

BIODIVERSITY ASSESSMENT STUDY FOR PROPOSED 132 kV TRANSMISSION LINE FROM WEST PHAILENG TO MARPARA IN BUFFER ZONE OF DAMPA TIGER RESERVE



PREPARED BY



ASSAM STATE BIODIVERSITY BOARD

“The earth, the air, the land and the water are not an inheritance from our forefathers but on loan from our children. So we have to handover to them as at least as it was handed over to us.”

- Father of the Nation, Mahatma Gandhi

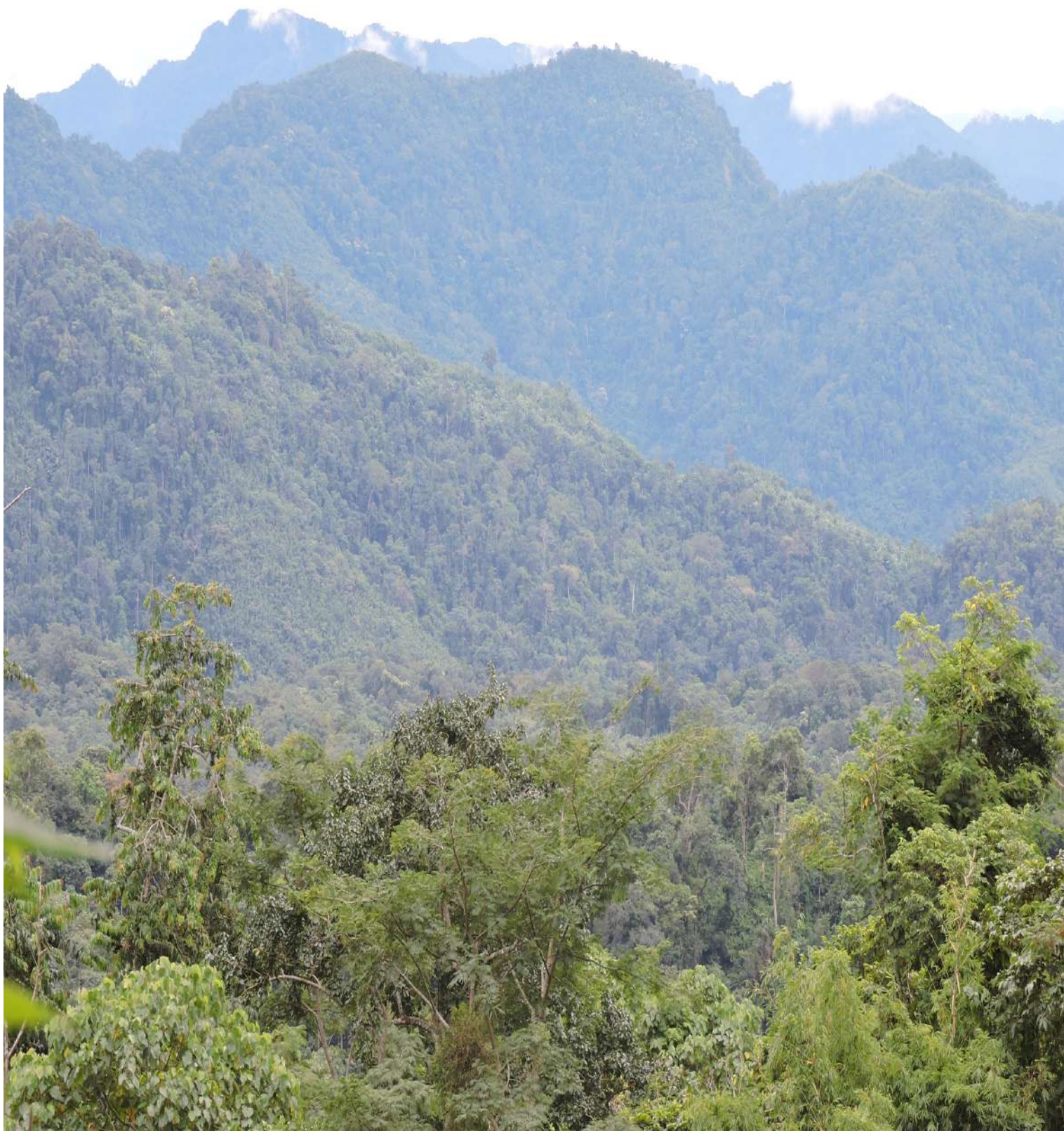


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Mizoram is predominantly a hilly state and Mamit is one of its less-developed districts having inadequate road connectivity. It is because of this reason that the survey of the buffer zone of Dampa Tiger Reserve was a challenge. The Board is grateful to the Mizoram Forest Department and in particular to the P.C.C.F. Mizoram, Mr. L. R. Thanga, the Chief Wildlife Warden, Mr. Liandawla and Mr. L. Murray, Field Director, Mr. R. Lalrinmawia, Assistant Conservator Mr. C. Vanlalrama, for their incessant support to the study.

