forest-based activities;
- ✓ To regulate grazing to maintain the ecology and natural regeneration potential of forest;
- ✓ To promote local research, demonstration, aesthetic and educational values of the natural forest ecosystem.
- ✓

17.1.3 Project Location and Area

Paro-Zonglela Forest Management Unit is situated within Wangchang, Shaba, Doga, Lungnyi, and Lamgong Gewog under Paro Dzongkhag. It is located between 27º 26'32.59'' to 27º 16'36.90''N and 89º 31'00.27" to 89º 19'28.82'' E. The total area of the FMU is 15,803 hectares. The Pachu forms the eastern boundary and the high ridge which separates Paro and Haa valleys forms the western boundary of the FMU. The entire area will not be subjected to harvesting. From the gross production area of 6474.07 ha, the net production area allotted for scientific and sustained timber extraction operation for this plan period is fixed at 4272.41 ha. Rest of the area is categorized under various protection and non-production zones.

17.1.4. Benefits

The forest management inventory results indicated that timber species trees within some mixed conifer and fir stand of Zonglela FMU have attained harvestable size and some stands are matured and annual increment growth will be not significant. Removing matured stands would create space for regeneration and help to improve the forest condition. Regeneration is always a problem in the natural forest due to limited space and light, grazing pressure from the domestic animals and competition from unwanted species that dominates over the principle commercial species. Therefore, timber harvest with application of scientific approach will improve forest structure and condition to suit natural regeneration for restock and other ecosystem services. This not only benefits in terms of generating revenues but also help improve the forest conditions. The FMU activities can also contribute towards providing employment opportunities to local communities. Local people can be involved as unskilled labor during maintenance of road, construction of forest road, extraction of timber and transportation. This will help uplift the livelihood of the people residing in and near by the Forest Management Unit.

The existing FMU road and the proposed new roads will benefit the settlements within the FMU. Newly proposed FMU road will help people extract rural timber for their house construction and renovation purposes. The harvesting of matured trees as per the prescription of the plan will allow the extraction on sustainable basis and also contribute towards government revenues. Managed forest will definitely ensure future sustainability of the resources.

17.2 Forest Management Unit: Planning and Zoning

All the Management Plans have to be prepared based on Forest Management Code of Bhutan, 2004. Very comprehensive and consultative land use planning was carried out while preparing this Management Plan. The process is briefly outlined below:

Potential production forest area was identified using QGIS Desktop 3.0.0 with GRASS 7.4.0, Land Use Land Cover, 2016 and existing national data like Digital Elevation Model (DEM), drainage, road networks, protected area system, etc. Application of GIS was then followed by the ground reconnaissance of selected area in conjunction with the local community consultation to ascertain potential conflicts between forestry use and existing local use. These consultations included local communities and local government. Forest resource inventory was carried out to provide the information about tree stocking, regeneration, timber volumes, sites characteristics, wildlife presence and understory species.

Forest zoning is based on above data collected, using the forest function mapping prescribed in the Forest Management Code of Bhutan. The area is divided into different forest type called Working Circle and they are further divided into Blocks, Compartments and Sub-compartments. The protection areas such as soil protection, wild life protection, rivers and streams buffer protection, etc. are excluded from net operable area.

The silvicultural system to be implemented is Group Selection System for Mixed Conifer and Fir Working Circle and patch cut system for Broadleaf working circle. For Blue Pine Working Circle, Seed Tree System and Thinning operations will be applied. No clear cutting will be permitted and all the trees will be harvested using the skyline cable crane. The opening of the group size can vary between 0.1ha to 0.15 ha depending upon the stand composition and condition. The distance between the cable lines will be not less than 60 meters and distance between the groups will be not less than 50 meters.

17.3 Harvesting and Extraction

Fixed volume of timber expressed as *"Annual Allowable Cut or AAC"* is prescribed in this Management Plan. The AAC prescribed is **5118.53 m^3** in Standing Volume per year. This means that the maximum volume that can be harvested from Zonglela FMU will not exceed 5118.53 m^3 per year. The AAC allotted for Commercial is **3993.71 m^3** and **1124.82 m^3** for rural use. Considering the terrain condition and forest composition and structure, timber will be extracted using the skyline cable crane system. Skidding and rolling of timber from commercial production zone is strictly prohibited.

However, mitigating measures will be employed during harvesting and extraction to minimize potential negative environmental impacts. Cable cranes would be used for harvesting operation and no manual logging would be permitted in the laid cable lines. Power chain saws would be used in place of the axe to reduce waste.

The harvesting prescription and silvicultural treatment have been taken care of and described in detail in the Management Plan.

17.4 Road Maintenance

The new construction of FMU road has not been proposed in this plan period since almost all the commercial extraction areas are covered in the previous plans. For this plan period the NRDCL have to use existing FMU roads for extraction of commercial timber extraction. Based on the resource inventory result the NRDCL might have to construct new road towards Bebji Goenpa. Complete Road Standard is given in Annexure 2.

17.5 Regeneration and Post Harvesting Treatments

It is prescribed in the Management Plan that harvesting will be followed by natural regeneration. If the natural regeneration fails, artificial planting will be carried out with immediate fencing. 1,600 seedlings per hectare should be planted. Thereafter, weeding and tending operations should be carried out every year till the regeneration gets established. Regeneration is considered successful only if >80% of 1600 seedlings planted gets established. Therefore, establishment of a forest nursery of principal species by NRDCL is recommended in this Plan period.

Besides, regular maintenance of the plantation will be done by NRDCL. CFO, Paro TD shall monitor establishment of regeneration in harvested areas at the end of first year. If the survival percentage is lower than the above prescribed number, immediate beating up will be carried out

with the same local species. The established regeneration should be evenly distributed in the operated area and not concentrated in one particular place. Fencing could be removed once the regeneration gets established.

17.6 Existing Environment

17.6.1 Topography and Geology

The general terrain of FMU ranges from gentle slope to steep landscape. The terrain most of the compartment is gentle but, in some compartments, which are located in alpine areas and above Issuna has steep and rocky outcrops. The total area of FMU is 15803 ha and the net production area is only 4272.60 ha. About 1148.79 ha of the total area are delineated as soil protection (slope above 100%). The uppermost portion of the FMU is devoid of any tree stand; those areas are either blank or bear alpine grass. Elevation of FMU ranges from 2200 m above sea level at the valley bottom to 4000 m above sea level at the ridge top. The rock of is of Paro formation. This formation is characterized by mica-schist, quartzite-schist, calc-silicate, graphite schist, marble etc.

17.6.2 Hydrology

Within Zonglela FMU small streams and waters sources areas located in different compartments of the FMUs. The residents residing inside FMU and outside FMU area heavily dependent upon these water sources for drinking and cultivation. These smaller streams are also the source of water for livestock.

17.6.3 Air Quality and Noise

The air quality in the FMU is excellent as pollutions are very less. There are many important monasteries/lhakhangs situated within Paro-Zonglela Forest Management Unit. Kichu Lhakhang, one of the 108 monastries that were constructed by king Songtshen Gampo of Tibet in the 7th century, the second monastery constructed by Her Majestry the Royal Grand Mother in 1968, Kila Goempa, Ugyenguru Goempa and the Ugyel Pelri Palace are the most sacred structures located within the FMU. During the religious festivals, the area is under pressure from the tourists and may slightly add to the noise and air pollution

17.6.4 Plant, Animal Species and Habitat

Multi-resource inventory was carried out by Paro Forest Division with technical backstopping from FRMD. During the inventory, crew noted various signs and sighting of the animals and corresponding data collected via commonly identifiable signs (footprints, scats, actual sighting, browsing and other ground disturbances signs) includes animal like barking deer, Sambar deer, goral, wild boar, Himalayan black bear and occasionally Snow leopard, musk deer and Red Panda. Since data did not indicate number of different species in the particular area, the measure of density population of different species at this planning stage may not be possible.

17.6.5 Scenic Qualities

The entire FMU can be viewed from the Druk Air during take-off and landing. Therefore, special care has been taken to maintain the scenic beauty of the area by maintaining the road buffers both above and below the road across Chelala Highway and the entire FMU road network. Moreover, care has been taken to manage the FMU based on the scientific principles of sustainability.

17.6.6 Cultural Significant Sites

Kichu Lhakhang, one of the 108 monastries that were constructed by king Songtshen Gampo of Tibet in the 7th century. The second monastery constructed by Her Majestry the Royal Grand Mother in 1968, Kila Goempa, Ugyen Guru Goempa and the Ugyel Pelri Palace are the most sacred structures located within the FMU. There is another Nye located below Pangkala locally known as Tsherbum Nye.These areas attract lots of tourists from both within and outside Bhutan. All these areas are mapped out from the production area

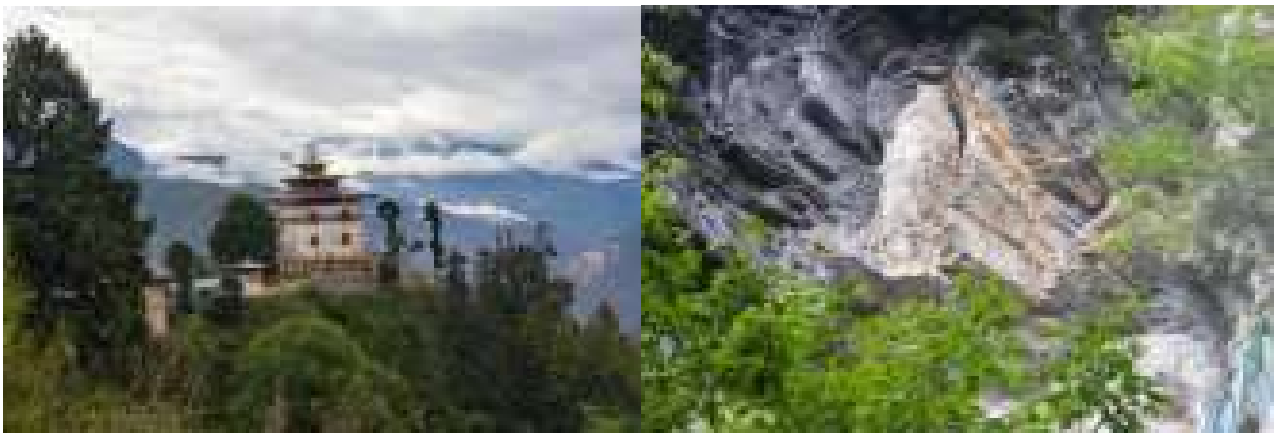


Figure28: Ugyen Guru and Tsherbum Nye

17.7 Assessment of Impacts and Mitigating Measures

17.7.1 Impact on water

Pollution

The FMU has a number of perennial streams, large and smaller ones. While carrying out the planned activities in the FMU, there are higher chances of polluting the water bodies within the FMU with garbage by workers engaged in road constructions and harvesting operations. Some harmful pollutants might include oil spills from vehicles and machineries

Drying up of water source

The entire FMU has been already covered by the road network. Therefore, minimum road construction will take place in the FMU. In two major catchment areas, Lungyni and Ngoba there will be minimum disturbance. Harvesting operations and opening of forests might result in decrease in the volume of water.

Mitigations

A buffer of 30 meters on the either of the main river, drinking water source and other perennial streams has to be maintained. The forested area where the drinking water source is located will not be subjected to commercial harvesting. The coupe will be laid in such a way that they are located away from the streams and rivers. Proper pit latrines and garbage disposal should be in place and the camp sites are at least 100 m away from the main streams.

During the road construction, NRDCL site engineer will monitor the construction activities. Moreover, the bulldozer will be replaced by excavator in order to avoid the blockage of river and streams from wind throw. At few places, forest road passes through streams and rivers sources but to mitigate the impacts, 100 meters buffer have been kept to prevent damage to the water source. Water pipes will be replaced, if damaged during road construction

17.7.2 Impact on Forest Resources

As the timber harvesting operation is the main activity in the FMU, it is evident that there will be impact on forest resources. Although, prescribed silvicultural systems are encouraged during harvesting operations, it will result in reduction of the forest cover within the FMU. Mixed conifer

will be worked under Group Selection System while the Blue Pine Working Circle will be worked under Seed Tree System. The opening of corridors and groups during the harvesting operation might open the area for grazing with less regeneration of principle timber species. This could result in exposing the site to various environmental and climatic conditions and thus affect the ecological processes in place. In certain forest type, openings can lead to increased undergrowth and hence regeneration of commercial native species will be affected.

Employment of untrained personnel during harvesting operations might lead to wastage of resources while felling trees such as increased number of splitting, breaking and other sorts of felling damages. Excessive collection of NWFPs may also lead to unsustainable harvesting of such resources in the future.

Mitigations

The management plan for the FMU is prepared for a period of ten years and before the commencement of harvesting operations. The harvesting will not exceed the prescribed AAC, nor will the size of the opening be larger than that prescribed in the management plan. If the natural regeneration fails to establish then the area will be planted with local timber species. However, natural regeneration is preferred over artificial regeneration considering its ecological as well as economic importance. The introduction of exotic species will be restricted.

For proper planning, implementation and monitoring of activities in the Forest Management Unit, a full-time dedicated staff for the FMU will be required from both DoFPS and NRDCL. CFO, Paro, will be responsible for deputing adequate staff for effective functioning of FMU. Only trained power chain saw operators will be allowed to carry out the felling and harvesting operations to reduce the felling damage within the FMU. The Unit-in-Charge should monitor community activities outside Production Working Circle to ensure that they are not locally concentrated to the extent that they affect biodiversity, water quality and soil stability.

17.7.3 Impacts on the Faunal Diversity

Habitat fragmentation and disturbance to wildlife is one of the major threats as a result of operation in the FMU. Activities such as road construction and timber extraction will cause disturbance in the wildlife habitat and thereby increasing the chances of reduction in wildlife population. Construction of roads will also affect the movement of animals from one niche to another.

Harvesting operations will adversely impact the prey base and may create imbalance in the food chain.

Mitigations

Certain areas within the FMU have been designated as wildlife protection areas while the remaining areas are designated as nature conservation areas. No harvesting operations will be allowed in area designated as wildlife protection function. As all forest areas are not subjected to harvesting operations, enough areas have been kept for free movement of wild animals. Sufficient number of snag trees and fruit bearing trees will be retained to provide enough food for survival and reproduction of wild animals.

In the interest of wildlife, clear felling of large stretch of forest will be avoided so that sufficient forest is retained for forage, shelter and cover. In operated areas, if natural regeneration fails to establish, artificial regeneration by native trees will be undertaken and subsequently fenced to avoid grazing by domestic as well as wild animals. Regular monitoring and patrolling of the forest area will be carried out in order to minimize poaching and other illegal activities within the FMU.

17.7.4 Impacts on Ecology (Flora)

One of the possible impacts of harvesting operations within the FMU is the change in present forest composition. There are higher possibilities of the harvested areas being invaded by non-native species of plants if proper monitoring of the area from time to time is not undertaken. Moreover, colonization of mixed conifer areas and natural grassland by Blue Pine is one of the perceived threats.

Mitigations

In order to retain the original forest composition in the harvested areas, the operation should follow the prescriptions strictly. Opening along the cable lines should be maintained as per the prescribed silvicultural systems so that it creates conducive environment for desired species to regenerate. Larger openings will be avoided in the mixed conifer stand in order to avoid its colonization by blue pine species. To ensure adequate regeneration of desired species, mother trees will be retained in sufficient numbers as a source of seed. Forest roads have been aligned in such a way that it does not pass through sensitive and critical areas. Proper monitoring should be ensured while constructing new forest roads to ascertain minimal damage to nearby vegetation.

17.8 Monitoring and Evaluation

The Management plan, which is for the period of ten years, will be prepared by Divisional Forest Office, Paro and facilitated by FRMD, DoFPS. It will be approved by the Minister, Ministry of Agriculture and Forests. The plan will be implemented by NRDCL under supervision of Chief Forestry Officer, Paro. Annual Operational Plans (OP) will be prepared by Divisional Forest Office, Paro, in consultation with the stakeholders, based on the management plan. The OP will be approved by the Head of the Department. Annual monitoring will be carried out by Division (CFO and Unit In-charge). A report will be submitted to FRMD, Department of Forest and Park Services, based on the annual monitoring forms. FRMD will also monitor the implementation of the activities.

There will be two evaluations of FMU: mid-term evaluation at last quarter of the fifth year and final evaluation at the last quarter of the ninth year by the independent of staff implementation. An evaluation team will be constituted by the head of the Department. CFO will apprise the Department for evaluation and evaluate the FMU as per terms of reference.

