ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF AGRICULTURE AND FORESTS
DEPARTMENT OF FORESTS AND PARK SERVICES
DIVISIONAL FOREST OFFICE, MONGAR

FOREST MANAGEMENT PLAN FOR LINGMETHANG FOREST MANAGEMENT UNIT, MONGAR DZONGKHAG

PLAN PERIOD: JULY 2019 TO JUNE 2029

Tashi Wangdi, Sr. Forest Ranger
Divisional Forest Office, Mongar
&
Tashi Norbu Waiba, Sr. Forest Officer
Forest Resources Management Development, Thimphu.

PERIOD OF THE PLAN

This Plan is valid for the period of 10 years from 1st July 2019 to 30th June 2029

AUTHORITY FOR PREPARATION, REVIEW AND APPROVAL

The authority for preparation of this plan was given to the Divisional Forest Office (DFO), Mongar, Department of Forest and Park Services.

PROVISION FOR REVISIONS AND CHANGES

The Head of the 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, or if huge challenges arise and need to relook at the management plan. The CFO, Mongar may prepare revisions and changes to the plan for submission to the Director, DoFPS for approval.

APPROVAL

This plan was examined by a wide section of user groups, clients and organisations. The final revision of the plan was reviewed and technically cleared by the Head, FRMD and an environmental clearance was obtained from National Environment Commission Secretariat. It was then submitted to the Director, DoFPS who after further review and amendment forwarded with his recommendation for approval to the Secretary, MoAF. The Secretary, MoAF, further reviewed and submitted the plan to the Minister, MoAF for his approval for implementation.

Submitted for Approval

Chief Forest Officer
Forest Resources Management Division

Recommended for Approval

Director
Department of Forests and Park Services

Secretary
Ministry of Agriculture and Forests

APPROVED

Hon'ble Minister
Ministry of Agriculture and Forests
Date: .....

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དཔལ་ལྡན་འབྲུག་གཞུང་།
National Environment Commission
Royal Government of Bhutan

NECS/EACD/Dzo-Mongar/3708/2019/ 1285

June 21, 2019

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 (FRMD), Department of Forests and Park Services for the operation and management of the final phase of **Lingmithang Forest Management Unit (LFMU)** measuring an area of **10,601.33 hectares/26,192.42 acres** with Annual Allowable Cut (AAC) Fixed at **9,900 m^3 (Nine Thousand Nine Hundred Meter cube)** and covering the plan period from January 1, 2019 till December 31, 2028; and construction of **10 Km forest road** within the FMU at Mangling village under Saling Gewog, Mongar 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 Act 2000 and its Regulation 2016, Waste Prevention & Management Act of Bhutan 2009 and its Regulation 2012 (Amendment 2016), The Water Act of Bhutan 2011 and its Regulation;
2. ensure that the operation and management of FMU is in line with Environmental Impact Assessment and Management Plan submitted for EC;
3. ensure that Annual Allowable Cut is fixed to 9,900m^3 (Nine Thousand Nine Hundred Meter cube);
4. ensure that no extraction of timber is carried out at the critical watershed and wetland;
5. ensure that local communities, properties and any religious, cultural, historic and ecologically important sites are not adversely affected by the operation and management of FMU;
6. restore the damage to any public or private properties caused by the operation and management of FMU;
7. restore the damage to water pipelines supplying water to local community by the construction of the forest road;
8. avoid disturbances and damage to the internal drainage system by the construction of the forest road;
9. ensure that fencing around the opened up areas shall be removed after 05 years and that alternative grazing ground is identified and provided to the animals;
10. inform NECS and any other relevant authorities of any unanticipated or unforeseen chance-find of any precious metals or minerals or articles, that have historic, cultural, religious, archeological, and/or ecological importance; and
11. erect a signboard at the take-off point of the main entry of the FMU stating the name of the FMU and contact address.

NEC, PO Box 466, Thimphu, Bhutan
Tel: (975-2) 323384/325856/324323/326993 Fax: (975-2) 323...
www.nec.gov.bt

II. Environmental standards

The holder shall comply with the Environmental Standards 2010.

III. Import and use of secondhand equipment and ODS

The holder shall:

1. ensure that import and use secondhand equipment and machineries are strictly prohibited; and
2. Not use Ozone Depleting Substances as per the Revised Regulation on the control of ODS 2008.

IV. Protection and management of water resources

The holder shall:

1. ensure that operation and management of FMU 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.

V. Waste prevention and management

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

VI. Management of excavated materials and run-off

The holder shall:

1. disposeexcess excavated materials generated during construction of access road and operation and management of FMU onlyat the pre-identifiedapproved dumpsite; and
2. put appropriate measures for management ofsurface run-off to avoid erosion and landslides.

VII. 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.

VIII. Monitoring and reporting

The holder shall 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;

IX. Renewal and modification

The holder shall:

1. ensure that renewal of this EC is processed at least three months prior to its expiry along with a copy of EC and a report on the implementation of its terms and conditions as per the format attached herewith; and
2. obtain prior approval from NECS for any modification to the existing proposal/application.

NATIONAL ENVIRONMENT COMMISSION ★ THIMPHU:BHUTAN ★

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 to the Environmental Assessment Act 2000 and/or existing environmental laws.

Validity:

This EC is issued with valid from **June 21, 2019** to **June 20, 2024** for the operation and management of the final phase of Lingmithang Forest Management Unit (LFMU) measuring an area of 10,601.33 hectares/26,192.42 acres with Annual Allowable Cut (AAC) Fixed at 9,900 m^3 (Nine Thousand Nine Hundred Meter cube) and covering the plan period from January 1, 2019 till December 31, 2028; and construction of 10 Km forest road within the FMU at Mangling village under Saling Gewog, Mongar Dzongkhag.

(Phento Tshering)
DIRECTOR

NATIONAL ENVIRONMENT COMMISSION
THIMPHU:BHUTAN

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

ACKNOWLEDGEMENT

The planner would like to extend gratitude to the CFO, Divisional Forest Office, Mongar for supporting to carry out field works pertinent to plan writing and making it complete on time.

My thanks goes to Mrs. Kezang Yangdon, Deputy Chief, FRMD, Thimphu for training field staff on handling equipments for carrying out forest management inventory in the Lingmethang FMU. Thanks also goes to the FRMD official who compiled the forest inventory data and Mrs. Kezang Yangdon, Deputy Chief, FRMD for analysing and producing the inventory results for annual allowable cut calculation. Thanks to Arun Rai, Dy. CFO and Dawa Zangpo, Sr. FO, FRMD for their kind comments for production of standard maps as entailed while carrying out forest functions mapping

Special thanks go to all the field staff of Territorial Division and Natural Resources Development Corporation Limited (NRDCL), who participated tirelessly for months to carry out forest management inventory in Lingmethang FMU. This lot of people has done the toughest job. Without their hard work and great contribution, this plan would have remained incomplete.

In addition, I would like to express my sincere appreciation and gratitude to Regional Manager (RM), Natural Resources Development Corporation Limited (NRDCL). Zhonggar Division, NRDCL and people of Saling Geogs for rendering assistance during the field visit and field work.

I also wish to express my heartfelt thanks to the Saling Geog Office and farmers who responded to my questions during social survey.

Lastly, I would like to express my deepest gratitude to persons not mentioned here but have their hands on successful completion of writing this plan.

LIST OF ABBREVIATIONS

%	Percentage
AAC	Annual Allowable Cut
CFO	Chief Forest Officer
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
FMCB	Forest Management Code of Bhutan
FNCA 1995	Forest and Nature Conservation Act 1995
FNCRR 2017	Forest and Nature Conservation Rules and Regulations 2017
FRMD	Forest Resources Management Division
GIS	Geographic Information System
Ha	Hectare
Km	Kilometer
LFMU	Lingmethang Forest Management Unit
m	Meter
m^3	Cubic meter
masl	Meter Above Sea Level
MC	Mixed Conifer
mm	Millimetre
MoAF	Ministry of Agriculture and Forests
NRDCL	Natural Resources Development Corporation Limited
NTFP	Non-Timber Forest Products
Nu	Ngultrum
NWFP	Non-wood Forest Products
OPs	Operational Plans
PIC	Production In-charge
PFM	Participatory Forest Management
PRA	Participatory Rural Appraisal

RGoB	Royal Government of Bhutan
RM	Regional Manager
RME	Reliable Minimum Estimate
RNR	Renewable Natural Resources
RRA	Rapid Rural Appraisal
SFED	Social Forestry & Extension Division
sp(p)	Species (pl)
SRF	State Reserve Forests
TD	Territorial Division
UIC	Unit In-charge
UWICER	Ugyen Wangchuk Institute for Conservation and Environmental Research
WC	Working Circle

EXECUTIVE SUMMARY

This is the third plan for Lingmethang Forest Management Unit (LFMU). The plan structure is as per the guidelines reflected in the Forest Management Code of Bhutan (FMCB). It comprises 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

1. Lingmethang FMU has an area equal to 10490 ha and it is situated in Mongar Dzongkhag. It lies between $27^0$12'12.86" to $27^0$10'54.60" North latitudes, and $91^0$03'44" to $91^0$12'40" East longitudes. The Kuri Chu demarcates its eastern boundary. Kuri Chu dam is located at about 100 m from the confluence of Yunari Chu and Kuri Chu. The western boundary corresponds to the ridge that forms the headwater of Yunari Chu valley. Mauri Chu borders Lingmethang FMU in the north-east for about 3.5 km, and the ridge forming Songjari Chu valley forms its northern boundary. The southern ridge of Yunari Chu valley marks its southern boundary.

2. The general terrain of Lingmethang is moderate in most part of the area with occasional steep and mountainous in some parts. West-Gyelposhing block has the highest proportion of steep area. The altitude ranges from 640 m to 3321 m.a.s.l at its highest point. There are numerous small streams, which flow into the main rivers, viz, Songjari Chu and Yunari Chu during the monsoon season, which ultimately drains into Kuri Chu.

3. The forest type in LFMU has been classified into two major groups, namely Chir pine and Hardwood forests. The chir pine forest varies from immature to mature stands, but the hardwood forest is mostly mature. The forest in general is in relatively good condition with good regeneration underneath. Majority of the FMU area has broadleaf forest with predominant species such as *Schima wallichii, Juglans spp, Castanopsis indica, Morus australis, Engelhardtia spicata, Cinnamomum sp., Macaranga sp., Oak sp*., etc.

4. This is the third 10 year plan of Lingmithang FMU. During the second plan period , the total AAC was **9000 m^3** (commercial = **7000 m^3** and rural = **2000 m^3**). The total commercial

timber harvested during the second plan period was **51,041.18 m^3** in standing volume which is undercut by **18958.82 m^3** and the total rural timber harvested was **4433.90 m^3** in standing volume which is undercut by **15566.10 m^3** of the total AAC for 10 years. Harvesting comprised of both chir pine and hardwood forests in Songjari and Yunari blocks.

PART 2 FUTURE MANAGEMENT

1. The overall Goal of the management plan is to:

Manage the Forest Resources within Lingmethang FMU on a multiple use, sustained yield basis for the production of timber, fuelwood, non-wood forest products and for watershed, wildlife and environmental protection.

The Lingmethang FMU has been organized into Management Circles and Working Cirlces. This organization is for the smooth implementation of the plan. Three Management Circles have been identified viz **Protection**, **Production** and **Non-Production** including **Non Wood Forest produce (overlapping)** with all other Management Circles. Production Management circle have been further divided into two Working Circles; Chirpine working circle and Broadleaf working circle. This allows different areas to be managed and evaluated separately. Some of the objectives may overlap in all the Working Circles mainly due to multiple functions occuring in the Management Circles. However, the Non Wood Forest produce Managenment Circle shall overalap with all other Management Circles, including Protection and Non-Production Management Circles, which constitute the entire FMU area. The overall objective of this Managenment Circle is to manage the NWFPs in Lingmethang FMU on sustainable basis and monitor low impact collection.

2. Management based on Forest Functions

Management based on different forest functions will also be adopted as per the prescriptions in the Plan. Following forest functions and management options with restrictions have been described in detail.

To facilitate better organisation of management activities during the implementation of the plan and better field orientation within the FMU, the area has been sub-divided into Blocks and Compartments.

Table 1: Codes of fucntion group

Code	Function Group	Code	Function Group
S	**Soil Protection and Conservation**	**N**	**Nature Conservation**
SC	*Soil Conservation*	***NWP***	*Wildlife Protection*
SP	*Soil Protection*	***NWC***	*Wildlife Conservation*
W	**Water and Watershed Conservation**	**SoC**	**Social Function**
	Riparian Reserve Protection	***SoCL***	*Social (Local use only)*
WRR	*Watershed Conservation*	***SoCRs***	*Social (Religious Site Protection)*
WSH	*Local Water Supply Protection*		
WLS			

3. AAC for Management Working Circles in standing volume.

Production Management Circle has been divided into two working circles: Broadleaf working circle and Chirpine working circle for this plan period. The AAC for each of these working circles is as indicated as below:

Table 2: Annual Allowable Cut for Working Circles in standing volume.

Strata	Net operable area (ha)	Rotation (Year)	RME of Average Standing Volume (m3/ha)	AAC (m3/year)
Broadleaf forest	**5079.26**	**130**	**174.56**	**6820.27**
Chir pine	**1989.23**	**130**	**174.56**	**2671.07**
Total	**7068.49**			**9491.34**

Based on the inventory data and net operable forest area available, the Annual Allowable Cut (AAC) for this plan period has been fixed at 9400 m^3 in standing volume per year.

1. Allocation of AAC

Local Use- 500 m^3	Allocated to local users (local villages, general public and *adhoc*). The volume of cham, tsim, dangchung, etc. from operations will be included in this allocation. The territorial DFO, Mongar will be responsible for allocating this volume.
Commercial- 8900 m^3	Allocated to NRDCL to meet commercial demand.

2. Silvicultural Systems

The prescribed Silvicultural System for the commercial harvesting of Chirpine is the Seed Tree System and Patch Clear-cut System for Broadleaf. Adequate number of seed trees shall be retained as mother trees in case of Seed Tree System. While in case of patch opening clear cut patches of

suitable sizes shall 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 patch openings and laying out annual coupes are given detailedly in the plan.

For rural marking, Single Tree Selection System will be applied.

3. Environmental Assessment

A team from DFO Mongar in consultation with NRDCL carried out detailed EIA and its findings are incorporated in preparing the Forest Management Plan. Checklist of Environment Parameters for Forestry projects as per NEC guidelines and Forest Management Code of Bhutan has been followed and the following activities were taken into consideration in this Management Plan.

1. FMU Planning and Zoning
2. Road Construction and Maintenance
3. Harvesting and Extraction
4. Regeneration and Post-harvesting Treatment
5. Riparian Zone Protection
6. Biodiversity Conservation within the FMU
7. Local use forest area

PART 3 IMPLEMENTATION OF THE PLAN

1. The CFO, Mongar assisted by Unit Incharge and other supporting staff of Lingmithang FMU will be the implementing agency. Determining of cutting cycles, annual coupes, harvesting, reforestation, road construction, etc. will be done as per prescriptions in this plan. Annual planning will be facilitated through Operational Planning. Record keeping and Monitoring will be done by the CFO on annual basis as per the format. FRMD in collaboration with CFO Mongar will conduct mid-term and final evaluation of the FMU as per the timeline outlined in this plan.

2. FMU Level Management Committee chaired by the CFO, Mongar has been established to assist in objective setting and ensuring the smooth implementation of the plan. The committee comprises of the stakeholders of the FMU and each member has equal say in recommendation for management and implementation of the FMU. Plan activities to achieve the FMU objectives will be discussed in the FMU Level Management Committee.

3. Unforeseen circumstances may warrant deviation from plan prescriptions and in such an event the CFO Mongar 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 in this respect and such approved deviations entered into the Management Plan during the next scheduled planning priod and plan revision.

Table 3: Actions and responsibilities

Actions required by the FMU Plan	**Responsibility**
1. **Implementation and Review**	
The CFO Mongar, Divisional Forest Division will be responsible for the implementation of this Management Plan, assisted by the Unit-In-charge and staff.	CFO
A FMU Management Committee, chaired by the CFO, will be established to ensure the smooth implementation of the Management Plan.	CFO
The CFO and UIC will ensure that silvicultural systems prescribed for each working circle are used for that working circle, and they are implemented thoroughly and correctly.	CFO & UIC, FMU
The Head, FRMD, will ensure that the mid-term evaluation and final evaluation of the plan is carried out as per the ToR developed by the Department.	Head, FRMD
2. Monitoring and Evaluation	
The CFO will ensure that monitoring is carried out on an annual basis according to the guidelines issued by FRMD	CFO
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.	Head, FRMD
3. Operational Planning	
A bi-annual Operational Plan will be prepared by the CFO to facilitate timely implementation of this Management Plan. The OP be completed and submitted to FRMD by 1st Week of November every year, before the start of operating year.	CFO RM, NRDCL
The budget in the operational plan should be jointly developed by the CFO and RM, NRDCL and agreed by both.	CFO RM, NRDCL

The UIC will determine the location and extent of cable lines in the compartment to be harvested annually in consultation with NRDCL staff as prescribed in the Operational Plan.	UIC, FMU
The CFO and the RM, NRDCL will cooperate and coordinate to ensure that the logging operation and log out turn are conducted smoothly and in accordance with local and other demands.	CFO RM, NRDCL
The UIC, FMU will ensure that plantation survival surveys are conducted annually to ensure enough restocking of harvested area.	UIC, FMU
Plantation will be carried out by NRDCL.	RM, NRDCL
Tending operation must be done as per the norms and standard of nursery and plantation to facilitate good health of seedlings.	RM, NRDCL
The UIC, FMU will inspect the coupes post completion of Operations in a cable line and will issue a Coupe Clearance Certificate only upon fulfillment of the criteria set for issuance of coupe clearance.	UIC, FMU
Road survey, design and construction will be carried out by NRDCL.	NRDCL
NRDCL road engineers must follow acceptable standards, designs, estimates and provide supervision during construction to ensure that the standards are met.	NRDCL staff
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
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 UIC, FMU and furnished monthly to the CFO Mongar.	UIC, FMU
Timber and Non-Wood Forest Products can be allotted to bonafide local villagers.	UIC, FMU as per Operational Plan
4. Participatory Forest Management	
The views of stakeholder groups will be incorporated into the operational plans through the inclusion of stakeholder representatives on the FMU level Management Committee.	CFO

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PART 1: GENERAL DESCRIPTION AND THE CURRENT SITUATION

1. LOCATION, AREA, BACKGROUND AND STATUS

1.1 Location and extent

Lingmethang Forest Management Unit (LFMU) has a total area of 10490 hectares and is situated in Mongar Dzongkhag between $27^0$10' to $27^0$16' North latitudes, and $91^0$4' to $91^0$11' East longitudes. The Kuri Chu demarcates its eastern boundary. Kuri Chu dam is located at about 100 m from the confluence of Yunari Chu and Kuri Chu. The western boundary corresponds to the ridge that forms the head water of Yunari Chu valley. Mauri Chu borders Lingmethang FMU in the north-east for about 3.5 km, and the ridge forming Songjari Chu valley forms its northern boundary. The southern ridge of Yunari Chu valley marks its

Southern boundary.

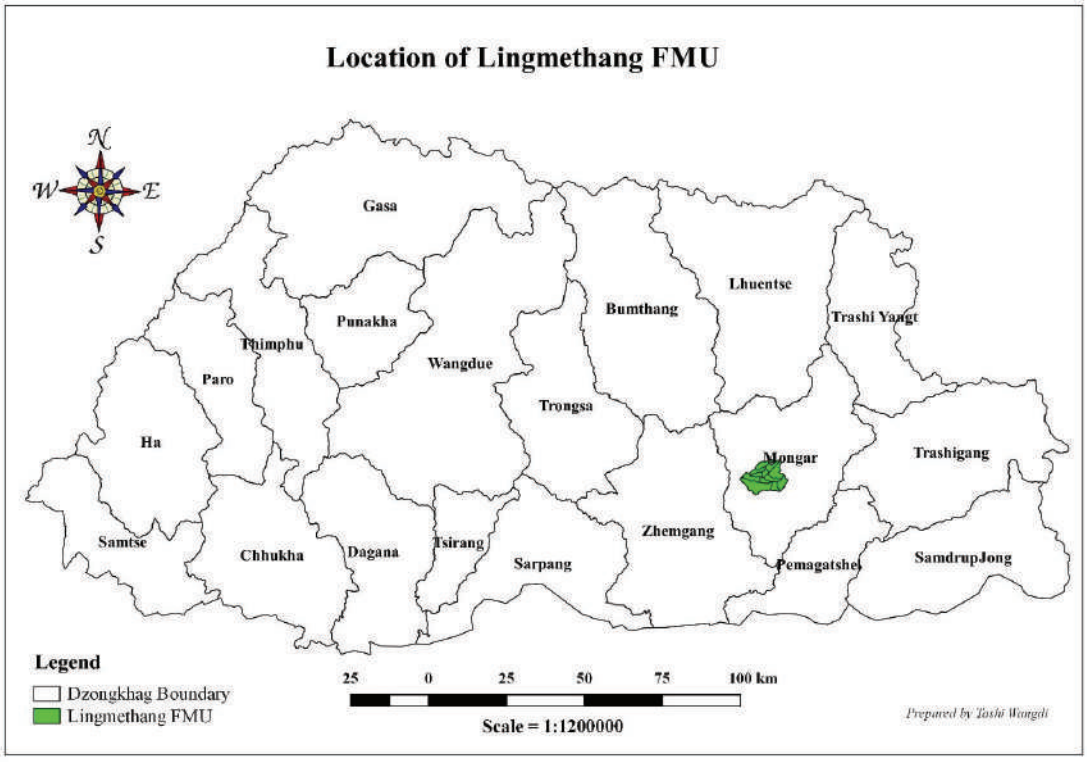


Figure 1: Location of Lingmethang FMU

1.2 Historical Background

Commercial Logging had taken place in the FMU during the first plan period in Songjari block and Kalapang block and in the second plan period in Songjari and Yunari blocks. However, there's no shortage of rural timber and local population still have access to the forest. Substantial amount of chirpine was harvested from West-Gyelposhing block during the constrution of Kuri Chu hydropower.

1.3 Area statement

Table 4: Area Statement by Land Use

Land use	**Area (ha)**
Built up	1.23
Landslide	10.70
Rivers	30.37
Meadow	2.64
Shrubs	124.94
Kamzhing	175.75
Chuzhing	19.48
Chir pine	3303.06
Mixed conifer	3.32
Broad leaf forest	6818.64
Total	**10490.13**

1.4 Forest Condition

The predominat forest types found at Lingmithang FMU are matured warm broad-leaved forest and chirpine forest. Majority of the FMU area has broadleaf forest with predominant species such as *Schima wallichii, Castanopsis indica, Macaranga sp., Oak sp*. found along Yunari Chu valley. Chirpine forest is found only along Songjari Chu and Kalapang blocks. The timber is very popular among the local people and is in great demand for construction.

1.5 Legal Status

1.5.1 Ownership

The Forest and Nature Conservation Act 1995, defines forest as "*any land and water body, whether or not under vegetative cover, in which no person has acquired a permanent and transferable rights of uses and occupancy, whether such land is located inside or outside the forest boundary pillars, and includes land registered in a person's name as tsamdo (Grazing land) or sokshing (woodlot for collection of leaf litter)*"**.** All such areas are considered as State Reserved Forest (SRF) and constitute about 10266 ha (98%) and human settlement and cultivated lands constitutes about 211 ha (2 %).

1.5.2 Rights and privileges

The Rights and Privileges of the local inhabitants, with regard to the use of forest comply with Forest and Nature Conservation Act of 1995 and Forest and Nature Conservation Rules Regulations 2017 (FNCRR 2017). Collections of dry firewood from dead and fallen trees are permitted. The timbers in standing trees are issued for *bona fide* rural domestic use upon proper approval and permits issued by the Department of Forest and Park Services. Hunting is prohibited in the forest.

1.5.3 Grazing rights

The local communities have traditional rights for grazing their cattle in the forest within the unit. The local cattle graze during the summer months while the migratory cattle graze the same area during winter months. Some of the villages outside of the FMU also has grazing rights within the FMU area. The Forest and Nature conservation Act, 1995 has the provision of regulating grazing in State Reserve Forest Land.

1.5.4 Water rights

The local population has traditional rights to use water from rivers and streams for their domestic purposes, such as home consumption, irrigation and other uses. The main streams are Songjari Chu, Yunari Chu and Kuri Chu. Besides, there are many streams and creeks found in the FMU that serve as water source for the communities.

1.5.5 Historical Monuments and Monasteries

There are four Lhakhangs under LFMU namely; Tshanzabi Lhakhang, Kalapang Lhakhang, Mangling Lhakhang and Broksar Lhakhang.

Figure 2 : Tshanzabi Lhakhang

2. PERMANENT SITE FACTORS

2.1 Topography

The general terrain of Lingmethang is moderate in most part of the area with occasional steep and mountainous in some parts. West-Gyelposhing block has the highest proportion of steep area. The altitude ranges from 640-3321 m.a.s.l at its highest point. There are numerous small streams which flow into the main rivers, i.e. Songjari Chu and Yunari Chu during the monsoon season which ultimately drains into Kuri Chu.

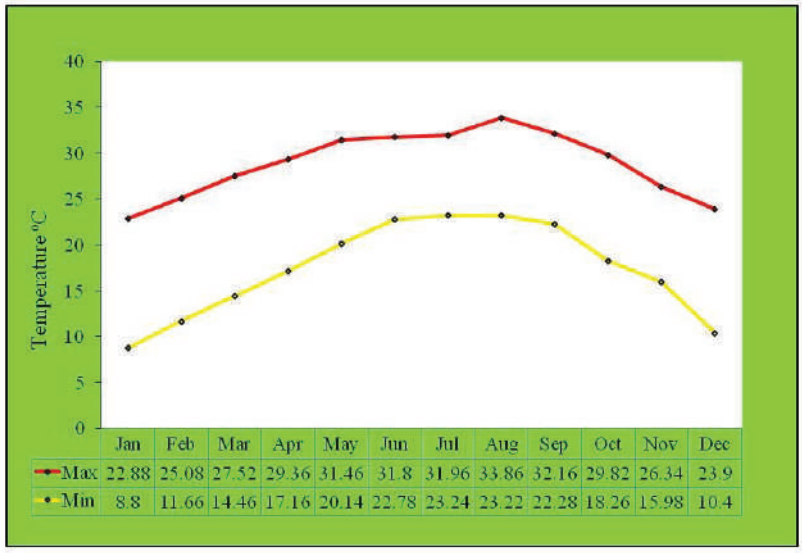
2.2 Slope

Slopes are usually steep at higher elevations above 4000 m and gentler at the bottom of the valley. Slope classification was done by Quantum GIS 2.18 (QGIS 2.18). Areas with >45^0 slope were delineated on the Function Map as *SPP - Soil Protection* where no activities are allowed to take place. Slopes that ranged from 25^0 - 45^0 are classified as *SC - Soil Conservation* where limited forestry activities can take place.

2.3 Climate

There is one meteorological station at Lingmethang RNR RC sub-station, which is located close to LFMU; but the data was not available at the station. All the meteorological data presented in this plan is from Department of Hydro-Met Services, Ministry of Economic Affairs, Thimphu, Bhutan.

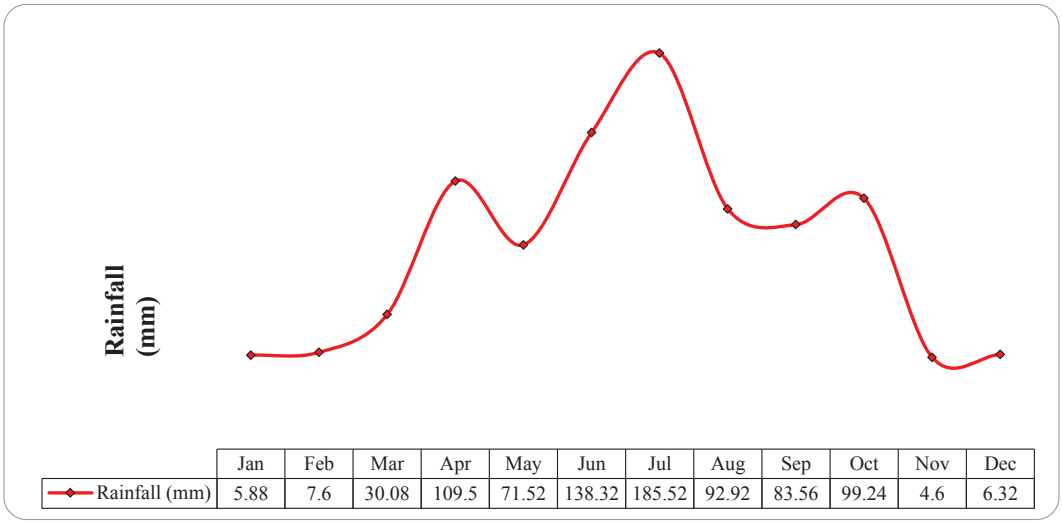
2.3.1 Temperature



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	22.88	25.08	27.52	29.36	31.46	31.8	31.96	33.86	32.16	29.82	26.34	23.9
Min	8.8	11.66	14.46	17.16	20.14	22.78	23.24	23.22	22.28	18.26	15.98	10.4

Figure 3: Average Maximum and Minimum Temperature of last ten years

2.3.2 Precipitation

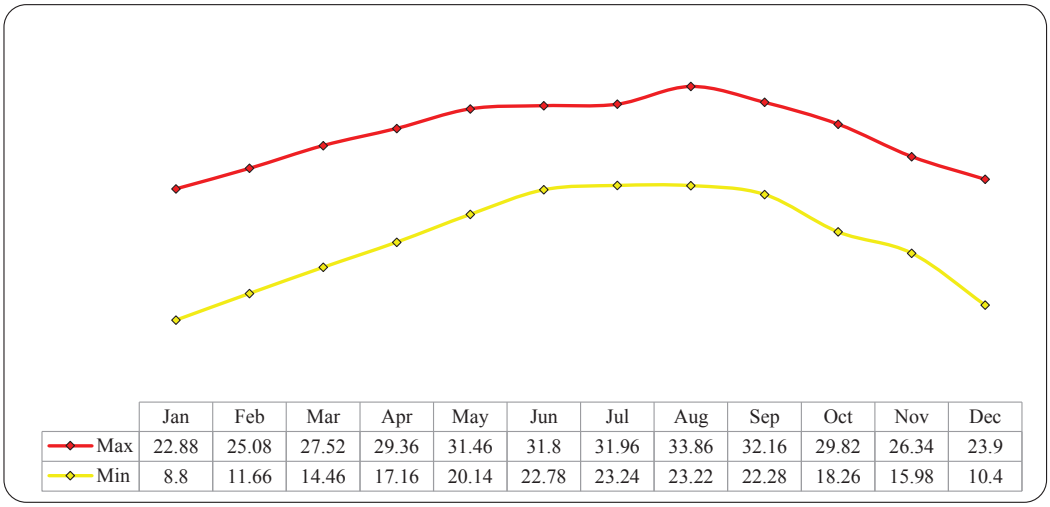


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	5.88	7.6	30.08	109.5	71.52	138.32	185.52	92.92	83.56	99.24	4.6	6.32

Figure 4: Monthly average rainfall for last 10 years

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

2.3.3 Relative Humidity



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	22.88	25.08	27.52	29.36	31.46	31.8	31.96	33.86	32.16	29.82	26.34	23.9
Min	8.8	11.66	14.46	17.16	20.14	22.78	23.24	23.22	22.28	18.26	15.98	10.4

Figure 5: Monthly average maximum and minimum relative humidity for last 10 years

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

2.4 Geology and Soils

The geological formation is dominated by the Pre-Cambrian era. It is characterised by the presence of assorted combinations of rocks such as quartzites, phyllites, biotite gneisses interbedded with quartzite, quartz-mica-schists, crystalline limestone and garnetiferous schists intruded by basic sills.

Phyllite derived soils are clayey to fine sandy loam, and is brown in colour depending on the amount of quartzite; while quartzite derived soils are pale brown and coarse. Generally, the soil is clayey to sandy loam in nature and is moderately fertile. Owing to its arid and warm climate, the exposed soils are reddish in colour due to oxidation of ferrous inclusions. High humus content corresponding to dark brown colour marks the forest soils in broadleaf forest, whilst chirpine forest is marked by pine needles covering bare mineral soil. It has also been observed that the soil is not exceptionally prone to frequent or extensive surface erosion or landslides. However, there is a moderate risk of surface erosion and gullying. Such soil type can only be preferred for forestry activities, provided the silviculture and management prescribed are appropriate. Therefore, adequate care must be taken, not to expose large areas to avert the loss of soil fertile.

2.5 Hydrology

The entire LFMU is the watershed for Kuri Chu. It comprises of three principal valley basins, i.e. Songjari Chu, West-Gyelposhing and Yunari Chu. The former two directly drains into Kuri Chu reservoir, while the latter also flows into Kuri Chu but outside the reservoir. Several natural springs occur in the FMU; however the water flow is moderate owing to its small valley basins and low rainfall. Peak flows occur during monsoon season (June - September) and minimun flow is evident during winter months (Dec-Mar). These are imperative water sources and serve as water holes for livestock too.

Residents of LFMU are dependent upon these water sources for drinking and paddy cultivation. The Chanzabi/Pangsabi community has maintained several irrigation channels. Cattle grazig in these watersheds should be regulated to control bacteria population in the drinking water supply. It was observed that the water sources are clean enough for drinking because of the sparce population. Besides drinking, these water sources also serve as water holes for livestock. In addition, appropriate silvicultural systems prescriptions and harvesting methods are implemented in order to ensure that the quality and quantity of water supply are not affected through forest operations. Population is scattered all over the FMU, therefore it’s of utmost importance to maintain water quality and quantity.

3. VARIABLE SITE FACTORS

3.1 Population and Demography

The total population of the people living both within and in the vicinity of the FMU is 606 as of 2018. Of the total population 271 are males and 335 are females. There are 131 households within the LFMU. Generally the households are scattered throughout the FMU. The local inhabitants have usually two storied houses in Songjari Chu and Kalapang blocks and single storied houses in Yunari Chu block. During the 2nd management plan there were 76 households. It has increased by 55 numbers over the last 10 years. The population has also increased by 91 during the same period.