Table 33: Check list of Environmental parameters for forestry projects

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
I. COMMERCIAL LOGGING					
A. Environmental Considerations Regarding Project Siting					
1. Watershed Areas					
a) erosion	*a) downstream economic losses*	✓			
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*	✓			
2. Relation to other dedicated land uses					
a) conservation areas	*a) impaired ecological and recreational opportunities*	✓			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
b) economic ventures	*b) possible economic loss*	✓			
3. Traditional forest uses	3. Impaired beneficial uses		✓		
4. Re-habitation	4. Social problems	✓			
5. Relation to regional/ national forestry plans	5. Possible conflicts with established management policies	✓			
6. Critical environmental areas	6. Downstream economic losses	NA			
a) erosion	*a) downstream economic losses*	✓			
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*	✓			
7. Precious ecology	7. Loss of ecological values	NA			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis		✓			
2. Operations and maintenance	2. Diminished project efficiency and objectives if lack of funds	✓			
3. Data base for decision making			✓		
4. Road network design					
a) erosion	*a) downstream economic losses*		✓		
b) siltation	*b) downstream economic losses*		✓		
c) hydrology	*c) increased peak and flood flows*		✓		
d) water quality	*d) loss of downstream beneficial uses*		✓		
5. Design of logging activities	5. Unnecessary damage to residual stand		✓		
6. Critical environmental areas		NA			
a) erosion	*a) downstream economic losses*				
b) siltation	*b) downstream economic losses*				
c) hydrology	*c) increased peak and flood flows*				

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
d) water quality	*d) loss of downstream beneficial uses*				
7. Precious ecology	7. Loss of ecological values	NA			
8. Appropriate technology	8. Diminished project objectives if inappropriate				
C. Considerations Regarding Project Operations					
1. Road construction					
a) erosion	*a) downstream economic losses*				
b) siltation	*b) downstream economic losses*				
c) hydrology	*c) increased peak and flood flows*				
d) water quality	*d) loss of downstream beneficial uses*				
2. Felling					
a) erosion	*a) downstream economic losses*	✓			
b) siltation	*b) downstream economic losses*	✓			
c) hydrology	*c) increased peak and flood flows*	✓			
d) water quality	*d) loss of downstream beneficial uses*	✓			
3. Log conveyance and allocation					
a) erosion	*a) downstream economic losses*				
b) soil compaction	*b) increased runoff*				
c) log floatation	*c) impede navigation*	N.A.			
d) allocation	*d) less than optimum economic benefits*	✓			
4. Logging in riparian zones	4. Degradation of waterways/fisheries		✓		
5. Socio-economics					
a) employment opportunities			✓		
b) loss of traditional forest use	*b) economic and cultural losses*		✓		
D. Considerations Regarding Post-Project Activities					
1. Rehabilitation and conservation					
2. Road shutdown			✓		
II. REFORESTATION/AFFORESTATION					

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
A. Considerations Regarding Project Siting					
1. History of forest abuse	1. Negation of project goals if not effectively controlled		✓		
2. Relation to other dedicated land uses					
a) conservation areas					
b) economic ventures	*b) Interference with more profitable ventures*				
c) regional/national forestry plans		✓			
3. Rehabitation	3. Social Problems	✓			
4. Siting in degraded forest	4. Possible unnecessary loss of ecological values	✓			
B. Considerations Regarding Planning and Design					
1. Cost/benefit analysis		✓			
2. Selection of tree species	2. Diminished project objectives				
3. Precious ecology		NA			
a) wildlife					
b) fisheries					
c) plants					
d) soil and water					
4. Allocation of benefits to locals			✓		
a) employment opportunities	*a) social conflict if local people not significantly involved*		✓		
b) training			✓		
c) non-wood products		✓			
5. Operations and maintenance	5. Diminished project efficiency and objectives if lack of funds		✓		
6. Data base for decision making			✓		
7. Project financing and reservoirs		NA			
8. Appropriate technology	8. Diminished project objectives if inappropriate	✓			
9. Relation to other dedicated land uses	9. Potential social and economic conflicts	✓			
a) extensive land use modification		✓			
10.Road network design	10.Increased erosion	✓			

	Adverse Environmental Impacts	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
11. Use of grasslands		✓			
C. Consideration Regarding Project Operations					
1. Commercial logging	1. Same as in Commercial Logging A and B				
2. Reduced water supplies	2. Socioeconomic losses	✓			
3. Chemicals and fertilizers	3. Impaired fisheries and aquatic systems	NA			
4. First-year operations	4. Increased erosion due to soil disturbance	NA			
5. Soil conservation benefits					
a) erosion				✓	
b) sedimentation		✓			
c) soil capacity		✓			
d) soil surface moisture		✓			
e) soil nutrients		✓			
6. Socioeconomic benefits					
a) employment opportunities			✓		
b) fuel-wood			✓		
c) enhanced fisheries		✓			
d) enhanced recreation/ tourism		✓			
7. Water resources benefits					
a) minimized overland flows		✓			
b) reduced flood peaks		✓			
c) water quality		✓			

18. FINANCIAL AND ECONOMIC APPRAISAL

Ten-year financial forecast and economical appraisal has been drawn for Zonglela FMU. This is intended to identify the revenue to NRDCL and Treasury (via royalty) and the cost and royalty paid by NRDCL. Overhead costs to NRDCL are not included. Some of the figures are estimates based on the assumptions listed and the information made available to the planner. The assumptions for the forecast are listed in Table 34.

Table 34: Assumption used for financial forecast

Assumptions	Figures
M^3 to cft	35.31
Recovery volume (%)	60
Road construction (Nu/km)	1200000
Length of proposed new road (km)	10
Road maintenance (Nu/km/yr)	12000
Distance to depot (km)	5
Cable crane (Nu/cft)/(Nu/m^3)	10.01/cft or 353.45/m^3
Regeneration maintenance (for cable line) (Nu/ha)	3500
Plantation cost (as per plantation norms and standard, SFD)	19000

Table 35: Financial Forecast Summary (For this plan period)

Category	Amount (Nu)
Total Revenue for NRDCL	113662890
Total Costs for NRDCL	51347300
Total Royalty for NRDCL	10381140
Total Revenue-Total Costs-Total Royalty	51934450

THE FUTURE MANAGEMENT

					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	10 year
	AAC (m3)	Rec. Vol (m3)	Nu/cft	Nu/m3	Nu	Nu	Nu	NU	Nu	Nu	Nu	Nu	Nu	Nu	Total (Nu)
Revenue:NRDCL															
Timber-Commercial	5118	4828	107.3	3788.763	11366289	11366289	11366289	11366289	11366289	11366289	11366289	11366289	11366289	11366289	113662890
Timber-Rural	1124														
Total Revenue: NRDCL					11366289	11366289	11366289	11366289	11366289	11366289	11366289	11366289	11366289	11366289	113662890
Costs: NRDCL															
Bridge construction							1500000								1500000
Road construction						2400000	2400000	2400000	2400000	2400000	2400000	2400000	2400000	2400000	21600000
Road maintenance					238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	2380000
Marking cost			0.08	2.83	14150	14150	14150	14150	14150	14150	14150	14150	14150	14150	141500
Inventory cost			0.08	2.83	14150	14150	14150	14150	14150	14150	14150	14150	14150	14150	141500
Felling and crosscutting cost			5	176.06	852624.8	852624.8	852624.8	852624.8	852624.8	852624.8	852624.8	852624.8	852624.8	852625	8526248
Debarking			3	176.6	852625	852625	852625	852625	852625	852625	852625	852625	852625	852625	8526250
Cable craning			20	706.4	3410499	3410499	3410499	3410499	3410499	3410499	3410499	3410499	3410499	3410499	34104992
Transportation to depot			17	600.44	2898924	2898924	2898924	2898924	2898924	2898924	2898924	2898924	2898924	2898924	28989243.2
Stand tending (spacing etc.)															
Regeneration maintenance(Nu	Nu 3000/ha				56100	56100	56100	56100	56100	56100	56100	56100	56100	56100	561000
Creation of plantation	Nu 19000/ha				95000	95000	95000	95000	95000	95000	95000	95000	95000	95000	950000
Plantation maintenance	Nu 3500/ha				17500	17500	17500	17500	17500	17500	17500	17500	17500	17500	175000
Total Cost: NRDCL					8449573	10849573	12349573	10849573	10849573	10849573	10849573	10849573	10849573	1.1E+07	107595733
Total revenue less Total cost: NRDCL					2916716	516715.7	-983284	516715.7	516715.7	516715.7	516715.7	516715.7	516715.7	516716	6067156.8
Royalty-commercial			9.8	346.038	1038114	1038114	1038114	1038114	1038114	1038114	1038114	1038114	1038114	1038114	10381140
Total Revenue: (Revenue less Cost less Royalty): NR					1878602	-521398.3	-2021398	-521398.3	-521398	-521398	-521398	-521398	-521398.3	-521398	-4313983.2
Note: it is recommended that a contingency fund be established for these activities due to the uncertainity of the occurance of bark beetle during the plan															
period: the amount of plantation is for cable lines and does not include potential plantation areas															

19. RESEARCH

Research programs will be in collaboration with UWICER. The Division and Unit staffs can also collaborate as appropriate. The prioritized areas for research are mentioned below:

- Determination of Annual Allowable harvest of NWFPs in the FMU.
- Invasion of operated areas by bamboos and its impacts to natural regeneration
- Habitat assessment of Snow leopard and Musk Deer.
- Timber recovery rate for particular FMU.
- Forest composition change overtime due to commercial harvesting.
- Human wildlife conflict.
- Development of new Local volume table for Zonglela FMU

PART 3

IMPLEMENTATION OF THE PLAN

20. IMPLEMENTING AGENCY

The Department of Forests and Park Services is vested with the responsibility of protection and management of forest resources in Bhutan. In the field, the territorial division is mandated by the Department to discharge the responsibility of implementing and monitoring all the activities mentioned in the plan. The Chief Forestry Officer of Divisional Forest Office, Paro will be responsible for implementation of this Management Plan assisted by Unit In-charge and other staffs of Forest Management Unit.

20.1 Cutting Cycle

For sustainability of forest resources in FMU, the cable line spacing must be properly laid to enable subsequent passes in the future. A minimum of 60 meters needs to be kept in between cable lines so that two passes can be enabled in future. Mixed Conifer Working Circle has a rotation period of 160years, which means that the two cable lines that will be implemented in future are occurring at year 53 and year 106. This is diagrammatically represented in Figure 29. The original line will therefore be harvested in year 160. This gives the adjacent area time to regenerate and also prevents the area from being open largely. The same could be applied to the Fir Working Circle except that the return to the interlines would occur at after 60 years and size of group opening will be no more than 0.1ha.

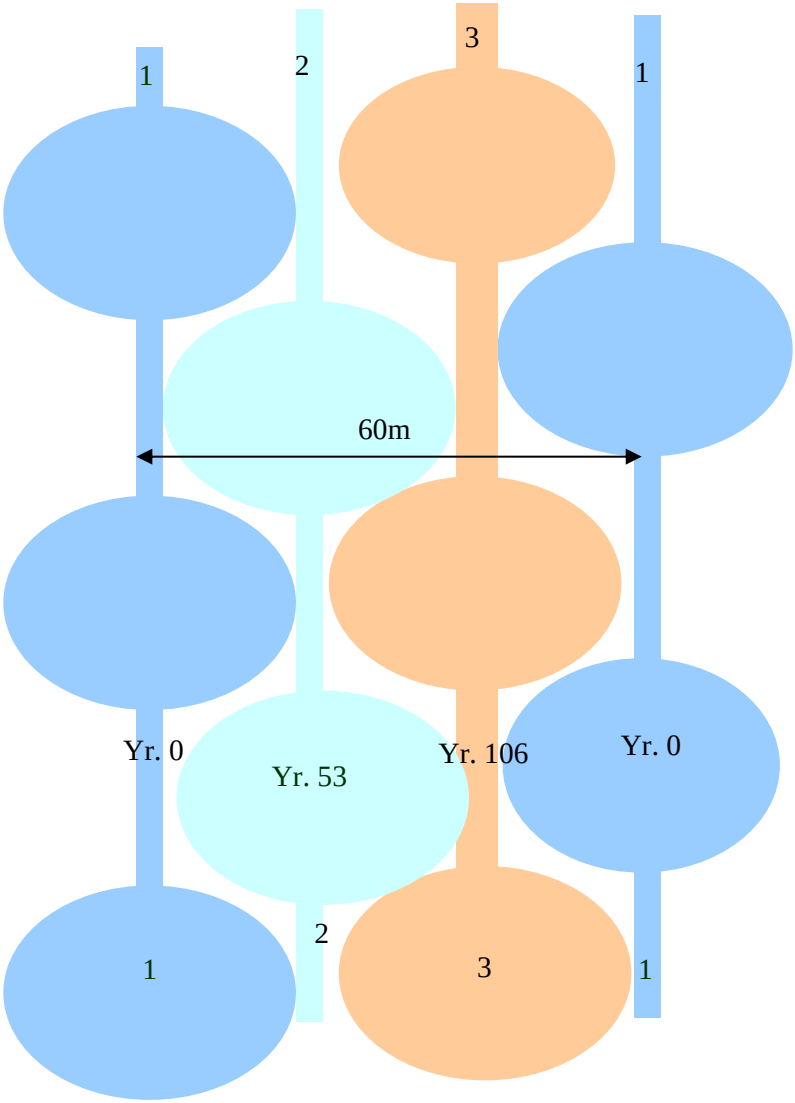


Figure 29: Map showing Cutting cycle diagram

The terrain in Bhutan poses a problem for layout. The layout in the field must be tailored to suit the terrain and to the best possible guidelines must be followed.
The Blue pine Working Circle, which will be worked under Seed Tree System, requires 90m spacing between initial cable lines. Thus, the two interlines in the future will be harvested at year 40 and 80, with original line being harvested at year 120.

The young Blue Pine stand will be worked under thinning. The thinning will be done by positive selection with due consideration to stabilize the structure of the stand. The thinning will ensure the growth potential of the stand and site to the most promising individual of the tree population to maximize the volume and quality production.

The Mixed Broadleaved working circle will be worked under Patch-cut System. The patch will not exceed more than 0.25 ha and will be spaced in the interval of 50 m. and 4 m cable corridor will be maintained. Artificial regeneration will be taken up immediately after coupe clearance is issued. NRDCL should maintain nursery at the site for artificial regeneration. Nursery should be well stocked with local and commercial species for replantation.

20.2 Annual Coupe

The Unit In-charge will determine the location and extend of cable lines in the compartment to be harvested annually, in consultation with NRDCL staff. All prescription and restriction laid down in the plan must be considered and adhered completely. NRDCL will obtain Coupe Clearance Certificate in writing from FMU to start marking felling. The Unit In-charge will arrange to mark along the cable corridor and openings and allot to NRDCL for felling. The annual coupe will follow the required spacing designed as per the prescribed silvicultural system of each working circle. The cable lines may traverse slopes greater than 100%, but extraction is not allowed. This means there should not be any group openings in those areas having slope greater than 100 %.

Coupes must comply with the following conditions:

- ✓ The Unit In-charge, in consultation with the NRDCL counterpart, will determine the location and extend of the cable lines in the compartment to be harvested annually. All prescription and restriction laid down in the plan must be considered and adhered to completely.

- ✓ The cable lines must be laid to the full length if the area is operable in order to avoid unnecessary loss of production area. This practice will also help cut down the expenditure for road construction.
- ✓ The Unit In-charge will arrange to mark the trees as per the approved annual Operational Plan.
- ✓ Cable line layout will be based on safety, stand composition, environment and cost consideration. This will be done in consultation with the Unit In-charge.
- ✓ The cable lines may traverse slopes greater than 100% but extraction is not allowed.
- ✓ Cable line layout will be based on safety, stand composition, environment and cost considerations. Alignment of cable line must be done in consultation with the unit in-charge. NRDCL, in consultation with the UIC may align the cable lines diagonally across contour lines in order to avoid environmentally sensitive sites to secure a more stable landing point or to achieve a more cost-effective harvesting.

20.3 Tree Marking Rules

- ✓ Groups of matured and over-matured trees are selected systematically according to the group size given in the plan.
- ✓ Trees within stream buffer stripes and on slopes greater than 100% must not be marked.
- ✓ The direction of the tree lean and topography has to be taken into account to prevent large tree being felled on nearby advanced growth.
- ✓ Some dead, dying, malformed or damaged (snags, scars. conk, etc.) and fruiting trees will be retained in between groups, and in the interline spaces, to safeguard the niches or habitats for the flora and fauna, but not in the harvested group themselves, where there is risk of wind throw and danger to personnel working underneath.
- ✓ Diseased trees (bark beetle, mistletoe) will be removed to protect the quality of the remaining stand.
- ✓ All species listed for protection under the Forest and Nature Conservation Act (1995) must be protected if encountered.
- ✓ The trees selected will be marked with the authorized marking hammer close to ground level by Unit Staff, and diameter measurements, along with estimated total tree height and tree species, will be entered in the Marking register.

- ✓ The volume of each tree will be estimated using an appropriate Volume Table. The standing volume marked will be recorded in the Marking Register. Log volume at the NRDCL Depot will be recorded.
- ✓ During the tree marking, the mitigating measure against the impacts recognized during the Environment Impact Assessment must be referred

20.4 Harvesting

To reduce the negative impact to the forest and environment due to extraction, the hauling method for transporting logs from the coupe to road will be done by skyline crane system. This system will allow logs to be kept above the forest floor during extraction and will enable logs to be taken across sensitive ecological sites, gullies and riparian filter buffer zones. Cutting trees 10 cm above the ground level will be strictly followed to avoid the wastage. To maintain the sanitation and hygienic condition of the forest, the cut over debris must be disposed off and if possible, burn in a proper place avoiding forest fire. The skyline cable system has the following advantages:

- ✓ Minimizes soil disturbance and initiation of soil erosion.
- ✓ Maximizes work safety (if used correctly according to the manufacturer's directions and according to the safety practices in the Code of Logging Practice).
- ✓ Avoid damage to residual reserve stands.
- ✓ Avoid disruption to wildlife corridors in the valley bottoms.
- ✓ Minimizes noise and dust pollution on any adjacent farmland and villages.
- ✓ Eliminates the need for log extraction tracks and feeder road construction

Harvesting in the Working Circle is to be carried out in accordance with following prescriptions:

- ✓ The layout of the cable lines should be planned and undertaken well in advance of the harvesting operations after the logging coupe has been demarcated. Suitable log landing site should be identified and incorporated into the forest road design.
- ✓ Care should be taken to avoid lines in and along gullies and other protected areas, but lines may cross these at an angle. Trees to be felled will be enumerated and marked in time so as not to delay harvesting operations.
- ✓ The cable corridor shall not exceed the prescribed width stated in the Silvicultural System for each working circle.

- ✓ Trees will be felled, de-limbed, crosscut, extracted on the cable, loaded and hauled to the log depot. Only chain saws and hand saws will be permitted in felling operations. Trees will be felled, where possible, into natural openings, into harvested openings or in a direction that will not damage residual stands. Damage to soil should be minimized at all times.
- ✓ The use of axes is discouraged except in fuel wood splitting.
- ✓ All infected Blue pine and Spruce, if any, will be debarked as soon as they are felled to avoid the spread of bark beetles.
- ✓ All logs will be measured and recorded in the Log Yard Register. This should be kept up-to-date and made available to inspecting officers as required. A copy of the list of log/timber entered in the Log yard Register will be submitted to concern CFO every month. This information will be used for royalty calculation and issuance of removal permits. Logs will be transported by private haulage contractors and all deliveries will be made to designated depots and/or sawmills.
- ✓ Records of all trees marked and issued for local use or for conversion within the forest, by blocks and compartments will be maintained by the Unit staff and furnished monthly to the concern CFO.
- ✓ The CFO and the Regional Manager, NRDCL will co-operate and coordinate to ensure that the logging operation and log outturn are conducted smoothly and in accordance with local and other demands.
- ✓ Fuel wood will be collected from harvesting residues. It is important that all lops and tops for fuel wood are collected along entire cable lines, not just the easily accessible areas. It is desirable that the trees to be used as fuel wood are extracted with the cable line and fuel wood conversion occurs at the designated log landing areas.

Skyline cable systems are the only form of cable harvesting systems used in Bhutan. Although no other harvesting systems are being introduced, it would be beneficial to investigate other possibilities that would increase the production. This would allow more ‘less desirable’ timber to make it to the landing, promoting utilization of poorer quality timber and fuel wood residues.

20.5 Reforestation of Harvested Sites

Natural regeneration is preferred method of reforestation in the harvested areas of FMU. Natural regeneration is ecologically and economically viable method to ensure sustainable development of forest resources. Therefore, it is crucial that natural regeneration is given preference over artificial regeneration.

It is essential that harvested areas are effectively regenerated as soon as harvesting operations are complete. However, if natural regeneration fails to get established in the harvested sites, restocking by means of artificial regeneration through plantation shall be carried out by NRDCL. It might be evident in some FMUs that the natural regeneration is either very poor or prove to be a complete failure because of site conditions, over grazing, prolonged disturbance due to protracted harvesting operations and overgrowth of weeds and other invasive plant species. These problems must be considered, analyzed and eliminated to successfully regenerate the operated areas.

It is prescribed that periodic tending activities such as weeding, brushing and fencing are carried out to increase the chances of natural regeneration establishment in FMU. Such interventions will help cut down the plantation cost and ensure higher survival percentage of forest crops. In case of natural regeneration failure, NRDCL should have a reserve of seedlings of locally viable species which can be done through establishment of forest nurseries. Care should be taken to plant commercially viable local species in the FMU to ensure sustainable harvest in the future. In areas where plantations are carried out, regular maintenance should be done for higher survival percentage. The maintenance of plantation should be carried out as per the Norms for Plantation and Nursery, 2019 and the concern CFO must monitor and evaluate the plantations on annual basis.

The past harvested cable lines should be monitored periodically and regeneration surveys should be conducted every three years until the regeneration has reached height that will ensure its survival. If the second survey (6^{th} year) indicates poor stocking, remedial actions must be taken in the following plantation season. The Unit In-charge must ensure that stocking of natural regeneration is first monitored within three years following completion of the harvested operation. Enrichment plantation, if necessary, should be carried out by NRDCL. The NRDCL in consultation with the Unit In-charge should keep adequate budget provisions in Operational Plan to carry out plantation creation and maintenance works.

FRMD recommends that the target stocking density in plantations to be up to 1600 stems per hectare. Any plantation with survival rate below 80% will require beating up.

20.6 Sequence of Operations related to the Annual Coupe

The operations relating to operating to annual coupe should follow the sequence given in following table

Table 12: Sequence of Operations Relating to the Annual Coupe

Operation Description	Timing (months) (-before felling; + after felling)
Unit In-charge decides regarding the location and size of annual coupe in accordance with the Biennial Operation Plan	-12
NRDCL and FMU In-charge prepares an estimate of human, material, equipment's and financial resources required.	-10
Unit In-charge finalizes the annual coupe size, demarcates the coupe and instructs NRDCL to carry out pre-logging planning	-6
NRDCL prepares cable line layout and alignment plan, proposed log depot and log landing points and submits these to Unit In-charge for approval	-3
Unit In-charge marks the carriage corridor trees and the tress to be felled in the first sub-coupe	-2
NRDCL manually fells trees that are in the way of the skyline installation and installs the skyline and cable crane	-1
NRDCL comments systematic harvesting and extraction operation according to the approved sequence in the Biennial Operation Plan	0
NRDCL/Contractor completes harvesting and extraction	When completed
The Unit In-charge will inspect the coups when harvesting is completed and will issue a Coupe Clearance Certificate only if all aspects of the operation are satisfactory.	When works completed
DoFPS asses success of natural regeneration	As per Guidelines
NRDCL completes post harvesting operation	As per Unit In-charge instruction

20.7 Road Construction

Forest roads are essential component for efficient management of forest. It allows transportation of timber from the landing sites to the depot at the right time. It also provides access to the forest areas for management and monitoring.

Road construction in the FMU requires extra precaution to achieve the environmental best practice. The basic necessity in the forest road construction is to avoid steep and fragile areas, to provide

proper drainage system, especially for safe discharge of run-off water during monsoon, with enough culverts and cross drains, to have an efficiently drained compacted road surface. In this plan period, no road construction has been proposed. The NRDCL will used the existing forest roads with adequate maintenance.

Road Standards

A set of road standards have been developed by the forest engineers of TFDP. These road standards although developed in the east, address policies that are required throughout Bhutan. These standards will be adopted for Zonglela FMU and NRDCL engineers must follow these standards, given in the annexure during designing and estimation and provide supervision during construction to ensure that the standards are met. The impact management recommendations from National Environment Commission (1999) and sectoral guidelines for Road must also be referred, where in general principle and practices to minimize negative economic and environmental impacts of road are cited. Road design in the Zonglela FMU should follow the recommended road profile in Figure 22 to avoid excessive water pooling leading to rutted road surfaces that inhibit access during monsoon season. Improper drainage may also lead to landslides. Following recommended road design would also decrease maintenance cost for future

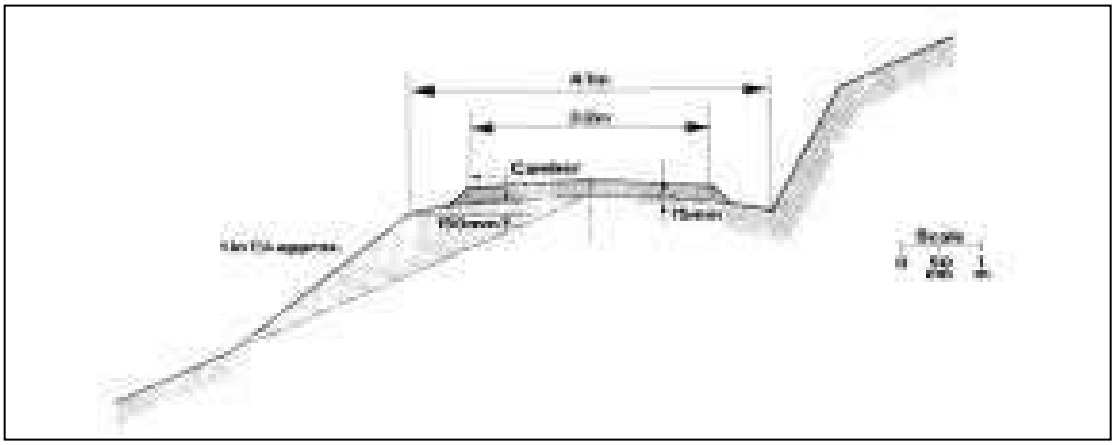


Figure 30: Figure showing Recommended Road Profile

21. PLANNING

21.1 Operational Plan

For facilitating the timely implementation of the Management Plan, a Biennial Operational Plan will be prepared by the CFO, Paro and the Unit In-charge. Guidelines for preparation of Operational Plan are given in the FMCB (2004) and a copy of each is available at Division office. The Operational Plan is also tool used to provide for changes that cannot be foreseen or allowed for in the FMU Plan, such as insect and disease outbreaks, severe fire, etc. If and when these occur, the current Operational Plan should be immediately reviewed and the areas and or methods of operation modified to deal most effectively with possible changes in the sustainable level of harvest

The Operational Plan will be prepared in consultation with all the agencies and parties who will be using the forest. Inclusion of a consultation process with local communities in the preparation of the plan is particularly important so that potential issues concerning communities in the forthcoming operational areas are worked through before the plan is implemented.

The Operational Plan is meant to be a rolling one, i.e., Operational Plan is prepared annually but the plan period is for two year. Therefore, activities for the second year of the plan are carried forward into the first year of the next plan (Table 24). This has important implication on budgeting (since will then be possible to estimate well in advance of the start of the financial planning year) and for participatory process since these can be carried out a year before the start of activity. The primary aim in preparing the Operational Plan is to determine and co-ordinate timely input of resources.

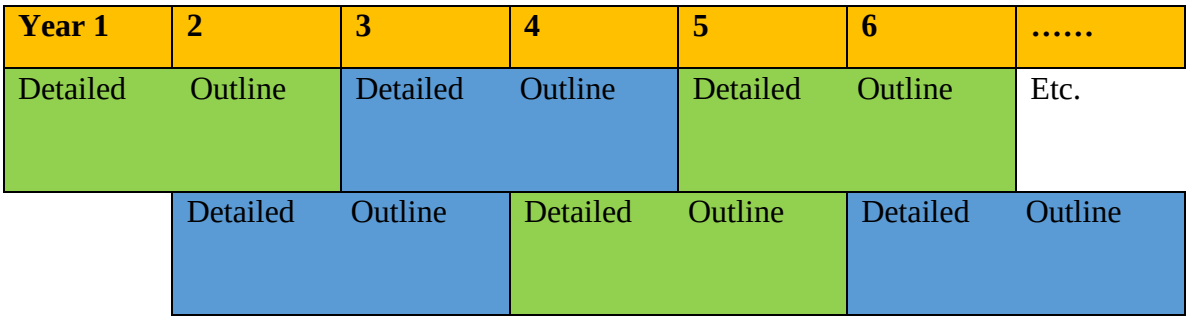


Figure 11: Figure showing Concept of Rolling Plan

Activity (Planning Step)	Objective	Output	Responsibility (lead)	Comments
1. Approved FMP				

2. PRAs with local Stakeholders	To prepare participatory plan for fire management, grazing control and rural timber To involve relevant stakeholders in planning for activities which have a direct impact in their "interest"	Participatory plan for fire management, grazing management and rural timber harvesting (to be incorporated within the OP)	CFO & FMU In-charge	First step is to enter into discuss with stakeholders and their representatives Use PRA technique to prepare the plan Plan cost are included in the OP
3.Operational inventory	To assess the resource availability for the planned harvesting area Calculation of the harvestable volume	Site-level inventory data for the operational area to be harvested Precise estimate of volume to be removed during the coming year	FMU In-charge NRDCL	For the areas proposed for harvesting during the next two years May be combine with harvesting plan and cable line survey
4. Harvesting plan and cable line survey	To plan for harvesting and extraction activities	Agreed extraction and roading plan	NRDCL	Within the selected identified harvestable area for the year
5. Preparation of Operational plan	To prepare a plan for implementation during the next two years (involving stakeholders for some activities)	Approved operational plan with budget Identified responsibilities for each planned activity	FMU In-charge with stakeholders as required	Activities linked with objectives identified in the FMP and following options and guidelines in the FMP

	To formalize local institutional responsibility for planned activities (e.g. grazing, fire management, rural timber distribution	Calculate cost for each planned activity		Each activity with identified responsibility for implementation, estimated cost, and site-specific location
6. FMU annual report presented to the FMU management committee	To review progress and identify and address any implementation problems To identify any future actions necessary based on issues arising	FMU Annual report endorsed by FMU management committee	FMU Manager presents to the management committee	During FMU management committee annual meeting Implementation problems need to be addressed before endorsing the new OP
7. OP review by FMU committee and endorsed	For the FMU management committee to endorse the OP (prior to approval by CFO) To endorse expenditure estimates for the coming financial year	OP endorsed by FMU management committee	FMU Manager presents to the management committee	During FMU management committee annual meeting
8.NRDCL financial commitment within OP agreed	To ensure that NRDCL is committed to funding the agreed activities in the OP	Budget estimates for the OP endorsed by NRDCL and FMU management committee	FMU management committee	Meeting needs to take by November to ensure that budget requirements can be included in the NRDCL APO for

				the next financial year
9. OP approved by Director, DoFPS	To approve OP for implementation	Approved plan and budget	Approved by FRMD and Director, DoFPS	OP approved linked with sanctioned budget for all planned activities
10. OP implementation by NRDCL	To carry out planned activities	Harvested timber; protected area; roads; fuel wood etc	According to responsibilities identified in the OP e.g., FMU In-charge, NRDCL, CFO	Each activity with specific responsibility and budget
11. Monitoring of activities	To assess the level of achievement of planned activities	Information for FMU annual report	FMU In-charge	CFO responsibility is to monitor the implementation of the activities carried by NRDCL Monitoring cost need to appear in the OP
12. CFO, Unit In-charge prepares FMU annual report	To report progress against planned activities To highlight any problems being encountered in implementation	FMU Annual report	FMU In-charge	Prepared annually Progress is reported against each FMP objective and the associated activities
13. Prepare the next year's OP (step 2-5)	To prepare the next OP taking into account progress over the past year	Operational Plan	FMU In-charge	OP may alter in response to FMU management committee suggestions and recommendations

21.2 FMU Level Management Committee

For the smooth implementation of the plan, the FMU-Level Management Committee has been established. The Committee will consist the following members:

- CFO, Paro Forest Division, Chairman
- FRMD Representative
- FMU In-charge, Zonglela FMU
- Regional Manager, Rinpung Region, NRDCL
- Gup of Shaba, Luyni, Lamgong & Wangchang
- Production in-charge NRDCL, Paro
- Key Village Elders

21.3 Terms of Reference for the FMU Level Management Committee:

During FMP preparation;

- To represent the interests of identified stakeholder groups during the planning process for FMP preparation;
- To discuss and agree on FMU forest management objectives for different parts of the forest (zones and working circles), based on national priorities and combined with specific local conditions and local needs;
- To consult (along with FRMD) with specific groups of stakeholders likely to be significantly affected by proposed activities such as road construction and timber harvesting and ensure that their interests are effectively accommodated in the final version of the management plan;
- To review and endorse the draft forest management plan before it is presented to the DoFPS, submitted to NEC and Ministry of Agriculture and Forests for final approval.

During operational planning, implementation and monitoring

- To represent the interests of all the identified stakeholder groups during annual planning and review of activities under Operational plans;
- To review achievements during the previous year (based on an FMU annual report submitted by the FMU In-charge) and advice and act on any issues identified in this report;

- To make recommendations for changes to the proposed OP for the coming year based on the previous years' experience and on the need to achieve the agreed objectives in the Forest Management Plan (FMP);
- To endorse activities, priorities and funding arrangements within the draft OP before submission to the DoFPS;
- To hold any additional meetings as required in response to specific issues arising from FMP and OP implementation;
- To participate in the mid-term (5-year) and final (10-year) evaluation of the FMP.

Sl No	Designation	Numbers
1	Unit In-charge (Forestry Officer)	1
2	Forestry Officer	1
2	Sr. Range Officer/ Forest Ranger II/ I/ Sr. Forester/ Forester	9

This will require minimum one annual meeting of the FMU-Level Management Committee during each year of FMP implementation with the possibility of further meetings to address any urgent matters arising. Meetings need to be timed to ensure consistency with the annual planning cycle and financial year.