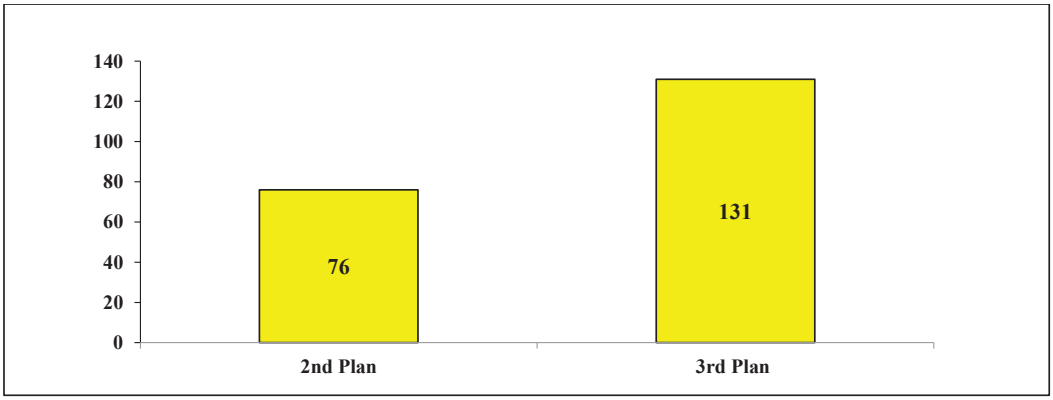


Figure 6: Increase in number of households from last to current plan

Out of the total population of 606, 271 are males and 335 are females. The average household size comes to about 4.6 persons per household. Migration in this area is not an unusual phenomenon. The probable reasons include employment, marriage and education. A total of 17 males and 11 females were recorded to have migrated from the villages.

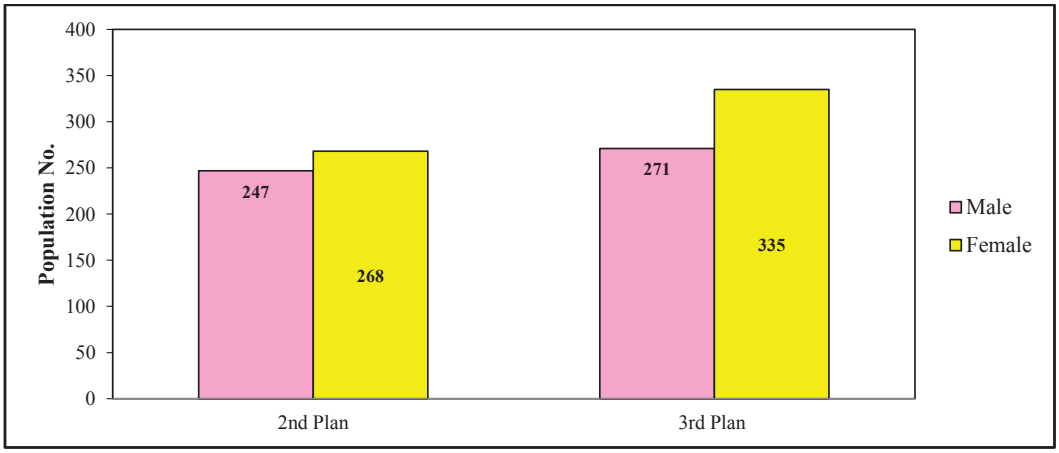


Figure 7: Number of male and female in current and last plan

The dependent population falling in the age bracket of 'less than 6 years and more than 64 years of age' constitutes 90, which is about 15% of the population. The young dependent constitute 15% of the population and the young productive aged group 70% of the population. With 70% of the population being in the productive age group it is assumed that the burden of dependent population on the productive population is not that large. During the last 10 years the population has increased by 91.

3.2 Agriculture and Farming Systems

Figure 8: Maize cultivation at Masangdaza

Agriculture is the mainstay of the people living in Lingmethang. They are entirely engaged in subsistence farming together with rearing of livestock or so called mixed farming. However, agriculture is restricted because of rugged terrain and fragmented land holdings. The average dry land holding per household amounts to about 2.6 acre among those that have dry land. The dry lands are operated by the owners themselves and hence, no leasing out. Sokshing accounts to about 2.6 acres where as tsamdrog is 310 acres. Potato and maize are their main crops. Potato is grown in January and harvested in the month of July/August. Maize is grown in January and harvested in July in all the villages within the FMU except Brogsar, where sowing is usually carried out in the February and harvested in August month.

Paddy is grown in July and harvested in November and December. Other vegetables grown are cauliflower, cabbage, lettuce, broccoli, beans, onion, pumpkin, cucumber and radish. Few cash crops like mango, orange and guava are also grown that earn them some money. Some villages in Lingmethang FMU fall under the category of remotest places in Bhutan where traditional method of farming is still very much prevalent.

People usually rear cattle, horses, pigs and poultry. They earn some income through agricultural and livestock products, which they sell at Lingmethang and Gyelposhing. During winter months, people move to warmer places along with their cattle in the month of October/November and return back in April/May.

3.3 Traditional Use of the Forest

The farmers of Lingmethang depend on the forest for the supply of construction timber, shingles, firewood, fodder, leaf litter, fencing material, farm implements, bamboo and grazing land for cattle. House

construction timber and shingles are considered as the most important forest products by the villagers, next to fuel wood which is their only source of cooking and heating, and poles/posts for fencing their fields and kitchen gardens. The Non Wood Forest Products such as fodder, leaf litter, mushrooms, medicinal plants, cane and bamboos are commonly collected from the forests. However, bamboo is given more importance due to its numerous uses such as fencing materials, thatching for houses, cords for tying animals, etc.

Timbers and shingles are required for the construction of new houses, maintenance and repairing of existing ones and lhakhang renovation. *Pinus roxburghii, Toona sp., Phoebe sp.* and *Terminalia myriocarpa* are usually used as construction timber. Mostly oak and castanopsis comprise of firewood. Common fodder species include *Bauhinia sp., Ficus sp., Kydia calycina*.

3.4 Grazing

With reference to the Socio-economic data there are 928 heads of cattle owned by the villagers, 12 heads of horses and 27 heads of goats grazing heavily in the forests and pastures of Lingmethang FMU. The seasonal grazing by the cattle of migratory herders in summer and winter add up to increased pressure on the grasslands and forests around the settlements, which could adversely affect the carrying capacity on long run. During winter months, cattle from Bumthang migrate to Lingmethang in the month of September/October and return during summer in the month of February/March. They earn some money from Livestock products such as milk, cheese, butter, etc.

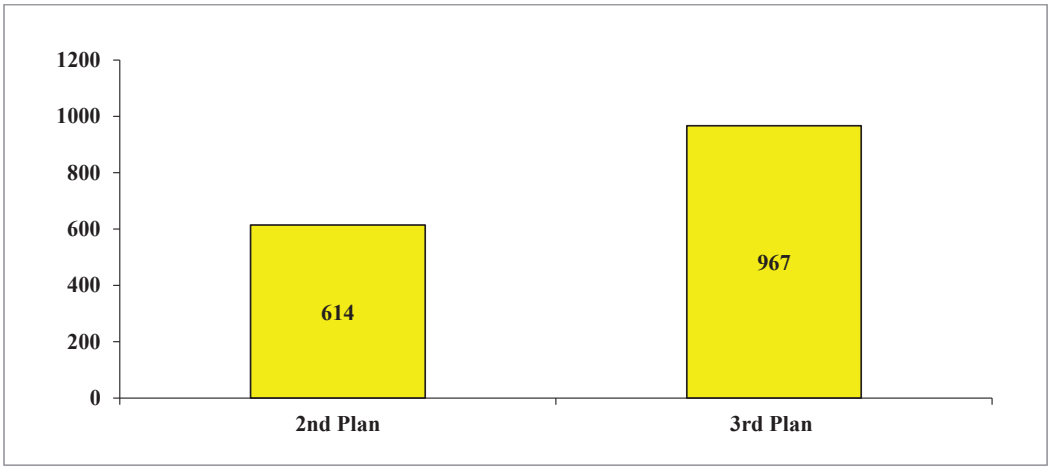


Figure 9: Cattle population in last and current plan within the FMU

Grazing is evident in most areas of the FMU. The grazing pressure is highest in the forest areas close to the settlements, despite the availability of pastures and grazing grounds for the animals. However, 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 times to come. With the forest road in the area, some of the horses

might be sold due to availability of trucks for easy transportation and therefore slightly reduce the grazing pressure. The livestock has increased by 353 over the last 10 years.

3.5 Forest fires

The incidence of fire recorded in the last plan plan was in 2012 and 2017 which burnt about 85 acres and 79 acres respectively. Al though not a severe problem for hard wood, the risk of forest fire in chir pine forest is expected to increase with the opening of forest to harvesting in future. Strict vigilance should be in place to prevent forest fire and also the local people should be made aware of it.

Figure 10: Forest fire in 2017 at Kalapang

3.6 Pests and diseases

So far, no pest and disease outbreak have been recorded from LFMU though it was under commercial harvesting for the past twenty years.

3.7 Non-Wood Forest Products

Local people usually collect the Non Wood Forest Products such as fodder, leaf litter, mushrooms, medicinal plants, cane and bamboos from the forests for their use. However, bamboo is given more importance due to its numerous uses such as fencing materials, thatching for houses, cords for tying animals, etc. The other potential NWFP that could be harvested is cane, particularly in Mangling and Brogsar villages.

4. ECOLOGY

4.1 Floral Associations

The forest type in LFMU is classified into two major groups, namely, Chir pine and Hardwood forests. The chir pine forest varies from immature to mature stands, but the hardwood forest is mostly mature stand. The forest in general is in relatively good condition with good regeneration underneath. Majority of the FMU area has broadleaf forest with predominant species such as *Schima wallichii, Juglans, Castanopsis indica, Morus australis, Engelhardtia spicata, Cinnamomum sp., Macaranga sp., Oak sp.*, etc. Chirpine forest is

found in Songjari, West-Gyelposhing and Kalapang blocks. The timber is very popular among the local people and is in great demand for construction.

Table 5: List of timber species found in the Lingmethang FMU

Sl.No	Local Name	Scientific Name	Class
1	Ta Shing (Dz)	*Juglans regia*	Special Class
2	Kimbu (Np)	*Morus sp.*	Special Class
3	Saur (Np)	*Betula alnoides*	A Class
4	Lampate (Np)	*Duabanga grandiflora*	A Class
5	Pani Sangh (Np)	*Terminalia myrocarpa*	A Class
6	Champ (Np)	*Michellia dolsofa*	A Class
7	Cyress (Np)	*Albezia sp.*	A Class
8	Kapasi (Np)	*Acer sp.*	A Class
9	Rawa Shing (Sh)	*Toona ciliata*	B Class
10	Zala Shing (Sh)	*Schemia wallchaina*	B Class
11	Zala Shing (Sh)	*Nyssia sp.*	B Class
12	Sisi Shing (Dz)	*Quercus griffithii*	B Class
13	Ghoom Shing (Dz)	*Quercus lanata*	B Class
14	Thom Shing (Dz)	*Quercus glauca*	B Class
15	Dhom Shing (Dz)	*Quercus lamelosa*	B Class
16	Golee (Sh)	*Persea sp.*	B Class
17	Drongdo (Dz)	*Cinamomum sp.*	B Class
18	Tongphu (Dz)	*Pinus roxburghii*	B Class
19	Sokey (Dz)	*Castronopsis hystrix*	B Class
20	Sokey (Dz)	*castronopsis indica*	B Class
21	Balu Kath (Np)	*Taluauma hodgsonii*	B Class
22	Uttis (Np)	*Alnus nepalensis*	B Class
23	Mauwa (Np)	*Engelherdia spicata*	B Class

24	Brown Pine (En)	*Podocarpus neriifolius*	B Class
25	Koruke (Np)	*Beilscmiedia sp.*	B Class
26	Kainjal (Np)	*Bichofia javanica*	B Class
27	Saur (Np)	*Betula utilis*	B Class
28	Jangali Amp (Np)	*Mangefera sylvitaca*	B Class
29	Shakor Shing (S h)	*Lithocarous elegans*	B Class
30	Akulem Shing (Sh)	*Exbucklendia populnea*	B Class
31	Gobre (Np)	*Sloanea dasycarpa*	B Class
32	Chhara Shing (Sh)	*Choerospondias axillaris*	B Class
33	Khak Balaiyo (Np)	*Drimycarpus racemosus*	B Class
34	Khewelaiseng (Sh)	*Aglaia cucculata*	B Class

Contributed by Deo Man Rai, FR-II, LFMU

4.2Fauna of Lingmethang

Table 6: List of mammals found in Lingmethang FMU

Sl.No	Common Name	Latin Name	Family	IUCN Status
1	Himalayan Black Bear	*Selenarctos thibetanus*	Ursidae	Vulnerable
2	Capped Langur	*Presbytis pileatus*	Cercopithecidae	Vulnerable
3	Common Leopard	*Panthera pardus*	Felidae	Vulnerable
4	Goral	*Nemorhaedus goral*	Bovidae	Near Threatened
5	Sambar	*Cervus unicolor*	Cervidae	Near Threatened
6	Hoary-bellied Himalayan Squirrel	*Callosciurus pygerythrus*	Sciuridae	Least Concern
7	Three-striped Palm Squirrel	*Funambulus palmarum*	Sciuridae	Least Concern
8	Porcupine	*Hystrix indica*	Hystricidae	Least Concern
9	Himalayan Yellowthroated Marten	*Martes flavigula*	Mustelidae	Least Concern
10	Assamese Macaque	*Macaca assamensis*	Cercopithecidae	Least Concern
11	Barking Deer	*Muntiacus muntjak*	Cervidae	Least Concern

12	Wild Boar	*Sus scrofa*	Suidae	Least Concern
13	Black Panther	*Panthera sp.*	Felidae	Least Concern

Contributed by Deo Man Rai, FR-II, LFMU

4.3 List of birds found in LFMU

Table 7: List of birds found in the Lingmethang FMU

Sl. No.	Common Name	Latin Name	Family	IUCN Status
1	Palla's Fish Eagle	*Haliaeetus leucoryphus*	Accipitridae	Endangered
2	River Lapwing	*Vanellus duvaucelii*	Charadriidae	Near Threatened
3	Rufous-necked Hornbill	*Aceros nipalensis*	Bucerodiae	Vulnerable
4	Great Hronbill	*Buceros bicornis*	Bucerodiae	Vulnerable
5	Red-vented Bulbul	*Pycnonotus cafer*	Pycnonotidae	Least Concern
6	Himalayan Bulbul	*Pycnonotus leucogenys*	Pycnonotidae	Least Concern
7	Striated Bulbul	*Pycnonotus striatus*	Pycnonotidae	Least Concern
8	Black-crested Bulbul	*Pycnonotus melanicterus*	Pycnonotidae	Least Concern
9	Mountain Bulbul	*Hypsipetes mcclellandii*	Pycnonotidae	Least Concern
10	Ashy Bulbul	*Hemixos flavala*	Pycnonotidae	Least Concern
11	Black Bulbul	*Hypsipetes leucocephalus*	Pycnonotidae	Least Concern
12	White-thorated Bulbul	*Alophoixus flaveolus*	Pycnonotidae	Least Concern
13	Bhutan Laughingthrush	*Trochalopteron imbricatum*	Leiothrichidae	Least Concern
14	White-crested Laughingthrush	*Garrulax leucolophus*	Leiothrichidae	Least Concern
15	White-thorated Laughingthrush	*Garrulax albogularis*	Leiothrichidae	Least Concern
16	Striated Laughingthrush	*Garrulax striatus*	Leiothrichidae	Least Concern
17	Rufous-necked Laughingthrush	*Garrulax ruficollis*	Leiothrichidae	Least Concern
18	Rufous-chined Laughingthrush	*Garrulax rufogularis*	Leiothrichidae	Least Concern
19	Scaly Laughingthrush	*Garrulx subunicolor*	Leiothrichidae	Least Concern
20	Red-faced Liocichla	*Liocichla phoenicea*	Leiothrichidae	Least Concern

21	Grey-sided Laughingthrush	*Garrlux caerulatus*	Leiothrichidae	Least Concern
22	Blue-winged Laughingthrush	*Garrulax squamatus*	Leiothrichidae	Least Concern
23	Lesser Necklaced Laughingthrush	*Garrulax monileger*	Leiothrichidae	Least Concern
24	Greater Necklaced Laughingthrush	*Garrulax pectoralis*	Leiothrichidae	Least Concern
25	Black Drongo	*Dicrurus macrocerus*	Dicruridae	Least Concern
26	Spangled Drongo	*Dicrurus hottentottus*	Dicruridae	Least Concern
27	Lesser Racket-tailed Drongo	*Dicrurus remifer*	Dicruridae	Least Concern
28	Brown Dipper	*Cinclus pallasi*	Cinclidae	Least Concern
29	Rusty-cheeked Scimitar Babbler	*Pomatorhinus erythrogenys*	Timaliidae	Least Concern
30	Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*	Timaliidae	Least Concern
31	Common Hoopoe	*Upupa epops*	Upupidae	Least Concern
32	Red-headed Trogon	*Harpactes erythrocephalus*	Trogonidae	Least Concern
33	Indian Roller	*Coracias benghalensis*	Coraciidae	Least Concern
34	Blue-bearded Beet-eater	*Nyctyornis athertoni*	Meropidae	Least Concern
35	Common Kingfisher	*Alcedo hervules*	Alcedinidae	Least Concern
36	White-throated Kingfisher	*Halcyon smyrnensis*	Halcyonidae	Least Concern
37	Crested Kingfisher	*Ceryle rudis*	Cerylidae	Least Concern
38	Long-tailed Broadbill	*Psarisomus dalhousiae*	Eurylaimidae	Least Concern
39	Golden-fronted Leaf Bird	*Chloropsis aurifrons*	Irenidae	Least Concern
40	Orange-bellied Leaf Bird	*Chloropsis hardwickii*	Irenidae	Least Concern
41	Great Barbet	*Megalaima virens*	Megalaimidae	Least Concern
42	Blue-throated Barbet	*Megalaima asiatica*	Megalaimidae	Least Concern
43	Golden-throated Barbet	*Megalaima franklini*	Megalaimidae	Least Concern
44	Yellow-breated Greenfinch	*Carduelis spinoides*	Fringillidae	Least Concern
45	Scarlet Finch	*Haematospiza sipahi*	Fringillidae	Least Concern
46	Gold-naped Finch	*Pyrrhoplectes epauletta*	Fringillidae	Least Concern

47	Green-tailed Sunbird	*Aethopyga nipalnensis*	Nectariniidae	Least Concern
48	Black-throated Sunbird	*Aethopyga saturata*	Nectariniidae	Least Concern
49	Crimson Sunbird	*Aethpyga siparaja*	Nectariniidae	Least Concern
50	Streaked Spderhunter	*Arachnothera magna*	Nectariniidae	Least Concern
51	Fire-breatsed Flowerpecker	*Dicaeum ignipectus*	Nectariniidae	Least Concern
52	House Sparrow	*Passer domesticus*	Passeridae	Least Concern
53	Russet Sparrow	*Passer rutilans*	Passeridae	Least Concern
54	Eurassian Sparrow	*Passer montanus*	Passeridae	Least Concern
55	Rufous-breasted Accentor	*Prunella strophiata*	Prunellinae	Least Concern
56	Grey-hooded Warbler	*Seicercus xanthoschistos*	Acrocephalinae	Least Concern
57	Grey-cheeked Warbler	*Seicercus poliogenys*	Acrocephalinae	Least Concern
58	Black-faced Warbler	*Abroscopus schisticeps*	Acrocephalinae	Least Concern
59	Common Tailorbird	*Orthotomus sutorius*	Acrocephalinae	Least Concern
60	Tickell's Leaf Warbler	*Phylloscopus affinis*	Acrocephalinae	Least Concern
61	Grey-sided Bush Warbler	*Cettia brunnifrons*	Acrocephalinae	Least Concern
62	Oriental White-eye	*Zosterops papebrosus*	Zosteropidae	Least Concern
63	Chestnut-headed Tesia	*Tesia castaneocoronata*	Acrocephalinae	Least Concern
64	Slaty-bellied Tesia	*Tesia olivea*	Acrocephalinae	Least Concern
65	Hill Prinia	*Prinia atrogularis*	Cisticolidae	Least Concern
66	Striated Prinia	*Prinia criniger*	Cisticolidae	Least Concern
67	Rufescent Prinia	*Prinia rufescens*	Cisticolidae	Least Concern
68	Sultan Tit	*Melanocholora sultanea*	Paridae	Least Concern
69	Green-backed Tit	*Parus monticolus*	Paridae	Least Concern
70	Yellow-cheeked Tit	*Parus spilonotus*	Paridae	Least Concern
71	Black-throated Tit	*Aegithalos concinnus*	Paridae	Least Concern
72	Scaly-breasted Munia	*Lonchura punctulata*	Estrildinae	Least Concern
73	Collard Grosbeak	*Mycerobas erythaca*	Fringillidae	Least Concern

74	Crested Bunting	*Melophus lathami*	Fringillidae	Least Concern
75	Olive-backed Pipit	*Anthus hodgsoni*	Motacillinae	Least Concern
76	Paddyfield Pipit	*Anthus rufulus*	Motacillinae	Least Concern
77	Citrine Wagtail	*Motacilla citreola*	Motacillinae	Least Concern
78	White Wagtail	*Matacilla alba*	Motacillinae	Least Concern
79	Rufous Sibia	*Heterophasia capistrata*	Leiothrichidae	Least Concern
80	Golden-breasted Fulvetta	*Alcippe chrysotis*	Sylviinae	Least Concern
81	Nepal Fulvetta	*Alcippe nipalensis*	Sylviinae	Least Concern
82	White-browed Fulvetta	*Alcippe vinipectus*	Sylviinae	Least Concern
83	Rufous-winged Fulvetta	*Alcippe castaneceps*	Sylviinae	Least Concern
84	Whiskered Yuhina	*Yuhina flavicollis*	Zosteropidae	Least Concern
85	Black-chinned Yuhina	*Yuhina nigrimenta*	Zosteropidae	Least Concern
86	White-bellied Yuhina	*Yuhina zantholeuca*	Zosteropidae	Least Concern
87	Striated Yuhina	*Yuhina castaniceps*	Zosteropidae	Least Concern
88	Grey-throated Babbler	*Stachyris nigriceps*	Timaliidae	Least Concern
89	Golden Babbler	*Stachyris chrysaea*	Timaliidae	Least Concern
90	Cutia	*Cutia nipalensis*	Leiothrichidae	Least Concern
91	Blyths Shrike Babbler	*Pteruthius flaviscapis*	Leiothrichidae	Least Concern
92	Rusty-fronted Barwing	*Actinodura egertoni*	Leiothrichidae	Least Concern
93	Hoary-throated Barwing	*Actinodura nipalensis*	Leiothrichidae	Least Concern
94	Sliver-eared Mesia	*Leiothrix argentauris*	Leiothrichidae	Least Concern
95	Red-billed Leiothrix	*Leiothrix lutea*	Leiothrichidae	Least Concern
96	Chestnut-bellied Nuthatch	*Sitta castanea*	Sittidae	Least Concern
97	Brown-throated Treecreeper	*Certhia discolor*	Certhiidae	Least Concern
98	Wallcreeper	*Tichodroma muraria*	Certhiidae	Least Concern
99	Winter Wren	*Trogolodytes troglodytes*	Certhiidae	Least Concern
100	Common Stonechat	*Saxicola torquata*	Muscicapidae	Least Concern

101	Grey Bushchat	*Saxicola ferrea*	Muscicapidae	Least Concern
102	Slaty-backed Forktail	*Enicurcus schistaceus*	Muscicapidae	Least Concern
103	Little Forktail	*Enicurcus scouleri*	Muscicapidae	Least Concern
104	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	Muscicapidae	Least Concern
105	White-capped Water Redstart	*Chaimarrornis leucocephalus*	Muscicapidae	Least Concern
106	Blue-fronted Redstart	*Phoenicurcus frontalis*	Muscicapidae	Least Concern
107	Oriental Magpie Robin	*Copsychus saularis*	Muscicapidae	Least Concern
108	Golden Bush Robin	*Tarsiger Chrysaeus*	Muscicapidae	Least Concern
109	Verditer Flycatcher	*Eumyias thalassina*	Muscicapidae	Least Concern
110	Large Niltava	*Niltava grandis*	Muscicapidae	Least Concern
111	Small Niltava	*Niltava macgrigoriae*	Muscicapidae	Least Concern
112	Rufous-bellied Niltava	*Niltava sundara*	Muscicapidae	Least Concern
113	Blue-throated Flycatcher	*Cyornis rubeculoides*	Muscicapidae	Least Concern
114	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	Muscicapidae	Least Concern
115	Ferruginous Flycatcher	*Ficedula ferruginea*	Muscicapidae	Least Concern
116	Rufous-gorgeted Flycatcher	*Ficedula strophiata*	Muscicapidae	Least Concern
117	Ultramarine Flycatcher	*Ficedula superciliaris*	Muscicapidae	Least Concern
118	Little Pied Flycatcher	*Ficedula westermanni*	Muscicapidae	Least Concern
119	Scarlet Minivet	*Pericrocotus flammeus*	Campephagidae	Least Concern
120	Long-tailed Minivet	*Pericrocotus ethologus*	Campephagidae	Least Concern
121	Bar-winged Flycatcher-shrike	*Hemipus picatus*	Vangidae	Least Concern
122	Yellow Bellied Fairy Faintail	*Rhipidura hypoxantha*	Stenostiridae	Least Concern
123	White-throated Faintail	*Rhipidura albicollis*	Rhipidurdae	Least Concern
124	Chestnut-bellied Rock Thrush	*Montaciola rufiventris*	Turdinae	Least Concern
125	Blue-capped Rock Thrush	*Montaciola cinclorhynchus*	Turdinae	Least Concern
126	Blue-whistling Thrush	*Myophonus caeruleus*	Turdinae	Least Concern
127	Blue Rock Thrush	*Montaciola solitarius*	Turdinae	Least Concern

128	Scaly Thrush	*Zoothera monticola*	Turdinae	Least Concern
129	Orange-headed Thrush	*Zoothera citrina*	Turdinae	Least Concern
130	White-collard Black Bird	*Turdus albocinctus*	Turdinae	Least Concern
131	Grey-winged Black Bird	*Turdus boulboul*	Turdinae	Least Concern
132	Maroon oriole	*Oriolus traillii*	Orioliadae	Least Concern
133	Slender-beilled Oriole	*Oriolus tenuirostris*	Orioliadae	Least Concern
134	Large-billed Crow	*Corvus macrorhynchos*	Corvidae	Least Concern
135	Grey-backed Shrike	*Lanius tephronotus*	Laniidae	Least Concern
136	Long-tailed Shrike	*Lanius schach*	Laniidae	Least Concern
137	Common Green Magpie	*Cissa chinensis*	Corvidae	Least Concern
138	Eurassian Jay	*Garrrulus glandarius*	Corvidae	Least Concern
139	Grey Treepie	*Dendrocitta formosae*	Corvidae	Least Concern
140	Great Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	Least Concern
141	Common Kestrel	*Falco tinnunculus*	Falconidae	Least Concern
142	Common Buzzard	*Buteo buteo*	Accipitridae	Least Concern
143	Eurassian Sparrowhawk	*Accipiter nisus*	Accipitridae	Least Concern
144	Black Eagle	*Ictinaetus malayensis*	Accipitridae	Least Concern
145	Crested Serpent Eagle	*Spilornis cheela*	Accipitridae	Least Concern
146	Common Sandpiper	*Actitis hypoleucos*	Scolopacidae	Least Concern
147	Black-tailed Crake	*Porzana bicolor*	Rallidae	Least Concern
148	Wedged-tailed Green Pigeon	*Treron sphenura*	Columbidae	Least Concern
149	Spotted Dove	*Streptopelia chinensis*	Columbidae	Least Concern
150	Oriental Turtle Dove	*Streptopelia orientalis*	Columbidae	Least Concern
151	Barred Cuckoo Dove	*Macropygia unchall*	Columbidae	Least Concern
152	Emerald Dove	*Chalcophaps indica*	Columbidae	Least Concern
153	Rock Pigeon	*Columba livia*	Columbidae	Least Concern
154	Tawny Fish Owl	*Ketupa flavipes*	Strigidae	Least Concern

155	Grey Nightjar	*Caprimulgus indicus*	Caprimulgidae	Least Concern
156	Spot-bellied Eagle Owl	*Bubo nipalensis*	Strigidae	Least Concern
157	Collard Scops Owl	*Otus bakkamoena*	Strigidae	Least Concern
158	Asian Barred Owlet	*Glaucidium cuculoides*	Strigidae	Least Concern
159	Lesser Coucal	*Centropus bengalensis*	Centropodidae	Least Concern
160	Plaintative Cuckoo	*Cacomantis merulinus*	Cuculidae	Least Concern
161	Asian Emerald Cuckoo	*Chrysococyx xanthorhynchus*	Cuculidae	Least Concern
162	Drongo Cuckoo	*Surniculus lugubris*	Cuculidae	Least Concern
163	Chestnut-winged Cuckoo	*Clamator coromandus*	Cuculidae	Least Concern
164	Large Hawk Cuckoo	*Hierococcyx sparverioides*	Cuculidae	Least Concern
165	Green-billed Malkoha	*Phaenicophaeus tristis*	Cuculidae	Least Concern
166	Grey-headed Woodpecker	*Picus canus*	Picidae	Least Concern
167	Greater Yellownape	*Picus flavinucha*	Picidae	Least Concern
168	Crimson -breasted Woodpecker	*Dendrocopos cathpharius*	Picidae	Least Concern
169	Lesser Yellownape	*Picus chlorolophus*	Picidae	Least Concern
170	Rufous Woodpecker	*Celeus brachurus*	Picidae	Least Concern
171	Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	Picidae	Least Concern
172	Bay Woodpecker	*Blythipicus pyrrhotis*	Picidae	Least Concern
173	Speckled Piculet	*Picumnus innominatus*	Picidae	Least Concern
174	White-browed Piculet	*Sasia ochracea*	Picidae	Least Concern
175	Kalij Pheasant	*Lophura leucomelanos*	Phasianidae	Least Concern
176	Hill Patridges	*Arobrophila torqueola*	Phasianidae	Least Concern
177	Barred Buttonquail	*Turnix suscitator*	Turnicidae	Least Concern
178	Mountain Tailorbird	*Orthotomus cuculatus*	Sylviidae	Least Concern
179	Spotted Forktail	*Enicurus maculatus*	Muscicapidae	Least Concern
180	Yellow-breated Fulvetta	*Alcippe cinerea*	Pellorneidae	Least Concern

181	Dark-sided Flycatcher	*Muscicapa sibirica*	Muscicapidae	Least Concern
182	Rufous-bellied Woodpecker	*Dendrocopos hyperythrus*	Picidae	Least Concern
183	Taiga Flycatcher	*Ficedula albicilla*	Muscicapidae	Least Concern

Contributed by Deo Man Rai, FR-II, LFMU

4.4 List of fish found

Table 8: List of fish found in the Lingmethang FMU

Sl.No	Common Name	Latin Name	Family	IUCN Status
1	Katli (Np)	*Neolissochilus hexagonolepis*	Cyprinidae	Near Threatened
2	Asla (Np)	*Schizothorax richardsonii*	Cyprinidae	Vulnerable
3	Katlay (Np)	*Garra gotyla*	Cyprinidae	Least Concern
4	Homaloptera (En)	*Psylorhynchus homaloptera*	Psilorhynchidae	Least Concern
5	Khasi Garra (En)	*Garra lissorhynchus*	Cyprinidae	Least Concern
6	Sucker Thorated Catfish (En)	*Pseudogenensis sp.*	Claroteidae	Least Concern
7	Tri Band Sumo Loach (En)	*Schistura sp.*	Balitoridae	Least Concern
8	Cat Fish (En)	*Parachiloglanis sp.*	Claroteidae	Least Concern
9	*Glyptothorax sp.*	*Glyptothorax sp.*	Sisoridae	Least Concern

Contributed by Deo Man Rai, FR-II, LFMU

5. SILVICULTURAL ASSESSMENT

5.1 Past Silvicultural Treatment

This is the third Forest Management Plan of Lingmithang FMU. During the second plan period, the total AAC was 9000 m^3 (commercial = 7000 m^3 and rural = 2000 m^3). The total commercial timber harvested from the FMU during the second plan period is 51,041.18 m^3 in standing volume. Similarly the total rural timber harvested from the FMU durng the second plan period is 4433.90 m^3 in standing volume. The harvest comprised of both chir pine and hardwood forests in Kalpang, Songjari and Yunari blocks.

The silviculture system prescribed for commercial harvesting durong the first and second Management Plan was Seed Tree System for Chirpine Forest and Patch Cut system for Broadleaf Forest. For rural timber harvesting Single Tree Selection System was prescribed and applied during the first and second management plan.