21.4 Staff

The Chief Forestry Officer, Paro is the overall controlling Officer of the area. The controlling and management of Zonglela FMU will be looked after by the FMU In-charge. They will be under the administrative control of the Chief Forestry Officer, Paro Division. The Chief Forestry Officer is the direct representative of DoFPS in the field and as such he is solely responsible for all forestry activities, both technical and administrative within his jurisdiction.

21.4.1 Responsibility

For the smooth monitoring and implementation of the plan in the FMU, following staff will be required (Table 34). It is also being recommended by the Organizational Development Exercise by Royal Civil Service Commission.

Table 13: Staff allocation in FMU office

IMPLEMENTATION OF THE PLAN

The UIC under the guidance of CFO will be directly responsible for the day-to-day implementation of the plan. The Unit In-charge will keep records of all the works, supervise and initiate other silvicultural activities as envisaged in this plan. Unit In-charge will be responsible to CFO, Divisional Forest Office, Paro.

Forest Ranger will be responsible for carrying out operational inventory, help to prepare the operational plan, supervise road construction and maintenance and keep the track of regeneration of the harvested areas. Ranger will also be responsible for supervising the tree marking and felling, timber extraction, transport of logs to depot and reporting the coupe clearance. He will also be responsible for marking of thinning, fire and pest activities. The forest guards will be assigned to help the Forest Ranger.

21.5 Buildings

A unit office for the UIC and his/her subordinate staff will have to be constructed by the Divisional office, Paro. NRDCL will also have to build an office for the Range manager and his/her subordinate staff to stationed unit staff in the field.

21.6 Vehicles and Equipment

The FMU is currently equipped with the following equipment and instruments:

• Computer (Desktop) set- 1, Printer- 2, Laptop- 1, Clinometer- 1, Diameter tape- 3, Measuring tape- 1, Compass- 1, GPS Garmin- 2, Walkie Talkie Sets- 13,

In order to ensure proper implementation of this plan, the Unit must be equipped with additional equipment as mentioned below:

Photocopy machine 1, Altimeter- 1, Binocular- 1, Digital Camera- 1, Tents- 2 Additional Garmin GPS- 2 numbers, Laptop- 2, Hypsometer- 1, Crown densitometer- 2, Bark gauge- 2 numbers

22. MONITORING AND EVALUATION

The primary focus of the Royal Government of Bhutan's forest policy is to ensure conservation of the environment and, only thereafter, to allow the derivation of economic benefits (such as commercial timber production) from the forest. To ensure that this policy is being carried out in the management of FMUs, a two-stage verification process is necessary. The first stage checks that on-ground activities are being carried out as planned in the short term, the second checks that the objectives of the plan are being achieved over the longer term. Monitoring (checking on inputs

on year-to-year basis) is the term used for first stage and evaluation (checking achievements against objectives over five-year periods) is the second stage. Standard forms for monitoring and evaluation were prepared and are available from the Forest and Nature Conservation Code of Best Management Practices of Bhutan. The forms for monitoring were subdivided into Physical, Financial and Environmental sections that contained an exhaustive set of questions and the forms for evaluation were also sub-divided into Evaluation form A and Evaluation form B.

The Third Forestry Development Project (TFDP), working closely with the FRMD developed a new monitoring and evaluation process in 1999, for use on FMUs in Bhutan. Different forms were developed on different time scales; **Monitoring Form A** for annual monitoring process, **Evaluation Form A** for the five-year evaluation, and **Evaluation Form B** for one-time Evaluation. The field data collection forms used, consists of **Physical and Financial Forms 1-3, Environmental Forms 4-11** and the **Physical, Financial and Environmental Summary Form.**

22.1 Monitoring

Monitoring is the continuous/periodic review undertaken by management at every level of implementation of an activity to ensure that input deliveries, work schedules, targeted output and other required actions are proceeding according to the plan. The CFO, Paro will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD.

22.2 Evaluation

Evaluation is the examination of whether objectives are being achieved. In the context to FMU evaluation, sufficient time has to elapse before a realistic assessment can be made of progress towards fulfilling objectives (Incoll 1999). Evaluation should be carried out at the intervals of five year, based on the information collected by annual monitoring.

The Head, FRMD will ensure that evaluation is carried out at five-year intervals, based on the information collected by annual monitoring and other necessary information. Copies of necessary forms can be collected from FRMD. Corrective actions, if necessary, may require changes to a range of inputs or to implementation methodology. The evaluation will be carried out by staffs that are independent of the field implementation activities. The evaluation team will be appointed by the Director, DoFPS.

22.3 Record Keeping

Record keeping and reporting is one of the important tools in this management plan of FMU for sustainability and it has to be maintained throughout the plan period. It is essential that all records of activities and operations within the FMU be maintained so that analysis and investigation of past management can be carried out. Record keeping is the backbone of future management decisions and the importance must be stressed by CFO and FMU in-charge.

FMU should keep detail records of the FMU activities by blocks and compartments, commercial and rural, planned and ad hoc separately in the data base of FMU by not only following all the recording forms recommended in the FMCB, but also by maintaining additional data and information. Records related to forestry activities should be updated until end of the plan period and produce a copy for office record. Data collection must also focus on people-not on trees alone since we need to improve our understanding of the people who live in and around forests to measure the importance of forests on social aspects. This would ensure recording and maintaining correct and consistent annual records of FMUs and facilitate mid-term and final evaluation of FMU. The guidelines to complete and fill in the forms; one for Rural Allotment, one for Commercial Allotment and one for Stand Tending and Regeneration activities are available in Forest and Nature Conservation Code of Best Management Practices of Bhutan or in Paro Forest Division and FMU office.

22.4 Reporting

FMU In-Charge should keep FMU records in the standard format recommended in the FMCB and any format circulated by the Divisional office and the DoFPS and follow the timeframe for the submission of required information. Any amendments of record through validation should be apprised to CFO, Paro for similar correction and update.

FMU should be able to furnish any kind of data or record to CFO and to the DoFPS at any time and data maintained in any form should be consistent to each other. Required records for mid-term and final evaluation should be made readily available to the evaluation team.

22.5 Evaluation & Compliance

Evaluation is the examination of whether objectives are being achieved. In the context of FMU evaluation, sufficient time has to elapse before a realistic assessment can be made of progress

towards fulfilling objectives (Incoll 1999). Evaluation must be carried out at five-year intervals, based on the information collected by annual monitoring.

The Head, FRMD and CFO, Paro, will ensure that evaluation is carried out at five-year intervals, based on the information collected by annual monitoring and other necessary.

information. Copies of necessary Forms can be obtained from the Territorial Division, Paro, or from FRMD. However, the detailed forms are there in the FMCB for evaluation.

Staff that are independent of field activities will carry out the evaluation. The evaluation team will be constituted by the Head, DoFPS (minimum five members). The team composition for evaluation of BFMU would comprise of the following members from:

FRMD (leading agency)
Policy and Planning Division, MoAF
CFO, Divisional office (not from same Division)
NRDCL Regional Manager (not from same Division)
RNR-RDC Forestry
Local Government

22.6 Mid-Term Evaluation

The Mid-Term Evaluation of FMU will take place during the last quarter (April-June) of the fifth year (2026) of the FMP period. Team will evaluate implementation of FMU activities based on the required forms and field observation. Observations with suggested recommendations will be provided to FMU and Paro Forest Division for implementation.

CFO and UIC will implement the recommendations and advices of the evaluation team and submit compliance report. Recommendations would be in achievable in short term and long term. However, the Department will provide sufficient time to implementers to implement the recommendations based on their nature of issues and time required.

The findings of mid-term evaluation should be communicated to the FMU Level Management Committee during their annual meeting by the CFO, Paro. Develop action plan based on the recommendations and address by proposing in the cycle of fiscal year of the Government and then into the operational plan. CFO should submit compliance report to the Department for perusal and record.

22.7 Final Evaluation

Final evaluation is to take place during the last quarter (April-June) of the ninth year (2030) of the FMP period. The evaluation team will evaluate FMU activities and specify corrective actions, if necessary, and who should carry out.

FMU and NRDCL will implement recommendations and submit compliance report to the Department through Division. The Paro Forest Division and NRDCL will be given sufficient time for implementation based on the nature of issues and recommendations. The final evaluation should directly inform the preparation of the FMP for the subsequent 10-year period.

CFO should communicate findings and recommendations of the evaluation to the FMU Level Management Committee during their annual meeting. Develop action plan and address by proposing in the operational plan. The CFO should submit compliance report to the Department of Forests and Park Services for perusal and record. The recommendations of the evaluation should be incorporated in the next planning period.

23. CONSTRAINTS AND RISKS

The possible risk and constraints in smooth implementation of the management plan are:

- Inadequate funds for forest management
- Uncertainty of natural regeneration, due to excessive grazing and undergrowth competition
- Lack of research information
- Lack of locomotives for field staffs, leading to an inability of the staff to supervise any management activities in the FMU.
- No regular training for field staffs on preparation of operational plans and other related surveys.
- Lack of skilled and trained forest workers
- Lack of sufficient support to UIC
- Poor coordination between field and office staff and between involved parties

Forest Management Plan relates to multiple uses of forest resources. Increasing benefits of one type may impair or damage others. For instance, timber management may lead to underproduction of non-wood forest products and degradation of bio-diversity. For effective assessment, not only the production function, demand and price structure of each product need to be understood, but also the relationship and conflicts of resource use should be fully comprehended.

24. DEVIATIONS FROM PLAN PRESCRIPTION

The annual harvested AAC should be made to allow for unforeseen situations. For these and other bono fide reasons, the annual AAC may vary +/- 10%. However, the total volume harvested over successive five-year period must be no more than five times the ACC volume.

Unforeseen other circumstances may warrant deviation from the Plan prescription. In such an event, the CFO, Paro Forest Division must obtain prior written approval from the Director, DoFPS. Any such request for plan deviation(s) must fully justified and such approved deviation(s) entered into the Management Plan during its next scheduled revision. The NEC Secretariat must be informed of any Plan Deviations approved by the Head of Department

ANNEXURES

25. References

NEC (1999). Bhutan Environment Assessment Sectoral Guidelines

DoFPS, MoAF (2004). Forest Management Code of Bhutan.

RGoB, MoAF (1995). Forest and Nature Conservation Act of Bhutan, 1995. Thimphu

RGoB, MoAF (2011). National Forest Policy of Bhutan.

NEC (2000). Environmental Assessment Act.

RGoB (2011). The Water Act of Bhutan

ANNEXURES

ANNEXURE: 1 Compartment Review and Prescriptions

COMPARTMENT REVIEW AND PRESCRIPTIONS

Block: Chelela **Compartment: I** **Sub-Compartment: a**

Altitude:	2190 – 3200 meters
Aspect:	North – North East
Slope:	10-35 degree
Terrain:	Gentle Slope
Production:	124.96 ha
Protection:	322.64 ha
Non-Production:	39.82 ha
Community Forest:	288.51 ha
Total Area:	**775.93 ha**

Forest Description

About 60% of this compartment is under forest cover and almost 50% of the forest area is under Community Forest. The areas excluding CF and private registered land under this compartment is put under local use. The south western part of the compartment which is under forest cover consists of blue pine, hemlock, fir and spruce. The Blue pine stands at the lower altitude are immature. The area was operated under selection felling in the past followed by Group Selection System during the implementation of its first and second Management Plan. In the third plan 11 ha of areas below Chelela depot was bought under scientific thinning. The rural timber allotted on single tree system marking from few places. No commercial harvesting was carried out from this compartment.

The lower areas of compartment are under settlement and cultivation.

Prescription for Future Management:

1. Thinning in dense blue pine stands.
2. Single tree marking for rural timber based on the availability of trees in the compartment.

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Block: Chelela	Compartment: II	Sub-Compartment: a

Altitude:	3200 – 3900 meters
Aspect:	North – North East
Slope:	10-35 degree
Terrain:	Steep towards the ridge
Production:	227.81 ha
Protection:	119.34 ha
Non-Production:	2.85 ha
Total Area:	**350 ha**

Forest Description

90% of the compartment is under forest cover and it has good stock of mixed conifer forests. In the 3rd management plan commercial timber extraction was made from this compartment. Cable lines were installed by NRDCL on group selection system

Prescription for Future Management:

1. Installation of cable lines below forest roads to extracted good stock of Mixed conifer forest. The length of cable line might be very short because in the 3rd plan management the areas left unextracted due to shortage of cable line length.
2. Intense thinning is required below forest road and above forest nursery areas

Block: Chelela	Compartment: III	Sub-Compartment: a

Altitude:	3300 – 3700 meters
Aspect:	North East and South East
Slope:	10-35 degree
Terrain:	Gentle Steep
Production:	158.78 ha
Protection:	311.53 ha
Non-Production:	14.38 ha

Total Area:	**484.69 ha**

Forest Description

The compartment is covered by almost 95% forest and the area has good stock of blue pine and mixed conifer forests in pockets. Regeneration is good in the operated areas.

Prescription for Future Management:

1. Thinning operations in dense Bluepine stands
2. Group selection system in the areas that are not harvested in the past.

Block: Chelela **Compartment: IV** **Sub-Compartment: a**

Altitude:	3000 – 4000 meters
Aspect:	North East and South East
Slope:	15-45 degree
Terrain:	Very steep slope toward ridge
Production:	164.81 ha
Protection:	89.05 ha
Non-Production:	35.23 ha
Total Area:	**289.09 ha**

Forest Description

About 25% of the compartment is covered by alpine meadows. The compartment has good stock of mixed conifer stands which is located opposite to Dratshang. However, the major chunk of areas falls under local water and soil protection zone. The mixed conifer stands located below meditation center and Dratshang can be harvested for commercial purpose. The stands in this compartment are matured.

Prescription for Future Management:

1. Thinning in dense Blue pine stands
2. Selection or Group selection system below meditation and Dratshang if terrain is suitable for cable line installation.

ANNEXURES

Block: Chelela	Compartment: V	Sub-Compartment: a

Altitude:	2500 – 3300 meters
Aspect:	North, East and South East
Slope:	10-35 degree
Terrain:	Gentle to steep towards the ridge top
Production:	115.51
Protection:	56.51
Non-Production:	1.39
Total Area:	**173.41**

Forest Description

In the 3rd plan total of 10 ha areas was bought under bark beetle sanitation operation. The rural timber marking following single tree selection system was carried out from this compartment. However, in few places there is good stock of mixed conifer species which can be harvested using cable line.

Prescription for Future Management:

1. Thinning in dense Blue pine stands
2. Commercial timber extraction from areas where there are good stands of intact trees

Block: Chelela	Compartment: V	Sub-Compartment: b

Altitude:	3000 – 3400 meters
Aspect:	South and South West
Slope:	10-35 degree
Terrain:	Gentle to steep
Production:	84.59 ha
Protection:	38.34 ha
Non-Production:	2.45 ha
Community Forest	11.14 ha
Total Area:	**136.52 ha**

ANNEXURES

Forest Description

25% of this sub-compartment is under Druk Tshenden Community Forests, 50% of the area is covered by forests and the alpine meadows constitute the remaining 25% of the sub-compartment. The stands in this sub-compartment are matured and comprises of mixed conifer and Blue pine stands. The rural timber marking was allotted from this compartment in the 3rd plan period.

Prescription for Future Management:

1. Area under CF will be managed as per the Community Forest Management Plan
2. Remaining area will be managed under Selection System for commercial timber extraction

Block: Chelela **Compartment: VI** **Sub-Compartment: a**

Altitude:	2200 – 3100 meters
Aspect:	South East and South
Slope:	10-35 degree
Terrain:	Gentle to steep
Production:	165.37 ha
Protection:	132.87 ha
Non-Production:	161.81 ha
Community Forest	63.08 ha
Total Area:	**523.13 ha**

Forest Description

Only 25% of this sub-compartment is under forests cover and rest of the area is under settlement and cultivation.

Prescription for Future Management:

1. Selection system towards the western part of the sub-compartment
2. Protection from the local disturbances to the forest (grazing, lopping and illegal activities)

ANNEXURES

Block: Nabesa	Compartment: I	Sub-Compartment: a

Altitude:	2100 – 3800 meters
Aspect:	North and north east
Slope:	10-45 degree
Terrain:	Gentle to steep
Production:	472.97 ha
Protection:	892.71 ha
Non-Production:	167.74 ha
Total Area:	**1533.42 ha**

Forest Description

Settlement and agricultural land constitute about 20% of this compartment. The remaining area comprises of mainly Blue pine towards the lower region and Mixed conifer toward the higher region. The area has no forest road.

Prescription for Future Management:

1. Thinning operations in dense Blue pine stands

Block: Nabesa	Compartment: II	Sub-Compartment: a

Altitude:	2600 – 3800 meters
Aspect:	North and north east
Slope:	10-35 degree
Terrain:	Gentle to steep
Production:	490.75 ha
Protection:	360.62 ha
Non-Production:	20.12 ha
Total Area:	**871.49 ha**

ANNEXURES

Forest Description

This compartment comprises of middle-aged Blue pine stands and Mixed conifer forest towards the higher region. In the 3rd plan period few cable lines were installed for timber extraction. The area has good stock of Mixed conifer stands and in few pockets of areas has a walnut stand.

Prescription for Future Management:

1. The compartment has good stock of Blue pine and Mixed conifer stands. The area can be managed under group selection system in this plan period.