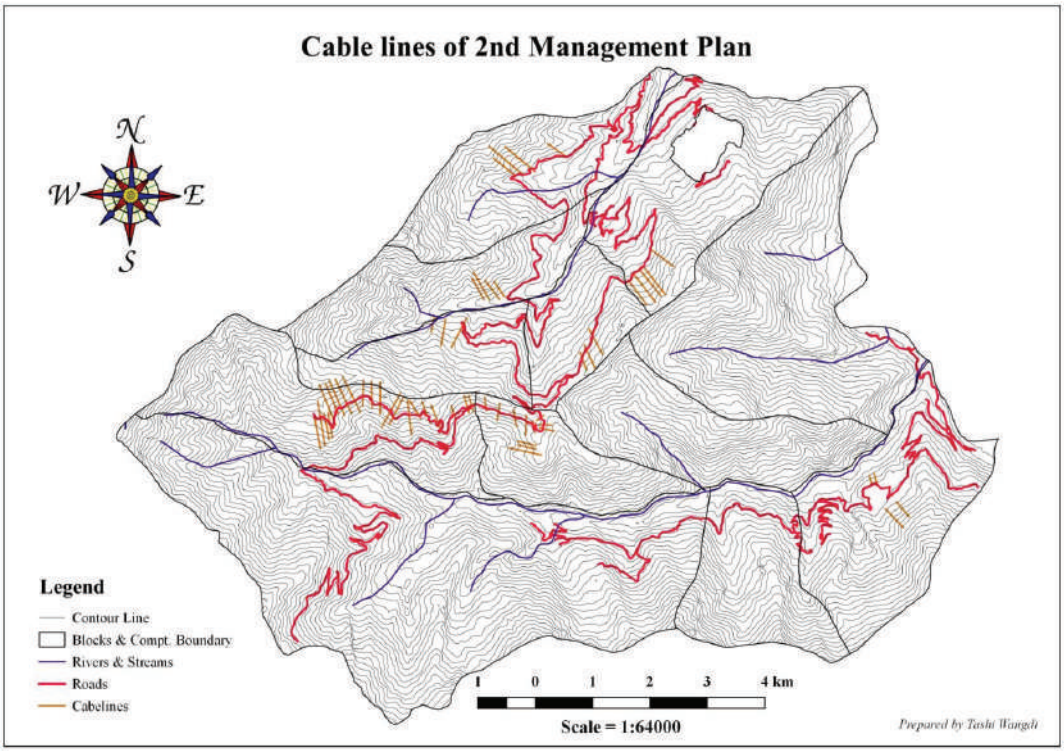


Figure 11: Cable lines laid during second management plan

In total 55 nos. of cable lines were laid in these 3 blocks (Kalapang = 4, Shongjari = 19 and Yunari = 32).

5.2 Forest Types

The predominat forest types found in Lingmithang FMU are Broadleaf and Chirpine Forest. Chir pine forest is found in Songjari, West-Gyelposhing and Kalapang blocks. The stands are mature in Songjari and Kalapang blocks whereas in West-Gyelposhing block it is immature. A small patch of young chir pine occurs just opposite to Mangling Lhakhang as well. The regeneration in chir pine forest is very good. Warm broad-leaf or hardwood forest is found in all the four blocks. The stand in general is matured but pockets of immature stands also exist. Regeneration in the area is good and the grazing pressure is also less at the moment.

6. SOCIO-ECONOMICS

6.1 Common sources of Income

Subsistence Farming and raisning livestock are the main livelihood activities of farmers living in LFMU and constitutes the major income generation activities in the villages. However, large scale agricultural activities are restricted and marginalized because of rugged terrain and fragmented land holdings. Potato and maize are the main crops. Other vegetables grown are cauliflower, cabbage, lettuce, broccoli, beans, onion, pumpkin, cucumber and radish. Few cash crops like mango, orange and guava are also grown that earn them some money. People usually rear cattle, horses, pigs and poultry. They earn some income through agricultural and livestock products, which they sell at Lingmethang and Gyelposhing.

7. CURRENT TIMBER SUPPLY AND DEMAND

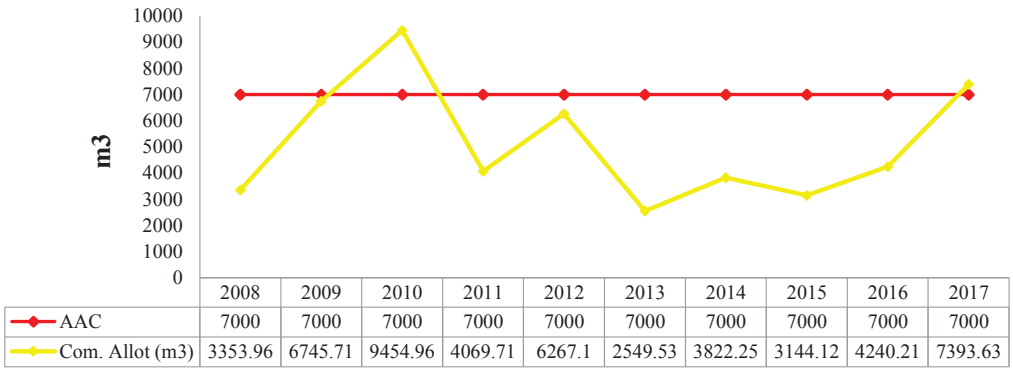
7.1 Supply of commercial timber

The Annual Allowable Cut (AAC) of the second Management Plan has been set at 7000 m^3 for commercial use. Against this prescribed allowable cut a total standing volume of **51041.18 m^3** of commercial timbers (Table 9) was harvestd from the FMU during the second management plan period against a total stading volume of **70000 m^3** (7000 X 10) allotted to NRDCL for commercial harvesting. However, NRDCL could not harvest around 18958.82 m^3 of timbers in standing volume as per the AAC prescribed in the Management Plan. The details of the allotment are as indicated below.

Table 9: Commercial timber allotted during the last paln from FMU

Year	Timber (log m^3)	Firewood (m^3)	Woodchips (m^3)	Total (m^3)
2008	2221.83	966.47	165.66	3353.96
2009	3084.4	1727.2	1934.11	6745.71
2010	6049.77	1247.43	2157.76	9454.96
2011	3461.08	302.29	306.35	4069.71
2012	3309.65	439.05	2518.4	6267.1
2013	1772.26	388.67	388.6	2549.53
2014	2356.78	565.45	900.02	3822.25
2015	869.71	2274.41	-	3144.12
2016	2769.86	1470.35	-	4240.21
2017	3886.50	3507.13		7393.63
Total	**29781.84**	**12888.45**	**16741.79**	**51041.18**

Source: FMU Office, Lingmethang (Note: All figures in standing volume)



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
AAC	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000
Com. Allot (m3)	3353.96	6745.71	9454.96	4069.71	6267.1	2549.53	3822.25	3144.12	4240.21	7393.63

Figure 12: Comparison of commercial Timber Allotment against the Commercial AAC

The reason for the extraction of timber more than AAC in 2010 as shown in the Figure 12 is owing to the demand by the earthquake victims of 2009.

The clearcut area (Table 10) includes the area of forest clear felled for forest road and farm road constructions, transmission line and the patch cut for extraction of commercial timber including the cable corridor area of the operated cable lines. During the last 10 years the clearcut area was 147.18 ha, although the total clearcut area for the FMU was 268.60 ha.

Table 10: Clearcut area during the last plan period in Lingmithang FMU

Year	Patch cut (ha)	Corridor	Roads and others	Total (ha)	Clear Cut
2008	7.6	3.50	0.72	11.82	26.86
2009	7.2	5.08	16.2	28.48	26.86
2010	7.43	3.37	1.2	12.00	26.86
2011	6.75	4.33	0.792	11.87	26.86
2012	11.13	5.04	0	16.17	26.86
2013	4.5	2.09	3	9.59	26.86
2014	6.836	3.02	0	9.85	26.86
2015	5.5	3.69	2.76	11.95	26.86
2016	6.75	8.07	0	14.82	26.86
2017	12	9.28	0	21.28	26.86
Total	**75.696**	**47.60**	**23.88**	**147.18**	**268.60**

7.2 Supply of rural timber

People residing within the LFMU extract rural house building timbers and firewood from the FMU. It is utilised for construction of new houses, repair, renovation and extension of rural houses, shed for livestock,

farm guard shed, watch tower, toilet and machinery sheds. Besides, it is also used for agricultural implements such as domestic furniture, flag poles and fencing poles.

The supply of rural timber and firewood from Lingmethang FMU during the period from 2008-2017 is given in the Table 11.

Table 11: Rural timber allocation from Lingmethang FMU (2008- 2017)

Year	Timber (log m^3)	Firewood (m^3)	Total (m^3)
2008	482.6	239.4	722
2009	701.6	128.9	830.5
2010	105.6	58.75	164.35
2011	189	112.86	301.86
2012	469.48	263.99	733.47
2013	103.24	165.72	268.96
2014	191.1	146.58	337.68
2015	110.55	37	147.55
2016	381	56	437
2017	399.53	91	490.53
Total	**3133.7**	**1300.2**	**4433.9**

Source: FMU Office, Lingmethang

The average annual rural timber allotment from the FMU is 443.9 m^3. It is about 22% of the Rural AAC allocated in the plan. The comparison of rural timber allotment and rural AAC is shown in the Figure 13.

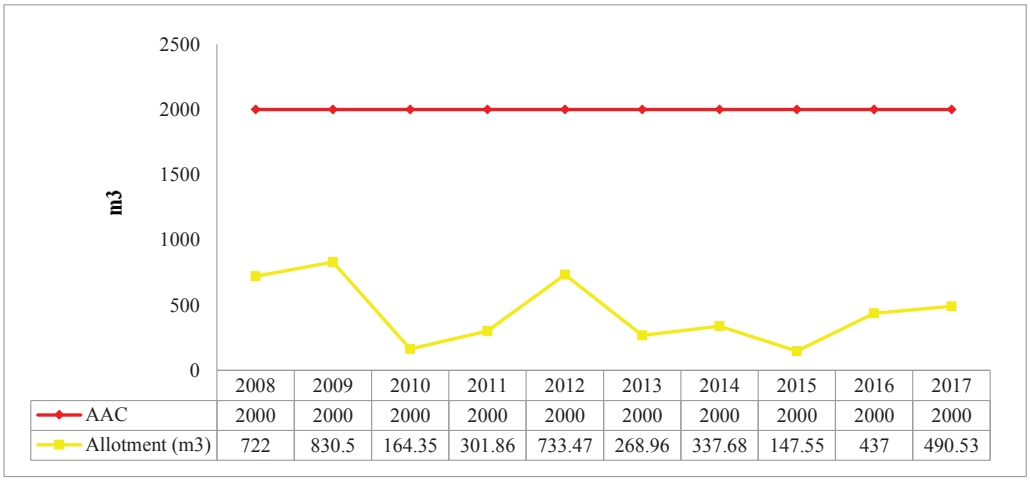


Figure 13: Rural Timber Allotment against the Rural AAC

8. ORGANISATION AND ADMINISTRATION

8.1 Organisation

The Lingmethang FMU is under the jurisdiction of Mongar Territorial Division and it is directly administered by the CFO. The CFO will be supported by the Unit In-charge (UIC), who will supervise the FMU operations. Operational Plans (OPs) will be prepared by the UIC with assistance from the CFO, Mongar. All activities within the FMU will be administered by the CFO, Mongar

8.2 Health and Safety

The forestry operation involves major risk during harvesting and transportation of timber. Site specific risk assessment is required for the FMU to ensure health and safety of the field staff. During the process of felling, the chainsaw should be equipped with full functioning chain breaks and feller should ensure to keep two tree lengths apart while felling. The danger of felling timbers and overhead cable lines is inevitable and care should be taken while staking. The staking should be done to a standard height in the same direction. First aid box and necessary field gears needs to be provided to the workers during the operation.

In line with the recommendation of Richard W Bradshaw, the suggested route to follow would be:

1. All the workers will be equipped with safety gears and proper safety equipment
2. Carry out risk assessment for all active harvesting sites
3. Implement pollution control measures
4. Implement emergency evacuation plans
5. Implement supervisory checks for contractors and subcontractors, for conformity to ‘best practice’ while working on harvesting sites
6. Implement accident/incident reporting procedures

8.3 Record Keeping

The FMU office shall maintain the records of all the activities within the FMU as per the record keeping format of the Forest Management Code of Bhutan (FMCB 2004). The activities may include area or number of cable lines harvested annually to achieve Annual Allowable Cut (AAC), timber volume accrued from operated cable lines, forest road construction and sanitation or epidemic felling among others. The records should be maintained both for standing and log volume.

9. INFRASTRUCTURE, TRANSPORT AND EQUIPMENTS

9.1 Forest Roads

During the second plan period, about 9.75 km Forest road has been constructed in Lingmithang FMU. The detail of forest road construction during the 2nd management plan period is shown in Table 12:

Table 12: Details of Forest road construction during the second plan by NRDCL

Block/Compatment	Year	Road constructed (km)
Shongari IV	2008	0.6
Shongari IV	2009	0.69
Kalapang II	2009	2
Kalapang II	2010	1
Kalapang II	2011	0.66
Yunari I	2013	2.5
Yunari II	2015	2.3
Total		**9.75**

Source: FMU Office, Lingmethang

There is in total 70.06 km of fair weather forest and farm roads. The details of the length of road in each block are as shown in the Table 13.

Table 13: Length of roads in each block (Forest Roads and Farm roads)

Block	Road (km)
Kalapang	14.04
Shongjari	29.01
West-Gyelposhing	0.71
Yunari	26.3
Total	**70.06**

Some sections of the forest road are in need of maintenance and side drains are blocked in some places. The FMU road has immensely benefitted villagers of Broksar, Kalapang Mangling and Tshanzabi.

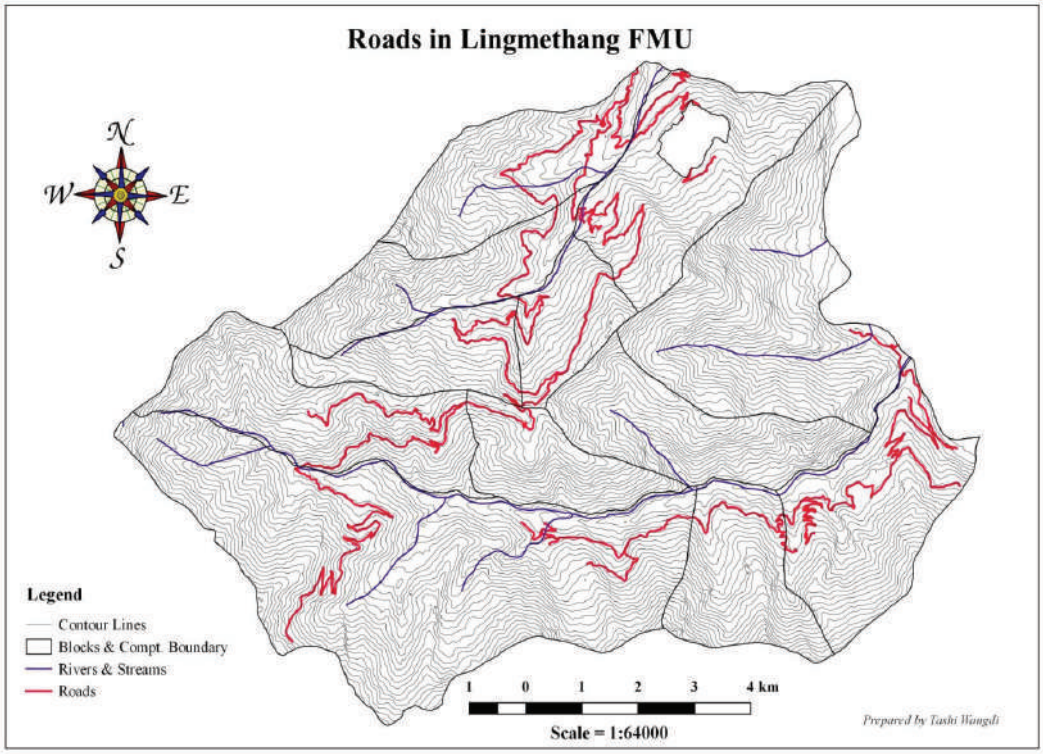


Figure 14: Roads inside Lingmethang FMU

10. EVALUATION OF SECOND PLAN (February 2008 to January 2018)

The second Forest Management Plan 2008-2018 was prepared by Mrs. Dimple Thapa, Planner, FRMD. The review of the previous plan is imperative to identify areas that are in need of management interventions and comment on objectives that were set in the Plan. The final evalution of the FMU was carried out by DoFPS from 25th to 28th April, 2017 by a team constituted by the Specialist, DoFPS.

10.1 Review of Goals and Objectives

The overall goal of the second management plan was to manage the FMU on a sustained yield basis for the production of timber, firewood and other forest products and for watershed and environmental protection. To this the objective of timber production from the FMU has been largely achieved as around **51041.18 m^3** of commercial timber in standing volume has been harvested against the total allocation of **70000 m^3** as per the Management Plan**.** Similarly, around **4433.90 m^3** of Rural Timber in standing volume has been extracted and distirubted to the publics against the total allocation of **20000 m^3** as per the Management Plan. Therefore the timber production from the FMU during the last plan period was less than the AAC prescribed in the

Management Plan for both commercial and rural timbers. It was observed that forest cover around the water sources have been protected well and no felling or harvesting was allowed in the second management plan period. Further much of the vegetation cover in the FMU is largely intact due to improved harvesting technology.

10.2 Review of Reforestation

During field visit the evaluation team found sufficient natural regeneration of Chir pine saplings (12000/ha) in harvested areas of Chirpine forest. The areas which were harvested in the first plan period are well restocked while those which were harvested in the second plan period (2008-2018) have adequate natural regenerations.

Figure15: During final evaluation at LFMU

But the evaluation team didn't find adequate natural regeneration in the harvested areas of Broad Leaved Forest. Thus, most of the harvested areas in broad leaved forest were artificially regenerated by NRDCL with native species such as Toona, Champ, Walnut, Morus, etc. It was found that most of the plantations near the road had successful survival rate of plantation (1600/ha), the plantation away from the forest road showed poor plantation performance (25/ha) based on sampling (limited replication). The plantations were taken over by profuse weed growth in most of the areas. Plantation (3600/ha) which were carried out in 2007 and 2008 had mean height of 18.9 m and were handed over to the Mongar Territorial Division.

NRDCL has also established a nursery which is located within the FMU to meet the seedling demand for plantations in the FMU. However, the nursery also caters to the needs of seedlings outside the FMU and local communities. Some of the tree species raised in the nursery are Walnut, Champ, Morus, Toona, etc which are native to the FMU. The seeds are collected from forest within the FMU.

Figure 16: Assessing plantation survival

One of the main reasons for failure of plantations in the FMU was due to inadequate budget provisions. Currently, as per the plantation norms and standards of NRDCL, the plantation cost for the same extend of area is 30% less than the norms and standards adopted by DoFPS. This leads to minimal or no budget provisions especially for plantation maintenance at the later stages of the establishment period. To this, the evaluation team strongly recommends NRDCL to adopt the norms and standards developed by DoFPS with immediate effect. NRDCL should keep adequate financial provisions for establishment of plantations and its maintenance in the next plan period. They should maintain species diversity in the plantations by planting seedlings of atleast 5 native species.

The evaluation team also recommended NRDCL for immediate refilling of the plantations in the broad leaf forests especially those with very low survival percentage.

During the 2nd Forest Management Plan of the FMU the NRDCL has planted 124441 numbers of saplings in 74.57 ha of harvested area. The survival percentage of the plantation submitted to the Divisional Forest Office, Mongar after plantation survival survey in 2018 is 50-60 percent.

Table 14: Plantation creation in the harvested area

Year of	Block/Compt.	Area (ha)	Nos. of seedlings	Species
2008	Shongjari	10.91	17200	Walnut, Morus sp., Exbucklandia sp., Michelia sp., Nysia sp., Toona sp. and Persea
2009	Shongjari	8.48	12477	
2010	Shongjari	3.54	4468	
2011	Shongjari	3.03	7844	
2012	Shongjari	5.57	10272	
2013	Shongjari	5.09	8144	
2014	Shongjari	6.15	9780	
2015	Shongjari	8.50	17455	
2016	Shongjari, Yunari II	12.19	19504	
2017	Yunari	6.6	10560	
2018	Yunari	4.51	6737	
Total		**74.57**	**124441**	

Source: FMU Office, Lingmethang

10.2.1 General Observations of final evaluation team

1. In the collective judgement of the team, all the recommendations of mid-term evaluation of the FMU had been properly implemented.
2. However, plantations carried out in Broad Leaved Forest needs immediate refilling as survival percentage is still very low.
3. NRDCL has opened a retail shop of sawn timber at NRDCL depot which is a good initiative towards making timbers more accessible and affordable to the general public. They have more proposals to establish similar retails in other locations too.
4. Width of the cable corridors are more than the prescribed width according to the sampling measurement done by the evaluation team.
5. Harvesting of NWFPs is not done based on resource assessment and a prescribed management plan.
6. The implementation of FMU activities by NRDCL is hampered due to man power shortage.

10.2.2 Recommendations

1. Besides the prescribed management plan of the FMU, the timber extraction from the FMU must be based on the demand of the market.
2. Though watersheds and catchment areas are adequately preserved in the Management Plan of the FMU, the conservation and protection of catchment areas within the production still needs to be prioritised during the implementation of the FMU activities.
3. NRDCL needs to ensure proper fencing of the plantations especially during the later stages of seedling establishment period since the seedlings are very prone to cattle/wildlife grazing.
4. NRDCL must keep adequate financial provisions for successful plantations in the FMU. It is recommended that they adopt the plantation norms and standards adopted by DoFPS or rectify and make necessary changes in the norms and standard adopted by NRDCL. Currently, as per the plantation norms and standards of NRDCL, the plantation cost for same area is 30% less than the norms and standards adopted by DoFPS.
5. More efforts need to be made to create awareness about the FMU among the general public in and around the FMU for better implementation of FMU activities.
6. Cable corridor should be maintained as per the prescription of the management plan. Directional felling towards the centre line should be carried out to avoid increase in the width of the corridors.
7. 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 identified and prioritised must be developed in close consultation with Social Forestry and Extension Division of the Department.
8. It is recommended to retain snag trees wherever possible in the FMU cable lines to provide nesting space for wild life especially for hornbills. Snag trees must be protected as far as possible.

PART 2 FUTURE MANAGEMENT

PART 2 FUTURE MANAGEMENT

11. INTRODUCTION

The Constitution of Bhutan has the provision to maintain 60% of the total lands under forest cover for all times to come (Royal Government of Bhutan, 2008). This important provision of the constitution has also been re-emphasized in the National Forest Polciy, 2011 which froms an important aspect of the developmental process of the country. This constitutional provision can be fulfilled by following scientific sustainable forest management practices which will not only help us in managing our forest sustainably but also full fill the social, economic, ecological and cultural needs of the present and future generations.

11.1 Forest Policy

The Forest and Nature Conservation Act of Bhutan 1995 requires that management plans to be approved and implemented for all protected areas and for all forests where commercial logging is to be undertaken. This plan has been prepared in line with the Forest and Nature Conservation Act 1995 and the Forest and Nature Conservation Rules and Regulations of Bhutan, 2017 in close adherence to the guidelines provided in the Forest Management Code of Bhutan. Further the National Forest Policy of Bhutan, 2011 consist of long term goal, major policy objectives and specific statements to enable various aspects of forest production, use and management. It has five guideing priniciple viz, equity and justice in terms of accessibility, poverty alleviation through integrated approach, deregulation and devolution, integration of siencence and indigineous knowledge and allowing import of logs and sawn timbers (Department of Forest and Park Services, 2011).

This plan has been prepared in line with the Forest and Nature Conservation Act (1995), Forest and Nature Conservation Rules and Regulations (2017), National Forest Policy 2011 and Forest Management Code of Bhutan 2004.

11.2 Overall Goal

The overall Goal of the management plan is to:

Manage the forest resources within Lingmethang FMU on a multiple use, sustained yield basis for the production of timber, fuelwood and other forest products and for watershed, wildlife and environmental protection.

11.3 Objectives

The objectives of Lingmithang Forest Management Unit were framed based on different management circles identified to ease the implementation of the plan. The three Management Circles identified are (Figure 17) **Protection**, **Production** and **Non-Production** Management Circles. This allows different areas

to be managed and evaluated separately. However, there are instances where different management circles share similar objectives. The objectives of each Management circles are listed below.With proper record keeping, vigilant monitoring and evaluation and appropriate budget considerations by NRDCL it is expected that all the following objectives can be met easily.

Protection Management Circle

1. To conserve the water catchment functions by keeping buffer zones and not harvesting timber;
2. To protect the forest from fire and illegal activities through involvement of local people;
3. To allow low-impact collection of Non-Wood Forest Products through some regulations;
4. To conserve and protect wildlife habitats and biodiversityby not interfering any human interventions while managing FMU;
5. To raise awareness on biodiversity and the natural forest to local communities and stakeholders;
6. To respect the sanctity of religious places and to protect historical sites through FMU management.

Non-Production Management Circle

1. To manage and regulate grazing for livestock through involvement of local communities;
2. To conserve and protect biological diversity by regulating function maps of FMU;
3. To conserve the water catchment areas by keeping buffer zone and not harvesting timber;
4. To maintain the forest condition by following the plan prescriptions of management plan;
5. To meet the local demand for NWFPs on sustainable basis.

Production Management Circle

1. To meet local requirement, as a priority, for timber, fuelwood and other forest products on a sustainable basis;
2. To manage the FMU for commercial timber production on a sustainable basis;
3. To enhance and improve forest condition and productivity to meet national needs;
4. To create local employment opportunities through forestry activities;
5. To protect the forest from pest and diseases, fire, illegal activities and from grazing in regenerating area.

11.4 Management Based on Forest Function

11.4.1 Introduction

Forest function mapping is an essential tool for forest management planning by the planner and implementation of the management plan by FMU In-charges. Function mapping is used for groping different potential uses of the forest. The different potential includes soil conservation, watershed conservation, habitat for flora and fauna and resource based for many kinds of human needs. The forest functions are objectively limited by site conditions, its dominant site of forest type with its accessibility and slopes, habitat for wildlife, water catchment, social and religious sites, ecological/biodiversity area, barren area, etc. Forest functions are not subjective to human demands but are significantly and objectively limited by site condition of forest stand as stated above.

FMCB (2004) describes forest function as, the forest area within the FMU and can be categorized as ecological, environmental and social functions. It serves to balance the often diverging interests of commercial logging, local forest use and nature conservation.

11.4.2 Objectives of forest function mapping

The main objectives of forest function mapping in this plan are:

1. To define different environmental and social functions of the forest and depict them on the maps;
2. To identify production, non-production and protection area within the FMU;
3. To provide a tool for the management planner for balancing the nature conservation, environment protection, social forestry and commercial timber production and also to provide the spatial information required to compute the sustainable AAC;
4. To provide the FMU In-charge with information on the location of different forest functions in order to enable him/her to specify the required management prescriptions on the ground and to control their implementation.