2. Silvicultural activities should be implemented with minimum disturbance to the catchment area.

3. NRDCL might have to construct new forest road after intense study of timber stock and site suitability for cable line installation in this plan period.

4. Thinning operations in dense Blue pine stands

Block: Nabesa **Compartment: III** **Sub-Compartment: a**

Altitude:	2700 – 3800 meters
Aspect:	North and North east
Slope:	10-35 degree
Terrain:	Gentle to steep
Production:	262.57 ha
Protection:	219.65 ha
Non-Production:	0.19 ha
Total Area:	**482.41 ha**

Forest Description

The commercial timber harvesting by NRDCL was carried out from this compartment in 3rd plan period. In the year 2015 bark beetle sanitation operation was carried out by NRDCL. There are still good stock of timber left below forest areas which can be harvested using short cable lines in this plan period.

Prescription for Future Management:

1. After completion of extraction from below forest roads, the compartment to be keep intact without any marking activities.

2. Marking in the inter-lines should be avoided.

3. Plantation will be carried out in the cable corridors if the natural regeneration fails.

Block: Nabesa **Compartment: III** **Sub-Compartment: b**

Altitude:	2700 – 3800 meters
Aspect:	East
Slope:	15-35 degree
Terrain:	Steep and very steep in few pockets of areas
Production:	37.51
Protection:	28.68
Non-Production:	0.06
Total Area:	**66.25**

Forest Description

The entire sub-compartment has good forest cover and the composition is dominated by Mixed conifer forests. The rural marking for few applicants were made from this compartment and heavy environmental damage was observed from manual dragging and rolling of timber logs.

Prescription for Future Management:

1. This sub-compartment will be managed under single tree selection system to avoid disturbances to the catchment area. As far as possible marking from this block should be avoided considering the steep slope. However, if there are good stands of trees NRDCL may go for commercial timber harvesting on single tree selection system.
2. Thinning operations in dense Blue pine stands

Block: Nabesa **Compartment: IV** **Sub-Compartment: a**

Altitude:	2700 – 3800 meters
Aspect:	North East and East
Slope:	15-35 degree
Terrain:	Gentle

Production:	604.67
Protection:	332.17
Non-Production:	108.27
Total Area:	**1045.11**

Forest Description

Settlements and agricultural land constitute about 25% of this sub-compartment and the remaining 75% is under forest cover. The composition is mainly Mixed conifer forests. The area has been extracted during the past plan period. Regenerations are good in all past operated cable line areas. In the 3rd plan major bark beetle sanitation operation was carried out in this compartment. The areas which are located below forest roads has been allotted for rural use for this plan period. The water source for Pombesa college and law college is located inside this compartment. Total protection to be given to avoid any complication in future. The local "NYE" called Tsherbum nye is located inside this compartment.

Prescription for Future Management:

1. No commercial operations will be carried out in this sub-compartment since it has been already extracted in the past plan. However, allotment of rural timber may be considered from below forest roads areas.
2. additional sanitation operation needs to be carried out since there are few trees affected by bark beetle in peripheral of sanitation areas.
3. Plantation in sanitation areas if natural regeneration fails
4. No marking in water sources areas

Block: Nabesa **Compartment: IV** **Sub-Compartment: b**

Altitude:	2600 – 3900 meters
Aspect:	South East
Slope:	25-35 degree
Terrain:	Steep
Production:	60.35 ha
Protection:	60.05 ha
Non-Production:	1.98 ha

Total Area:	**122.38 ha**

Forest Description

Alpine meadows towards the west, Blue pine and Mixed conifer forest in the middle constitute this sub-compartment. The eastern half of the sub-compartment is degraded. The rural markings were made from this compartment in 3rd plan period.

Prescription for Future Management:

1. Plantation needs to be carried out in the degraded areas and sanitation areas if regeneration fails

2. The Mixed conifer forests may be managed under single tree selection system

Block: Nabesa **Compartment: V** **Sub-Compartment: a**

Altitude:	2100 – 2600 meters
Aspect:	South East and East
Slope:	10-35 degree
Terrain:	Gentle
Production:	38.18 ha
Protection:	75.94 ha
Non-Production:	185.85 ha
Total Area:	**299.97 ha**

Forest Description

Only 25% of this sub-compartment is covered by forest. Settlements, agricultural lands and barren areas constitute the remaining 75% of the sub-compartment. In the 3rd plan large portion of areas was taken by Pombesa college.

Prescription for Future Management:

1. A plantation and soil conservation work needs to be carried out since the area is degraded.

2. Thinning operation needs to be carried out wherever there are dense Blue pine stands.

Block: Nabesa **Compartment: V** **Sub-Compartment: b**

Altitude:	2900 – 3900 meters
Aspect:	South East and South
Slope:	25-35 degree

Terrain:	Steep
Production:	132.06 ha
Protection:	37.01 ha
Non-Production:	5.79 ha
Total Area:	**174.86 ha**

Forest Description

This sub-compartment has good forest cover. The composition is mainly Mixed conifer and Fir forests. The area has been extracted during the 1st or 2nd past plan period. Regenerations are good. In the 3rd plan rural timber for few applicants were marked from above forest road and on way to Pangkala. Small patch was areas was bought under bark beetle sanitation operation in the year 2019.

Prescription for Future Management:

1. No commercial operations will be carried out in this sub-compartment since it has been already extracted during the implementation of the past plan.

2. additional sanitation operations if necessary, will be carried out

Block: Ngobephu Compartment: I Sub-Compartment: a

Altitude:	2100 – 2800 meters
Aspect:	North and North East
Slope:	10 - 35 degree
Terrain:	Gentle
Production:	189.52 ha
Protection:	260.27 ha
Non-Production:	219.32 ha
Community Forest:	519.68 ha
Total Area:	**1188.79 ha**

ANNEXURES

Forest Description

The entire Tshongdu town which falls under this compartment in 1st, 2nd and 3rd plan was excluded and only area like Damsebu, Khangku and the historic Kichu lhakhang was included within this compartment. About 40% of this compartment is settlements and agricultural land. Community forests constitute about 40% of this compartment. In between CFs rural block has been identified for this plan period. The local use resource allocation to be made to non-CF members only.

Following are the community forests within this compartment:

i. Khangkhu Pendeling CF

ii. Namjo CF

iii. Druk Tsenden CF

iv. Ngoba Puensum CF

Prescription for Future Management:

1. Plantation in the barren and degraded areas of the compartment
2. Thinning operation needs to be carried out wherever there are dense Blue pine stands.
3. Area within the community forests will be managed as per the community forest management plan.

Block: Ngobephu Compartment: I Sub-Compartment: b

Altitude:	2600 – 3400 meters
Aspect:	North West and North
Slope:	15 - 35 degree
Terrain:	Gentle to Steep
Production:	37.55 ha
Protection:	86.48 ha
Non-Production:	175.32 ha
Community Forest:	134.38 ha
Total Area:	**433.73 ha**

Forest Description

This sub-compartment has very good forest cover. The vegetation comprises of mainly

Mixed conifer species. About 60% area of this sub-compartment falls within Community Forest area. Around 30% of the areas is under settlement.

Prescription for Future Management:

1. The area falling within the community forest will be managed as per the community forest management plan.
2. The remaining area will be managed under single tree selection system
3. Thinning operation needs to be carried out wherever there are dense Blue pine stands.

Block: Ngobephu Compartment: II Sub-Compartment: b

Altitude:	2700 – 3700 meters
Aspect:	North West and North
Slope:	15 - 35 degree
Terrain:	Gentle to Steep
Production:	68.56 ha
Protection:	0.48 ha
Non-Production:	1.82 ha
Community Forest:	182.73 ha
Total Area:	**253.59 ha**

Almost 80% of areas is under Community Forest management and areas which are not included in CFs are identified for rural timber allocation. This sub-compartment has very good forest cover. The vegetation comprises of mainly Mixed conifer species.

Prescription for Future Management:

1. The area falling within the community forest will be managed as per the community forest management plan.
2. The remaining area will be managed under single tree selection system for rural marking

ANNEXURES

Block: Ngobephu	Compartment: III	Sub-Compartment: a

Altitude:	3200 – 3800 meters
Aspect:	North and North East
Slope:	10 - 35 degree
Terrain:	Gentle
Production:	80.87 ha
Protection:	28.49 ha
Non-Production:	0
Total Area:	**109.36 ha**

Forest Description

This sub-compartment has been already subjected to commercial extraction in the past. However later in 3rd plan rural timber allotment was also made from this compartment. There are evidences of cable line being used by rural applicants for timber extraction below forest road. Regeneration is good in this sub-compartment. The forest cover is dominated by Fir and Spruce species. The rural timber marking should be carried out below forest road on single tree selection system. The areas above forest road where there is interline to be strictly prohibited from rural marking.

Prescription for Future Management:

1. Commercial extraction will not be carried out in this sub-compartment however on single tree selection rural marking may carried out in below forest road areas. Installation of cable line is recommended in past unoperated areas and non-interline areas
2. Marking in the inter-lines should be avoided however sanitation operations may be carried out if necessary.
3. Water source and critical watershed areas to be protected for marking of trees.

Block: Ngobephu	Compartment: III	Sub-Compartment: b

Altitude:	2800 – 3400 meters
Aspect:	North and North East
Slope:	10 - 35 degree
Terrain:	Gentle to Steep

Production:	73.24 ha
Protection:	27.92 ha
Non-Production:	0
Community Forest:	92.74 ha
Total Area:	**193.9 ha**

Forest Description

This sub-compartment has good coverage of Mixed conifer and Blue pine forests. About 70% of this sub-compartment falls within Ngoba Phensum community forest. A small wetland can also be seen towards the eastern part of this sub-compartment, within the community forest. The compartment was fully operated for commercial timber extraction in 1st and 2nd plan period. However, some portion of interline areas has been included inside CF areas and this might have impact to cutting cycle rotation period in long run. In the 4th plan revision period we tried to trace out how interline areas got inside CF and even we tried to exclude interline areas from CF but CFMG members were reluctant to agree. In the 3rd plan period no timber extraction works were carried out in this compartment.

Prescription for Future Management:

1. The area falling within the community forest will be managed as per the community forest management plan.
2. The timber marking to CFMG from interline areas to be discourage

Block: Ngobephu Compartment: IV Sub-Compartment: a

Altitude:	3000 – 4000 meters
Aspect:	North and North East
Slope:	25 - 35 degree
Terrain:	Steep
Production:	38.02 ha
Protection:	235.29 ha
Non-Production:	0.01 ha
Total Area:	**273.32 ha**

ANNEXURES

Forest Description

This compartment is entirely covered by mixed conifer and fir forest towards the ridge top. The compartment also forms one of the catchment areas for the rivers and the streams below. Forest road has been already constructed till the base of this compartment. The large portion of areas is under protection zone.

Prescription for Future Management:

1. Feasibility of forest road construction with minimum damage to the catchment area needs to be explored to bring the compartment under management.
2. Steep areas towards the west of this compartment needs to be protected from commercial logging activities.

Block: Ngobephu Compartment: V Sub-Compartment: a

Altitude:	2200 – 3300 meters
Aspect:	North East, East and South East
Slope:	10 - 35 degree
Terrain:	Gentle
Production:	111.66 ha
Protection:	8.55 ha
Non-Production:	32.33 ha
Community Forest:	4.67 ha
Total Area:	**157.21 ha**

Forest Description

Only 15% of this sub-compartment is covered by forest, mainly Blue pine. The remaining 85% of the sub-compartment is settlements and the agricultural lands.

Prescription for Future Management:

1. A scientific thinning operation needs to be carried out in the dense Blue pine stands.

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Block: Ngobephu	Compartment: V	Sub-Compartment: b

Altitude:	2200 – 3300 meters
Aspect:	North East, East and South East
Slope:	10 - 35 degree
Terrain:	Gentle
Production:	140.43 ha
Protection:	65.20 ha
Non-Production:	0.82 ha
Community Forest:	0.085 ha
Total Area:	**206.535 ha**

Forest Description

This sub-compartment has good forest coverage. Alpine meadows constitute about 5% of this sub-compartment. The sub-compartment has been already utilized for commercial extraction of timber in past 1st and 2nd plan period.

Prescription for Future Management:

1. Marking in inter-lines needs to be avoided
2. The Mixed conifer forest towards the western part of the sub-compartment needs to be managed under the single tree selection system.

Block: Pombesa	Compartment: I	Sub-Compartment: a

Altitude:	2100 – 2700 meters
Aspect:	North East and East
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	120.14 ha
Protection:	245.52 ha

Non-Production:	436.89 ha
Community Forest:	14.92 ha
Total Area:	**817.47 ha**

Forest Description:

About 55% of the area of this compartment is under settlement and cultivation. The remaining 45% of the area is degraded and are almost barren. Scars of human activities on the forest area are clearly visible. Around 10% of areas falls under Jaripheusum and Jamling Community Forest

Prescription for Future Management:

1. Some of the degraded area needs to be planted so that soil erosion can be minimized and the scenic beauty of the area can be improved.
2. The area falling within the community forest will be managed as per the community forest management plan.
3. Thinning operation needs to be carried out wherever there are dense Blue pine stands

Block: Pombesa Compartment: II Sub-Compartment: a

Altitude:	2100 – 2500 meters
Aspect:	North East, East and North
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	194.31 ha
Protection:	318.42 ha
Non-Production:	449.98 ha
Total Area:	**962.71 ha**

Forest Description

Settlement and cultivations constitute about 70% of this compartment and 30% of the compartment is under forest cover. The large portion of FMU area was put under law and Pombesa college. Young Blue pine stands in few pockets of areas needs thinning in this plan period

Prescription for Future Management:

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1.Some of the degraded area needs to be planted so that soil erosion can be minimized and the scenic beauty of the area can be improved.

2. Thinning operation needs to be carried out wherever there are dense Blue pine stands

Block: Pombesa **Compartment: III** **Sub-Compartment: a**

Altitude:	2700 – 3200 meters
Aspect:	North East and East
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	334.46 ha
Protection:	64.07 ha
Non-Production:	12.35 ha
Total Area:	**410.88 ha**

Forest Description:

Mixed conifer and Blue pine forests constitute the main vegetation of this compartment. The western part of this compartment has been already utilized for commercial extraction of timber. In the 3rd plan period major bark beetle sanitation operation was carried out above the forest road from Ugyen Guru Lhakhag. Few patches of sanitation were also carried out below the forest road. For this plan period the entire areas below forest road will be used for local timber allotment. The marking should be on single tree selection system. Considering the limited timber stock, the rural allotment to be made only for the public of Pombesa villages who are non-CFMG members. Water source and catchment areas to be fully protected from rural marking. The same compartment has been used for rural marking in 3rd plan period and concerned UIC and site In-charge to make sure that marking is not done in previously marked areas.

Prescription for Future Management:

1. Single tree selection marking system to be followed for rural marking
2. Avoid marking in water sources areas and previously marked areas
3. Thinning operation needs to be carried out wherever there are dense Blue pine stands

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Block: Pombesa **Compartment: IV** **Sub-Compartment: a**

Altitude:	2400 – 3200 meters
Aspect:	North East, South East and East
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	15.72 ha
Protection:	90.53 ha
Non-Production:	47.20 ha
Community Forest:	312.05 ha
Total Area:	**465.5 ha**

Forest Description:

Majority of the vegetation within this compartment is Blue pine followed by Mixed conifer, towards the higher elevations. The Blue pine forests are densely stocked. No commercial harvesting was carried out in the 3rd plan period. However, rural marking was made from this compartment. Around 80% of the compartment shared boundary with three community forest areas. The UIC and site In-charge to authentic the CF boundary while marking timber for rural use.

Prescription for Future Management:

1.Single tree selection marking system to be followed

2.Avoid marking in water sources areas and previously marked areas

3.Thinning operation needs to be carried out wherever there are dense Blue pine stands

4.The area falling within the community forest will be managed as per the community forest management plan.

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Block: Zonglela	Compartment: I	Sub-Compartment: a

Altitude:	2100 – 3300 meters
Aspect:	North West and North
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	243.01 ha
Protection:	164.27 ha
Non-Production:	144.02 ha
Community Forest:	175.02 ha
Total Area:	**726.32 ha**

Forest Description:

Settlement and agricultural land constitute about 30% of this compartment (towards the northern side of the compartment). About 50% of the area has been delineated towards Jariphensum community forest. The remaining 20% of the area have good stock of Blue pine and Mixed conifer forests. The areas outside CF to be used for rural marking on single tree selection system. The installation of cable line for RHBT extraction is recommended owing to remoteness of the marking sites.