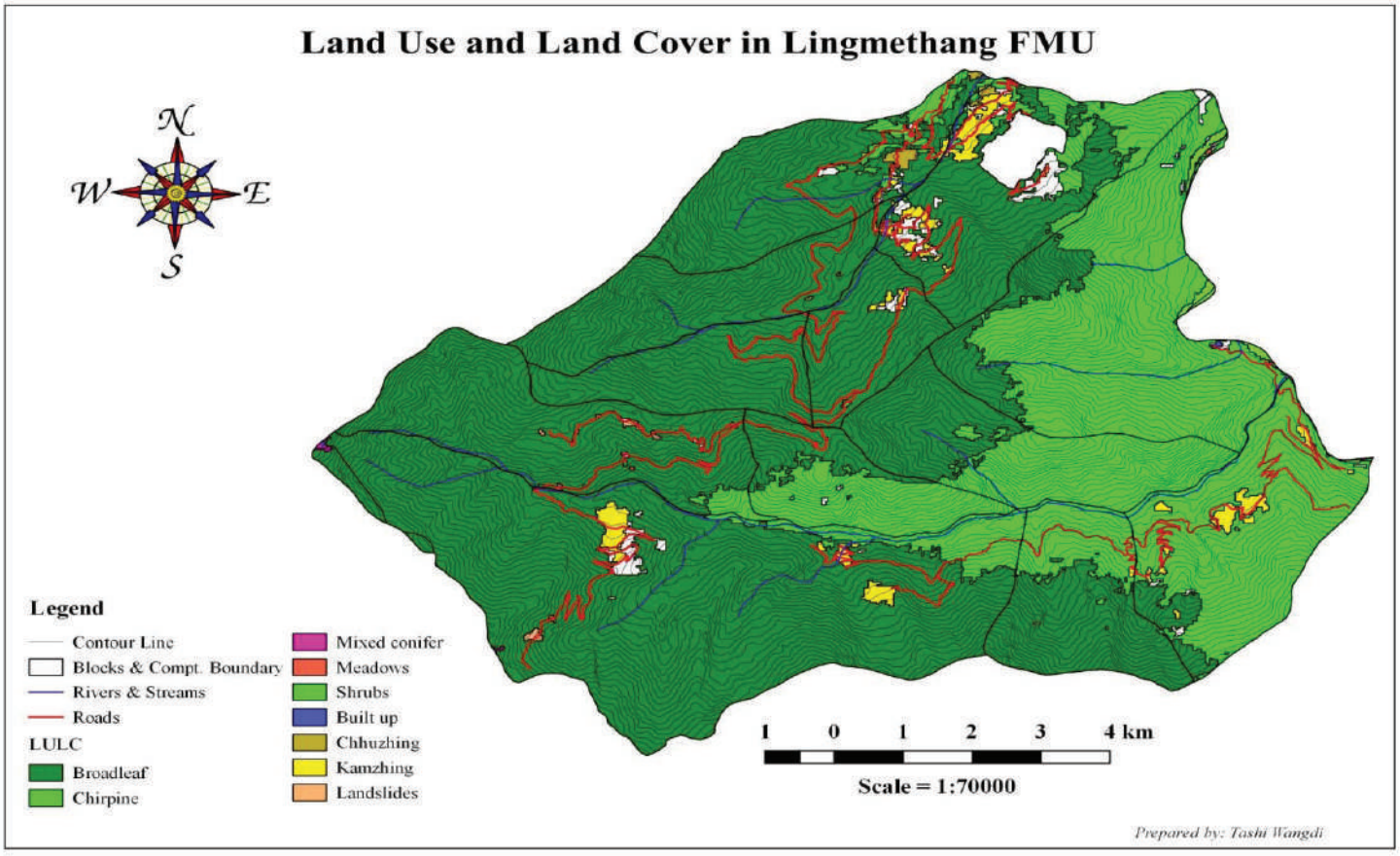


Figure 17: Land Use and Land Cover of Lingmethang FMU

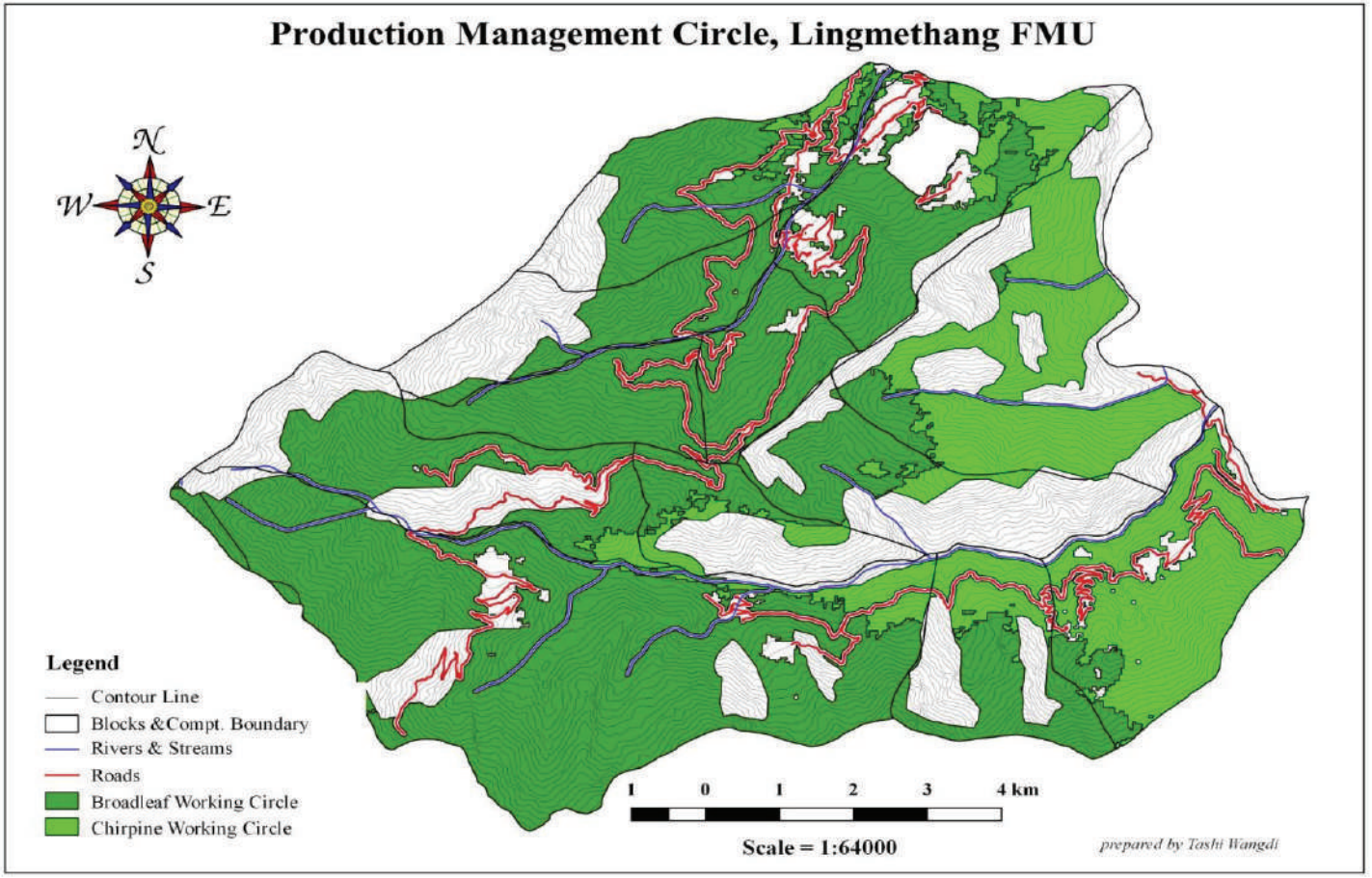


Figure 18: Production management circle of the FMU

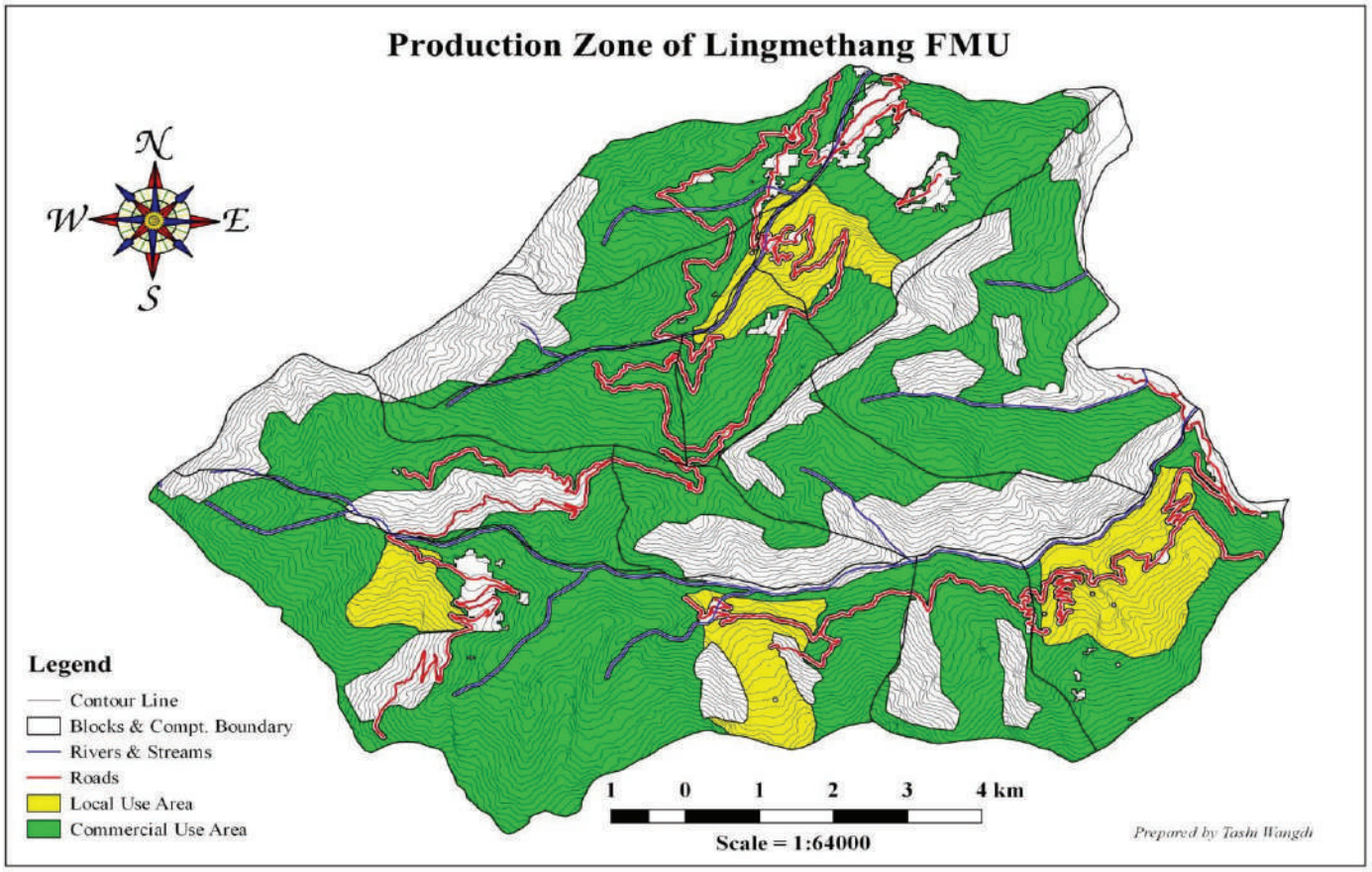


Figure 19: Production Zone of Lingmethang FMU

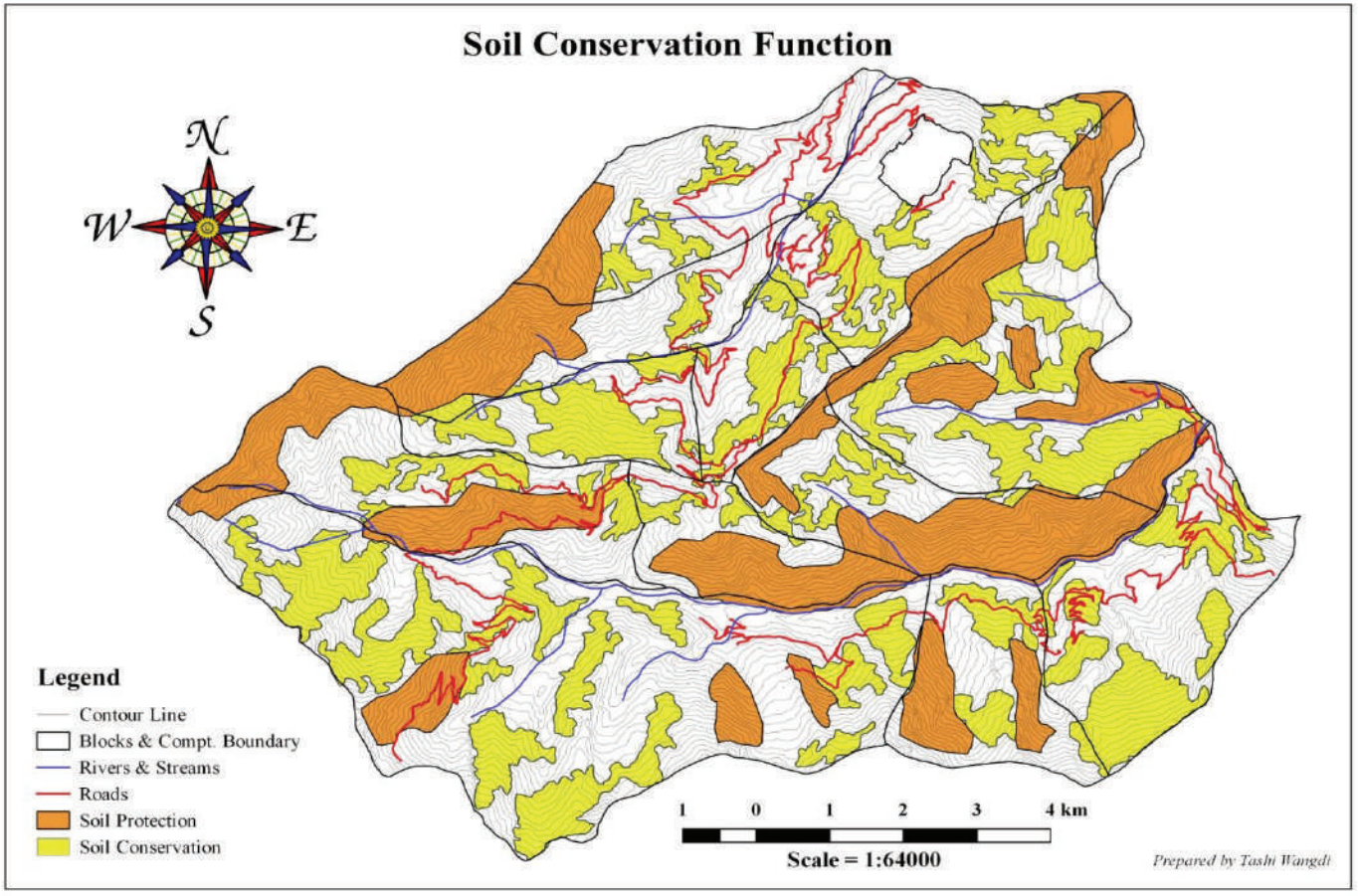


Figure 20: Soil conservation function in the FMU

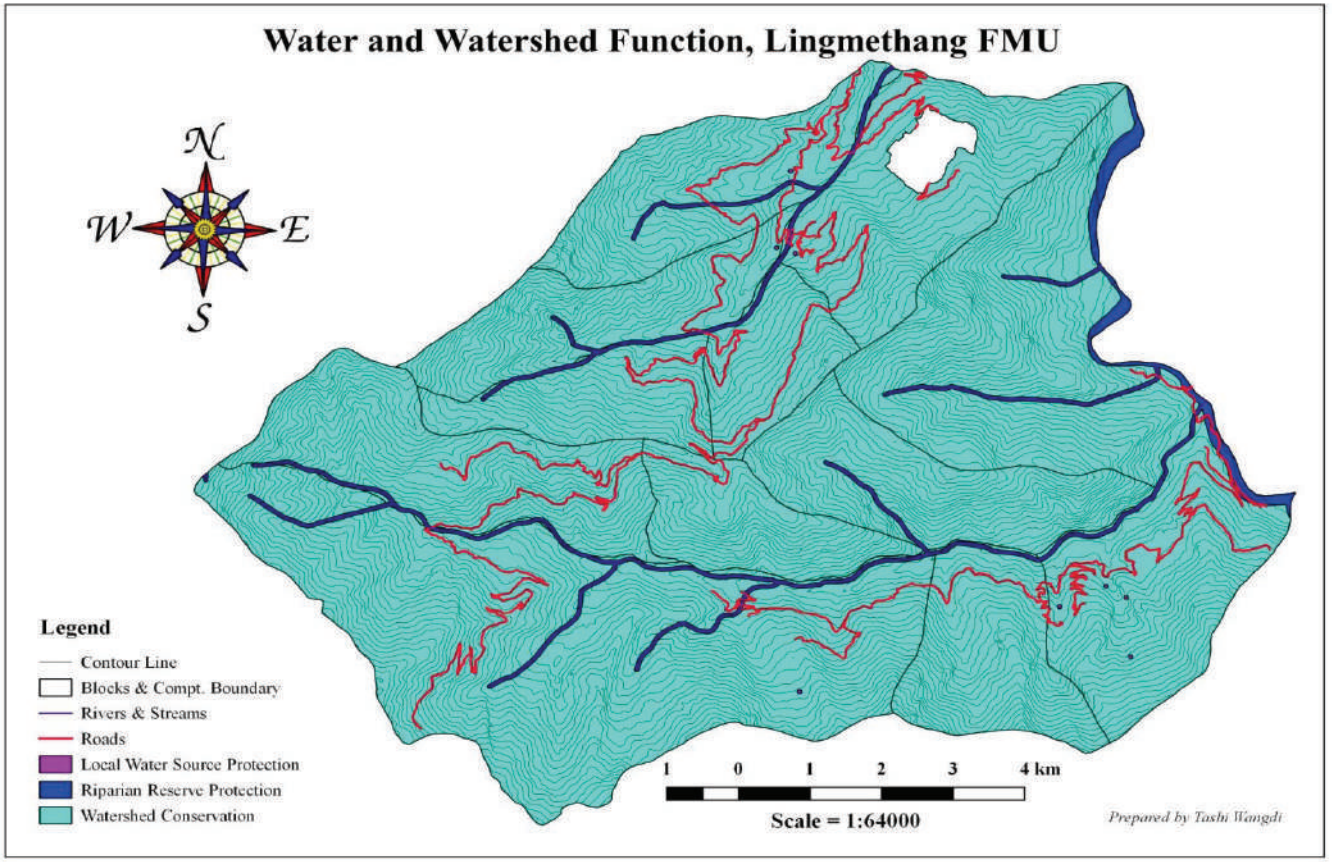


Figure 21: Watershed function in the FMU

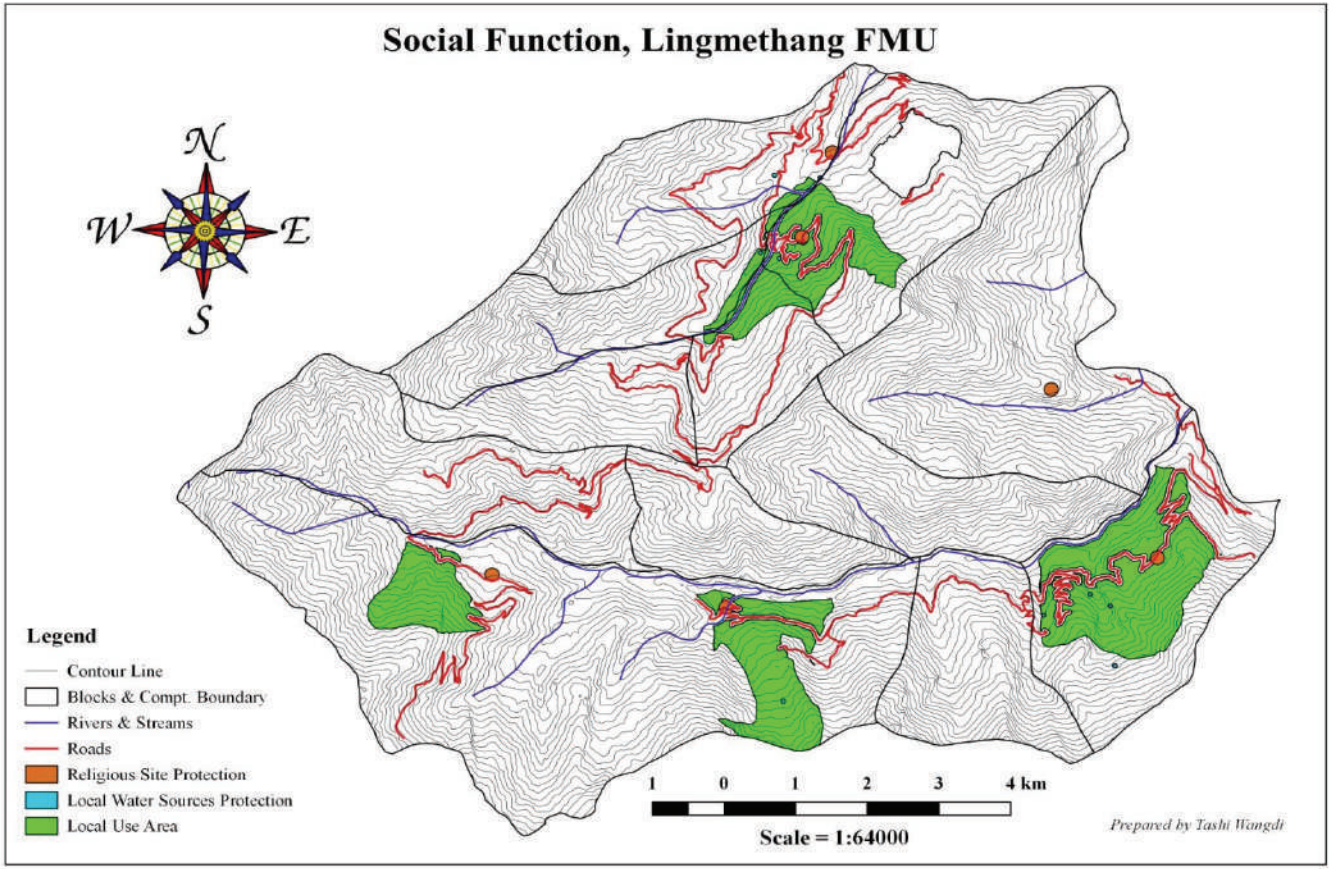


Figure 22: Social function of the FMU

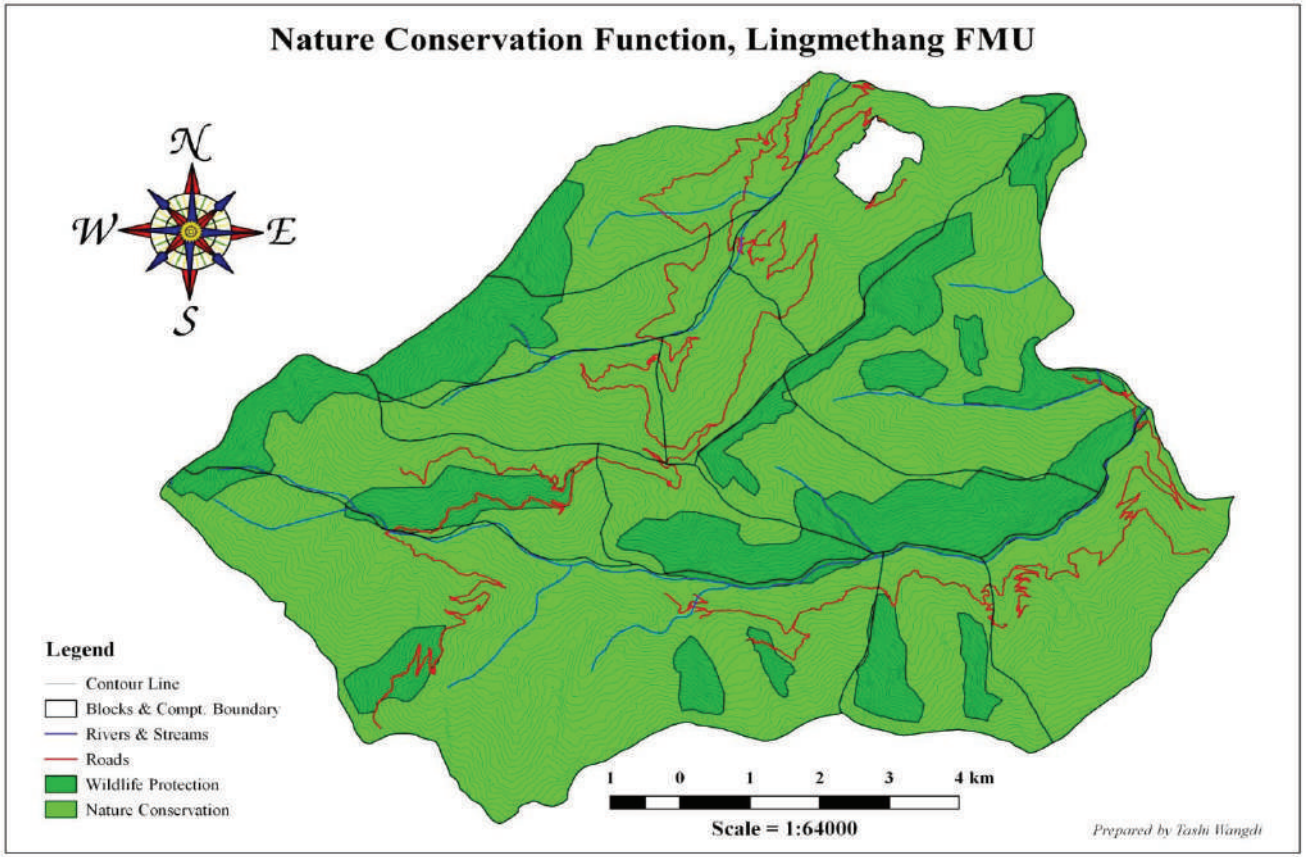


Figure 23: Nature conservation function in the FMU

11.4.3 Function groups

The functions used in this management plan are listed in Table 15. Some of these groups include functions that differ only in the degree of intensity of their management prescriptions.

Table 15: List of Different Forest Function Groups and Functions

Code	Function Group	Code	Function Group
S	**Soil Protection and Conservation**	**N**	**Nature Conservation**
SC	*Soil Conservation*	***NWP***	*Wildlife Protection*
SP	*Soil Protection*	***NWC***	*Wildlife Conservation*
W	**Water and Watershed Conservation**	**SoC**	**Social Function**
WRR	*Riparian Reserve Protection*	***SocL***	*Social (Local use only)*
WSH	*Watershed Conservation*	***SocRs***	*Social (Religious Site Protection)*
WLS	*Local Water Supply Protection*		

11.4.4 Mapping forest functions

The criteria used to prepare forest function maps for the FMU are given in Table 16 below. In this table, information for some criteria is not available or cannot be mapped at the scale used for planning. These criteria are printed in *italics*. When Operational Plans are prepared new detail is to be collected and these criteria should be implemented.

Table 16: Criteria for Mapping Forest Functions

Function group and codes	Criteria for mapping
Soil Protection and Conservation	**SP:** very steep areas (slopes of greater than 100%), *areas with indication of slight to moderate erosion,* **SC:** steep or sensitive areas (slopes of 76 - 100%).
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 thirty metre along all perennial streams, Shongari Chu, and Yunari Chu, *poorly drained or waterlogged sites, moist areas and swamps*.
Nature Conservation	**NWP:** Endangered species territory, alpine areas, *ecosystems of high conservation value (e.g., swamp forests)*
Social Function	**SocL:** area close to or accessible to settlement or village, the areas traditionally used already, with definable boundaries; **SocRS:** lhakhangs/goembas and gneys and other places with high religious value

11.4.5 Restrictions of Forest Functions

The specific restrictions to be applied to forest in the various function categories are summarized in Table 17. These restrictions should be applied in conjunction with the objectives set for each Management Circle.

Table 17: Impact of Forest Function Classification on commercial and local use.

Code	Function	Restriction on Commercial Use	Restriction on Local Use
SP	Soil Protection	No commercial use	No tree felling, minimise human interference
SC	Soil Conservation	No clear cutting; no conversion into plantation; extension of regeneration periods; no ground skidding	Low impact local use
WLS	Local Water Supply Protection	No commercial use	No tree felling, minimise human interference
WSh	Watershed Conservation	No clear cutting; no conversion into plantation; minimise disturbance to understorey vegetation	Low impact local use, single tree selection
WRR	Riparian Reserve Protection	No commercial use	Only collection of NTFP
NWP	Wildlife Protection	No commercial use	Restriction to activities that do not change habitat quality and disturb wildlife; minimise grazing activities where possible
SocRS	Religious Site Protection	No Commercial use	Use only which do not disturb sanctity of place
SocLC	Local cum Commercial Use	Tree marking together with local people	

11.5 Identification and description of functions

11.5.1 Soil Protection and Conservation

11.5.1.1 Soil Protection (SP)

Soil Protection includes all areas, which are extremely sensitive to soil erosion, land and snow slides. These areas include in particular very steep slopes, rocky and stony areas, water logged gleys and already eroded areas. Unstable slopes above or near important objects such as villages, settlements, individual houses, roads, agricultural land, etc are defined for protection reasons as Soil Protection, too. The objectives are to

prevent damages caused to the environment and infrastructure by landslides, snow slides, falling stones and other physical impacts and to protect the soil from erosion and to sustain soil fertility. Soil Protection is subjected to complete protection with no commercial activity. However, some degree of interference is permitted for *bona fide* use only (i.e. collection of minor forest produce).

11.5.1.2 Soil Conservation (SC)

Soil Conservation function covers all areas, which are sensitive to soil erosion, which are, for instance steep slopes, water logged areas and exposed sites.

The objective is to minimize or prevent negative impacts due to forest resource use in order to protect the soil from erosion and other degradation processes and to sustain soil fertility.

Harvesting operations is permissible under strict management prescriptions in Soil Conservation area. There should be minimum disturbance and damage to the under storey vegetation and/or residual trees. Indiscriminate grazing should be strictly prohibited in regeneration areas.

11.5.2. Water and Watershed Conservation

11.5.2.1 Riparian Reserve Protection (WRR)

Riparian areas occur along the banks of rivers and streams. They include the water body itself, areas subject to periodic inundation and flooding, areas with high water tables and immediate adjacent uplands. Riparian areas often contain the highest plant and animal diversity, and some of the highest valued non-timber forest resources in the forest landscape. They provide critical habitats, home ranges, travel corridors for many mammal and bird species, and maintain ecologically important vertical and horizontal linkages throughout the forest landscape. The objectives are to prevent negative impacts due to forest resource use on stream channel stability, water quality, and aquatic ecosystem productivity and diversity and to protect and sustain plant diversity associated with riparian areas.

Generally, the streams are not entrenched and do not have high risk of soil erosion. Moreover, it has been observed that the soil is not exceptionally prone to frequent or extensive surface erosion or landslides in the presence of vegetation. However, there is a possibility of surface erosion and gullying if vegetation is removed. So to intercept the problem of soil erosion a buffer of 30 m (SCHINDELE and DHITAL, 1997) has been maintained along all the streams and rivers.

As per chapter III section 14 a (ii) of the Forest and Nature Conservation Act (1995) "*no permits shall be issued to fell and take timber within 100 feet (30 m) of the bank or edge of any river, stream, water course and or water source".* The act does not distinguish between the type of water course (entrenched or not), and whether this applies also for tributaries or seasonal streams. The

buffer of all water courses with a 30m buffer each side would increase the total area of river buffers tremendously and would put the economic feasibility of commercial forest management in many areas at risk. The forest function mapping guideline (SCHINDELE and DHITAL, 1997), therefore, prescribes to buffer each water course individually, depending on the actual need of protection. It has finally to be decided during the course of operational planning which streams need to be buffered and what is the appropriate buffer distance. On macro-planning level, only the main rivers and the heavily entrenched streams can be buffered. As such the area of the Riparian Reserve Protection has to be considered as a best estimate.

Riparian Reserves are put under strict protection. No forestry operations are allowed to carry out within the buffer zones except for those required to improve the forest conditions and to restore its original natural condition. Road construction has to be undertaken after considering all the measures to prevent soil erosion and allow continuous flow of water.

11.5.2.2 Local Water Supply (WLS)

Clean water supply is a basic requirement for flourishing human civilization. It is therefore of utmost importance that buffer zones have to be defined for all areas, including, the water-body itself and swampy or water logged catchment areas. The objectives are to prevent negative impacts due to forest resource use on water quality and stream channel stability and to prevent damage to water and irrigation channels. It has been found that people drink water from the streams.

All the water sources that are located in the forest areas used by the villagers have been identified. Local Water Supply area is also strictly protected with a buffer of 30 m along the water source. The buffer zone is devoid of tree felling, intensive cattle grazing, chemical application, disposal of garbage and oils and infrastructure establishment.

11.5.2.3 Watershed Conservation (WSh)

Upper catchment areas of watercourses on steep slopes and poorly drained or permanently waterlogged areas and all other sites serving as water retention or water feeding bodies are classified as Watershed Conservation areas. The objective is to maintain both ground and surface water cleanliness to prevent surface run-off of precipitation and to sustain continuous water supply. The entire forest area of Lingmethang FMU is classified under Watershed Conservation area because of the presence of steep areas having slope greater than 10 degrees for the entire FMU area. It forms the upper catchment area of Songjari Chu and Yunari Chu that drains into Kuri Chu. Water quality can be affected through the fast decomposition of raw humus layer, the application of chemicals or fertilizers, the wash out of the top soil and increased surface run-off of precipitation and intensive forest pasture. To sustain and maintain continuous water

supply the water infiltration rate should be kept as high as possible. Therefore, forest harvesting operations should minimize disturbance to under-storey vegetation. Clear felling and conversion of natural forests into plantations is prohibited. Efforts should be made to develop multi-storied structure of forest. Indiscriminate grazing should not be allowed in the area. The use of heavy machines, application of fertilizers and changing of oils is strictly prohibited.

11.5.3 Social Functions

The social functions and local uses of the forest were identified and described during the course of the Socio-Economic Study.

11.5.3.1 Local Use Only (SocL)

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

For this purpose all areas in the immediate vicinity of settlements were classified as Local Use Only. The size and boundary was determined based on the present forest use, the resource and site condition, the vicinity to the settlements, and on demand/supply considerations.

Most of the areas identified for Local Use are intensively used by the local people for firewood, fence posts, timber and cattle grazing. The potential for commercial use is rather low, as road construction and mechanised forest harvesting would be extremely difficult and cost intensive. The standing forest in the settlement vicinity does not qualify for commercial harvesting. It is just enough to meet the rural demand.

11.5.3.2 Local cum Commercial Use (SocLC)

Forest areas which are used by the local population for the collection of construction timber, shingleps, non timber forest products, especially bamboo, brooms, fence posts, medicinal plants and mushrooms were classified as Local cum Commercial Use Forests. These areas are located adjacent to the Local Use Only zone in the northern half of Lingmethang watershed. Commercial forest management in this zone must be carried out in such a way, that continuous and sufficient supply with the above-mentioned products is ensured. This requires, that forest management activities implemented by NRDCL in these areas need to be done in consensus with the local population. It has to be mentioned at this place, that there will be not much conflict when it comes to the use of trees for construction timber. During commercial harvesting, joint marking of trees should be done, NRDCL and local people.

11.5.3.3 Religious Site Protection (SocRS)

Many religious sites such as monasteries, gneys, meditation houses and other religious objects plays an important role in disseminating religion. In order to respect the sanctity of these holy places and not to disturb people in their religious practice, any kind of forestry operations should not be permitted within a distance of 100 m around the site.

Silvicultural improvement measures such as planting, weeding, tending and thinning should be planned and implemented if the religious site is located on a Soil Protection area. Local use shall be restricted to those activities, which do not disturb the sanctity of the religious sites. Four religious sites have been identified during Socio-economic Survey, namely, Tshanzabi Lhakhang, Kalapang Lhakhang, Mangling Lhakhang and Brogsar Lhakhang.

11.5.4 Nature Conservation

It is the objective of the nature conservation functions to balance the diverging interests of commercial logging with that of nature conservation and environment protection.

11.5.4.1 Wildlife Protection (NWP)

In order to prevent protected and rare animals from human disturbance, their habitats and corridors used for their movement are excluded from commercial use. All the habitats and other relevant areas that have the occurrence of rare or endangered mammals and birds are included under wildlife protection function. Such areas are under complete protection and have to be totally excluded from commercial use. To avoid the transformation of vulnerable wildlife to endangered ones over the time, their protection must be given the foremost priority.

In order to create a balance between wildlife and nature, firstly, the conservation of habitat of protected wild animals along with the wildlife corridors for their movement must be taken care of. Secondly, as far as possible, these protected animals have to be prevented from human disturbance. Commercial logging has to be strictly prohibited in wildlife habitats and corridors. Only local forest use is permitted on the basis that habitat quality must not show any significant degradation (i.e. single tree felling for shinglep production) and the disturbance to protected animals is as minimum as possible. Road construction in vulnerable areas should be avoided as much as possible.

11.5.4.2 Wildlife Conservation (NWC)

Wildlife conservation function includes all the forest areas that thrives quite a number of wildlife in terms of variety and number, particularly of mammals and birds. Its aim is to minimize or prevent negative impacts on wildlife habitats as a result of forest resource use and to minimize disturbances due to human impacts.

Wildlife Conservation areas are not under strict protection and some degree of forestry operations are permitted with minimum disturbance to under storey vegetation, particularly bamboo and to residual trees. There should not be any kind of exploitation of fruit and fodder trees, fed on by wildlife. Small pasture areas and gaps have to be left open. Snag trees shall be left to provide arboreous living with tree cavities.

11.5.4.3 Biodiversity Protection (NB)

Biodiversity Protection deals with the preservation of rare and extraordinarily rich ecosystems (i.e. swamp forests, gallery forests, alpine shrubs) and ecological niches. Such areas are generally smaller than Wildlife Conservation areas and may range between 1 and 100 (or more) hectares. Forest management activities shall not be permitted within these areas including the collection of NWFP and other minor forest products. These areas shall also be exempted from cattle grazing. No road construction within the Biodiversity Protection areas is permitted.

So far, no information was available on rare or extra ordinary rich ecosystems. In case, during operational planning one comes across areas which qualifies for Biodiversity Protection then those areas shall be delineated on the Forest Function Map manually.

11.5.4.4 Road Buffer

A road buffer is the zone along a road to protect the road from rock fall, land and snow slides, surface run-off of precipitation and erosion and to safeguard traffic. According to section 14 a(i) of the Forest and Nature Conservation Act (1995) it states that " no permit to fell or to take any timber within 200 m uphill and 100 m downhill along motorable roads will be allowed". Forest road buffer will be determined once forest road is constructed. Harvesting operations should be restricted within 30 m uphill and 10 m downhill on unstable terrain along the forest road.

A road along steep slopes, poor drainage or watershed areas, clayish soil texture, high stoniness and fragile geologic formations requires the need of a road buffer. Commercial logging has to be prohibited, particularly, within this zone. Besides, the collection of NWFP such as fruits, medicinal herbs, etc for the local use and deadwood and fallen branches for firewood are permitted.

On the basis of identified forest functions, the entire area of Lingmethang FMU was classified into four categories of forests, namely,

1. Areas where commercial production is feasible under defined sets of management prescriptions are considered as Production Forests, without any particular management restriction except those imposed by the FNCRR 2017 and other relevant rules issued by DoFPS from time to time.
2. Areas where commercial production is feasible under defined sets of management restrictions depending on forest functions are considered as Limited Production Forests,

3. Areas where no commercial production is permitted and is exclusively set aside for local population are considered as Local Use Only Forests,
4. Areas where no forest management activities are allowed are considered as Protection Forests.

12. QUANTITATIVE RESOURCE ASSESSMENT

12.1 Forest Management Inventory

Figure 24: Forest management inventory at LFMU

The Forest management Inventory of Lingmithang FMU for the preparation of third Management Plan was carried out in 2017. The standard FMU Inventory technique was used with data being collected from trees > 10 cm DBH (OB). A total of 294 plots were laid throughout the FMU areas with spacing of 600 m x 600 m, thus a plot representing an area of 36 ha. All the sample plots were measured as special plots. The data in the field was collected using the SAMSUNG GALAXY TAB for trees >10 cm diameter at breast height (DBH).

The inventory design was aimed at a sampling error of +/- 10% at confidence level of 95%. The general objective of the inventory was to provide essential background information for drawing up a management plan. More specifically the objectives of the inventory were:

1. To provide a relatively accurate overview of the growing stock and regeneration potential of the natural forest in the area, according to major forest types;
2. To give an overview of the general site characteristics of the natural forest, in terms of soil, non-green vegetation and use by the local population;
3. To provide an indication of timber quality in different forest types;
4. To furnish essential data on tree height to enable the construction of local volume tables for main species;
5. Toallocate supply of timber for commercial and local use from the FMU area;
6. To compare and observe the change in analysed inventory data of first and second plan period.

12.2 Forest Management Inventory Results

The inventory was not designed to provide information for commercial and local use separately. The summary of inventory results is shown in the Table 20 below.

Table 18: Summary of inventory results

Result Type	Measures	Absolute Error	T-value at 90%	SE/MoE for Total tree count	SE%	Lower value	Upper value
Total tree volume	2135771.48	175343.59	1.66	291070.36	13.63	1844701.13	2426841.84
Mean tree volume	202.10	16.59	1.66	27.54	13.63	174.56	229.64
Total tree count	1646135.95	85305.72	1.66	141607.49	8.60	1504528.46	1787743.44
Mean tree count	155.77	8.07	1.66	13.40	8.60	142.37	169.17
Total tree basal area	181611.51	12048.21	1.66	20000.02	11.01	161611.48	201611.52
Mean tree basal area	17.19	1.14	1.66	1.89	11.01	15.29	19.07

*Based on the Inventory results the RME (Reliable Minimum Estimate) determined for Standing volume per hectare (Vol/ha) is **174.56 m3/ha** with standard error of 13.63%.*

13. AREA ORGANISATION

13.1 Spatial Organisation

To facilitate better organisation of management activities during the implementation of the plan and better field orientation within the FMU, the area has been further sub-divided into Blocks, Compartments and Sub compartments.

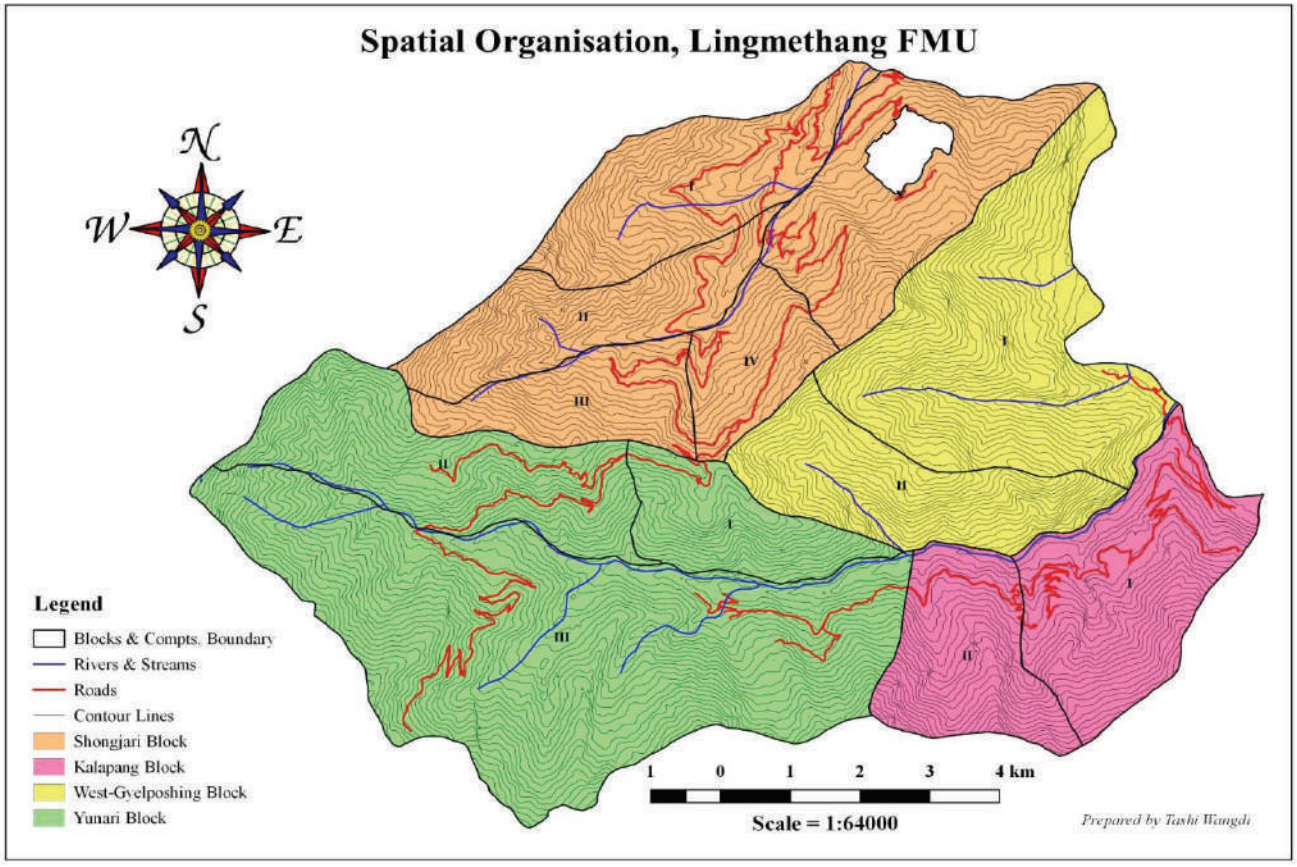


Figure 25: Spatial organisation of Lingmethang FMU

13.2 Blocks

The blocks are the basic orientation and administrative units within the FMU. They are essentially major water-catchments areas. Therefore, the block boundaries in most cases followed ridges separating individual water-catchments. Other prominent topographical features such as large streams or rivers were also used to identify block boundaries.

The whole FMU area is divided into 4 major Blocks: **Songjari, West-Gyelposhing, Kalapang and Yunari Blocks.**

13.3 Compartments

The compartments are basically orientation units created to facilitate easy orientation within each Blocks and to provide for easy administration, recording and monitoring of operations within the FMU. The boundaries of the compartments followed easily identifiable topographic or planimetric features such as roads, streams, rivers, main ridges, etc.

The Four Blocks are further sub-divided into compartments as shown in Table 21.

Table 19: Areas by Blocks and Compartments in the FMU

Block	Compartment	Area (ha)
Kalapang	I	886.94
	II	568.79
	Total	**1455.73**
Shongjari	I	719.87
	II	580.88
	III	447.08
	IV	357.94
	V	829.27
	Total	**2935.04**
West-Gyelposhing	I	1434.79
	II	691.06
	Total	**2125.85**
Yunari	I	422.84
	II	881.75
	III	2668.95
	Total	**3973.54**

13.4 Determining Operable Area

FMUs are multiple-objectives oriented. There are many functions of which, commercial and rural forestry activities are two such functions. The areas for commercial and rural forestry activities are the remaining areas after the 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:

1. Riparian buffers and zones
2. High altitude zones (above 4000 m)
3. Soil protection and conservation
4. Biodiversity areas (wildlife conservation and protection)
5. Religious site protection
6. Agricultural uses
7. Road buffers

13.5 Organisation into Management Circles and Working Circles

The function mapping was used to delineate two three broad management Circles for Lingmithang FMU. They are Production, Non-Production and Protection Management Circles. The Production Management Circle is further divided into two working circles: Broadleaf working circle and Chirpine working circle. Working circles are managed for objectives specific to that working circle. The organisation into different Management and Working circles and the specific prescriptions are given below.

Table 20: Area Statement for Management Circles and Working circles

Functions/Zones	Area covered(ha)
Protection Management Circles	
Soil Protection & Wildlife Protection	2377.21
Road Buffer Protection	635.99
Riparian Reserve Protection	362.44
Local Water Supply Protection	2.54
Religious site protection	18.72
Non-Production Manageemnt Circles	
Private/Cultivated Land	195.23
Meadows	2.64
Built Up Areas	1.23
Shrubs	124.94
Production Manageemnt Circles	
Broadleaf Working circle	5079.26
Chirpine Working circle	1989.23

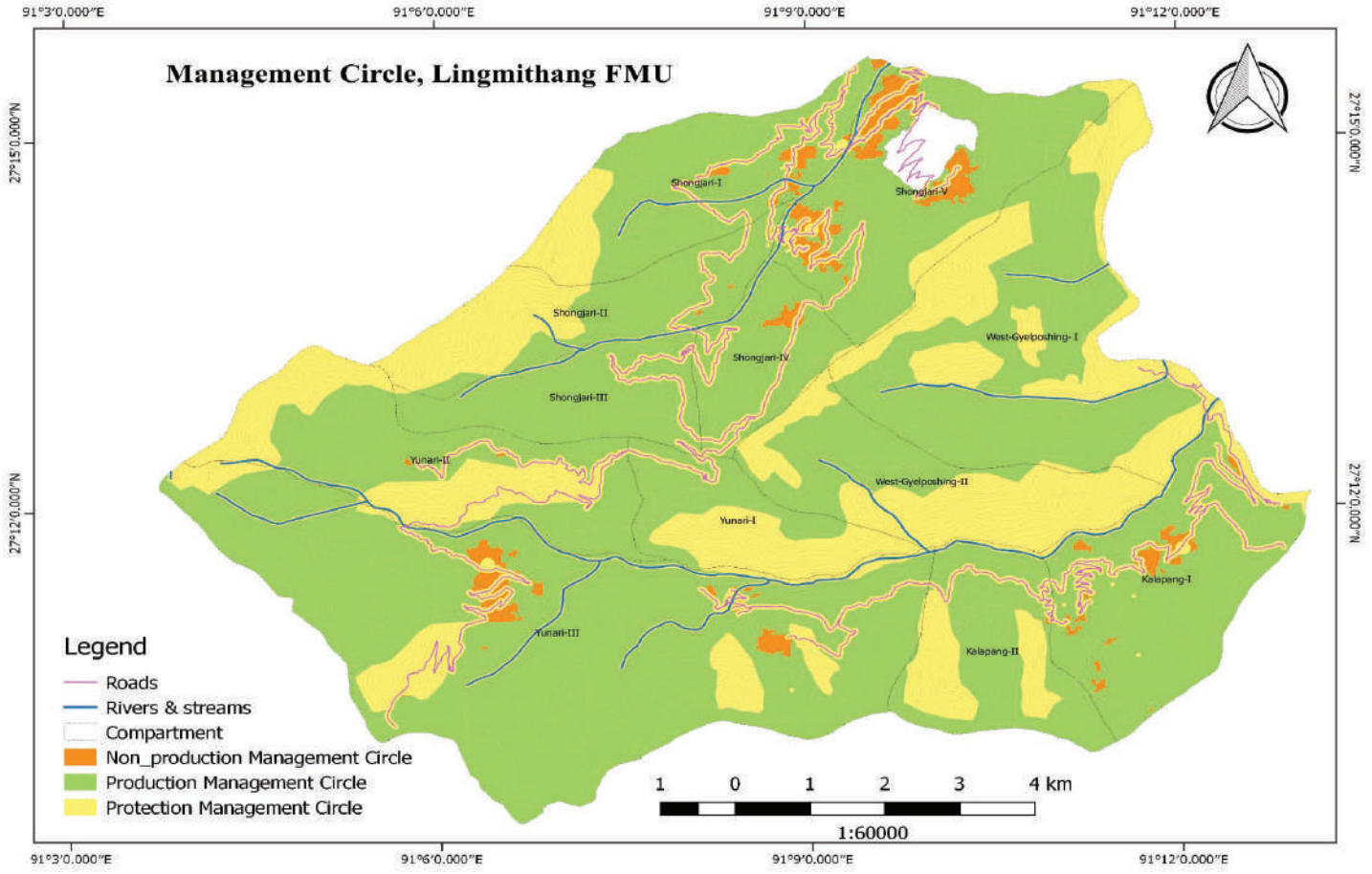


Figure 26: Management Circles in the FMU

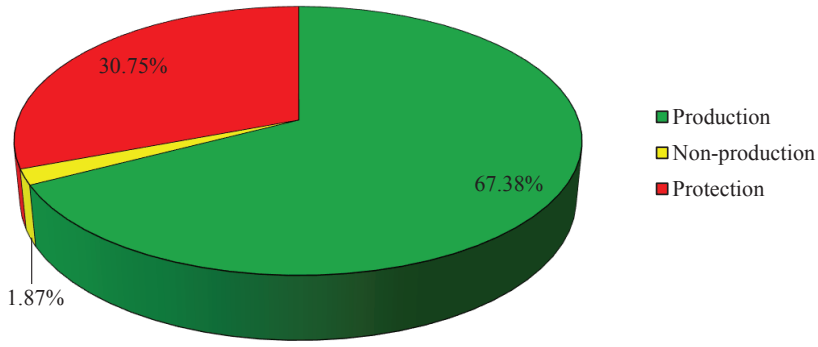


Figure 27: Area statement in percentage

13.6 Management Circles

13.6.1 Protection Management Circle

The Protection Management circle is the sum of all protection functions where no commercial activities can take place. The Protection Working Circle includes wildlife protection, soil protection, riparian reserve protection, religious site protection and local water supply protection and covers a total area of **3225.64 ha**. The management objectives and options are briefly outlined below, but management of individual protection functions will comply with prescriptions.

Table 21: Protection Management Circle

Management Objectives	Management Options	Responsibility
1. To conserve and enhance wildlife habitats and biodiversity.	1. Avoid disturbance 2. Promote research	1. All parties 2. Territorial
3. To conserve the water catchment functions and watershed values of the FMU	1. Minimal intervention	1. All parties
2. To meet local needs for NWFPs, sustainably, from alpine areas.	1. Provide licensing for local residents 2. Resource assessment	1. Territorial 2. Territorial
3. To protect the forest from grazing, fire and illegal activities	4. Involve local people in mitigating impacts	1. Territorial

2. To raise awareness of the important biodiversity areas.	1. Public meetings/field visits 2. Literature 3. Research	1. Territorial 2. Territorial 3. Territorial
4. To respect the sanctity of religious places.	5. Non-intervention	6. All parties

13.6.2 Non-Production Working Circle

The Non-Production ManagementCircle includes areas where production is not economical or feasible. The management circle generally comprises non-forest areas, settlements and agricultural use areas. The total area under Non-Production Management circle is about **196 ha** and it is 1.87 % of the total LFMU area.

As principle of equity and justice has been considered as one of the principle 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 22:Non-Production Management Circle

Management Objectives	Management Options	*Responsibility
7. To manage grazing for livestock	1. Rotational grazing 2. Local involvement	1. Territorial/DFEO/Gup 2. Territorial/Gup
3. To conserve and enhance biodiversity	1. Promote research	1. Territorial
1. To conserve water catchment functions	1. Replant deforested area 2. Maintain vegetation cover 3. Introduce Soil & Water Conservation Activities.	1. Territorial / NRDCL 2. All parties 3. Territorial / NRDCL

*Note: Lead agency is the first agency listed

13.6.3 Production Management Circle

The Production Management Circle is the area derived from the remaining area after critical functions were identified and mapped out and consequently grouped into protection and non-production management circles. The Management circle is divided into two working circles (viz Broadleaf and Chirpine Working

circles) and management options and objectives are described for each in subsequent sections. The presence of 1.96 ha of mixed conifer under production area is merged with the broadleaf working circle to ease the management. The whole production area has been divided into blocks and compartments and the total area under Production Management circle is about **7068.49 ha.**

Table 24: Production Management Circle

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

13.6.4 Non Wood Forest Products (Overlapping) Management Circle

The Managenment Circle shall overalap with all other Management Circles, including Protection and Non-Production Management circles, which constitutes the entire FMU area. The overall objective of this Working Circle is to manage the NWFPs in Lingmethang on sustainable basis, and monitor low impact collection.

Management Objectives	Management Options	*Responsibility
To meet NWFPs for local needs	Apply management guidelines and involve community for monitoring	Territorial Division
Environmental conservation	Consider environmental values in the planning process	NRDCL/Territorial Division
To maintain and improve the non-forested area	Follow plan prescriptions	NRDCL/ Territorial Division
To regulate grazing by livestock	People's participation through workshops and sensitization	NRDCL/Territorial Division

13.6.5 Organization into Working Circles

The Production Working Circle includes all areas where harvesting can occur, both commercial and local. The Working Circles have been created on the consideration of stands requiring similar silvicultural treatment and rotation age. The Production Working Circle has been divided into two major working circles:

1. Chir pine Working Circle

2. Broadleaf Working Circle

Table 24 and 25 describe the objectives, management options, responsibilities, monitoring and evaluation and Silvicultural systems specific to each working circle.

Table 23 : Chirpine Working Circle

WORKING CIRCLE: CHIRPINE				
Management Objectives	***Management Options***	****Responsibility***	****Monitoring***	***Silvicultural Systems***
To manage the commercial timber production on a sustainable basis.	1. Operate entire length of cable line 2. Ensure cable-line layout allows interline logging 3. Encourage cleaning of ENTIRE lines by firewood contractors 4. Use appropriate logging and silvicultural methods	1. Territorial/ NRDCL 2. Territorial/ NRDCL 1. NRDCL 1. NRDCL/ Territorial	1. Territorial 2. Territorial 1. Territorial 1. Territorial	**Seed Tree System** For cable harvesting, felling areas of 1000 m x 30 m can be logged, leaving 15-20 trees/ha as a seed source. Minimum distance between seed trees should be one tree length.
To create local employment opportunities.	1. Provide proper training 2. Encourage contractors to hire worker locally	1. NRDCL/ Territorial 2. NRDCL	1. Territorial 2. NRDCL	More seed trees to be retained in poorer or exposed sites.
To protect the forest from fire and illegal activities and from grazing in regenerating areas.	1. Control grazing, fire, poaching and illegal felling with local community participation	1. Territorial	Territorial	

To enhance and improve forest condition and productivity.	2. Ensure that all bare and past harvested areas are restock sufficiently with desired species composition 3. Use stand tending techniques 4. Work with local communities for planting/restocking activities 5. Create favourable conditions for regeneration and growth	2. NRDCL/ Territorial 3. NRDCL/ Territorial 4. NRDCL/Territorial 5. NRDCL	2. Regeneration Survey 3. Territorial 4. Territorial 5. Territorial	Seed trees must be of good form, not over matured and representative of existing stand.
To maintain biodiversity within the production area.	6. Low impact silviculture systems	1. Territorial/NRDCL	1. Territorial	

Note: 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 Review.

Table 24: Broadleaf Working Circle

WORKING CIRCLE: BROAD LEAF				
Management Objectives	***Management Options***	****Responsibility***	*****Monitoring***	***Silvicultural Systems***
To manage the commercial timber production on a sustainable basis.	1. Operate entire length of cable line 2. Ensure cable-line layout allows interline logging 3. Encourage cleaning of ENTIRE lines by firewood contractors 4. Use appropriate logging and silvicultural methods 5. Harvest all areas regardless of financial return	1. Territorial/NRDCL 2. Territorial/NRDCL 3. NRDCL 4. NRDCL/Territorial 5. NRDCL	1. Territorial 2. Territorial 3. Territorial 4. Territorial 5. Territorial	Silviculture system applied will be patch clear-cut system with natural regeneration. NRDCL will provide fencing for proper establishment of seedlings for a period of 7-8 years. Commercial harvesting in this working circle is dependent on the construction of proposed forest road.
To create local employment opportunities.	1. Provide proper training 2. Encourage contractors to hire locally	1. NRDCL/Territorial 2. NRDCL	1. Territorial 2. NRDCL	
To protect the forest from fire and illegal activities and from grazing in regenerating areas.	1. Control grazing, fire, poaching and illegal felling with local community participation	1. Territorial	1. Territorial	

To enhance and improve forest condition and productivity.	2. Ensure that all bare and past harvested areas are restock sufficiently with desired species composition 3. Use stand tending techniques 4. Work with local communities for planting/restocking activities 5. Create favourable conditions for regeneration and growth	2. NRDCL/Territorial 3. NRDCL/Territorial 4. NRDCL/Territorial 5. NRDCL	2. Regeneration Survey 3. Territorial 4. Territorial 5. Territorial	
To continually improve health and safety standards.	1. Provide training to contractors 2. Promote awareness in the local community	1. NRDCL 2. Territorial	1. Territorial 2. Territorial	
To conserve the water catchment functions.	1. Minimal intervention 2. Abide by stream buffer regulations	1. Territorial/ NRDCL 2. NRDCL/Territorial	1. Territorial 2. Territorial	
To maintain biodiversity within the production area.	1. Low impact silviculture systems	1. Territorial/ NRDCL	1. Territorial	

Note: 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 Review.

13.7 Implementing Working Circle Management

The Forest Function planning concept has been used in this plan to allocate land use among the forest in the FMU, so that strategic planning for sustainable yield can be carried out. The problem remains to implement these prescriptions on the ground. Later sections indicate that this will be done through an operational planning process whereby information that is more detailed is collected through inventory and discussions with stakeholders, local communities and NRDCL. However, even when this more detailed data is collected, the requirement remains to locate individual Forest Functions on the ground so that the prescriptions and the objectives can be implemented. Although maps have been prepared indicating the boundaries of Forest Functions, location on the ground can be quite complex. In addition, experience in the field indicates that the base from which all maps are derived, the 1:50,000 topographic maps, are often inaccurate and difficult to use for implementing operational plans.

Therefore, the Unit In-charge will have to use the provided maps to the best of his/her ability. Areas should be observed on the forest function maps prior to going into the field. Once in the field visual observation within the operable areas should be able to provide the needed information. For example, stream buffers will occur on all streams and steep slopes should be measured and observed for soil protection or conservation. The forest function map will be updated accordingly as per the field observations.

14. YIELD REGULATION AND HARVESTING

14.1 Determination of the Annual Allowable Cut (AAC).

14.1.1. Introduction.

Principle of Sustained Yield is an accepted norm in Forest Management; forming the core principle of organized forestry without impairment of the productivity of the soil. It ensures stability and continuous supply of raw material to meet the social and domestic needs of the people. The principle envisages that a forest should be so exploited that the annual or periodic felling do not exceed the annual or periodic growth. The concept has been evolved from the basic consideration that the later generations may derive from the forests at least as much of the benefits as the present generations. Calculation of Sustained Yield is expressed as Annual Allowable Cut (AAC).

14.1.2 Increment Based AAC

In a perfectly structured normal forest, it should be possible to sustainably cut the annual increment each year. Some calculation methods rely heavily on increment. Unfortunatly data on increment is still limited for Lingmithang FMU and Bhutan in general and it will be some time before valuable data from permanent plots are available. The forests are not perfectly structured, but have very varied natural growing stock (of different cohorts), some of which is actually in negative increment at present as the rate of decay exceeds new growth. In long term, increment should increase as over matured stands are replaced by younger stocks,

but it will be many decades before this second growth is available for harvest. There is an over-matured growing stock and too little and unreliable data on oncrement to be usded in determining AAC. Therefore, increment based AAC is currently unsuitable for Bhutan.

14.1.3 The most appropriate AAC Method.

Given the options of many formulae with their own advantages and disadvantages, many studies were done and it was found that a fairly simple and robust methodology could be used and accordingly the following calculation is used for calculating the AAC in standing volume equivalent. The formula is based on a combination of area, volume and rotation.

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

14.1.4 Calculation of AAC for Lingmithang FMU

14.1.4.1 Net operable Area

The total operable area is the sum total of the area identified through mapping using GIS but it has been observed, in almost all the FMUs, not all the operable areas are available for harvesting. Within the mapped area there are small rocky terrain, water and other conservation areas which prevent harvesting operation, this occurs mainly when the cable lines are being laid out. Also Patch clear-cut 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 the total removal of the over-storey would cause. In such challenging terrain as in Bhutan, exact geometric-shape patch layout is rarely possible.Due to above inevitable fact, the past management plan practiced the method whereby around 20% of the area from the gross operable area has been reduced to calculate the net operable area in commercial Working circles. However , this practice has led to inefficient use of production areas and has affected the sustainability of FMUs in the country.. Therefore this management plan does not prescribe the reduction of areas to calculate net production area as all areas which are inaccessible and inoperable are already mapped out as designated under protection working circle. This prescription mandates the unit incharges and NRDCL to properly utilize the available production areas so that the area can be sustained for future harvesting operations. Any deviation from the prescribed cableline layout should be approved by the Department prior to implementation.

Table 25: Net Operable Area

Forest Types	Gross Operable Area (ha)	Net Operable area (ha)
Broadleaf forest	5079.26	5079.26
Chir pine	1989.23	1989.23
Total	**7068.49**	**7068.49**

14.1.4.2 Rotation

Species *Rotation* or *Production Period* is an imprecise concept in silvicultural system other than *Clear-felling System* and *Plantations*. Since reliable increment data is still very limited for Bhutan, assumed rotation lengths need to be cautious. For Patch Cut System, the objective is to have more or less even aged regeneration in areas worked out an each cut. The assumed rotation length for Chirpine and Broadleaf Forest is 110 years. Consideration of regeneration period while calculating rotation lengths is a crucial factor. Therefore, while calculating AAC in LFMU, for this plan period a 10 years of regeneration period has been added to the rotation age of Chirpine and Broadleaf forest. The assumed rotation lengths for the calculation of AAC in LFMU are:

Chirpine working circle : 120+10 years

Broadleaf working circle : 120+10 years

14.1.4.3 Average Standing Volume

The mature average standing volume is derived from management forest inventory data statistically analysed using "R". The standing volume at 90% confidence interval is determined. The AAC, the rotation period and the RME is shown Table 27.

Table 26: Average result of the forest management inventory

Result Type	Average Measures	Sampling Error %	Reliable Minimum Estimate (m^3/ha)
Tree volume	202.10	13.62	174.56
Tree count	155.77	8.60	142.37
Tree basal area	17.18	11.01	15.29

14.1.4.4 AAC for each working circle

The AAC for each working circle, based on the above table is given in Table 28.

Table 27: AAC for Working Circles in standing volume

Strata	Net operable area (ha)	Rotation (Year)	RME of Average Standing Volume (m^3/ha)	AAC (m^3/year)	Clear-cut equivalent (ha)
Broadleaf forest	5079.26	130	174.56	6820.27	39.07
Chir pine	1989.23	130	174.56	2671.07	15.30
Total	**7068.49**			**9491.34**	**54.37**

The total AAC of the FMU is equal to 9491 m^3 calculated based on net operable area and inventory result. The workable AAC is fixed at 9400 m^3. It is permissible to vary the AAC by plus or minus 10% in individual years, but the volume cut in each five year period mus not be more than five times the AAC .

Both AAC and clear-cut equivalent area must be used as a control measure for timber extraction from the FMU annually. Under no circumstances, the total timber extraction and total clear cut equivalent area in the FMU must exceed the permissible limit as indicated in the above table. The timber extraction must be stopped upon reaching the AAC or clear-cut equivalent area of the FMU, which ever is achieved earlier.

14.2 Recording and Accounting for AAC

Monitoring of AAC will be done through the records of number of trees marked and recorded in the Tree Marking Register (TMB) for both **commercial and local use** in all Working Circles. The AAC should be calculated as gross bole volume, and this is the measure that should be totalled on an annual basis from the TMB.

14.3 Allocation of the AAC

The allocation of AAC must take into account the needs of the local people (within the FMU) while providing NRDCL with timber and accounting for the needs of other organisations. The AAC for commercial and rural has been allotted as follows:

Standing volume (m^3)	**Allotted to**
Local Use- 500 m^3	Allocated to local users (local villages, general public and *adhoc*). The volume of cham, tsim, dangchung, firewood, flag post, fencing post, etc. from operations will be included in this allocation. The DFO, Mongar will be responsible for allocating this volume.
Commercial- 8900 m^3	Allocated to NRDCL to meet commercial demand.

The rural AAC of 500 m^3 has been allotted based on the rural timber demand trend of the last 10 years. The commercial AAC allocated for commercial purpose is 8900 m^3 which shall be allotted to NRDCL for extraction annually. However the allocation of prescribed AAC to NRDCL annually shall be subjected to the timber demand and market scenerios of hardwood timbers in the locality which shall be regulated through annual Operational Plans prepared by the Unit Incharge. During instances when the demands for hardwoods timbers from the FMU are very low, allocation of 100% commercial AAC to NRDCL shall be deferred**. D*uring this plan period the rural AAC allocation is strictly for the local communities within the FMU and NRDCL. Demands from people outside FMU and other Dzongkhags for rural timber should be encouraged to be met from the NRDCL depots at subsidized rates wherever applicable.***

NOTE: The AAC and sustainability of the FMU are based on the above considerations. The forest is highly variable, and the above are ***guidelines***, not prescriptions. Cycles for specific sites can be lengthened or shortened, depending on restocking and growth rates.

14.4 Distribution of the cut

Although the AAC is volume based, it is essential to monitor the amount of area that is being harvested. Assuming the reliability of the inventory (average standing volume) is reasonably high, the volume per hectare should be calculated to represent the number of lines that can be feasibly operated and mentioned in Operational Plan. Therefore, if the UIC notices that more cable lines (or less) are being harvested annually then the AAC **must be** adjusted.

Once the harvesting in each individual coupe is completed according to the work detailed in the Operational Plan no other cut will be permitted in the area without an agreement and approval of the Director of DoFPS. This is important to maintain the integrity of the spatial and sequential progression of the chosen silvicultural system. It is, however, important to ensure that harvesting is not concentrated in one isolated area but distributed throughout the FMU in each year of the plan duration.

15. SILVICULTURAL SYSTEMS

15.1 Patch clear-cut System

Patch clear-cut system is generally applied for broad leaf forest, which was based on the recommendation made by the RNR RC Yusipang during the 8th FYP. Under the patch clear-cut system, several patch openings will be created along the cable line 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. Natural regeneration of principal species should be encouraged in opened-up areas with fencing provision by NRDCL till the regeneration is established at the site.

It is observed that the natural regeneration is very poor in case of broadleaved forest. Therefore, NRDCL should regenerate the clear-cut patches artificially with five strands of barbed wire fencing and necessary tending operation till the saplings are established at the plantation site.

15.1.1 Working Pattern

Only one third of the selected area will be subjected to harvesting between intervals of fourty years. The patches size of 0.25 ha will be opened up along the cable lines. The distance between the cable lines will not be less than 75 m and not less than 50 m between the patches along the cable lines.

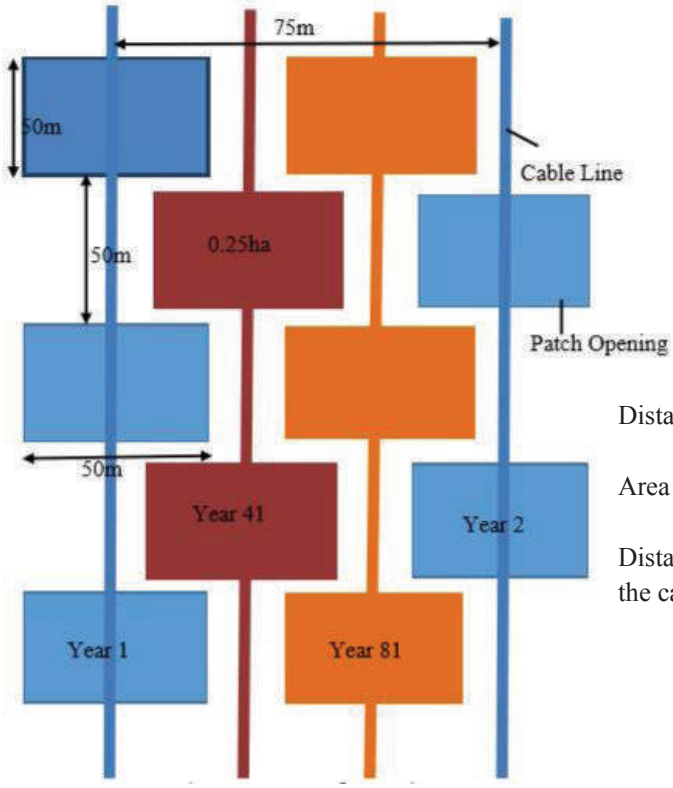
The approach of working to a minimum cable line spacing of 75 m for the Patch Cut system will only work, if matched with appropriate felling group sizes. Execution of this plan will keep a minimum of three times the distance of the radius of circular patch opening to pass subsequent cable lines running through old previously cut groups and to prevent damaging regeneration. This is owing to the experiences gained from the implementation of the first and the second plan. As have been planned in the paper it does not work in practical ground situation due to terrain, slope, direction of tree leaning, expertise of loggers, etc. Line spacing and group size then need to be carefully considered on a site-by-site basis and provide for a specific number of subsequent passes. One prescription will not be appropriate everywhere.

It is, therefore, very important for cable lines to be recorded properly. Once the cable lines are calibrated for the group openings, it would be important to have the same group opening spacing for the first phase of cable lines since the interlocking openings of second and third passes should not fall on the previously harvested areas. This requirement of the Square Interlocking groups' layout necessitates the excellent record keeping of the worked cable lines and their openings' locations.

The length of the cable lines and number of openings along a cable lines must be determined by the availability of the stocks in a cable line. In the event of good stocks, the AAC or clear cut area equivalent of the FMU (whichever is achieved earlier) could be met even from a single cable line. In such instances, laying of subsequent cable lines must be restricted to next harvesting period only **(NEXT OP).**

The individual openings need not be uniform in shape and size or systematically located along cable lines. In most cases the openings will be irregular in shape and systematic location of patches will be almost impossible. Aspect, slope and Silvicultural requirement will influence the actual size and shape of the patches.

The figure in the following page gives the schematic diagram for laying out the patches along the cable lines. This figure is to be used as a guide and reference only and is not to scale with actual dimensions in the field.



Distance between two cable lines = 75 m

Area of the group openings = 0.25 ha

Distance between two group openings along the cable line = 60 m

Figure 28: Placement of patches along the cable lines

15.2 Seed Tree System

For the Chirpine Working Circle in the FMU, Uniform System with Seed Tree Retention is the prescribed Silvicultural System as per the resolution of Consultation Workshop on Silvicultural Systems held on 17th Jan 2005, DoFPS Conference Hall, Thimphu. This system is justifiable for Chir pine because of it being a highly light demanding species and seeds being dispersed by wind. The matured stand is open up through a number of regeneration fellings where phenotypically sound trees serve as seed trees having not more than one crown width between the seed bearers. Chir pine regenerates easily when light are ample and ground vegetation is sparse.

Figure 29: Chirpine regeneration under the seed tree

15.2.1 Working Pattern

For cable line harvesting, the felling area of 1000 m x 30 m can be logged, if the felling is confined only to chir pine stratum, with the retention of 15-20 trees/ha that are phenotypically superior. The distance between the seed bearers should not be more than one crown length as weeds and unwanted species can easily colonize it with very little regeneration. The trees should be felled towards the centre to avoid damage to the unmarked trees. Care should be taken that spatial distribution of the trees are strictly followed to avoid felling trees on environmentally sensitive areas, buffer areas and corridor protection areas.

The Uniform System with seed tree retention has following advantages:

1. Regeneration under the shelter of older trees results in larger-sized trees with long clean cylindrical boles.
2. There is little danger of invasion of the area by weeds as the regeneration occurs under the shelter of older trees
3. Harvesting is more concentrated, so logging cost is lower
4. Aesthetically and environmentally more acceptable than clear cutting

15.3 Single Tree Selection System

This System will be practiced in Local Use Only forests areas for rural marking. 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 the forest. This system helps to maintain uneven-aged character of the crop in the forest as in nature.

It is observed that in most cases, the trees of best economic interest are selected and felled. Instead of following this, the UIC should judge and familiarize with the forest condition and silviculture 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.

1. Dead, dying, diseased, mis-shapen or otherwise defective trees interfering the growth of neighbouring vegetation.
2. Trees of undesirable species
3. Immature trees which can be removed by judicious thinning
4. Mature trees above the exploitable diameter, which will leave gaps for regeneration to come up.