Prescription for Future Management:

1. The area falling within the community forest will be managed as per the community forest management plan.

2. The remaining area will be managed under single tree selection system for rural timber.

Block: Zonglela	Compartment: II	Sub-Compartment: a

Altitude:	3100 – 3900 meters
Aspect:	North and North East
Slope:	10 - 35 degree
Terrain:	Gentle to Steep

Production:	481.58 ha
Protection:	90.23 ha
Non-Production:	10.78 ha
Community Forest:	2.22 ha
Total Area:	**584.81 ha**

Forest Description:

This compartment has excellent forest coverage. Majority of the area is covered by Mixed conifer forests. The area has been already managed under Group Selection System during 1st and 2nd plan period and during the 3rd plan period few patches of areas was bought under bark beetle sanitation operation. Towards Ugyen Guru Lhakhang there are few pockets of areas which can be used for commercial timber harvesting in this plan period. Around 10% of areas falls under Community Forest area

Prescription for Future Management:

1. The area falling within the community forest will be managed as per the community forest management plan.
2. The remaining area will be managed under group selection system for commercial timber extraction

Block: Zonglela Compartment: III Sub-Compartment: a

Altitude:	2600 – 3200 meters
Aspect:	North and North West
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	209.4 ha
Protection:	58.9 ha
Non-Production:	3.68 ha
Total Area:	**271.98 ha**

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Forest Description:

The below forest road area has been managed for extraction of RHBT in the 3rd plan period. There is also evidence of sanitation operation carried out either in 1st or 2nd plan period. For this plan period the rural allotment will be made from this compartment. The interline areas from RHBT in 3rd plan to be maintained intact. The rural marking to be made from areas which were not marked in pervious plan period. The installation of cable line is recommended to transport timber to road point.

Prescription for Future Management:

1. Single tree selection marking system to be followed for rural marking
2. Avoid marking in water sources areas and previously marked areas
3. Interline areas to be maintained intact

Block: Zonglela Compartment: IV Sub-Compartment: a

Altitude:	3000 – 3900 meters
Aspect:	North East and East
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	183.75 ha
Protection:	42.31 ha
Non-Production:	3.11 ha
Total Area:	**229.17 ha**

Forest Description:

Blue pine, Mixed conifer and fir constitute 90% of this compartment. Remaining 10% of the compartment is covered by rocky outcrops. No timber logging activities were initiated during 3rd plan period.

Prescription for Future Management:

1. The compartment is feasible to be managed under Group Selection System (Mixed conifer) and Selection System (Fir forest).

2. Dense Blue pine stands needs to be thinned scientifically.

Block: Zonglela	Compartment: V	Sub-Compartment: a

Altitude:	2900 – 3900 meters
Aspect:	South East and East
Slope:	25 - 35 degree
Terrain:	Gentle to Steep
Production:	183.75 ha
Protection:	42.31 ha
Non-Production:	3.11 ha
Total Area:	**229.17 ha**

Forest Description:

The vegetation of this compartment consists of Blue pine, Mixed conifer and few rhododendrons. The compartment has a fair stock of timber and no commercial and rural timber extraction has been carried out in 3rd plan.

Prescription for Future Management:

1. Mother trees should to be removed on selection basis.

2. Thinning in the Blue pine stands needs to be carried out.

Block: Zonglela	Compartment: VI	Sub-Compartment: a

Altitude:	2100 – 3100 meters
Aspect:	East, North East and South East
Slope:	10 - 35 degree
Terrain:	Gentle to Steep
Production:	414.75 ha
Protection:	196.67 ha
Non-Production:	67.01 ha
Community Forest:	0.79 ha
Total Area:	**679.22 ha**

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Forest Description:

Settlement and agricultural land constitute about 30% of the compartment. About 10% of the area has been delineated for Jariphensum community forest. Remaining 60% has good coverage of Blue pine forests. Few markings for rural use were carried out from this compartment in 3rd plan. The commercial timber extraction for this plan period is recommended for this plan period

Prescription for Future Management:

1. Thinning operations in dense Blue pine stands
2. Commercial timber harvesting on group opening system.
3. Soil conservation works needs to be carried out to minimize erosion.

Annexure 2: Road and Standards

The road standards developed in the east by TFDP will be implemented for design, drainage and construction of all forest roads in the Zonglela FMU.

Road Design

- Road lengths and density should be minimized, consistent with access requirements to reduce environmental impacts and enhance access economics.
- Where possible locate roads in areas with low side slopes, the maximum side slopes allowed in all areas except rock is 100%.
- Roads must be constructed in such a way that no earth works or soil spill into water courses or watercourse buffer areas. Care should also be taken to ensure that no earth works or soil is allowed to spill onto agricultural land, near houses or main roads.
- Roads should be planned in such a way as to balance cut and fill to minimize transport of construction materials.
- Roads should not be constructed in steep and unstable areas where there is the possibility of landslide. A thorough survey of any area suspected of being unstable should be undertaken prior to work commencing.
- Roads should be kept as narrow as possible to reduce damage to the environment and to reduce costs.

- Where possible, box cuts should be avoided, however they are acceptable for short distances (up to 300 m), if they reduce the length of the road, reduce environmental damage and are properly drained.
- Minimum radius formed by curves or corners should be 15m and should where possible fit the topography of the land.
- Roads should be located on elevated areas where possible to minimize side cutting, width of clearing and drainage problems.
- Side cutting should be carried out leaving a stepped batter, each step no more than 3m in vertical height and no more than 100% gradient with a 1.5m horizontal step.
- Convex road surface should be maintained at all times with the center line 30cm higher than the edges.
- Stabilize and revegetate cut and fill slopes with shrubs, grasses and legumes as soon as possible after construction.
- Ensure proper maintenance of roads and enforce road use restrictions during critical weather conditions such as monsoon seasons.

Drainage

- Road planning should ensure that roads are located in such a way as to minimize stream river crossings and avoid areas which are prone to floods during monsoon
- In areas where side slopes of 70% or greater extend for a distance of 100 m or more above the proposed road catch drains should be constructed to divert surface water into culverts. Side drains or table drains should be at least 40 cm deep and 65 cm wide and should drain into culverts of sufficient size and frequency
- All culverts must have stone or concrete aprons at their exit points to prevent erosion by water. These aprons should be of suitable width and design to prevent any erosion, taking place and should extend down the slope for at least the length of the spill. They should divert the water back into the stream if the water came from a stream.
- Culverts of appropriate diameter (not less than 30 cm) should be placed at regular intervals along the road. The following table gives the minimum spacing required according to road gradient. Should the roadside drain be composed of erodible material then the distance between the culverts must be reduced by 50%.

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Road Gradient (%)	Distance Between Culverts (m)
4	110
5-8	90
9-10	80
11-15	60

Culverts should be laid at 2 to 5 % gradient across the road to enable water to flow but should not exceed 6% as damage from erosion will result. Culverts pipes (Hume pipe) should be buried a minimum of 700 mm below the surface of the road.

- In areas of high seasonal rainfall, catch drains should be constructed above the road to collect surface runoff and prevent it from reaching the road.
- Drains should not be allowed to directly enter a watercourse but should be diverted into surrounding vegetation at least 50 m before a watercourse
- Sumps or silt traps should be places in drains every 50 m in erodable soils and must be cleaned regularly

Road Construction

- All timbers above 30 cm diameter must be felled and removed from the road alignment, the remaining timber should be cut and burnt (no organic material should be used as fill).
- Primary excavation should be done in such a manner as to remove the topsoil and place it on the downward slope of the road. This will allow vegetation to regenerate and stabilize the slopes
- Where side slopes of 70% or more extend more than 100 m downhill no side casting of spoil should be allowed. In this situation end haul methods must be used
- Forest roads should only be constructed on stable soil types where there is no possibility of slippage
- All road construction on side slopes of over 50% or difficult terrain, such as boulder fields, must be carried out using excavators
- Batter and fill slopes should not exceed 100%.
- Where road construction is carried out on side slopes of over 90% rock or concrete wall should be built to support both batter and fill (this is not required in solid rocks).

- ❖ On side slopes of over 70% all of the load carrying surface of the road must be built on stable ground. The road should not be supported by fill.
- ❖ The adverse gradient should not exceed 10%. However, grades of up to 12% will be allowed for distances of up to 300 m if this substantially reduces road length. Following this incline, a minimum distance of 100 m of grades of 10% or less must be maintained
- ❖ The favorable gradient should not exceed 12%. However, grades of up to 15% for distances of up to 300 m will be allowed if this substantially reduces road length. These grades should be followed by grades of less than 10% for distances of 100 m or more.

Annexure 3: Tree Marking Guidelines

Marking Guidelines for Group Selection System

The Group Selection System aims to secure natural regeneration by imitating nature in the creation of small opening in the forest stand; thus, allowing light to reach the forest floor and creating favorable microclimatic condition for seed germination and seedling establishment. It is important to avoid damage to the remaining stand by selecting only trees that will fall into the opening and ensuring that accurate felling is carried out.

- ✓ Small groups spaced at specified interval will be harvested removing all tress over 10 cm DBH.
- ✓ The group will be located along extraction lines.
- ✓ The distance between the extraction lines will be no less than 60 m.
- ✓ The distance between the groups, along the extraction lines, will be less than 50 m.
- ✓ The shape of the harvested groups can be irregular, according to the site and terrain conditions.
- ✓ Existing opening in the stand having already established regeneration should be used as a nucleus for marking the groups.
- ✓ Signs of existing wind fall in the stand should form the basis of the opening. In such a case, opening boundaries should correspond to changes in soil moisture that is often the cause of the windfall.
- ✓ Wind firm trees must surround the selection groups. This could be achieved by leaving intermediate height trees along the edge of the opening.

- ✓ The trees will be marked for harvesting along the extraction corridors.
- ✓ The extraction corridors must be as narrow as possible; 2-4 m in the Fir stands and no wider than 4 m in the Spruce and Hemlock stands.
- ✓ The maximum size of the groups will be on an average less than 0.15 hectares depending on the sites characteristics and stand condition.
- ✓ Diseased, dead and malformed tress will be marked on the priority basis and should be used as a nucleus for creating as opening.
- ✓ Boundaries of opening should, where possible corresponds to change in slope. An opening should not end in the middle of a steep slope since tree will slide into the remaining stand during logging.
- ✓ Care must be taken in choosing the boundary of the opening. Trees, which can be expected to fall into the opening, should be marked while trees leaning out of the proposed opening must be left standing so as to minimize damage to the remaining stand.
- ✓ Trees damaged during harvesting will be cut and removed in the subsequent cleaning operations.
- ✓ Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking guidelines for Single Tree Selection System

Felling under the Single Tree Selection System should be done in accordance with the following guidelines:

- ✓ Trees marked for harvesting will be evenly distributed throughout the stand.
- ✓ Diseased, malformed, dead and decaying trees will be marked on a priority basis; especially these are hampering the better ones (unless objectives of biodiversity conservation dictate otherwise). These trees can be marked even if below the set diameter limit of 50 cm. However, care should be taken that no large openings are created in the stand by marking these trees.
- ✓ Trees of exploitable size should be marked, particularly if defective or lacking in vigor; mature and over-mature trees over 50 cm DBH outside bark to be marked.
- ✓ No more than one third of the stand volume should be marked for harvesting.
- ✓ In mixed stands, an even and suitable distribution of species should be left standing.

- ✓ Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.

Marking Guidelines for Blue Pine under Seed Tree System

- ✓ The seed tree system is used in pure pine stands or mixed stands consisting of mixture of pine and spruce with pine predominating.
- ✓ The Seed Tree System will be used in the above stands only on suitable sites.
- ✓ The system will not be used on steep and exposed, South or South-West sites.
- ✓ In mixed stands, an equal distribution of pine and spruce will be left standing.
- ✓ Slope characteristics, wind firmness and aesthetic value will be considered.
- ✓ About 20 to 25 trees per hectare (i.e. approximately 22 to 26 meters apart) will be left standing.
- ✓ Diseased, malformed and dying trees will be cut on priority basis.
- ✓ Trees left standing will be of good health and form to ensure good seed source.
- ✓ The shape of the area chosen for the seed tree can be irregular.
- ✓ Maximum size of a contiguous area harvested using this system should not exceed one hectare.
- ✓ Fruiting trees and some hollow trees which will have less economic value will not be harvested; it will be left for preserving biodiversity.
- ✓

Marking Guidelines for Thinning in Blue Pine Stands

Thinning will be carried out in immature stands. The objective of thinning is to increase growth and quality of stands and at the same time provide small dimension. Healthy, vigorous trees will be released by cutting.

Spacing and stand Density Regulation

The spacing of trees should be roughly 2 m and the resulting stand density, approximately 2,500 trees/ha. Preferentially maintain admixed species, unless damaged or malformed. Mean maximum diameters of solitary blue pines provide guidance for optimal size dependent stand density considering a 25% deduction of mean maximum crown dimensions for optimal spacing in closed stands. Trees in closed stands will not develop the crown dimensions of free growing (solitary) trees and at the same time individual tree growth and stand growth have to be optimized.

A too severe reduction of stem density (increase of spacing for optimized growth of individual trees) would result in lower standing volume per hectare.

Selection of Plus Trees

Once the stand reaches crown closure at the beginning of pole stage (at top heights of 12-15 m), differentiation between trees in terms of performance and quality will start to become clearly visible in case initial spacing has been carried out. Trees forming part of the stand at time of the final cut (plus trees) have to be selected and marked during this time. A change or supplementary marking of plus trees at a later stage are not possible.

The number of plus trees depends on the target diameter during the final harvest. Considering crown dimensions with a target DBH of 50 cm at rotation period of 100-130 years, selection of 200 plus trees per hectare resulting in a spacing of 7 m between plus trees is recommended. In case the target production for the stand is 40 cm DBH at final harvest, optimal spacing is 6-6.5 m resulting in 260 stems per hectare (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

In case of doubt, stability should have priority before quality. In locations where suitable trees are lacking, no plus tree should be selected. While carrying out thinning operations, special care should be given to plus trees in order to protect them from damage. In case initial spacing has not been carried out, stands reaching pole stage are densely stocked and differentiation between trees in terms of vitality and quality is not clearly visible. Marking of plus trees at this stage is not meaningful.

Therefore, a series of low-intensity thinning entries should be completed before trees are differentiated enough in terms of stability and quality criteria so that selection of plus trees can be carried out (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

- ✓ For each plus tree, mark the one or two (maximum three) strongest competitors for removal in order to provide it enough growing space. Ideally, the total volume removed should be around 25% corresponding to moderate thinning intensity
- ✓ Paint plus trees with yellow band to signalize their importance and for ease of marking in subsequent entries. Trees with such a yellow band should be protected throughout the stand development as they represent the final crop

- ✓ The remaining stand may optionally be thinned, but this is not an essential requirement. In case of thinning the remaining stand, concentrate on removal of malformed and diseased trees.
- ✓ In case the favored tree (plus tree or other) has a crown ratio below half or an asymmetric crown, remove maximum one competitor in order not to jeopardize stability
- ✓ Remove trees affected by dwarf mistletoe on a top priority basis.
- ✓ The stems of forked trees belong to the same vegetative individual and have to be treated together- if you remove one, you have to remove both.
- ✓ Remove malformed trees and trees with other diseases than dwarf mistletoe
- ✓ Marking should not result in creation of gaps in the canopy
- ✓ Focus on maintaining a well-structured stand
- ✓ Focus on promoting a mixed-species stand
- ✓ Do not blaze trees in the remaining stand. Blazing wounds weaken the trees and provide entry point for pathogens, devaluating the most valuable first log of the tree
- ✓ Remove wolf trees (large emergent trees remaining from an earlier cohort) in a priority basis and do not consider their volume within the target of 25% volume removal
- ✓ Do not worry about having to induce regeneration in the course of thinning
- ✓ Thinning is primarily about stand improvement and is not a regeneration cut (Darabant, Rai, Eckmullner, Gratzer, & Gyeltshen, 2012).

Marking for Rural Uses

- ✓ It is necessary that the marking for rural use, whether for timber or fuel wood, should be done under standard Silvicultural system.
- ✓ Firewood marking when necessary should be done under Single Tree Selection System from local use area only
- ✓ Flag posts, fence posts and poles demand should be met by marking for thinning in the pole crop high density stands thereby subjecting the stands to Silvicultural thinning

ANNEXURES

Annexure 1: Minutes of meeting

FMU Consultation Meeting			
Day and Date of Meeting: Wednesday 02 November 2022.			
Venue:	Rangers' Hall Paro Forest Division		
Agenda	Issue Raise by	Comments	Resolutions:
Introduction to FMUS	Brief history and background of FMUs in Bhutan, objectives of FMUs, Overview of FMUs in Paro Forest Division-Presented by Mr.Dhendup Jamtsho (FO)		
ZFMU Present Status	Area 15803 ha AAC 5118m3 Plan Period 2022-2031, 4 Blocks 37 sub compartment; net production area 4273.59 ha (41.7%), Commercial & Rural blocks for 2022-2032 protection areas and community forests were presented to committee		
Need to increase AAC	Lungnyi Gup & Wangchang Gup	Recommended to reduce commercial AAC & adjust to Rural AAC. Also, to look into possibility of adjusting some commercial area into rural block. To this RAMS head replied to it would be near impossible as there are no commercial operable areas although allocated AAC is quite higher than Rural AAC. Further he commented Rural areas and commercial areas were well designated and operated in last three 10 years plan and allocating some portion of commercial areas to rural in the plan will disturb and affect the interviews thereby defeating the very purpose of scientific management. This will have many implications in implementing the plan in next 10 years and beyond.	Since allocating commercial area to Rural use will have negative impact on rotation period and cutting cycle, the forum decided to maintained rural block as reflected in the plan.
Need of annual FMU Road maintenance	Shabo Gup	Forest road and farm road in Nabee areas become redundant to travel in summer due to heavy plying of vehicle and flooding in raining days. This requires constant funding to enable clearing and maintenance. Since the NRDCL also use this road for logging there need to put in place plow back mechanism where NRDCL should pay or invest in road maintenance annually. To this NRDCL ant In-charge comments such mechanism is already in place where they provide Nu.50,000 annually for road maintenance directly to road user group. The Gup was rather surprised that Gewog Administration to this date was not aware of such mechanism, and she recommended if NRDCL can inform or at least make them aware when such payments to community is being made. She questions the transparency of payment and expenditure made in field.	NRDCL to make payment for such maintenance through Gewog Administration but not directly to user group.