16. FOREST PROTECTION

16.1 Fire

The fire incidence recorded in the past is two times. Though it is not a severe problem for hard wood, the risk of forest fire in chir pine forest is expected to increase with the opening of forest to harvesting in future. Strict vigilance should be in place to prevent forest fire and also the local people should be made aware of it. The UIC and the PIC should review forest fire protection programs at regular intervals in close consultation with local people.

Figure 30: Forest fire in the FMU

16.2 Pest and Diseases Management

The FMU staff should regularly conduct inspection to detect any outbreak of any pests or diseases. Detailed descriptions on symptoms and damages, preventive and control measures including information on life cycles and identification photographs can be sought from *Important Forest Pests and Diseases of Bhutan with Control Measures,* Tshering & Chhetri (2000). Reports should be made to the CFO or relevant research specialist.

16.3 Grazing

Figure 31: Grazing in the FMU

The Forest Policy of Bhutan lays emphasis on multiple-use of forests. Grazing shall be allowed in the FMU area at minimised scale in Protection Management Circle and focussing more on Non-Production Management Circle.

Grazing must be excluded from regeneration areas and allow the areas to establish with regeneration in order to continue the forest to be productive for timber in the future.

17. ENVIRONMENTAL STATEMENT FOR ENVIRONMENTAL ASSESSMENT

17.1. Project Description

For any developmental proposals in Bhutan, the Environmental Assessment Act (2000) requires the proposals to meet a series of environmental criteria. The National Environmental Commission Secretariat has developed various Sectorial Environmental Guidelines to be adopted by the applicants. The Environmental Clearance for Forestry Activities specifies the detail criteria to be met by an applicant to carry out the forestry activities. If the Sectoral Guidelines are met in this chapter, it is assumed that the requirement of the Act will also be met.

This section of the plan provides information on how the forestry activities will be carried out and controlled so that the proposed activity meets the requirement of the Act.

17.1.1 Introduction

Lingmithang forest management unit has been supplying timber and other ecological goods and services for last 10 years with Sustainable Forest Management Plan and it will be worked on the same principle of sustainability in the second plan period thereby making timber available in the market as well as meeting the *bonafide*requirement of the local people and providing other ecological goods and services from BFMU forest. The demand for timber is continuously increasing in the market,but the supply of the timber is more or less remaining the same. Besides removal of timber through regulated annual allowable cut, timbers are also removed through *ad hoc* locality factors interference.

17.1.2 Objectives

1. To maintain and improve the present vegetation cover and also to protect the environmental, soil, watershed and biodiversity of Lingmithang FMU;
2. To ensure sustainable supply of timber, poles and posts, fuel wood and non-wood forest productsthrough regulated harvesting and collection;
3. To enhanced the awareness of the local communities within the FMU to participate in forest protection and conservation;
4. To generate employment opportunities for the local people in forest based activities;
5. To regulate grazing to maintain the ecology and natural regeneration potential of forests;
6. To promote local research, demonstration, aesthetic and educational values of the natural forest ecosystem.

17.2 Method and project summary

The Forest Management Planner, DFO, Mongar carried out a detailed EIA for the FMU in consultation with an engineer from NRDCL. The name of the project is “Construction of forest road”. LFMU is located in Mongar Dzongkhag. The Kuri Chu demarcates its eastern boundary. Kuri Chu dam is located at about 100 m from the confluence of Yunari Chu and Kuri Chu. The western boundary corresponds to the ridge that forms the headwater of Yunari Chu valley. Mau Ri Chu borders Lingmethang FMU in the north-east for

about 3.5 km, and the ridge forming Songjari Chu valley forms its northern boundary. The southern ridge of Yunari Chu valley marks its southern boundary. The gross area of FMU is **10,490 ha.** The altitude ranges from approximately 640 m to 3321 m at its highest point. Lingmethang FMU consists of 131 households spread over 9 villages namely, Masangdaza, Tshanzabi, Kalapang, Domrang, Mangling, Yunari, Chutebee, Chulumbii and Brogsar, all falling under Saling geog. The corporal environment in the project is described with reference to forest resources, particularly flora, fauna, water quality, air quality and forest scenery.

The climate is warm and humid wherein the temperature is considerably high during the months of May to September, with highest temperature in August reaching up to 33.86 ^{0}C during the summer. The lowest temperature recorded is in the month of January, which is as low as 8.8 ^{0}C in winter. Snow is confined only to the mountaintops during winter. The rainy month starts from April till October and is recorded to be highest in July (185.52 mm).

The chief activity involved would be the construction of approximately 10 km forest road within the FMU to obtain timber. Songjari and Kalapang block had been worked during the first plan period and Kalapang, Yunari and Songjari block in second plan period. This plan period will operate Yunari block with focus into sustainable management of forest resources by determining Annual Allowable Cut (AAC).

Grazing is a common sight in the area. The seasonal grazing by the cattle of migratory herders in summer and winter add up to increased pressure on the grasslands and forests around the settlements, which could adversely affect the carrying capacity on long run. During winter months, people move to warmer places along with their cattle in the month of October /November and return during summer in the month of April/May. The negative impact on the vegetation and over use of the resources should not be under estimated even though the impact seems to be very diminutive at present. The forest could be under tremendous pressure and hence no regeneration of principal species in future.

Lingmethang does not fall under any form of protected area network notified by the Government; hence it is not falling under any parks, sanctuaries or under strict nature reserves.

The construction of forest road has made the rural life easier for the villagers. It helped them in transporting the farm produce which in turn earns them substantial income. However, new forest road construction would result in pollution of air quality, noise pollution from machines and blasting, pollution of drinking water sources and dust pollution. The forest road has been aligned in such a way that it doesn't affect the drinking water source of any of the villages. NRDCL engineers will supervise the entire road construction and no deviation from the proposed road alignment should take place. In presence of steep terrain, excavators will be used in place of bulldozers.

If natural regeneration fails to occur in the chir pine forest, plantation will be carried out. In case of broadleaved forest plantation shoulb be carried out immediately in the following plantation season with good five strands barbed wire fencing. The tending operations should be carried till the plantation is fully

establihshed. This is very important because the future harvest would exclusively depend on the status of regeneration and their establishment.

Harvesting operations would be done by using cable cranes and no manual logging would be encouraged. Power chain saws would be used instead of axe in order to reduce the waste.

Labor camps have to be established 100 m away from the stream and the waste water needs to be diverted carefully and should not be allowed to enter the main stream again. No washing and bathing will be allowed in the running stream if there is settlement below the stream.

17.3 Project Description

17.3.1 Introduction

The key guiding principle of DoFPS is to encompass one Forest Management Unit (FMU) in each and every Dzongkhags to supply timber to the people of Bhutan on a sustainable basis. Lingmethang forest was chosen as one of the potential FMUs that could cater to the needs of the people on a sustainable basis and had proved to be so during its implementation in the first plan period. Lingmethang FMU will be worked on the principal of sustainability thereby making timber available in the market as well as meeting the *bona fide* requirement of the local people. Forest management based on the principal of sustainability will considerably improve the forest stand. The project will be harvesting vis-a-vis reforesting the whole area. On one hand, matured and over matured trees will be felled to improve the stand condition and on the other hand, timber will be available in the market. In order to transport the harvested timber out of the unit, a total of approximately 10 km forest road needs to be constructed during this plan period of ten years.

17.3.2 Objective:

The main objective of creating FMU is:

1. To improve the forest stand of Lingmethang;
2. To ensure supply of timber, fuel wood and non wood forest produces on a sustainable basis;
3. To regulate grazing in an organized manner so as to curtail its adverse effects;
4. To help local people develop the area by constructing forest road.

17.3.3 Benefits

The existing forest of Lingmethang is matured at the moment and therefore has to be felled so as to create opening to facilitate natural regeneration to come up. Establishment of natural regeneration is a problem due to indiscriminate grazing, competition from undesirable species that dominate over the principal species and other related factors.

Forest road of the FMU is of immense help to the local communities in easing their transportation inconvenience as well as provide easy access to market to sell-off farm and livestock products earning them money. FMU establishment created job opportunities for the local people.

The overall benefit is the sustainable management of forest which otherwise would degrade if not harvested in time. At the same time it provides revenue to the Government as well as improves the forest stand.

17.4. Forest Management Unit Planning and Zoning

The project would help in restoring the ecological condition of the forest and at the same time those timber that would rot in the forests would be brought to the market and utilized which would not only earn revenue for the government but also provide employment to the local people. No operation should take place in the project area without proper management plan and operational plans. The DoFPS and the NRDCL would provide sufficient staff to prepare and implement the management plan and operational plans. Strict monitoring will be done to assure the correct implementation of the plans.

The management plan is based on the forest function map, which is already prepared where all the protected areas are clearly demarcated. Harvesting of matured trees will be on the basis of sustainable management. The UIC will mark the trees for the road clearance. Forest Function mapping was done with reference to the Forest Management Code of Bhutan 2004 (FMCB 2004) identifying important functions like Soil Protection and Conservation, Watershed Conservation, Biodiversity and Wildlife Conservation Religious Site Protection, Riparian Water Reserves, Local Water Supply Protection etc. and only thereby deriving the remaining area for timber production.

17.5 Road Construction and Maintenance

The Forest Road construction in Lingmethang FMU is aimed at minimum negative environmental impacts.

During road construction, the NRDCL engineers will supervise and no deviation from the proposed road alignment should take place. The road was aligned in such a way that none of the drinking water sources are affected. For stream crossings, culverts, Hume pipe and bridges have been designed to minimize the pollution of the stream along with side drains. As general rules, excavators will be deployed. Bulldozers shall not be permitted to be used. Road Standards recommended by FRMD and the general principles and practices to be followed during forest road construction as identified by NEC Forestry Sectoral Guidelines will be followed. These will ensure that the road construction within the FMU will meet the recommendations and also ensure that any erosion or other negative impacts will be minimized or eliminated.

17.6 Harvesting and Extraction

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. Power chain saws would be used in place of the axe to reduce waste. The harvesting prescription and Silvicultural treatment are taken care of and described in detail in the management plan.

17.7Regeneration and Post-harvesting treatment

If the natural regeneration does not occur within three years in case of chir pine, it will be resorted to artificial planting of the principal and local species. But in case of broadleaved forest plantation shoulb be carried out immediately in the following plantation season with good five strands barbed wire fencing. The tending operations should be carried till the plantation is fully establihshed.This would be the most crucial as the future harvest would depend on the status of the regeneration and the establishment of the seedlings. However, in this case artificial planting in the harvested areas, regular maintenance of the plantation will be done by the NRDCL and the UIC should carry out the plantation survival survey every year and submit the report to the CFO, FRMD and Mongar. If the survival percentage is lower than 70 %, immediate beating up should be carried out with the same native species.

The regeneration survey must be carried out at the end of three years as entailed by the FMCB 2004. Monitoring of plantations and regeneration surveys must be carried out regularly without fail.

17.8 Existing Environment

17.8.1 Topography, Geology and Soils

The general terrain of Lingmethang is moderate in most part of the area with occasional steep and mountainous in some parts. Gyelposhing West block has the highest proportion of steep area. The altitude ranges from 640-3321 m.a.s.l. There are numerous small streams, which flow into the main rivers, i.e. Songjari Chu and Yunari Chu during the monsoon season that ultimately drains into Kuri Chu. The geological formation is dominated by the Pre-Cambrian era. It is characterised by the presence of assorted combinations of rocks such as quartzites, phyllites, biotite gneisses interbedded with quartzite, quartz-mica-schists, crystalline limestone and garnetiferous schists intruded by basic sills. Phyllite derived soils are clayey to fine sandy loam and is brown in colour depending on the amount of quartzite; while quartzite derived soils are pale brown and coarse. Generally, the soil is clayey to sandy loam in nature and is moderately fertile. Owing to its arid and warm climate, the exposed soils are reddish in colour due to oxidation of ferrous inclusions. High humus content corresponding to dark brown colour marks the forest soils in broadleaf forest, whilst chirpine forest is marked by pine needles covering bare mineral soil. It has also been observed that the soil is not exceptionally prone to frequent or extensive surface erosion or landslides. However, there is a moderate risk of surface erosion and gullying. Such soil type can only be preferred for forestry activities, provided the silviculture and management prescribed are appropriate. Therefore, adequate care must be taken, not to expose large areas to avert the loss of fertile soil.

17. 8.2 Surface and Ground water hydrology and quality

The surface water is used primarily for drinking and irrigation. All the households within the FMU have access to drinking water through the PVC pipes. The ground water is not used at all. However, it was seen that water pollution by the people and the animals is very negligible. Moreover, there is no interference by the tourists or any kind of hazardous harvesting operations that affect water quality. It has also been observed that livestock being one of the major sources of income for the farmers, grazing is very much prevalent in the FMU area and there are chances of water pollution by the animals. Grazing of the animals around the water source might result in the release of bacteria from the animal dung polluting the drinking water.

17.8.3 Air quality and noise

There is no pollution at the moment as there is neither developmental works being carried out owing to plan expiration nor any kind of tourist interference. Hence the air in the area is fresh and the noise pollution can be regarded as very negligible. Certain decline in air quality and increase in noise pollution could be expected once the revised plan is implemented.

17.8.4 Plant and animal species and habitat

No endemic plant habitat was recorded for Lingmethang FMU. Some of the recorded species include Rufous necked hornbill, deer, Wild dog, Himalayan black bear, Grey langur, Yellow-throated marten, Mongoose, Serow, Goral, Flying squirrel and Giant squirrel.

17.8.5 Scenic qualities

As of now, the area has no unique scenario in particular to complement its scenic qualities and hence the tourists have not used the area so far. The area is competent to be considered as either national park or wildlife sanctuary. But in future, owing to fund availability rehabilitation of peacock habitat called Majathang in West-Gyelposhing block should be given preference so that it can be used for recreation purpose as well as for tourist attraction. Furthermore, the completion of 1st and 2nd plan period have placed Lingmethang FMU as the model especially for forestry students wherein they could see practical application of scientific silvicultural systems in both conifer and broadleaf forests as well as management of a community forest, all together.

17.8.6 Cultural significant sites

Brogsar Lhakhang, Mangling Lhakhang, Kalapang Lhakhang and Tsanzabi Lhakhang are the only sites of religious importance in Lingmethang FMU.

17.9. Assessment of Impacts and mitigating measures

17.9.1 Impact on water:

1. Pollution

Disposal of garbage and sewage into the streams pollute the drinking water. Commercial logging as well as the labors engaged in the same would definitely pollute the drinking water sources. The establishment of the camp and the human defecates would be the main polluting agent. Oil spill from the machines and vehicles also pollute drinking water. Road construction creates gaps in the forest areas from where soil, debris, etc will be thrown away into the streams by the wind and surface run-off polluting the drinking water.

2. Damage to Pipes lines for Lhakhang and household

The construction of forest road as well as the farm road will not cause any damage to the existing water pipelines. However, the implementers have to strictly maintain the buffer delineated for local water supply to avoid any complications in future.

3. Dying up of water sources.

Though, the forest road does not cut through any of the drinking water sources, it would damage the surrounding vegetation during the course of road construction. Harvesting operation as well as patch clear-cut might result into drying up of water sources.

Mitigations

In order to maintain the continuous flow of stream water without drying, the coupes should be laid away from the stream and water sources. Therefore, river and stream buffers need to be maintained as mentioned in the management plan and forest function maps have to be referred as well. NRDCL site engineer will monitor the road construction activities during the construction phase. The use of bulldozer will be replaced by excavator in order to avoid the blocking of rivers and streams by wind-throw resulting from the road construction. A garbage pit has to be dug near the labor camp to dispose the water. Pit latrines have to be dug and use of stream sides should be avoided. The sewage water should not be drained into the stream supplying water to the households. Labor camp should not be set up in an area above the water source. No bathing and washing should be allowed in the stream above, if the people below use the water. Care needs to be taken that no vehicles and machinery used in the forest are allowed to change their oils in and around the stream, not to spill the oil or dispose the oil in the field area. The forest road should not pass through any river or stream source and a minimum of 100 m road buffer have to be maintained to prevent the drying or polluting of the water source. The water pipes damaged during road construction have to be replaced by NRDCL.

17.9.2 Impact on forest resources

Opening of a FMU has both positive as well as negative impacts on the forest resources and the environment as a whole. Areas that are very steep are not entertained to commercial logging and grazing. Hence such areas are classified under complete protection primarily set aside from any kind of interventions by the people. Areas with gentle slope permit some degree of intervention where collection of forest products particularly for their *bona fide* use is allowed except harmful grazing by the animals. The foreseen consequence of FMU establishment would definitely be road construction that might give way to illegal exploitation and over grazing of such vulnerable areas.

Most often the harvesters tend to exploit good timber earlier leaving behind all the unwanted and decayed trees in the process making short-term gains. Patch clear cut system of harvesting results in area opening where animals take grazing advantage leading to poor or no regeneration of principal species thereby failing to fulfill the principle of sustainability. There will be invasion by the unwanted species and competes with the principal species for establishment. If this situation persists, the idea of opening a FMU would be completely over-ruled.

It is of utmost importance to consider the staff strength engaged in the FMU functioning. There should be adequate qualified staffs with complete package of equipment for the defined jobs. As a matter of fact, application of suitable management practices would definitely improve the forest condition in line with the sustainable production.

Mitigations

A management plan for a period of ten years has to be prepared before the onset of harvesting operations. The areas for commercial logging should be clearly delineated except for the areas set aside primarily for protection and local uses. The scientific harvesting should be prescribed on the basis of AAC calculation together with the consideration of all the available function maps prepared for the same. If natural regeneration fails in chir pine forest, then the area has to be replanted by artificial means, particularly of the principal species and not exotic species. However, in this case of broadleaved forest artificial planting in the harvested areas is recommended immediately in the following plantation season after harvesting.

In general, harvesting operations create significant area openings where the regeneration of unwanted species is most commonly seen. Therefore, such situation can be avoided by properly regulating the size of patch cut and should be mentioned clearly in the management plan. Fencing around the opened up areas could be done in order to protect them from grazing by the animals and to keep check on the natural regeneration of undesired species. Monitoring of the FMU activities needs to be done constantly by the FMU planner of the DFO, Mongar.

17.9.3 Impacts on the faunal diversity

Wildlife is a vital component of forest resources and therefore its protection and conservation is equally important for harmonizing wholesome ecology. Essentially, harvesting operations result in the loss of wildlife habitats thereby reducing their number in the area, but the forest areas that are under protection and the non-harvested forest provide adequate space, food and cover for movement. Hence the impact on fauna diversity as a result of road construction and forest harvesting are considered to be rather negligible.

Mitigations

As far as the mitigating measures for wildlife and birds of Lingmethang are concerned, a good forest cover would be required that would provide them with adequate food and shelter. Therefore, large patch cuts should be avoided and natural or artificial planting must bring the harvested forest areas under forest cover within the shortest period of time. However, in the planning process the habitat of Rufous necked hornbill was identified and is well protected as it falls under Protection Zone.

17.9.4 Impact on scenic beauty

Generally, Eco-tourism cannot be recommended in an area where harvesting operation is fully functional. In the case of Lingmethang FMU, a larger part of Songjari block was operated during the 1st and 2nd plan period and there is no significant harvesting operation in this plan period. Therefore, Songjari block could be used for Eco-tourism wherein the visiting tourists can sight different wildlife found in the FMU along with scientific management of both conifer and broad leaf forests in one place.

17.9.5 Impacts related to Ecology (Flora)

The most anticipated impact of operating forest areas in long run is the change in the present forest composition, from uneven aged stand to even aged stand particularly in the operated areas. Opening of forest areas would result in the loss of shade bearing species and epiphytic plants (not identified as of now) found in abundance on the trunks of all layers of forest canopy.

Mitigations

The appropriate size of patch clear-cut should be prescribed for the FMU, considering that there isn't any drastic change in forest composition in the long run. Forest road needs to be aligned in such a way that it does not disturb areas of ecological importance.

17.10 Monitoring and Evaluation.

The CFO, Mongar under DoFPS will prepare a management plan for a period of ten years which is approved by the Minister of Agriculture. The plan will be implemented by NRDCL for which yearly operational plan is prepared based on the mother plan by the concerned CFO in close consultation with NRDCL. Subsequently the operational plan is approved by the Director of the DoFPS. The annual monitoring will

be carried out by the concerned UIC and the FMU Planner and the result must be submitted to the FRMD based on the annual monitoring forms. FRMD will also monitor the implementation activities and the plan must be reviewed every five years. Plan evaluation at the end of plan period needs to be done before the revision of the plan.

Checklist for Environmental Parameters for Forestry Projects.

	Adverse Environmental Impact	**Preliminary Evaluation**			
		No Significant Effect	**Small Effect**	**Moderate Effect**	**Major Effect**
I. COMMERCIAL LOGGING					
A. Environmental Considerations Regarding Project Sitting					
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	*			
b) economic ventures	b) possible economic loss	*			
3. Traditional forest uses	3. Impaired beneficial uses	*			
4. Rehabilitation	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				
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	*			
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 based 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					
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	*			
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) siltation	b) increased runoff	*			
c) hydrology	c) impede navigation	*			
d) water quality	d) less than optimum economic benefits		*		
4. Logging in riparian zones	4. Degradation of waterways/fisheries	**N.A**			
5. Socio-economic		*			
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					

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. Rehabilitation	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					
a) wildlife		*			
b) fisheries		*			
c) plants		*			
d) soil and water		*			
4. Allocation of benefits to locals		*			
a) employment opportunities		*			
b) training		*			
c) non-wood products		*			
5. Operation and maintenance	5. Diminished project efficiency and objectives if lack of funds			*	
6. Data base for decision making		*			
7. Project financing and reservoirs		*			
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	*			
11. Use of grasslands		*			
C. Considerations Regarding Project Operations					
1. Commercial logging	1. Same as in Commercial Logging A and B	*			
2. Reduced water supplies	2. Socioeconomic losses	*			
3. Chemical and fertilizers	3. Impaired fisheries and aquatic systems	*			
4. First-year operations	4. Increased erosion due to soil disturbance		*		
5. Soil conservation benefits					
a) erosion			*		
b) sedimentation		*			
c) soil capacity		*			
d) soil surface moisture		*			
e) soil nutrients		*			
6. Socio-economic benefits		*			
a) employment opportunities		*			
b) fuel-wood		*			
c) enhanced fisheries		*			
d) enhanced recreational/tourism		*			
7. Water resources benefits		*			
a) minimized overland flows		*			
b) reduced flood peaks		*			
c) water quality		*			

18. FINANCIAL AND ECONOMIC APPRAISAL

18.1 Economic Analysis

Investments in forest management are made with the expectation of high financial as well as economic returns. Economic benefits can be in the form of socio-economic development of the community or the people and at the same time improving the quality of the forests.

Technically, good forest management by using appropriate Silvicultural treatments can improve the existing stands of Lingmethang forests, thereby yielding better growth and also promoting better regeneration of principal species. The forests of Lingmethang in general have reached the stage of maturity. The management plan, thus prescribes the removal of these stands using technically sound Silvicultural systems and following the principle of sustainability.

The road is going to act as the lifeline towards developmental projects in future. Transportation of agriculture and dairy products, for instance is going to be easy with the road network in coming years and is expected to find a place and early season market.

The objectives of good forest management cannot be derived without a proper and sound financial and economic analysis. And this has been taken into consideration during the management planning.

18.2 Financial Analysis

The present financial forecast is done based on the existing NRDCL rate. The assumptions on which the calculations are based are those made available to the planner and are listed in Table 30 and the financial forecast in Table 31 and 32. The NRDCL engineers have estimated preliminary costs for 10 km road. The total cost estimated is about Nu. 26.673 million (12, 00,000/km).

The financial forecast is only for 10 years and does not include the profitability of the FMU in the long run. But all developmental activities within the FMU will be beneficial in the future. This financial forecast is based on assumptions available and only a projection of a possible cash flow scenario. ***This is not a valid/legal statement and therefore should only be used as a guide.***

With the road network to the valley, rural allotment is expected to increase and royalty from rural timber and firewood allotment is also going to fetch good revenue to the DFO office. This has not been worked out due to unpredictability of the trend in rural demand in coming years.

Table 28: Financial forecast-assumptions

Particulars	Assumptions
m^3 to cft	35.31
Recover Volume NRDCL (%/AAC)	60% for chirpine and 40% for hardwood
Commercial harvesting	2100 m^3 or 74151 cft
Road construction (Nu/km)	1800000.00
Length of proposed new road (km)	10
New road construction (km/yr)	1
Road maintenance (Nu/km/yr)	15000.00
Distance to Depot (km)	27
Cable crane (Nu/cft) (Nu/m3)	14.90
Rural Allotment (m3)	500
Regeneration maintenance per cable line (Nu/ha)	15000.00
Existing plantation (ha)	74.57
Plantation cost (as per plantation norms and standard, SFD for 5 ha model plantation)	75000.00
Royalty for timber	9.80

Table 29: Financial forecast summary

Financial Summary for Plan Period	
Total Revenue NRDCL	202650512.30
Total Costs NRDCL	62629972.20
Total Royalty NRDCL	13481566.00
Total Revenue less Royalty less Costs NRDCL	**126538974.10**

Table 30: Financial forecast for 10 years (2019-2028)

Year					2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	AAC (m3)	Rec. Vol m^3	cft	Nu/m3	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu	Nu
Revenue: NRDCL														
Timber – Commercial (BL)	7491	2996	105788	142.69	15094889.72	15094889.72	15094889.72	15094889.72	15094889.72	15094889.72	15094889.72	15094889.72	15094889.72	150948897.20
Timber – Commercial (Conifer)	1500	900	31779	162.69	5170125.51	5170125.51	5170125.51	5170125.51	5170125.51	5170125.51	5170125.51	5170125.51	5170125.51	5170125.51
Timber – Rural	500													
Total Revenue NRDCL					20265015.23	20265015.23	20265015.23	20265015.23	20265015.23	20265015.23	20265015.23	20265015.23	20265015.23	2026501520.30
Bridge Construction/														
Road Construction	10 km		1 km/yr	1800000	1800000	1800000	1800000	1800000	1800000	1800000	1800000	1800000	1800000	1800000
Road Maintenance	38 km		3.8 km/yr	15000	57000	57000	57000	57000	57000	57000	57000	57000	57000	57000
Marking Costs			74151	0.08	5932.08	59320.8	5932.08	5932.08	5932.08	5932.08	5932.08	5932.08	5932.08	5932.08
Felling and Crosscutting			74151	2.5	185377.5	185377.5	185377.5	185377.5	185377.5	185377.5	185377.5	185377.5	185377.5	185377.5
Cable craning			74151	14.9	1104849.9	1104849.9	1104849.9	1104849.9	1104849.9	1104849.9	1104849.9	1104849.9	1104849.9	1104849.9
Transportation to Depot			74151	16.74	1241287.74	1241287.74	1241287.74	1241287.74	1241287.74	1241287.74	1241287.74	1241287.74	1241287.74	1241287.74
Regeneration maintenance			74.57	15000	1118550	1118550	1118550	1118550	1118550	1118550	1118550	1118550	1118550	1118550

Plantation creation			10 ha	75000	75000	75000	75000	75000	75000	75000	75000	75000	75000	75000
Total Costs NRDCL					**6262997.22**	**6262997.22**	**6262997.22**	**6262997.22**	**6262997.22**	**6262997.22**	**6262997.22**	**6262997.22**	**6262997.22**	**6262997.22**
Total Revenue					**20265015.23**	**20265015.23**	**20265015.23**	**20265015.23**	**20265015.23**	**20265015.23**	**20265015.23**	**20265015.23**	**20265015.23**	**202650152.30**
Royalty														
Royalty - Commercial			137567	9.8	1348156.6	1348156.6	1348156.6	1348156.6	1348156.6	1348156.6	1348156.6	1348156.6	1348156.6	13481566.00
Total Royalty DoFPS					**1348156.6**	**1348156.6**	**1348156.6**	**1348156.6**	**1348156.6**	**1348156.6**	**1348156.6**	**1348156.6**	**1348156.6**	**13481566.00**
Total Revenue - Royalty - Costs NRDCL					**12653897.41**	**12653897.41**	**12653897.41**	**12653897.41**	**12653897.41**	**12653897.41**	**12653897.41**	**12653897.41**	**12653897.41**	**126538974.10**

19. RESEARCH

Research programs will be taken care by UWICER and the DFO/FMU staff may collaborate as appropriate. The areas identified for the research activities in the last plan will be taken up on priority bases. The other areas of research are:

1. Revive older research site within the FMU
2. Utility and treatment packages for the less priority species
3. Domestication of Nationally important NWFPs, which are under risk of local extinction
4. Study on the Epiphytes, an increase trend within the FMU. It deteriorates the quality of the timbers
5. Study on mistletoe attacks on Chir pine trees along Chaskar road.
6. Impact of commercial harvesting on wildlife
7. Change of forest composition in the operated areas
8. Human wildlife conflicts due to harvesting operation

PART 3 IMPLEMENTATION OF THE PLAN

PART 3 IMPLEMENTATION OF THE PLAN

20. IMPLEMENTING AGENCY

The CFO, Mongar Territorial Division, will be responsible for the implementation of this Management Plan. He will be assisted by the Unit in-charge and other support Staff. FRMD will provide technical support in sustainable forest management during the plan period. CFO, Mongar, will identify relevant field of training required by FMU staff and propose adequate budget for training in the fiscal year.

20.1 Determination of Cutting Cycles

For future return it is felt that proper spacing between cable line layouts must be kept. The improper cable line spacing results in areas being over harvested with no chance for future cutting cycles. The forest will be sustainable if the cable line spacing is properly laid so that subsequent passes can be achieved. To ensure two passes in the future, a minimum of 75 m needs to be kept in between the cable lines. Both broad leaf forest and chir pine forest are assumed to have a rotation period of 120 years, this means that two cable lines that will be implemented in the future are occurring at year 40 and year 80. Figure 29 depicts the cable layout. The initial line will be revisited in the year 120. This ensures every aspect of sustainability, before the forests are put into management regime. Understandably, terrain in Bhutan possesses a problem for layout. The layout in the field must be customized to suit the terrain, but to the best possible the guidelines must be followed.

20.2 Annual Coupe

The annual coupe for harvesting in the operable area must be selected based on the criteria's that shall include; accessibility, slope, stand condition, and environmental conditions. Coupes must comply with the following conditions:

1. Based on the Silvicultural System, the annual coupe will follow the required spacing designated above, within the limits of the AAC.
2. The UIC will determine the location and extent of cable lines in the Compartment to be harvested annually, in consultation with NRDCL staff. NRDCL will then plan for harvesting operations and the location of the cable cranes, alignment of cable lines and designated log landing points. Environmentally sensitive areas designated in the forest function map will be identified, their position indicated and care taken to ensure the appropriate prescriptions restrictions are followed.
3. The UIC will then mark the trees in the sub-coupes as prescribed.
4. Cable line layout will be based on safety, stand composition, environment and cost considerations. NRDCL will be permitted, in consultation with the UIC to align cable lines diagonally across contour lines in order to avoid environmentally-sensitive sites, identify stable landing points or to

secure a sufficient length of cable corridor in order to put the cutting system into effect in a cost efficient manner.

5. The cable lines may traverse slopes greater than 100 % but forest on such slopes is not to be harvested.
6. Because of constraints imposed by the terrain and other on-site considerations, adjacent cable lines need not be necessarily parallel to one another. The prescribed interval between the sub-coupe cable lines is considered a *minimum* value.

20.3 Tree Marking Rules

In general, the following factors are to be considered when determining the spatial framework and sequential order of the patches selected to harvest:

1. Patches of mature and over-mature trees showing profuse regeneration underneath should be selected.
2. Generally, the size of patch clear-cut opening is 0.25 ha; but the opening can vary from 0.15 ha to 0.5 ha depending on the stand composition and site condition. However, care should be taken not to make the opening too large, as it will favour the growth of unwanted species.
3. The direction of the tree lean and topography has to be taken into account to prevent large trees being felled on nearby advanced growth.
4. Dead, dying, malformed, or damaged (snags, scars, conk, etc.) trees will be retained in between patches, and in the interline spaces, to safeguard flora and fauna niches or habitats, but not in the harvested patches themselves, where there is the 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.
5. All species listed for protection under the FNCA 1995 must be protected if encountered.
6. The trees selected will be marked with the authorized marking hammer close to ground level by Unit staff, and diameter measured, along with estimated total tree height and tree species should be entered in the TMB. The volume of each tree will be estimated using local volume table or calculated using the volume calculation formula used by DoFPS. The standing volume of trees should be recorded in the TMB and Tree Production Register. Log volumes at the NRDCL depot should also be recorded.

20.4 Harvesting

In view of the generally steep terrain and the management objectives set for the Unit, the harvesting method to be used will be a skyline cable 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. The advantages of this system are:

1. Minimises soil disturbance and initiation of soil erosion,
2. Maximises worker safety (if used correctly according to the manufacturer's directions and according to the safety practices in the Code of Practice),
3. Avoids damage to residual reserve stands,
4. Avoids disruption to wildlife corridors in valley bottoms,
5. Minimises noise and dust pollution on any adjacent farmlands and villages, and,
6. Eliminates the need for log extraction tracks and feeder road construction.

Harvesting in the Working Circles is to be carried out in accordance with the following prescriptions.

1. 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 landings should be identified and incorporated into the forest road design. Care should be taken to avoid locating 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.
2. The cable corridor shall not exceed the prescribed width stated in the Silvicultural System for each Working Circle.
3. Trees will be felled, de-limbed, crosscut, extracted on the cable, loaded and hauled to the log depot. Only chainsaws and handsaws 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.
4. The use of axes is discouraged except in fuel wood splitting.
5. All infected Blue pine and Spruce, if any will be debarked as soon as they are felled to avoid the spread of bark beetle.
6. All logs will be measured and recorded in the Log Production Register (LPR). This should be kept upto date and made available to inspecting officers as required. A copy of the list of logs/timber entered in the LPR will be submitted to the CFO every month. This information will be used for royalty calculation and issuance of removal permits. Logs will be transported by haulage and all deliveries will be made to designated depots and/or sawmills.
7. 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 CFO, Mongar.

8. The CFO and the RM, NRDCL will co-operate and co-ordinate to ensure that the logging operation and log outturn are conducted smoothly and in accordance with local and other demands.
9. 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 become fuel wood are extracted with the cable line and fuel wood conversion occurs at the designated log landing areas.

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

20.5 Reforestation of Harvested Sites

The harvested area must be reforested immediately after the harvesting operation. Natural regeneration is preferred in chir pine forest, but if natural regeneration fails; artificial regeneration must be carried out. For broadleaf forest artificial regeneration must be carried out immediately after harvesting in the following plantation season. Prior to plantation, nursery for local species shall be raised in the FMU by the NRDCL. The area shall be planted with commercially viable local species with not more than 5 species on each site. Regular maintenance of plantation shall be done to ensure the survival percentage of the plants till it is fully established. The UIC shall carry out plantation survival survey every year to monitor it status of establishment. If the survival percentage is lower than 70%, immediate beating up should be carried out with the same species.

Although a monitoring process has been adopted in FRMD, it is recommended that regeneration surveys be conducted every three years in corridor and interlines until the regeneration has reached a height that will ensure its survival. If the second survey (6^{th} year) indicates poor stocking, remedial action must be taken in the planting season following. The UIC will ensure that stocking of natural regeneration is first monitored within three years following completion of the harvesting operation

The factors that limit the success of regeneration include; grazing pressure, protracted harvesting periods and weeds and brush growth. These problems must be addressed if regeneration is to have a fighting chance. It is recommended in this plan period to adopt more tending activities, such as weeding, brushing and fencing, so that regeneration has a chance to establish. This would also reduce the cost of reforestation as clearing and replanting a failed area would cost much more than the initial tending for natural regeneration.

Figure 32: Natural regeneration

There is a developing understanding by territorial and NRDCL staff of the right size of openings to promote regeneration of various species and this knowledge is being supplemented by recent research. It is vital that this silvicultural knowledge is utilised and implemented. Openings that are too large or too small for the target species can again lead to excessive weed and brush growth before regeneration can become established (Whitfield, 2001).

Enrichment planting, if necessary, will be carried out by NRDCL. Depending upon the cattle population and site condition barbed wire fencing shall be done in the plantation area. Fencing or other action to protect regeneration will be carried out by NRDCL, in consultation with the UIC and the FMU Level Management Committee. ***All regeneration surveys and regeneration activities will be funded by the implementing agency i.e. NRDCL***. Budgetary requirements will be written in the Operational Plan in consultation with NRDCL.

Table 31: Sequence of Operations Relationg to the Annual Coupe

Operation Description	**Timing (months)** **(- before felling; + after felling)**
UIC decides on the location and size of annual coupe in accordance with the Annual Operational Plan	-12
NRDCL and UIC prepares an estimate of human, material, equipment and financial resources required	-10
UIC finalises 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, as well as proposed log depot and log landing points and submits these to CFO for approval	-3
UIC marks the carriage corridor trees and the trees 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 commences systematic harvesting and extraction operations according to the approved sequence in the Annual Operational Plan	0
NRDCL/Contractor completes harvesting and extraction	When completed
The UIC will inspect the coupes when harvesting is completed and will issue a Coupe Clearance Certificate - only if all aspects of the operation are satisfactory and all timber is removed from the annual coupe.	When works completed
CFO and UIC assess success of natural regeneration.	As per guidelines
NRDCL completes post-harvesting operations.	As per UIC instructions

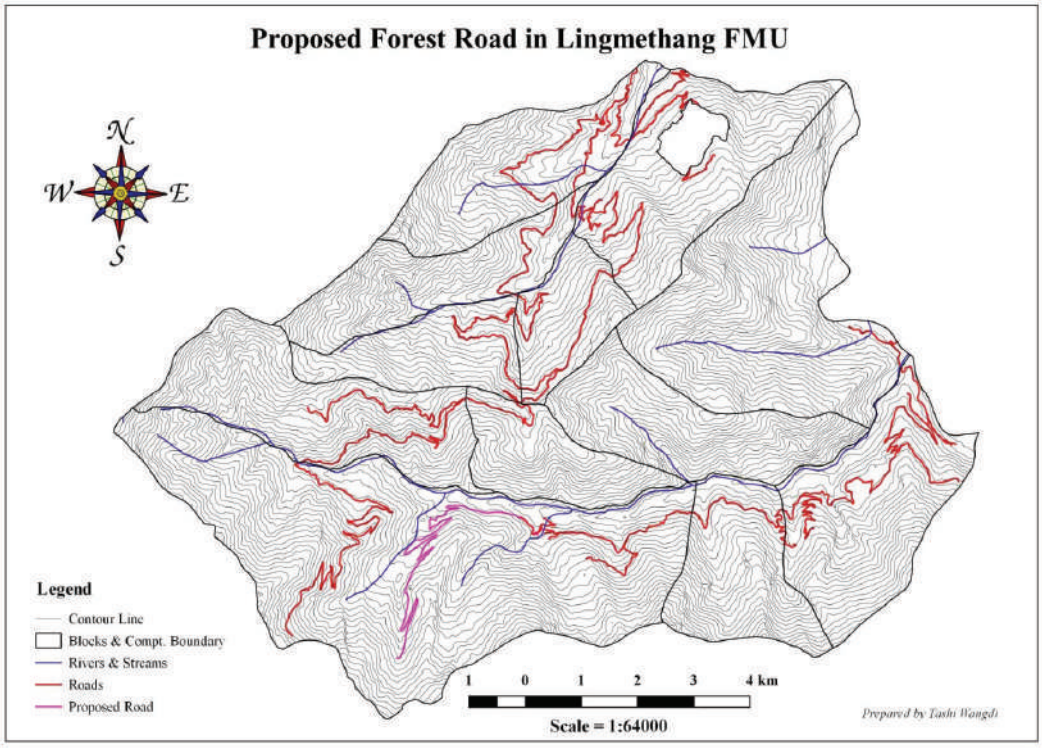
20.6 Road Construction

During this plan period **10 km of forest road** is proposed to be constructed by NRDCL. The entire length of the forest road falls under the Yunari Block, compartment III. Forest Roads, despite its negative impacts on forests and local environment, still forms an essential part of managed forest estate, both for timber construction and to provide access to forest management and monitoring. Road construction in the FMU requires extra precautions to achieve environmental best practice. The basic necessity in forest road construction is to avoid steep and fragile areas, to provide a proper drainage system, especially for safe discharge of run-off water during the monsoon, with enough culverts and cross drains, to have an efficiently draining compacted road surface.

Figure 33: Forest road blocked by wing fallen tree

The total road within the FMU is approximately 70.06 km inclusive of national highway, farm road and forest road. Jainala-Brogsar-Sherila Farm road constructed by the Dzongkhag will be good enough to harvest the Yunari block.

Road survey, design and construction will be carried out by NRDCL. The road is to be located by marking a gradeline on the ground. This gradeline is then used as a basis for the road design, which will vary with the location of the road as necessary to meet the standards mentioned below in terms of bend radius, proportion of cut and fill for various slopes, etc. NRDCL will mark the design centreline in the field so that contractor compliance to it can be monitored effectively. The road design should be part of the contract document.



20.6.1 Road standards

A set of road standards has 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 the Lingmethang FMU and NRDCL road engineers must follow these standards, given in Annexure 2 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), Forestry: Bhutanese environmental assessment sectoral guidelines must be also referred to, wherein general principles and practices to minimize negative economic and environmental impacts of road access are cited.

Road design in Lingmethang FMU should follow the recommended road profile in Figure 36 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 costs for the future.

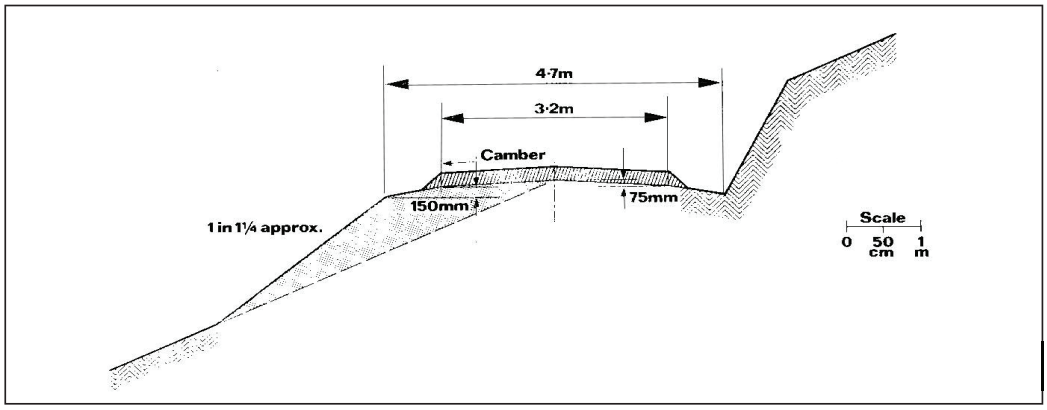


Figure 34: Recommended Road Profile

21 PLANNING

21.1 Operational Plan

Operational Plan (OP) will be prepared by the CFO Mongar and the UIC to facilitate the timely implementation of this Management Plan. OP will be prepared annually (for a two-year rolling period). Assistance in preparation of the OP can be provided by other parties e.g. NRDCL and technical assistance and back-stopping will be provided by Planner, DFO. The primary aim in preparing OP is to determine and co-ordinate the timely input of resources to put the overall Plan into effect in a cost-effective manner and according to the objectives.

The OP is also the tool used to provide for changes that cannot be foreseen or allowed in the Management Plan, such as insect and disease outbreaks, severe fires etc. If and when these occur, the current OP should be immediately reviewed and areas or methods of operation modified to deal most effectively with possible changes in the sustainable level of harvest.

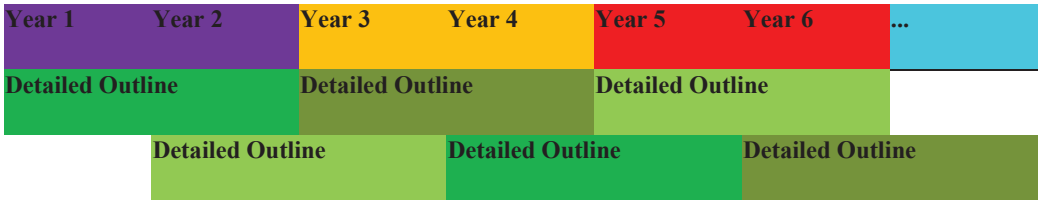


Figure 35: Concept of Rolling Plan

The Rolling OP will include detail of activities for the coming year (year 1) and an outline of activities for the following year (year 2). Guidelines for OP have been prepared by FRMD and are available in all Territorial Divisions and UIC offices. The Guidelines is user-friendly and contains detailed process for preparing and implementing the OP.

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

The process for preparing and implementing the Operational Plan is laid out in Table 34.

Table 32: Preparation and implementation of Operational Plans

Activity (Planning Step)	Objective	Output	Responsibility (lead)	Comments
Approved FMP				
PRAs with local stakeholders	To prepare participatory plans 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 grazing management; fire management or rural timber harvesting (to be incorporated within the OP)	UIC, DoFPS	First step is to enter into discussions with stakeholders and their representatives Use PRA techniques to prepare a plan Plan costs are included in the OP
Operational inventory	To assess the resource availability for the planned harvesting area Calculation of the harvestable volume	Site-level inventory data for operational area to be harvested Precise estimate of volume to be removed during the coming year.	UIC & NRDCL	For the areas proposed for harvesting during the next 2 years May be combined with Harvesting plan and cable line survey
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 May be combined with Operational inventory
Preparation of OP	To prepare a cost plan for implementation during the next 2 years (involving stakeholder participation for some activities)	Approved OP with budget	UIC with local stakeholders as required	Activities linked with objectives identified in the FMP and following options and guidelines in the FMP

	To formalise local institutional responsibility for planned activities (e.g. grazing, fire management, rural timber distribution)	Identified responsibilities for each planned activity Calculated costs for each planned activities		Each activity with identified responsibility for implementation, estimated cost, and site-specific location OP prepared according to standard formats
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 FMU management committee	During FMU management committee annual meeting Implementation problems need to be addressed before endorsing the new OP
OP reviewed by FMU committee and endorsed	For the FMU management committee to endorse the OP (prior to approval by DoFPS) To endorse expenditure estimates for the coming financial year	OP endorsed by FMU management committee	FMU Manager presents to the FMU management committee	During FMU management committee annual meeting
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 place by November to ensure that budget requirements can be included in the NRDCL APO for the next financial year
OP approved by Director DoFPS	To approve the OP for implementation	Approved plan and budget	Approval by FRMD and Director DoFPS	OP approval linked with sanctioned budget for all planned activities

OP implementation by NRDCL	To carry out planned activities	Harvested timber; protected area; roads; fuelwood etc	According to respponsibilities identified in the OP e.g. UIC & NRDCL	Each activity with a sppecific respponsibility and budget
Monitoring of activities	To assess the level of achievement of planned activities	Information for FMU annual report	UIC	CFO & UIC respponsibility is to monitor the implementation of activities carried out by NRDCL Monitoring also has a cost which needs to appear in the OP
UIC, DoFPS prepares FMU annual report	To report progress against planned activities To highlight any problems being encountered in implementation	FMU Annual report	UIC	Prepared annually Progress is reported against each FMP objective and the associated activities
Prepare the next year's OP (steps 2-5)	To prepare the next OP taking into account progress over the past year	OP	UIC	OP may alter in respponse to FMU Management Committee suggestions and recommendations

21.2 FMU Level Management Committee

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

Figure 36: FMU level meeting at Saling Geog Office

1. CFO, Mongar, Chairman
2. UIC, Lingmethang FMU, Secretary
3. RM, Zhonggar Division, NRDCL, Mongar
4. PIC, NRDCL, Mongar
5. Gup, Saling Geog, Mongar

FMU-Level management committee; terms of reference

A. During FMP preparation

1. To represent the interests of identified stakeholder groups during the planning process for FMP preparation
2. 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
3. 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

4. To review and endorse the draft forest management plan before it is presented to Director, DOF and Minister of Agriculture for final approval

B. During operational planning, implementation and monitoring

1. To represent the interests of all the identified stakeholder groups during annual planning and review of activities under OP
2. To review achievements during the previous year (based on an FMU annual report submitted by the UIC) and advise and act on any issues identified in this report
3. To make recommendations for changes to the proposed OP for the coming year based on the previous year's experience and on the need to achieve the agreed objectives in the FMP
4. To endorse activities, priorities and funding arrangements within the draft OP before submission to the Director, DoFPS
5. To participate in the 5-year mid-term evaluation of the FMP
6. To hold any additional meetings as required in response to specific issues arising from FMP and OP implementation
7. To participate in the final (10-year) EVALUATION of the FMP

This will require at least 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.

21.3 Staff

The CFO, Mongar Division is the overall controlling officer. The UIC will have direct responsibility in control and management of the FMU. The UIC office will be under the administrative control of the CFO, Mongar Division. The CFO is the direct representative of the Department in the field and as such he is solely responsible for all forestry activities, both technical and administrative, in his jurisdiction.

21.3.1Responsibility

Unit In-charge = 1 (Sr. Forest Ranger or Forestry Officer)

Asst. Forester = 4

The UIC will be responsible for the day to day implementation of the plan under the overall guidance of the Divisional Forest Officer. The UIC will keep records of all the works, supervise and initiate other silvicultural activities as envisaged in this plan. The UIC will be responsible to CFO, Mongar.

Forest Ranger II will be responsible for carrying out operational inventory, help to prepare the OP, supervise road construction and maintenance and keep the track of regeneration of the harvested areas. Forest Ranger II 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 Asst. Foresters will be assigned to help the Forest Ranger II.

21.4 Buildings

LFMU has a unit office for the UIC and separate office for the PIC, NRDCL. The Divisional Forest Office is planning to build a forest check post for monitoring illegal activities.

21.5 Vehicles and Equipments

Lack of mobility is the main cause of inadequate implementation and supervision pertinent to field activities by the Departmental staff. This is hindering smooth implementation of management plan.

Figure 37: Hiring private vehicle for transportation

The CFO, Mongar has provided Lingmethang FMU staffs with all the necessary equipments required in efficient implementation of the plan including a set of computer. However, if fund is available more number of equipments could be provided for all the staffs such as Suunto clinometer, Suunto compass, Diameter tape, Distance measuring tape, Binoculars, etc

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 FMU, 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, and the second stage checks that the objectives of the plan are being achieved over the longer term. Monitoring (checking on inputs on a year to year basis) is the term used for the first stage and evaluation (checking achievements against objectives over five year periods) is the second stage.

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 the annual monitoring process, **Evaluation Form A** for the five year evaluation, **and Evaluation Form B** for the once only 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.**

The necessary Monitoring and Evaluation Forms is available with CFO Mongar or at FRMD.

22.1 Record Keeping

The records should be kept by blocks and compartments. This would ensure that each activity that occurs is recorded in an easy to find format. Totals of the AAC allotment would then be submitted monthly to the CFO - as is already required.

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 and AAC allotments can be followed. Although record keeping may not seem as important as some management activities, it is the backbone of future management decisions and the importance must be stressed.

The guidelines to complete and fill the forms; one for Rural Allotment, one for Commercial Allotment and one for Stand Tending and Regeneration activities are available in all territorial Divisions and UIC offices. It is also important to record ***all activities*** for future management and monitoring and evaluation.

22.2 Mid-term Review of the FMU Plan

The Head, FRMD, will ensure that the Plan is reviewed five years after implementation. The Mid-term review will be discussed with the FMU Level Management Committee. The mide-term review shall be conducted within **October to December 2024.**

22.3 Monitoring

Monitoring is the examination of whether inputs, activities and outputs are successfully supplied according to the planned schedule. The CFO Mongar will ensure that monitoring is carried out on an annual basis as per the guidelines issued by FRMD. In the context of FMU implementation, *inputs* include machinery availability and staff skills and availability, while *outputs* include OP completion, road construction, and production of forest produce.

It is essential that monitoring forms are recorded regularly and are handed over for review. The plan must be monitored to obtain the best practice of forest management.

22.4 Final Evaluation

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 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 FRMD.

Corrective action, if it is necessary, may require changes to a range of inputs or to implementation methodology. Staffs that are independent of field activities will carry out the evaluation.

The Director, DoFPS, will appoint the Evaluation Team

The Final Evaluation of the FMU will be conducted within **October to December 2028.**

23. CONSTRAINTS AND RISKS

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

1. Inadequate fund for implementation of the plan;
2. Uncertainty of natural regeneration, due to gazing, and undergrowth competition;
3. Lack of research information;
4. Lack of skilled and trained forest workers;
5. Lack of sufficient support staff to the UIC;
6. Lack of regular monitoring to determine whether objectives are being achieved or not;
7. Poor communication between field and office staff and between involved parties.

24. DEVIATIONS FROM PLAN PRESCRIPTIONS

The AAC shall be allowed to deviate for +/- 10% during any one year and the excess or deficit will have to be adjusted during the subsequent years so that there will not be any excess or deficit from the prescribed cut during the plan period of 10 years. **However, the total volume harvested over successive five year periods must be not more than five times the AAC volume.**

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

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Annexure 1: Compartment Review and Prescription

Shongjari Block, Compartment: I

Altitude: 680-2530 m.a.s.l **Aspect:** SouthEast **Slope:** 60-70%

Forest Type: Broadleaf with Chirpine **Age Stage:** Mature **Total Area:** 709.29ha

Forest description: This compartment has already been logged in the first plan period. It comprises of both Chirpine and Broadleaf/Hardwood forests. Abundant growth of young chirpine poles is seen in the area. Regeneration along the cablelines is preferably good, but not of the principal species. In general, the stock is mature and is sparcely distributed all over the area.

Prescription: This compartment will not be brought under commercial harvesting during this plan period. During the second management plan 4 cable lines were laid for commercial harvesting. Planting of principal species could be undertaken in blank areas.

Shongjari Block, Compartment: II

Altitude: 840-2880 m.a.s.l **Aspect:** SouthEast **Slope:** 60%

Forest Type: B roadleaf **Age Stage:** Pole Crop **Total Area:** 615.62 ha

Forest description: This compartment too harbours mature stands of broadleaf species that are barely straight bole. Thick undergrowth of bamboo is found along the streams, mostly in patches. Inferior stock predominate this compartment. Owing to its steepness, only two cablelines are operated during the first plan period.

Prescription: Logging during the first plan period was possible only at lower altitudes. Higher altitudes are not feasible for harvesting due to inaccessibility of the area. This compartment will not be brought under commercial harvesting during this plan period. During the second management plan 4 cable lines were laid for commercial harvesting. Planting of principal species could be undertaken in blank areas.

Shongjari Block, Compartment: III

Altitude: 1200-2720 m.a.s.l **Aspect:** NorthEast **Slope:** 60-70%

Forest Type: Broadleaf **Age Stage:** Mature **Total Area:** 456.82 ha

Forest description: Forest generally comprising of mature broadleaf. Stock is considerably good, however in some areas the stock is young due to shifting cultivation practised in the past. Major portion of this compartment is not feasible for harvesting due to its inaccessibility.

Prescription: Commercial logging from this compartment was undertaken during the first and second management plan period. During the second management plan 3 cable lines were laid for commercial harvesting. Planting of principal species could be undertaken in blank areas.

Shongjari Block, Compartment: IV

Altitude: 600-2040 m.a.s.l **Aspect:** NorthEast **Slope:** 50-60%

Forest Type: Broadleaf **Age Stage:** Mature **Total Area:** 1298.12 ha

Forest description: This compartment encompasses mature stands of broadleaf. Despite of the stock being unsatisfactory in general, considerable amount of timber could be harvested from some patches, i.e. below the forest road.

Prescription: This compartment had been logged in the previous plan period. During the second management plan 3 cable lines were laid for commercial harvesting. Planting of principal species could be undertaken in blank areas.

Profuse regeneration of non-commercial species such as Macaranga is seen in most of the cablelines in comparision to principal species.

West-Gyelposhing Block, Compartment I

Altitude: 480-2000 m.a.s.l **Aspect:** East **Slope:** 40-80%

Forest Type: Chirpine mixed with Broadleaf **Age Stage:** Mostly young

Total Area: 1468.67 ha

Forest description: Young poles of chirpine and immature broadleaf species are abundant in this compartment that is usually not harvested. Because of the steep terrain, the area cannot be put under production. Number of non-commercial species had escalated in this compartment over the years. Dense undergrowth of shrubs like rhododendron, rubus, eltsolzia, bamboo, etc is also widespread in the area.

Prescription: Substantial quantity of mature chirpine had been extracted from this area before the commencement of Kuri Chu hydel project, so availability of mature stock is very less. Moreover, the area is put under complete protection being the watershed for Kuri Chu hydropower plant, so no harvesting from this compartment is recommended.

West-Gyelposhing Block, Compartment II

Altitude: 480-2011m.a.s.l **Aspect:** SouthEast **Slope:** 70%

Forest Type: Chirpine with Broadleaf **Age Stage:** Young to mature Chirpine

Total Area: 704.10 ha

Forest description: This compartment comprises of young to mature trees of chirpine that could be used as poles and chams. Mature broadleaf trees exist at lower altitudes with immature trees at higher altitudes.

Prescription: Owing to its steepness no commercial harvesting is possible. However, mature trees could be harvested on the basis of Single Tree Selection System.Grazing must be regulated and prohibited in the area to facilitate regeneration.

Kalapang Block, Compartment I

Altitude: 480-2120m.a.s.l **Aspect:** NorthWest **Slope:** 60%

Forest Type: Mostly Chirpine, Sparce Broadleaf

Age Stage: Mature Chirpine, Immature Broadleaf **Total Area:** 889.80ha

Forest description: Almost half of the compartment is already operated. Mature stands of chirpine are predominant in this compartment. The area has gentle slope in general.

Prescription: This area had already been logged in the first plan period and during the second management plan 4 cable lines were laid for commercial harvesting. Planting of principal species could be undertaken in blank areas.

This compartment shall not be logged during this management plan period. The regeneration is very good.

Kalapang Block, Compartment II

Altitude: 840-2317 m.a.s.l **Aspect:** North **Slope:** 60%

Forest Type: Mostly Broadleaf with few small patches of Chirpine

Age Stage: Mature Broadleaf **Total Area:** 511.39ha

Forest description: This compartment comprises stands of mature broadleaf at lower altitudes and young stands at higher altitudes. Nevertheless, few patches of dense, mature chirpine also

occur in this compartment that is mature below and young above. A small patch of promising stand occurs just above the stream.

Prescription: No commercial operation had taken place in the past; however no large scale harvesting is possible for the reason that the area is very rocky and steep. Nevertheless, Single Tree Selection System could be appropriate only to meet local demands. Regulation and control of grazing needs to be strictly followed.

Yunari Block, Compartment I

Altitude: 960-2120m.a.s.l **Aspect:** South **Slope:** 70-80%

Forest Type: Mostly broadleaf with Chirpine

Age Stage: Young Broadleaf and young Chirpine **Total Area:** 426.69ha

Forest description: Small patch of young chirpine poles occurs just opposite to Yunari Chu. Broadleaf species are also immature at lower altitudes and in the vicinity of settlements. Yet, patches of mature broadleaf are available in some gentle areas and along the river. Generally, this compartment has abundance of young immature poles of chirpine and broadleaf.

Prescription: NRDCL had laid 11 cable lines for commercial harvesting during the second management paln period. Therefore, this compartment shall not be logged. Planting of principal species could be undertaken in blank areas.

Yunari Block, Compartment II

Altitude: 1200-3321 m.a.s.l **Aspect:** South **Slope:** 40-60%

Forest Type: Broadleaf **Age Stage:** Young to mature Broadleaf

Total Area: 932.36ha

Forest description: This compartment is entirely broadleaf. Normally young poles occur at lower altitudes and mature stands occur at higher altitudes due to the presence of settlements.

Prescription: 23 numbers of cable lines are laid for commercial harvesting during the second management paln period. Therefore, this compartment shall not be logged. Planting of principal species could be undertaken in blank areas.

Yunari Block, Compartment III

Altitude: 1160-3321 m.a.s.l **Aspect:** NorthEast **Slope:** 20-60%

Forest Type: Broadleaf **Age Stage:** Mature Broadleaf **Total Area:** 2558.88 ha

Forest description: The stock in this compartment is considerably good and substantial timber could be harvested from this area. Though young stands are usually seen near the settlements, mature stands predominates this compartment. People collect bamboo and cane for *bona fide* use that mostly occurs in moist places.

Prescription: Harvesting for this plan period shall take place in this compartment. However, people have been meeting their demands from this area in the past.

Annexure 2: Road Standards

As stated in the Dongdechu FMU management plan (D. Dorji and W. Incoll, 2001), the following standards will be implemented for design, drainage and construction of all forest roads:

Road Design

1. Road lengths and density should be minimised, consistent with access requirements to reduce environmental impacts and enhance access economics.
2. Where possible locate roads in areas with low side slopes, the maximum side slope allowed in all areas except rock is 100%.
3. Roads must be constructed in such a way that no earthworks or soil spill into watercourses or watercourse buffer areas. Care should also be taken to ensure that no earthworks or soil is allowed to spill onto agricultural land, near houses or main roads.
4. Roads should be planned in such a way as to balance cut and fill to minimise transport of construction material.
5. 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.
6. Roads should be kept as narrow as possible to reduce damage to the environment and to reduce costs.
7. Where possible, box cuts should be avoided, however they are acceptable for short distances (up to 300 metres) if they reduce the length of the road, reduce environmental damage and are properly drained.
8. Minimum radius formed by curves or corners should be 15 metres and should where possible fit the topography of the land.
9. Roads should be located on elevated areas where possible to minimise side-cutting, width of clearing and drainage problems.
10. Side cutting should be carried out leaving a stepped batter, each step no more than 3 metres in vertical height and no more than 100% gradient with a 1.5 metre horizontal step.
11. Convex road surface should be maintained at all times with the centre line 30 cm higher than the edges.
12. Stabilise and revegetate cut and fill slopes with shrubs, grasses and legumes as soon as possible after construction.
13. Ensure proper maintenance of roads and enforce road use restrictions during critical weather conditions such as monsoon season.

Drainage

1. Road planning should ensure that roads are located in such a way as to minimise stream river crossings.
2. Roads should not be constructed in areas, which are prone to flooding in the monsoon season.
3. In areas where sideslopes of 70% or greater extend for a distance of 100 metres or more above the proposed road catch drains should be constructed to divert surface water into culverts. Sidedrains or tabledrains should be at least 40cm deep and 65cm wide and should drain into culverts of sufficient size and frequency.
4. 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.
5. Culverts of appropriate diameter (not less than 30cm) 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 erodable material then the distance between the culverts must be reduced by 50%.

Road gradient %	**Distance between culverts (metres)**
4	110
5-8	90
9-10	80
11-15	60

6. 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.
7. Culvert pipes (Hume pipe) should be buried a minimum of 700mm below the surface of the road.
8. In areas of high seasonal rainfall, catch drains should be constructed above the road to collect surface runoff and prevent it reaching the road.
9. Drains should not be allowed to directly enter a watercourse but should be diverted into surrounding vegetation at least 50 metres before a watercourse.
10. Sumps or silt traps should be placed in drains every 50 metres in erodable soils and must be cleaned regularly.
11.

Road Construction

1. All timber over 30cm 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).
2. 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 stabilise the slope.
3. Where sideslopes of 70% or more extend more than 100 metres downhill no sidecasting of spoil should be allowed. In this situation endhaul methods must be used.
4. Forest roads should only be constructed on stable soil types where there is no possibility of slippage.
5. All road construction on sideslopes of over 50% or difficult terrain, such as boulder fields, must be carried out using excavators.
6. Batter and fill slopes should not exceed 100%.
7. Where road construction is carried out on sideslopes of over 90% rock or concrete walls should be built to support both batter and fill (this is not required in solid rock).
8. On sideslopes 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.
9. The adverse gradient should not exceed 10%. However, grades of up to 12% will be allowed for distances of up to 300 metres if this substantially reduces road length. Following this incline a minimum distance of 100 metres of grades of 10% or less must be maintained.
10. The favourable gradient should not exceed 12%. However, grades of up to 15% for distances of up to 300 metres will be allowed if this substantially reduces road length. These grades should be followed by grades of less than 10% for distances of 100 metres or more.

Annexure 3: Tree Marking Rules

Marking Rules for Single Tree Selection System

1. Selection System will be used on sensitive and exposed sites where other Silvicultural system cannot be applied.
2. Trees marked for harvesting will be evenly distributed throughout the stands.
3. Mature and over mature trees should be given preference for removal.
4. Dead, dying, diseased and malformed trees will be marked on a priority basis. However, care should be taken so that no large openings are created in the stands by marking these trees.
5. In a mixed stand, even distribution of species should be left standing as future crop.
6. Where cable cranes are to be used, the extraction line will be as narrow as possible, not wider than four meters.
7. Trees damaged during harvesting will be marked and removed during the subsequent coup cleaning operation.

Marking Rules for Patch Clear-cut System

1. 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, ahich absorbs sunlight if permitted to reach the forest floor would enhance seedling development.
2. In selecting patches, ridge top should be preffered over derression.
3. In general, the size opening of 0.25ha need not be strictly adhered to and the size of the opening can vary from 0.15 to 0.5ha depending on the stand composition and condition. However, it should be remembered that the patch opening should not be too large, as it will favour the growth of other unwanted species.
4. The minimum distance between the extraction lines will be approximately 75 metres.
5. The distance between the patch clear-cut, along the extraction lines will not be less than 50 metres.
6. The extraction corridors must be as narrow as possible, however, no wider than 4 metres.
7. The shape and size of the patch clear-cut can be adjusted according to the site and terrain conitions and need not be exactly circular.
8. The direction of the tree lean and topography has to be taken into account to prevent large trees being felled on nearby advanced growth.

9. Dead, dying, malformed, or damaged (snags etc.) trees will be retained in between patch clear-cut, and in the interline spaces, to safeguard flora and fauna niches or habitata, but not in the harvested groups themselves, where there is the risk of wind throw and danger to personnel working underneath. Diseased trees will be removed to protect the quality of the remaining stand.
10. All species listed for protection under tha Forest and Nature Conservation Act (1995) must be protected if encountered.
11. Sufficient seed trees in the interline space adjacent to the cable lines opened up should be retained as potential seed source for seedling regeneration in the patch cuts.
12. The trees selected will be marked with the authorized marking hammer close to ground level by Unit staff, and diameter measurements, alonmg 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 volumes at the NRDCL Depot will also be recorded.

Marking Rules for Seed Tree System

1. Seed Tree System will be used only in chir pine stands.
2. Seed Tree System will be used in the above stands only on suitable sites.
3. The system will not be used on steep and exposed, South or South West Sites.
4. Slope characteristics, wind firmness and aesthetic values will be considered while utilizing this system.
5. About 15-20 trees per hectare will be left standing.
6. Diseased, malformed and dying trees will be cut on priority basis.
7. Trees left standing will be of good health and form to ascertain good seed source.
8. Tree left standing will not be the oldest or tallest in the stand. Over mature trees will be cut on priority basis.
9. The shape of the area chosen for the Seed Tree System can be irregular.
10. Maximum size of a contiguous area harvested using this system will not exceed one hectare.

Marking for Rural Uses

1. It is necessary that the marking for rural use whether for timber or fuel wood, should be done under standard Silvicultural system.
2. Firewood marking when necessary should be done under Single Tree Selection System from Local Use (only) forest area.
3. 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.