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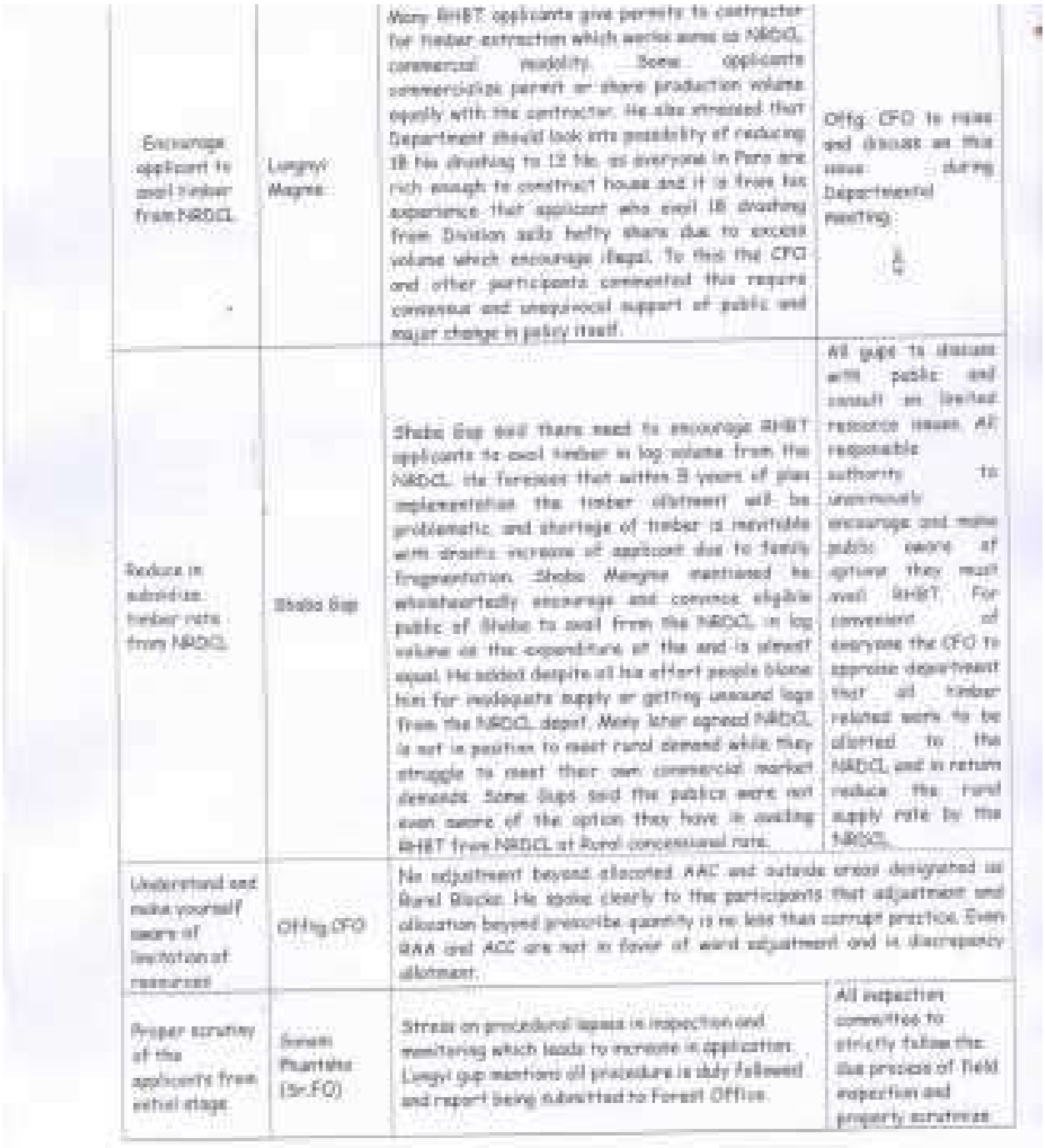

Encourage applicant to avail timber from NRDCL	Lungvi Magma	Many RHBT applicants give permits to contractor for timber extraction which works some as NRDCL commercial modality. Some applicants commercialize permit or share production volume equally with the contractor. He also stressed that Department should look into possibility of reducing 18 No shushing to 12 No. as everyone in Pare are rich enough to construct house and it is free for experience that applicant who avail 18 shushing from Division asks hefty share due to excess volume which encourage illegal. To this the CFO and other participants commented this require consensus and unequivocal support of public and major change in policy itself.	Offg. CFO to raise and discuss on this issue during Departmental meeting.
Reduce in subsidize timber rate from NRDCL	Shaba Gap	Shaba Gap said there need to encourage RHBT applicants to avail timber in log volume from the NRDCL. He foresees that within 3 years of plan implementation the timber allotment will be problematic and shortage of timber is inevitable with drastic increase of applicant due to family fragmentation. Shaba Mangma mentioned he wholeheartedly encourage and convince eligible public of Shaba to avail from the NRDCL in log volume as the expenditure of the and is almost equal. He added despite all his effort people blame him for inadequate supply or getting unsound logs from the NRDCL depot. Many later agreed NRDCL is not in position to meet rural demand while they struggle to meet their own commercial market demands. Some Gaps said the publics were not even aware of the option they have in availing RHBT from NRDCL at Rural concessional rate.	All gaps to discuss with public and consult on limited resource issues. All responsible authority to unanimously encourage and make public aware of options they must avail RHBT. For convenient of everyone the CFO to approve department that all timber related work to be allotted to the NRDCL and in return reduce the rural supply rate by the NRDCL.
Understand and make yourself aware of limitation of resources	Offg.CFO	No adjustment beyond allocated AAC and outside areas designated as Rural Blocks. He spoke clearly to the participants that adjustment and allocation beyond prescribe quantity is no less than corrupt practice. Even RAA and ACC are not in favor of ward adjustment and in discrepancy allotment.	
Proper scrutiny of the applicants from initial stage	Sonam Phuntsho (Sr.FO)	Stress on procedural lapses in inspection and monitoring which leads to increase in application. Lungvi gup mentions all procedure is duly followed and report being submitted to Forest Office.	All inspection committee to strictly follow the due process of field inspection and property scrutinize

ANNEXURES

Annexure 2: Paro Dzongkhag Administrative Approval

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THE ROYAL GOVERNMENT OF BHUTAN

[illegible]

DZONGKHAG ADMINISTRATION, PARO

[illegible]

[illegible] 6206 June 7, 2022

Chief Forest Officer
Department of Forest,
Paro Dzongkhag

Subject: Dzongkhag Administrative Approval/Location clearance

Sir,

This has a reference to your letter received vide letter no.PFD/RAMS/FRMS-11/2021-2022/29 dated May 31, 2022 with regard issuance of administrative approval for establishment and operation Zonglela Forest Management Unit Plan under Paro Dzongkhag.

In this regard the Dzongkhag administration is pleased to issue the administrative approval for the said activity however the activity should be carried out with strict adherence to NEPA 2007, EA Act 2000 and its regulation 2016 and any other rules and regulation in force.

This approval will stand valid only upon obtaining the required environmental clearance from the concerned competent authority.

Yours sincerely,

(Namgay Dorji)
DZONGDAH

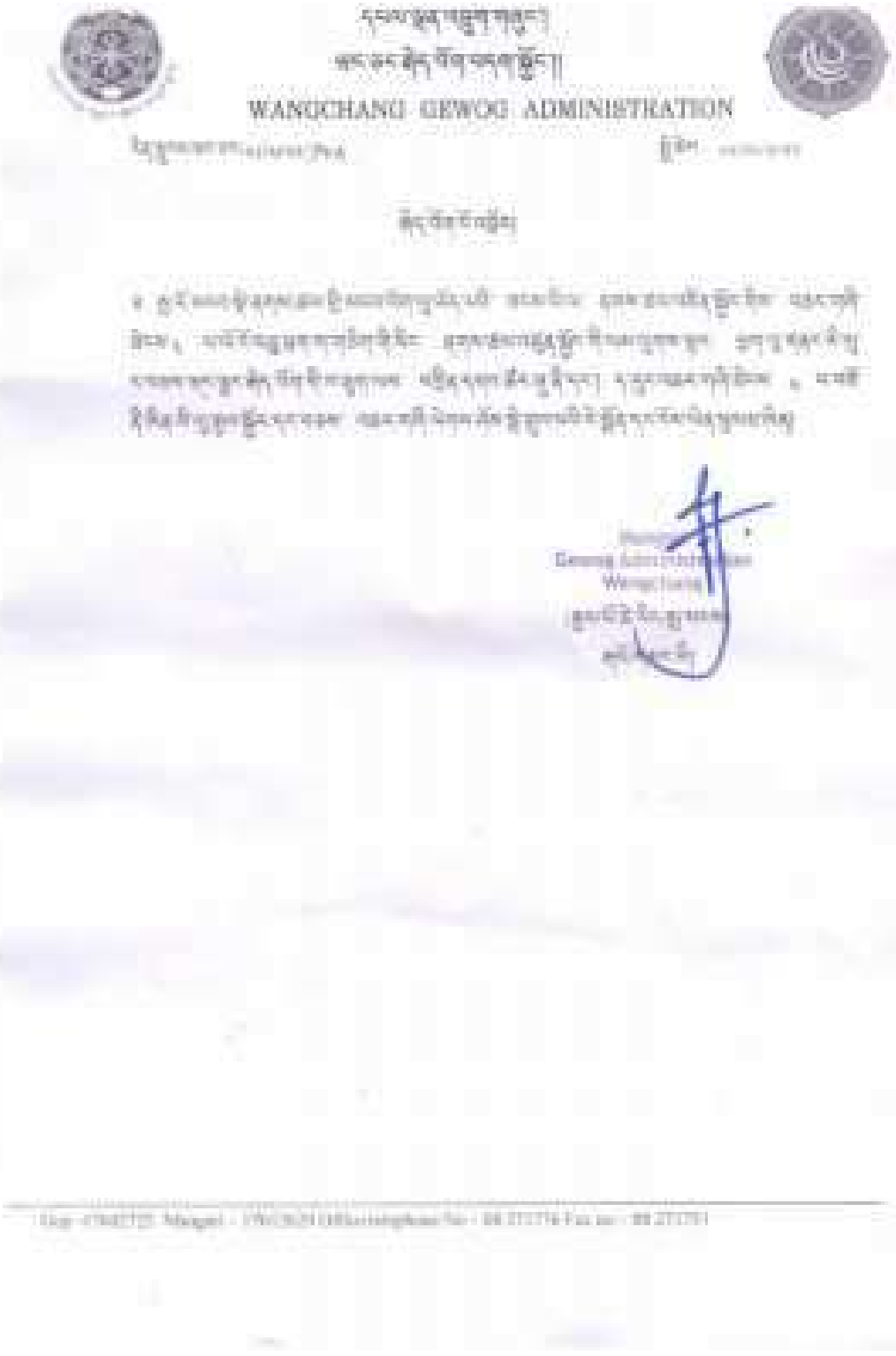
Cc:

1. Gup, Wangchang for kind information please
2. Gup, Shaba for kind information please
3. Gup, Lani gang for kind information please

Telephone : Fax # 08-271474 PABX # 08-271342

ANNEXURES

Annexure 3: Geog Administrative Approval, Wangchang Geog



WANGCHANG GEWOG ADMINISTRATION

ANNEXURES

ANNEXURES

Annexure 4: Administrative Approval Shaba geog

ROYAL GOVERNMENT OF BHUTAN
GEWOG ADMINISTRATION
SHABA, PARO

[illegible] Date: [illegible]

Chief Forest Officer,
Forest Division,
Paro

Subject: Gewog Administrative approval

Sir,

This has a reference to your letter received vide letter no.[illegible] dated on April 04, 2022 with regard issuance of administrative approval for revising 4th Zonglela Forest Management Unit Plan under Forest Division,Paro.

In this regard the Gewog administration is pleased to issue the administrative approval for the aforesaid subject.

Thanking You

Yours Sincerely

Gup, Shaba

Cc.Office file

ANNEXURES

Annexure 5: Administrative Approval Lungnyi Geog

ANNEXURES

Annexure 6: Participants list for management plan consultation meeting

ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF AGRICULTURE AND FORESTS
DEPARTMENT OF FORESTS AND PARK SERVICES
ZONGLELA FMU, PARO FOREST DIVISION
PARO, BHUTAN

FMU COMMITTEE LEVEL/CONSULTATION MEETING, ZONGLELA FMU

VENUE: Rangers Hall, Paro Division Compound
Date: Wednesday, 2nd November 2022

Participant list

Sl.NO	Name	Designation	Contact Number	Signature/Remarks
1	Jamtsho	Gup Lun[illegible]	17703715	
2	Gyelpo Tsering	Gup Naja[illegible]	17[illegible]	
3	Gyeltshen	Samphu[illegible]	1765 1157	
4	Chencey Rangdel	Sr. Forest Ranger	17[illegible]58	
5	Kinzang Dem	NRDCL [illegible]	17[illegible]	
7	Pema Tendzin	Sr. FR III	17170900	
8	Sangay Tenzin	FR II	17[illegible]	
9	Tshering Wangchuk	Sr. FG	77211995	
10	Gado Bhutia	Sr. FR III	17703666	
11	Sherab Jamtsho	FO	17702210	
12	Tashi	Sr. FR I	1766[illegible]	
13	[illegible] Dorji	FO	[illegible]	
14	Sangay Thinley	Gup [illegible]	7629378	

Divisional Forest Office, Paro, Bhutan. Tel. # +975-08-27 2164/ 27 21 83   Fax # +975-08-272162

ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF AGRICULTURE AND FORESTS
DEPARTMENT OF FORESTS AND PARK SERVICES
ZONGLELA FMU, PARO FOREST DIVISION
PARO, BHUTAN

15	Tshering Tobgay	[illegible]	[illegible]	[signature]
16	Gyeltshen	[illegible]	[illegible]	[signature]
17	[illegible] Gyeltshen	[illegible]	17660587	[signature]
18	[illegible] Wangdi	Division	17638517	[signature]
19	Pema Rinzin	-"-	[illegible]	[signature]
20	[illegible]	-"-	[illegible]	[signature]
21	Chodup	-"-	17630465	[signature]
22	Namgay	[illegible]	[illegible]	[signature]
23	Tshering Dorji	[illegible]	[illegible]	[signature]
24	Dorji Wangdi	Division	[illegible]	[signature]
25				
26				
27				
28				
29				
30				

Divisional Forest Office, Paro: Bhutan Tel. # +975-08-271166/ 27 21 63 Fax. # +975-08-272162

ANNEXURES

Annexure 7: Pictures of meeting participants




ANNEXURES

Annexure 8: Record keeping formats

MC	WC	Date	Name and Address	Permit #	TMB #	Particulars			Volume (m3)			Comments
						Species	Product Type	Amount	Marked	Recovered	Firewood	

ANNEXURES

Annexure 9: Commercial Allotment Form

Block: **Compartment:** **Sub-compartment:**

MC	WC	Year of Activity	Commercial Activities					Volume (m3)				Other Activities	TMB #	Comments (Include detailed description of cable line location in relation to mappable features)
			Cable Lines			Groups/Patches/ Other		Marked		Extracted (FDC)	Firewood (lops/tops)			
			Line #	Length (m)	Azimuth	Total #	Total Area (ha)	# of trees	Vol.					

Annexure 10: Stand Tending and Regeneration Form

ANNEXURES

Block: **Compartment:** **Sub-compartment:**

MC	WC	Cable line #	Year	Stand Tending		Regeneration						Comments or Other Activities
				Activity	Area (ha)	Natural/ Plantation	Species	Year Surveyed	Area (ha)	Survey Results (stems/ha or survival percent)	Resurvey?	