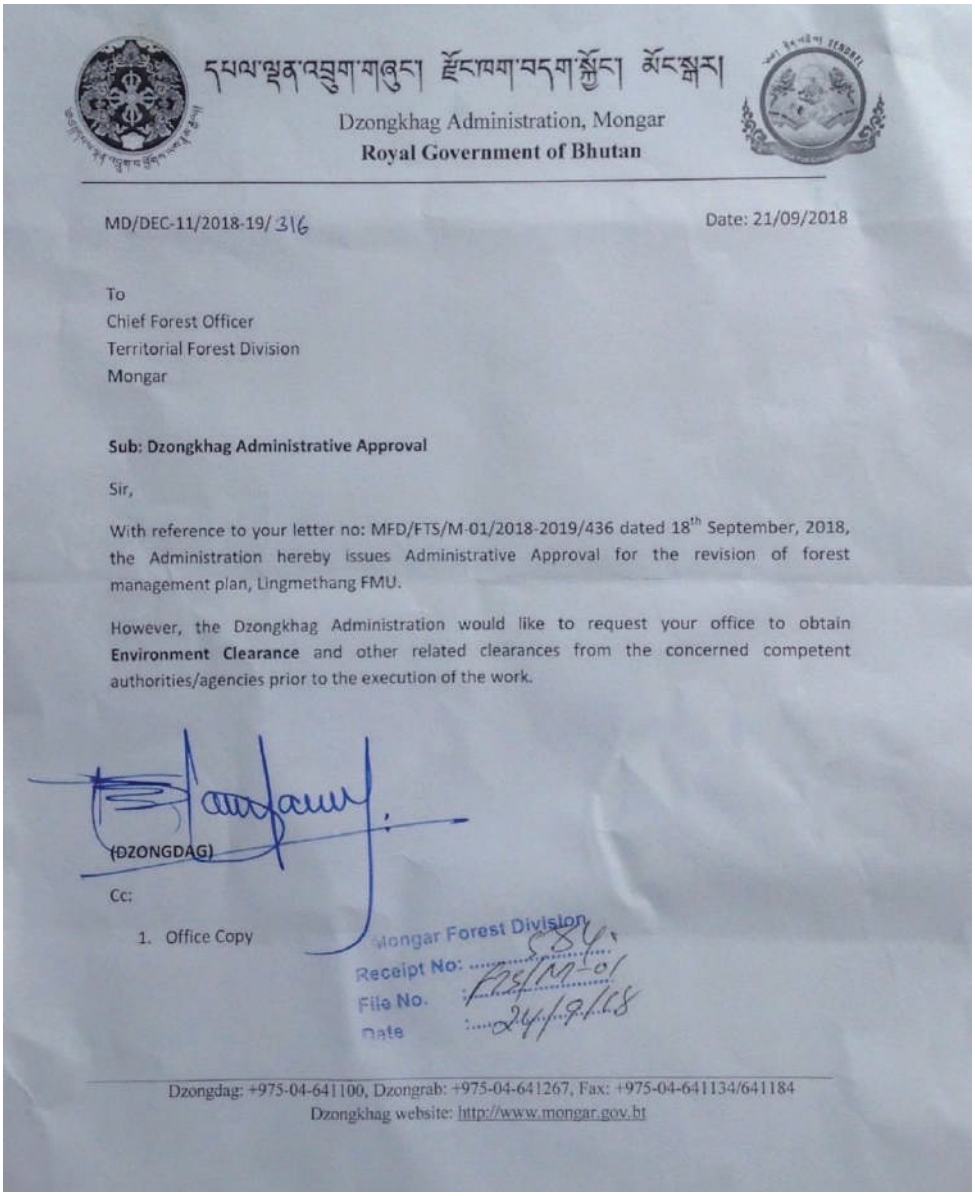
Annexure 4: Total volume per hectare in Lingmethang FMU

Tree Species	Total standing Tree Volume in m^3 (<10 cm dbh)
Acacia lenticularis	1454.72
Acacia sp.	304.12
Acanthocalyx nepalensis	925.9
Acer campbellii	9819.7
Acer laevigatum	1999.12
Acer sp.	7282.03
Acer thomsonii	772.5
Actinodaphne sp.	640.06
Aglaia spectabilis	2120.5
Ailanthus integrifolia	745.3
Albizia lebbeck	815.2
Albizia sp.	6875.77
Alnus nepalensis	3409.17
Alnus sp.	5102.27
Amoora rohituka	137.82
Artocarpus hirsutus	8213.67
Baccaurea sp.	3231.09
Beilschmiedia sp.	70801.93
Betula alnoides	2720.29
Betula sp.	3322.81
Betula utilis	4681.8
Bischofia javanica	16368.32
Boehmeria rugulosa	112.87
Boehmeria sp.	50.56
Bombax ceiba	3094.42
Brassaiopsis hainla	74.32
Brassaiopsis sp.	9359.55
Bridelia retusa	15266.33
Caryota urens	12207.41
Castanopsis hystrix	4389.14
Castanopsis indica	72.59
Castanopsis sp.	182377.11
Castanopsis tribuloides	48720.04
Celtis sp.	2479.51
Celtis tetrandra	315.46
Choerospondias axillaris	13733.21
Choerospondias sp.	394.78
Cinnamomum bejolghota	1352.97
Cinnamomum sp.	12074.77
Cinnamomum tamala	11903.6
Cordia obliqua	146.14
Cordia sp.	3594.46
Dalbergia sp.	450.41
Diploknema butyracea	142.13
Docynia indica	480.7
Duabanga grandiflora	961.13
Echinocarpus dasycarpus	2326.54
Echinochloa crus-galli	113.01
Elaeocarpus lanceifolius	101.17
Elaeocarpus serratus	445.9

Elaeocarpus sp.	8129.64
Engelhardtia sp.	1860.6
Engelhardtia spicata	1164.27
Ephedra sp.	860.33
Erythrina sp.	3494.09
Eurya sp.	677.99
Exbucklandia populnea	6809.36
Exbucklandia sp.	8101.75
Falconeria insignis	791.35
Ficus glaberrima	1836.66
Ficus religiosa	132.24
Ficus semicordata	4087.35
Ficus sp.	5564.66
Galinsoga quadriradiata	2719.54
Garcinia sp.	1878.4
Garuga pinnata	2127.27
Glochidion bourdillonii var. bhutanicum	673.99
Glochidion sp.	858.47
Gmelina arborea	940.46
Grevia optiva	1126.56
Holarrhena pubescens	345.98
Ilex sp.	260.44
Juglans regia	36560.05
Kydia calycina	1684.04
Kydia sp.	209.92
Lithocarpus elegans	68252.04
Lithocarpus glutinosus	336.38
Lithocarpus pachyphyllus	14818.04
Lithocarpus sp.	60122.38
Litsea sp.	19288.33
Lyonia ovalifolia	165.95
Lyonia sp.	422.71
Macaranga denticulata	10650.44
Macaranga sp.	5477.08
Machilus sp.	9138.64
Macropanax sp.	2209.41
Magnolia champaca	1998.88
Magnolia doltsopa	24260.18
Magnolia hodgsonii	831.27
Mallotus philippensis	1620.77
Mallotus sp.	1481.77
Mangifera indica	444.2
Mangifera sp.	1359.8
Mangifera sylvitica	121.5
Michelia sp.	5130.78
Morus alba	6596.83
Morus macroura	49437.03
Morus sp.	29775.8
Myrica sp.	290.96
Nyssa javanica	63354.44
Ostodes paniculata	10070.63
Ostodes sp.	2711.92
Pandanus furcatus	221.92

Pandanus sp.	173.51
Pentapanax sp.	1155.23
Persea bootanica	23189.73
Persea fructifera	17072.93
Persea sp.	81664.43
Phoebe hainesiana	1978.88
Phoebe lanceolata	219.01
Phoebe sp.	32952.86
Phoenix rupicola	186.54
Phyllanthus emblica	129.14
Pinus roxburghii	179288.23
Pinus wallichiana	194.75
Quercus glauca	69060.04
Quercus griffithii	15564.2
Quercus lamellosa	336437.41
Quercus lanata	41931.88
Quercus semecarpifolia	18798.77
Quercus semiserrata	1735.54
Quercus sp.	35330.18
Rhododendron anthopogon	1008.5
Rhododendron arboreum	8897.44
Rhododendron ciliatum	47.65
Rhododendron falconeri	2788.68
Rhododendron paplilatum	9006.67
Rhododendron sp.	2306.01
Rhododendron thomsonii	56.06
Rhus chinensis	256.6
Rhus paniculata	148.06
Rhus sp.	1665.15
Sapium insigne	7.91
Sapium sp.	603.76
Schima wallichii	49281.07
Solanum sp.	11090.21
Sorbus sp.	86.37
Sterculia villosa	1246.91
Stereospermum sp.	58.83
Symplocos glomerata	13649.8
Symplocos lucida	15058.72
Symplocos sp.	9061.75
Syzygium cumini	1192.34
Syzygium sp.	6829.92
Talauma hodgsonii	1440.69
Terminthia paniculata	176.49
Toona ciliata	19603.17
Toona sp.	19374.62
Toxicodendron hookeri	680.04
Trevesia sp.	168.51
Unknown	127366.88
Wendlandia puberula	867.15
Yushania hirsuta	24.96
Zanthoxylum sp.	25.87
Ziziphus sp.	308.65
Grand Total	**2123418.51**

Annexure 5: Dzongkahg Administrative Approval



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Dzongkhag Administration, Mongar

Royal Government of Bhutan

MD/DEC-11/2018-19/ 316

Date: 21/09/2018

To
Chief Forest Officer
Territorial Forest Division
Mongar

Sub: Dzongkhag Administrative Approval

Sir,

With reference to your letter no: MFD/FTS/M-01/2018-2019/436 dated 18th September, 2018, the Administration hereby issues Administrative Approval for the revision of forest management plan, Lingmethang FMU.

However, the Dzongkhag Administration would like to request your office to obtain **Environment Clearance** and other related clearances from the concerned competent authorities/agencies prior to the execution of the work.

(DZONGDAG)

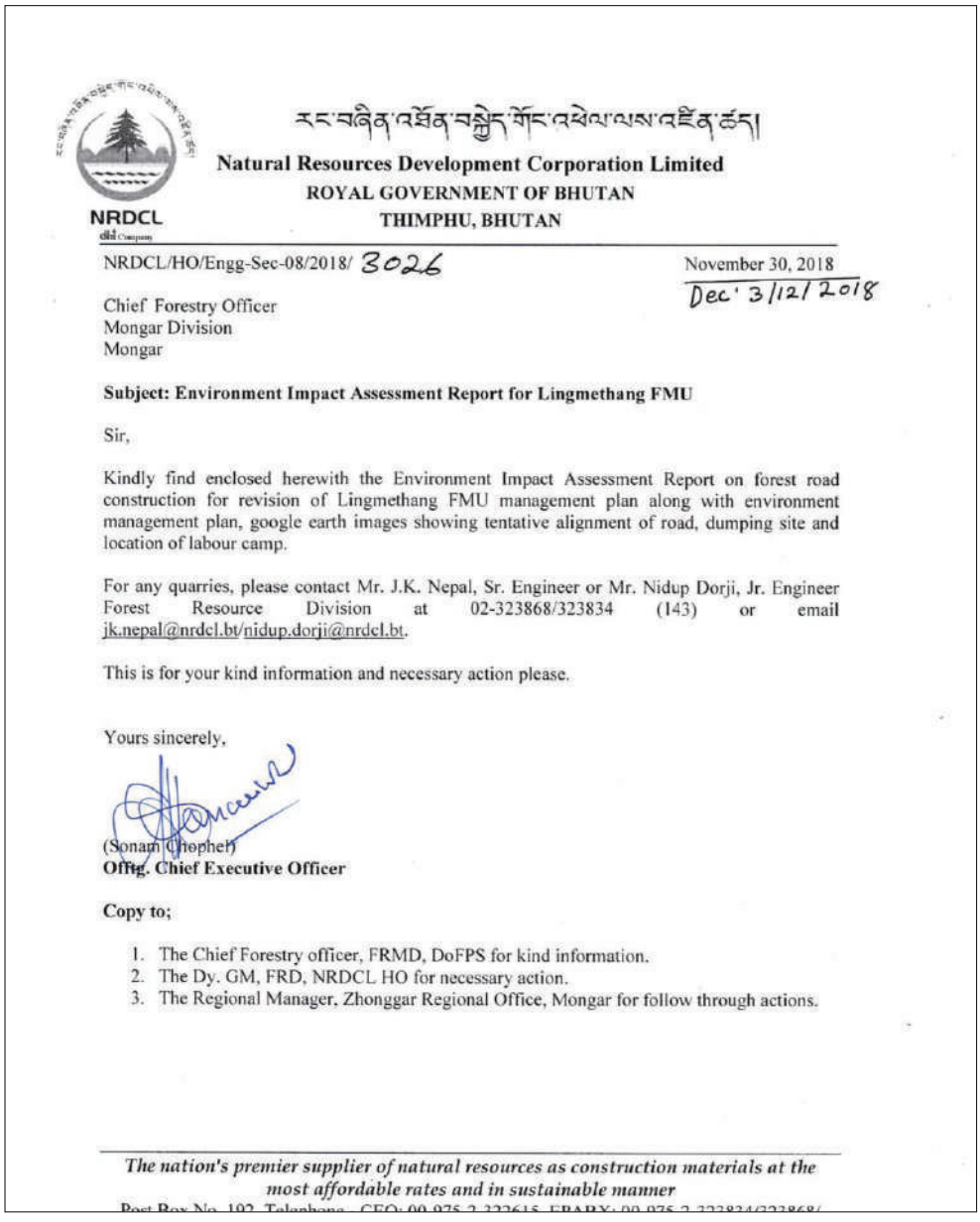
Cc:

1. Office Copy

Mongar Forest Division
Receipt No: 834
File No. FMP-01
Date 24/9/18

Dzongdag: +975-04-641100, Dzongrab: +975-04-641267, Fax: +975-04-641134/641184
Dzongkhag website: http://www.mongar.gov.bt

Annexure 6: Environement Impact Assessment Report



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Natural Resources Development Corporation Limited
ROYAL GOVERNMENT OF BHUTAN
THIMPHU, BHUTAN

NRDCL/HO/Engg-Sec-08/2018/ 3026

November 30, 2018
Dec' 3/12/2018

Chief Forestry Officer
Mongar Division
Mongar

Subject: Environment Impact Assessment Report for Lingmethang FMU

Sir,

Kindly find enclosed herewith the Environment Impact Assessment Report on forest road construction for revision of Lingmethang FMU management plan along with environment management plan, google earth images showing tentative alignment of road, dumping site and location of labour camp.

For any quarries, please contact Mr. J.K. Nepal, Sr. Engineer or Mr. Nidup Dorji, Jr. Engineer Forest Resource Division at 02-323868/323834 (143) or email jk.nepal@nrdcl.bt/nidup.dorji@nrdcl.bt.

This is for your kind information and necessary action please.

Yours sincerely,

(Sonam Chopher)
Offg. Chief Executive Officer

Copy to;

1. The Chief Forestry officer, FRMD, DoFPS for kind information.
2. The Dy. GM, FRD, NRDCL HO for necessary action.
3. The Regional Manager, Zhonggar Regional Office, Mongar for follow through actions.

The nation's premier supplier of natural resources as construction materials at the most affordable rates and in sustainable manner

Post Box No. 192, Telephone: CEO: 00-975-2-322615, EPABX: 00-975-2-322824/323868/

རང་བཞིན་བཙོན་བསྐྱེད་གོང་འཕེལ་ལས་འཛིན་ཚན།
Natural Resources Development Corporation Limited
ROYAL GOVERNMENT OF BHUTAN
THIMPHU, BHUTAN
NRDCL

NRDCL/HQ/Engg-Sec/02/2018/Camp Mongar Nov. 29, 2018

To
The Dy. General Manager
Forest Resource Division

Sub: **EIA report of Lingmethang FMU**

Sir,

Kindly find herewith enclosed detail Environment Impact Assessment Report of forest road for revision of Forest Management Plan of Lingmethang FMU along with google map showing the tentative alignment of the road.

This is submitted for favour of your kind information & further necessary action please.

(Nidup Dorji)
Jr. Engineer
Engineering Service Section, FRD

Sustainable utilization and management of natural resources
Post Box No. 192. Telephone - Managing Director: 00-975-2-322615, Dy. Managing Director: 00-975-2-326749, EPABX: 00-975-2-323834/323868/328959, Fax No : 00975-2-325585

ENVIRONMENTAL IMPACT ASSESSMENT REPORT ON CONSTRUCTION OF FOREST ROAD AT LINGMETHANG FMU, MONGAR DZONGKHAG

1 Name of the applicant : Natural Resources Development Corporation Ltd.

2 Name of project : Construction of forest road

3 Present mailing address : Chief Executive Officer, NRDCL Thimphu, P.O. Box no. 192, Tel. no 326749, EPABX no. 00975-02-323834/323868. Fax no. 00975-02-325585. Email: info@nrdcl.bt

4 Name of environmental focal person : Mr. Nidup Dorji, Junior Engineer, Forest Resources Division, NRDCL HQ, Thimphu. Tel. no. 02-323834/323868. Email: nidupdorji@nrdcl.bt

5 Project objectives : Timber harvesting & afforestation of harvested areas

6 Relevence to overall planning : Revision of Forest Management Plan

7 Funding and costs : Funded by NRDCL, Thimphu
: Nu.25,673,666.67

8 Project description

8.1 Project location : 27° 11' 12.81"N, 91° 08' 18.26" E to 27° 10' 01.06" N, 91° 06' 45.63" E

Table 1: Road location details by Dzongkhag and Geog

Road chainage		Dzongkhag	Gewog	Town	Village
From	To				
0 + 000	0 + 10000	Mongar	Saling		Mangling

8.2 Category of road :Forest Road

8.3 Road specification :

Table 2. Road Specification/Quantities

Item	Unit	Specification/Quantities
Right of way clearing	m	10.00
Formation Width	m	5.00
Pavement Width including edging	m	3.50
Pavement material (Edging, soling & agttes)	cum	10,500.00
Volume of excavated material		
a) Excavation in soil all type	cum	16,021.72
b) Excavation in rock all type	cum	9,229.33
Average road gradient	%	±7
Maximum road gradient	%	±12
Cross drain	no	NIL
Box/Hume pipe culvert	no	NIL
V-shaped side drain diamensions		
In soil (horizontal x vertical)	cm	40CM X 30 Cm
In rock (horizontal x vertical)	cm	30 CM X 20 CM
Total length of v-shaped drain	m	9,945.00
Box shaped side drain diamensions (lengthxbreadthxheight)	cm	NIL
Total length of box drain	m	NIL

8.4 Excavated Materials : The excavated material will be managed and disposed off safely at designated locations through the use of excavator and tipper trucks or hydraulic tractors.

8.5 Explosives : Approximate quantity of explosive to be used is as under:

Sl. No	Particulars	Quantity	
1	Safety fuse	1205 coils	(Approx)
2	detonator	2105Nos.	(Approx)
3	D-chord	1701 m	(Approx)
4	Jelatine	2701 kgs	(Approx)

Control single shot blasting technique will be adopted with the engagement of a trained & certified blaster.

9 Alternatives : NIL

10 Public Consultation : Public consultation meeting conducted

11 Project site Physical Environmental details

11.1 Topography and Geology

Table 3: Topography and observations along the road

Chainage(Km 0+000)		distance (m)	Side slope %	Observation on geology & possible problem	Method of slope & terrain stabilization Above & Below road
From	To				
0 + 000	0 + 10000	10,000.00	10 -120	Not foreseen	Normal Bio-engineering + Retaining & Breast wall structure works wherever required.
Total		10,000.00			

11.2 Water Course Crossings

Table 4: Details of water courses that will require crossing along the proposed road

Chainage at which road crosses water course	Name of water course	Type of crossing	If bridge, Length of bridge (m)	Down stream water users- details		
				Name of community or individual	House hold (no)	Type of use
0+000 + 0+118	N A	Hume pipe culvert	NIL	None	None	None
0+118+ 0+135	N A	Hume pipe culvert	NIL	None	None	None
0+135 + 0+293	NA	Hume pipe culvert	NIL	None	None	None
0+293 + 1+091	NA	Hume pipe culvert	NIL	None	None	None
1+091 + 1+301	NA	Hume pipe culvert	NIL	None	None	None
1+301+ 1+401	NA	Hume pipe culvert	NIL	None	None	None
1+401+ 1+505	NA	Hume pipe culvert	NIL	None	None	None
1+505 + 2+090	NA	Hume pipe culvert	NIL	None	None	None
2+090 + 2+360	NA	Hume pipe culvert	NIL	None	None	None
2+360 + 2+560	NA	Hume pipe culvert	NIL	None	None	None
2+560 + 2+766	NA	Hume pipe culvert	NIL	None	None	None

2+766 + 3+029	NA	Hume pipe culvert	NIL	None	None	None
3+029 + 4+096	NA	Hume pipe culvert	NIL	None	None	None
4+096+ 7+180	NA	Hume pipe culvert	NIL	None	None	None
7+180 + 8+696	NA	Hume pipe culvert	NIL	None	None	None
8+696 + 9+216	NA	Hume pipe culvert	NIL	None	None	None
9+216 + 9+310	NA	Hume pipe culvert	NIL	None	None	None
9+310 + 10+000	NA	Hume pipe culvert	NIL	None	None	None

12 Project Site Ecological Description

12.1 Land Use/Vegetation

Table 5: Land use and forest clearance required for road construction

Chainage from take off		Land use	Area (M^2)	Tenure	Affected House hold no
From	To				
0 + 000	10 +000	Mixed Hard Wood	100,000.00	10 years	12

Table 6: Areas Required for Project Facilities

Facility	Land use	Area (m^2)	hip	Remarks
Labour camp	Mixed Hard Wood	2000 per annum	Govt. reserve forest	Till project completes
Others	None	None	None	None

12.2. Protected area : The protected areas such as Soil protection, local water supply protection, Reparian protection, Wild life protection etc. shall be indentified where no commercial activities shall be allowed.

13 Project social environment

13.1. Population

Table 7: Project Beneficiaries. Households with possible access <2km either side of the road

Dzongkhag	Gewog	Households (No)
Mongar	Saling	12

Source of information: as per attached No Objection letter of the Gup, Khar Geog

Loss of Houses, Services, Infrastructure and Cultural Heritage Sites

Type of loss	NOS	Description of disturbance
Service	NIL	NIL
House	NIL	NIL
Infrastructure	NIL	NIL
Cultural sites	NIL	NIL
Heritage	NIL	NIL

13.3 Aesthetics

No aesthetic distrubance is foreseen however, grass seeding & other bio-engineering technique measures shall be applied on the slopes for reclaiming immediately after road construction.

14 Project Impacts and Mitigation Measures

Type of negative impact	Mitigation measures	Estimated metigation costs

Blockage of water canal	Cleaning & maintenance	Nu. 10,000.00 (Lumpsum)
House	NIL	NIL
Infrastructure	NIL	NIL

14.1. Monitoring Program

Monitoring of the construction works shall be done by Site supervisor, Lingmethang Unit, NRDCL, including time to time monitoring by the Unit Manager, Lingmethang Unit under Zhonggar Regional Office, Mongar. The Regional Manager, Zhonggar Regional Office, NRDCL Mongar, shall also carry out the frequent monitoring. Also the Engineer from Forest Resource Division, NRDCL HO, shall carry out the monitoring of the construction works as & when required.

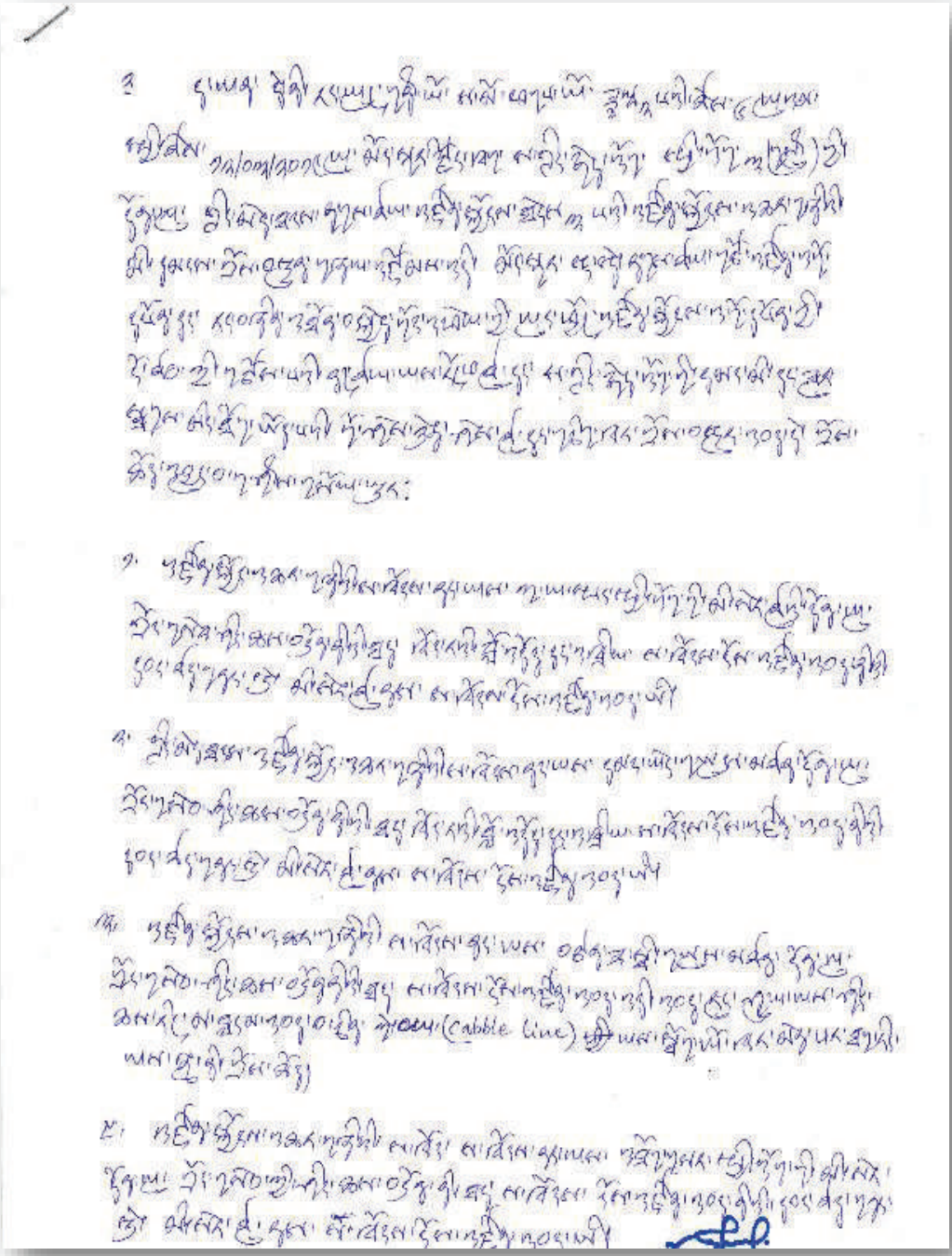
Ngawang Dorji
Jr. Engineer
Forest Resource Division,HO,NRDCL

ENVIRONMENTAL MANAGEMENT PLAN

Sl. No	Activity	Potential Negative Environment Impact	Mitigation Measures	Public participation & coordination	Socio- Economic & cultural considerations	Budgeting	Supervision	Monitoring
1	Stone Quarry Operation	• Landscape instability • Dust pollution • Aesthetics • Damage to vegetation	• Careful siting & investigation • Proper operation • rehabilitation	• DoFPS • Dzongkhag administration and locals	• Consider local resource demand	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
2	Soil Disposal	• Disruption of local hydrology • Landslide • Damage to vegetation	• Use of excavator • Balanced cut & fill • Deposit excess material in designated dump sites • Bioengineer exposed slopes	• Technical person knowing bioengineering	• Considering local water supply if any	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
3	Slope stability	• Slope failure • Clog side drain	• Bioengineer slopes and protect from grazing • Erect retaining structure	• Technical person knowing bioengineering	• Consider local land use and grazing	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
4	Drainage	• Surface run off along road • Siltation of water down stream • Slope failure • Water seepage	• Design structure to accommodate discharge • Adequacy of culverts / drains • Regular clearing of clogged culverts	• Involve locals	• Consider local drinking water supply and irrigation channels	• Included in the budget	• Unit Manager	• Unit Manager • Regional Manager • External agency
5	Work camp location, operation and closure, restriction on workers (sanitation, fuel wood collection poaching etc.)0	• Conflict with locals • Garbage, oil and grease pollution • Damage to the vegetation and wildlife	• Proper setting • Provide sanitary facilities • Restoration • Provide fuel to workers	• DoFPS • Local people • Awareness of labors	• Consider local culture, expropriate-on &compensatio n compensate, if required	• Incorporated in the budget	• Unit manager • Site supervisor	• Unit Manager • Regional Manager • External team
6	Explosive & toxic waste management	• Fire & explosion hazard • Ground and surface water pollution	• Do not store near surface water • Use plastic sheeting under hazardous material • Collect waste properly and dispose of safely	• Contact ministry of Home and Culture Affair in case of hazard or needing material innihilation	• Consider local drinking water sources	• Included in budget	• Unit manager • Site supervisor	• Regional Manager • Engineer NRDCL • External team
7	Water management	• Sedimentation of surface particle • Slope failure • Creation of new gullies • Water seepage	• Build check dams • Tap excess water by catch drains and dispose of natural gullies	• Involve locals when deciding about discharge location • Geog administration	• Irrigation channel and drinking water supplies need considerate – on	• Additional water management and other permanent structures included	• Unit manager • Site supervisor	• Regional Manager • Engineer NRDCL • External team

Figure 38: Google picture of the proposed road

Annexure 7: Clearance from Public Consultation Meeting



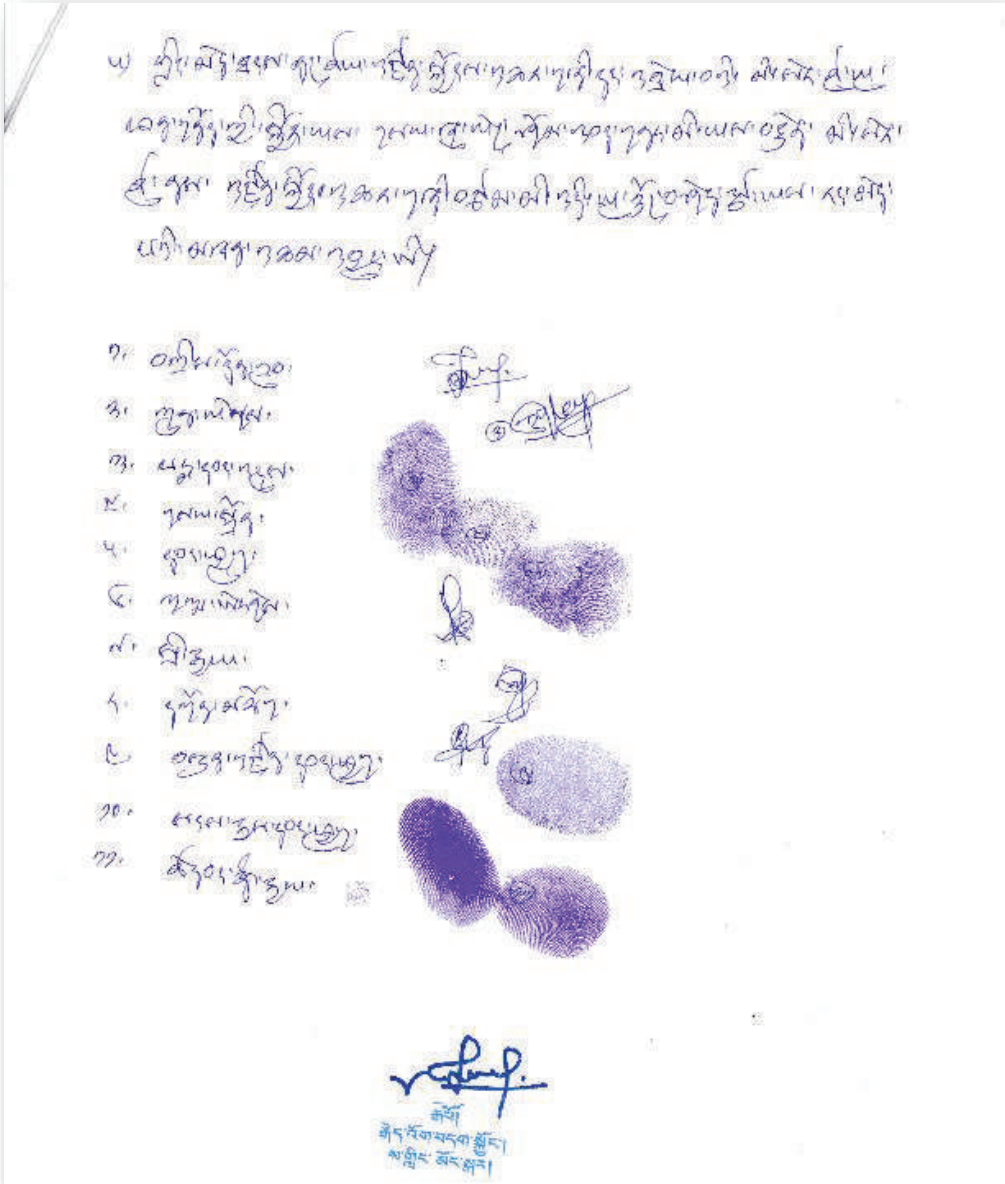


Figure 39: Public consultation meeting at Lingmethang on 12th March, 2019

Annexure 08: Control Forms

CONTROL FORM I

MARKING CONTROL FOR FIREWOOD SUPPLIED BY CONTRACTOR

Management Unit: **Block:**

Coupe: **Compartment:**

Year:

Species	No. of Stem marked	Volume (m^3)	Remarks

CONTROL FORM II

ANNUAL ALLOWABLE CUT CONTROL

Management Unit: **Block:**

Coupe: **Compartment:**

Year:

Area (ha.)	Estimated total volume (m^3)	Total Volume marked (m^3)	Remarks

CONTROL FORM III

POST HARVEST OPERATION

Management Unit: **Block:**

Coupe: **Compartment:**

Year:

1. Type of operation prescribed

1. ……..

2. ……..

3. ……..

2. Operations executed

1. ……

2. ……

3. ……

CONTROL FORM IV

POST HARVEST OPERATION

Management Unit: **Block:**

Coupe: **Compartment:**

Year:

Particulars	**Measurement**	**Species**	**No.**	**Volumes (m^3)**	**Remarks**
Marked trees not felled					
Felled trees / logs not extracted					
Lops & Top not extracted					
High stumps					
Felling outside coupe					
Avoidable damages					
Width of the corridors					
Any other deviations of the plan					