ANNEXURES

Annexure 11: Data Recording Forms

1. Timber Extraction Records for Cable lines and Adhoc areas

FORM 1.1: Timber Extraction Records from Cable Line

Form 1.1: Timber Extraction records from Cable Lines					
Name of FMU		Compartment			
Block		Year of Operation (m/y)			
Cable line No		No. of Group (s)			
Cable Line Length(m)		Clear-felled area (Ha)			
Azimuth (degree)					
GPS coordinates	Top Endmass (dd/mm/ss):				
	Bottom Endmass (dd/mm/ss):				
Start Date		End Date			
Detailed of standing and Log volume marked from cable lines (m3)					
Species	**Standing volume (m3)**	**Log volume (m3)**	**Poles (m3)**	**Firewood (m3)**	**Woodchips (m3)**
Hemlock					
Spruce					
Fir					
Broadleaf					
Total					

Details of Royalty Realized	
On Logs	
On firewood/Lops & Tops (Nu.):	
Total Royalty (Nu.):	

Description

FORM 1.1 is to be maintained one for every cable line operated in a year. The standing volume must be transferred from the Marking List maintained by the marking officer prior to operation of the cable line. The Log volume and the volume for Firewood/Woodchips must be entered post operation of

Cable line. The data for Log volume, volume for Firewood and Woodchips can be transferred from **FORM 2.1**

FORM 1.2: Timber Allotment Records from Ad-hoc area

Form 1.2: Timber Extraction records Ad-hoc areas				
Name of the FMU				
Block		Compartment		
Purpose				
Forestry Clearance no				
Length of Road/Transmission Line (m)				
Clear-felled area (ha)		Area (Substitude/alnd lease):		
Year of Operation (m/y)				
Start Date		End Date		

Details of Satnding volume Marked from Ad-hoc Activities(m3)					
Species	Standing volume Marked (m3)	Log volume (m3)	Poles (m3)	Firewood (m3)	Woodchips (m3)
Hemlock					
Spruce					
Fir					
Broadleaf					
Total					

Details of Royalty Realized (On Production Basis)	
On sawn timber (Nu)	
On Logs (Nu)	
On Poles (Nu)	
On Firewood/Lops & Tops (Nu)	
Total Royalty (Nu)	

Description

FORM 1.2 is to be maintained one for every ad-hoc activity in a year. The standing volume must be transferred from Marking List maintained by the Marking Officer prior to operation of the ad-hoc area. The Log volume and the volume for Firewood/Woodchips must be entered post operation of ad-hoc area. The data for Log volume, volume for Firewood and Woodchips can be transferred from **FORM 2.2**

ANNEXURES

Monthly Timber allotment records

FORM 2.1: Monthly Commercial Timber Production Details from Cable lines

Form 2.1 Monthly Commercial Timber Production Details from Cable Lines													
Name of FMU													
Month/Year													
Date	COSDTMO No	Cable lines no	Logs (A)			Poles (B)			Total Volume (A+B)	Firewood		Woodchips	
			Vol (Cfts)	No.of pieces	Species	Vol (Cfts)	No.of pieces	Species		Species	Vol (Cfts)	Species	Vol (Cfts)

Description

FORM 2.1 is to be used for maintaining data of Commercial Timber Production from cable lines on actual production basis every month

FORM 2.2: Monthly Commercial Timber Production Details from Ad-hoc areas

Form 2.1 Monthly Commercial Timber Production Details from Ad-hoc areas													
Name of FMU													
Month/Year													
Date	COSDTMO No	Ad-hoc areas	Logs (A)			Poles (B)			Total Volume (A+B)	Firewood		Woodchips	
			Vol (Cfts)	No.of pieces	Species	Vol (Cfts)	No.of pieces	Species		Species	Vol (Cfts)	Species	Vol (Cfts)

Description:

ANNEXURES

FORM 2.2 is to be used for maintaining data of Commercial Timber Production from Ad-hoc areas on actual production basis every month.

FORM 2.3: Monthly Rural Timber Allotment (New Construction/ Renovation/ Extension)

Form 2.3: Monthly Rural Timber Allotment Details (New Construction/ Renovation/ Extension)										
Name of FMU										
Month/Year										
Sl No	Date of Issue	Name of Applicant	Address	Tharm No	House No	Permit No	New/Renovation	Sanction letter no	Vol marked/ No.Trees	
									Standing vol (m3)	Log vol (M3)

Description

FORM 2.3 is to be used for maintaining data of Rural Timber allotments made for New Constructions, Renovation, Extension, Cow shed construction…etc from the FMU on monthly basis.

FORM 2.4: Monthly Rural Timber Allotment (Firewood, Flag Poles, Fencing Poles, Others)

Form 2.4: Monthly Rural Timber Allotment Details (Firewood, Flag Poles, Fencing Poles, Others																			
Name of FMU																			
Month/Year																			
Sl No	Date of Issue	CID No	Name of Applicant	Address	Tharm No	House No	Permit No	Purpose	Sanction letter no	Type and Quantity of Forest Produce Supplied									
										Firewood (m3)		Fencing Post		Flag Post		Others		Total Qty (m3)	
										Standing Vol (M3)	Actual production (m3)	Standing Vol (M3)	Nos	Standing Vol (M3)	Nos	Standing Vol (M3)	Nos		

Description

FORM 2.4 is to be used for maintaining data of Rural Timber Allotment made for Firewood, Flagpoles, Fencing Poles, Others.etc from the FMU on monthly basis.

ANNEXURES

FORM 2.5: Monthly NWFP Supply Record FORM

Form 2.5: Monthly NWFP Supply Record

Name of the FMU:

Month/Year:

Sl. No.	Name of the Applicant	CID No.	Thram No.	House No.	Address	Permit No.	Date of Issue	Purpose	Sanction No. and Date	Description and Quantity of NWFP Supplied					
										Stone (m3)	Sand (m3)	Soil (m3)	Bamboo (nos.)	Gravel (m3)	Others

Description

FORM 2.5 is the cumulative data recording form for NWFP extracted from the FMU on a monthly basis.

3. Annual Timber Allotment Records

FORM 3.1: Annual Commercial Timber Extraction from Cable Lines FORM

Form 3.1: Annual Cable Line Operation Data

Name of the FMU:

Reporting Year:

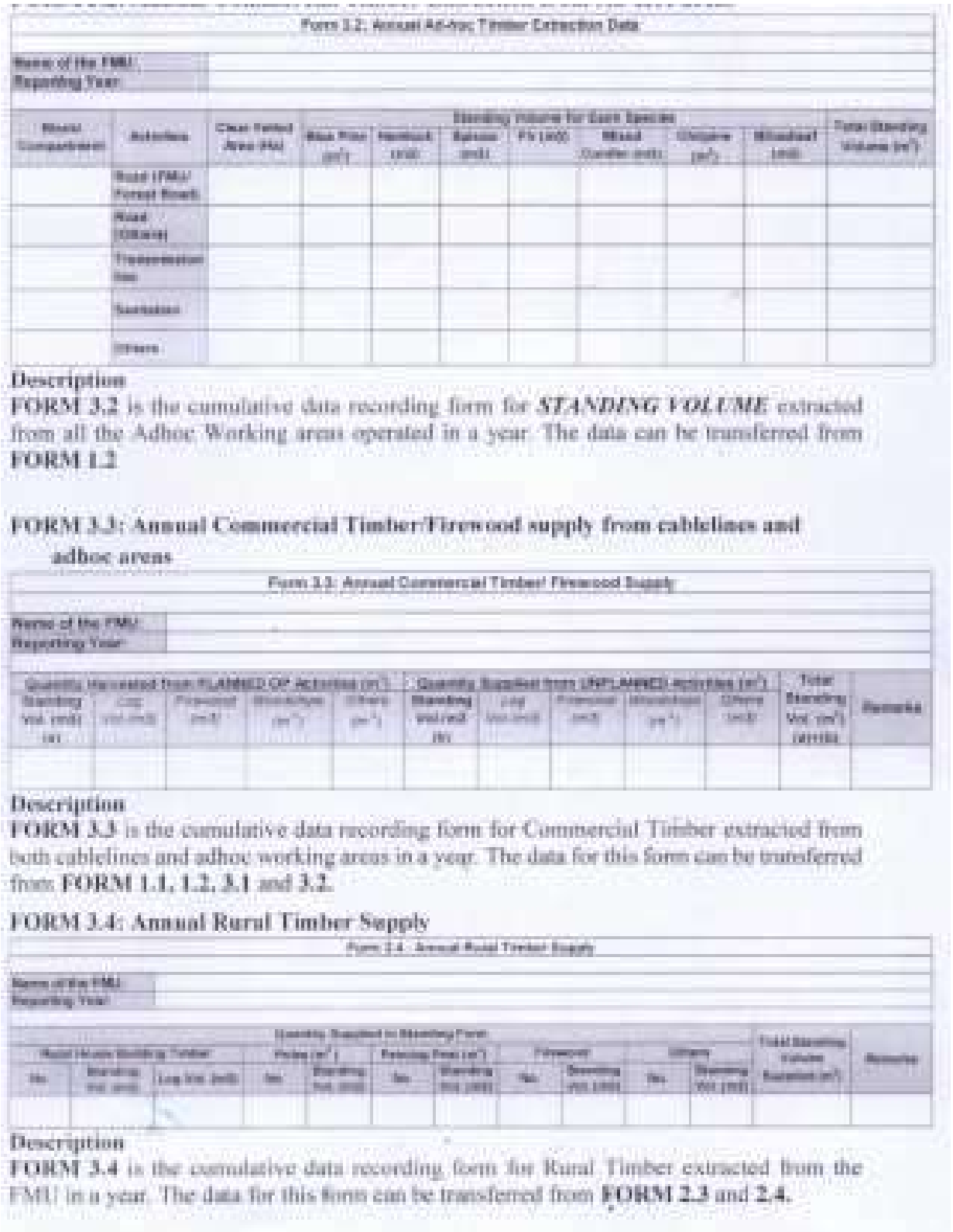
Block/ Compartment No.	Cable Line					Total clear felled area (ha)	Standing volume for each species							Total standing volume (m3)
	No./ Year	Length (m)	GPS Coordinate (Top and Bottom Endpoints)	No of Groups/ Area (ha)	Corridor Area (ha)		Blue pine (m^3)	Hemlock (m3)	Spruce (m3)	Fir (m3)	Mixed Conifer others (m^3)	Chirpine (m^3)	Broadleaf (m3)	

Description

FORM 3.1 is the cumulative data recording form for ***STANDING VOLUME*** extracted from all the cable lines operated in a year. The data can be transferred from **FORM 1.1**

ANNEXURES

FORM 3.2: Annual Commercial Timber Extraction from Ad-Hoc areas



Form 3.2: Annual Ad-hoc Timber Extraction Data

Name of the FMU:
Reporting Year:

Forest Compartment	Activities	Clear Felled Area (Ha)	Standing Volume for Each Species								
			Blue Pine (m^3)	Hemlock (m3)	Spruce (m3)	Fir (m3)	Mixed Conifer (m3)	Chilgoza (m^3)	Miscellaneous (m3)	Total Standing Volume (m^3)
	Road (FMU/ Forest Road)									
	Road (Others)									
	Transmission line									
	Sawmillers									
	Others									

Description

FORM 3.2 is the cumulative data recording form for ***STANDING VOLUME*** extracted from all the Adhoc Working areas operated in a year. The data can be transferred from **FORM 1.2**

FORM 3.3: Annual Commercial Timber/Firewood supply from cablelines and adhoc areas

Form 3.3: Annual Commercial Timber/ Firewood Supply

Name of the FMU:
Reporting Year:

Quantity Harvested from PLANNED OP Activities (m^3)					Quantity Supplied from UNPLANNED Activities (m^3)					Total Standing Vol. (m^3) (Annex)	Remarks
Standing Vol. (m3) (a)	Log Vol. (m3)	Firewood (m3)	Wood/Pole (m^3)	Others (m^3)	Standing Vol. (m3) (b)	Log Vol. (m3)	Firewood (m3)	Wood/Pole (m^3)	Others (m3)		

Description

FORM 3.3 is the cumulative data recording form for Commercial Timber extracted from both cablelines and adhoc working areas in a year. The data for this form can be transferred from **FORM 1.1, 1.2, 3.1** and **3.2.**

FORM 3.4: Annual Rural Timber Supply

Form 3.4: Annual Rural Timber Supply

Name of the FMU:
Reporting Year:

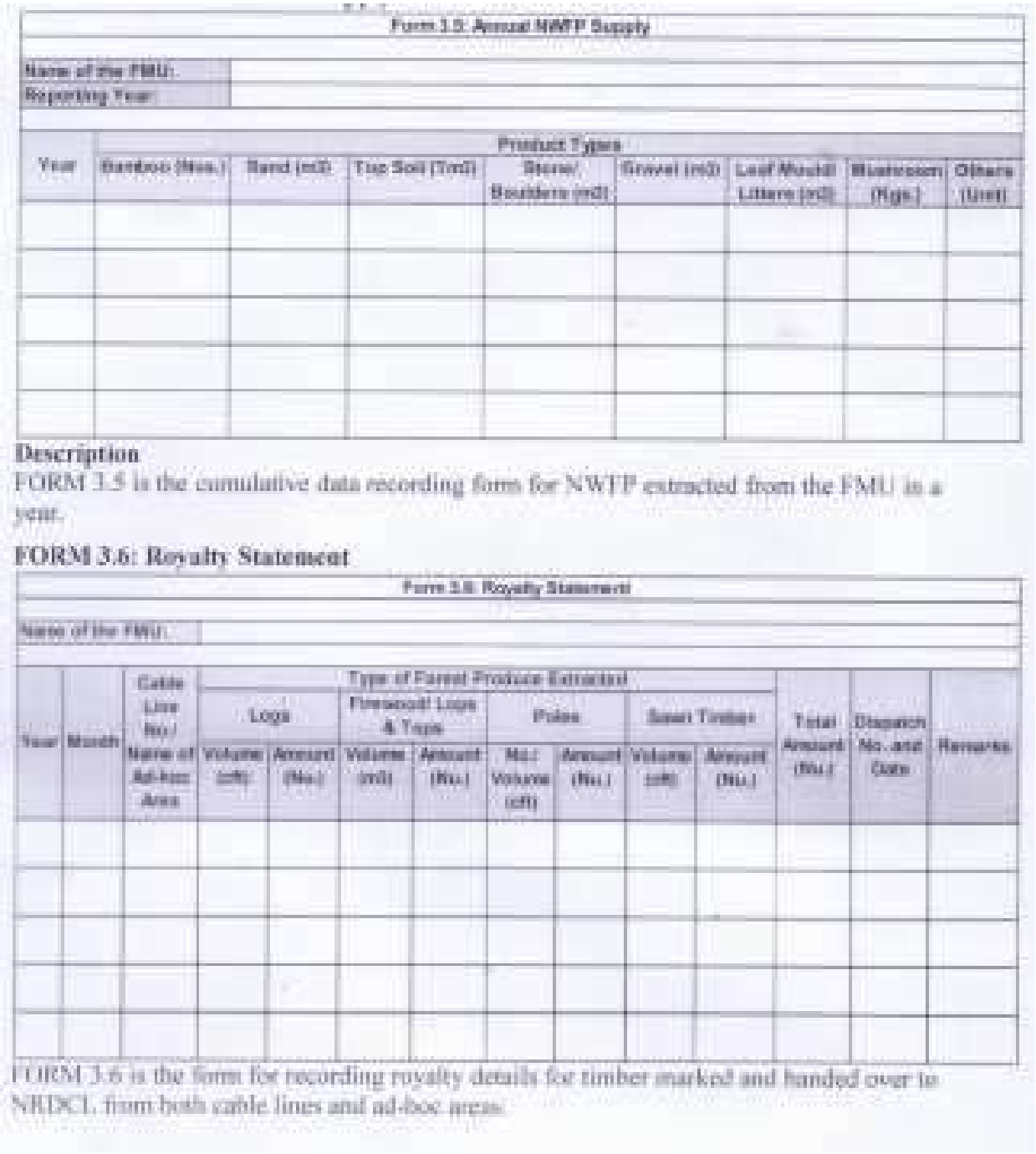
Quantity Supplied to Standing Farm											Total Standing Volume Supplied (m^3)	Remarks
Rural House Building Timber			Poles (m^3)		Fencing Post (m^3)		Firewood		Others			
No.	Standing Vol. (m3)	Log Vol. (m3)	No.	Standing Vol. (m3)	No.	Standing Vol. (m3)	No.	Standing Vol. (m3)	No.	Standing Vol. (m3)		

Description

FORM 3.4 is the cumulative data recording form for Rural Timber extracted from the FMU in a year. The data for this form can be transferred from **FORM 2.3** and **2.4.**

ANNEXURES

FORM 3.5: Annual NWFP supply



Form 3.5: Annual NWFP Supply

Name of the FMU:
Reporting Year:

Year	Product Types							
	Bamboo (Nos.)	Sand (m3)	Top Soil (Tm3)	Stone/ Boulders (m3)	Gravel (m3)	Leaf Mould/ Litters (m3)	Mushroom (Kgs.)	Others (Unit)

Description

FORM 3.5 is the cumulative data recording form for NWFP extracted from the FMU in a year.

FORM 3.6: Royalty Statement

Form 3.6: Royalty Statement

Name of the FMU:

Year	Month	Cable Line No./ Name of Ad-hoc Area	Type of Forest Produce Extracted								Total Amount (Rs.)	Dispatch No. and Date	Remarks
			Logs		Firewood/ Logs & Tops		Poles		Sawn Timber				
			Volume (cft)	Amount (Rs.)	Volume (m3)	Amount (Rs.)	No./ Volume (cft)	Amount (Rs.)	Volume (cft)	Amount (Rs.)			

FORM 3.6 is the form for recording royalty details for timber marked and handed over to NRDCL from both cable lines and ad-hoc areas.

ANNEXURES

Annexure 12: Zonglela FMU field inventory work pictures






ANNEXURES






ANNEXURES