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Finally, heartfelt thanks to the Chairmen of the Board, Shri Subhash C. Das, I.A.S., and Shri. V. K. Pipersenia, I.A.S., for their guidance; Dr. Ranjana Gupta, I.F.S., A.P.C.C.F. - Assam for finalising the draft and Dr. O. Sunanda Devi, Scientific Officer of the Board for day-to-day contribution.

(A. K. Johari, I.F.S.)

Additional P.C.C.F. & Member Secretary - A.S.B.B.

ii. Executive Summary




“North Eastern Region Power System Improvement Project” (NERPSIP) for 6 northeast states (Assam, Manipur, Meghalaya, Mizoram, Tripura and Nagaland) for strengthening the intra-state transmission and distribution systems (33 kV capacity and above) is being planned to be implemented by Government of India with financial assistance from the World Bank. The Government of India selected Power Grid Corporation of India Limited (POWERGRID), the central transmission utility of the country, to execute the projects on behalf of Power and Electricity Departments of the six states. Under the NERPSIP in Mizoram, a 132 kV S/C transmission line from West Phaileng to Marpara is planned to improve the availability and quality of power supply to remote areas of West Phaileng and Marpara in Mammit district. A portion of the proposed line (33 km approximately) is passing through buffer zone of Dampa Tiger Reserve as no other alternative route alignments are feasible/possible due to geographical constraints and proximity to the India-Bangladesh border.

The proposed line is passing through the buffer zone of Dampa Tiger Reserve, a declared protected area under the Wildlife Protection Act, 1972. As per the Honourable Supreme Court’s directive, prior permission of the Supreme Court and/or National Board for Wild Life (NBWL) is mandatory for implementation of any infrastructure project in any protected area.

The possible environmental issues associated with laying of Transmission Lines in forest areas and wildlife areas may become a matter of concern if due care and mitigation measures are not planned and implemented. Therefore, to assess the likely impact and to develop an action plan, the Biodiversity Assessment study has been made compulsory as per the provisions of Environmental and Social Policy & Procedures Framework (ESPPF) developed to implement projects covered under NERPSIP in Mizoram. Ministry of Environment, Forests and Climate Change, Government of India through its guidelines have also made such studies mandatory for developmental projects involving diversion of more than 50 Ha of protected area.

The task of Biodiversity Assessment study was assigned to the Assam State Biodiversity Board (ASBB) by POWERGRID, which in turn, engaged Green Initiatives Certification & Inspection Agency (GICIA), Noida, to support this study. This report is based on the outcome of field study carried out by the ASBB, its partner GICIA and the local team of experts from Mizoram.

The major objectives of the study were as follows:

-  To prepare a baseline of biodiversity values of the project affected area,
-  To study the impacts of power line construction on the biodiversity values in the affected buffer area,
-  To plan/suggest suitable measures and strategies for mitigation/management of the anticipated impacts.

The study involved field assessments, stakeholder consultations (including interviews with officials of POWERGRID, Forest and Wildlife Department, local population and affected persons) and review of literature. The study involves evaluation of the floral and faunal diversity of the region, along with identification of Rare, Threatened or Endangered species reported from the area. Evaluation of likely impacts on biodiversity of the buffer zone due to laying of proposed transmission line was also carried out to develop/list the possible mitigation measures for the same.

The assessment is based on extensive fieldwork in the affected area along the West Phaileng - Marpara road in the buffer zone of Dampa Tiger Reserve. The co-ordinates of starting and terminating stations of

the proposed line are 23°16'58.41"N to 23°40'56.25"N latitudes and 92°25'39.47"E to 92°28'54.59"E longitudes respectively. From the West Phaileng end of the line, the buffer zone area falls to the east of the road adjacent to most of the proposed line route, except for a small patch near Saitah village. The total length of the proposed transmission line within the buffer zone is approximately 33 km, having a RoW width of 27 m. The forest cover in this stretch is dense in patches especially towards West Pulpui and moderately dense to open in the rest of the areas. The several patches of *Jhoom* cultivation were also found at regular intervals in the stretch.

Considering the forest type and canopy density, sampling intensity of 1% (13200 m²) was chosen for the evaluation of floral diversity. A total of 30 standard quadrats of 20 m X 30 m were placed, covering an area of 18,000 m², which is more than chosen sampling intensity of 1% to facilitate covering of any overlaps and variability towards the end zones.

A total of 203 floral species belonging to 160 genera and 73 families were recorded. Out of these, 96 tree species; 86 species of herbs, shrubs and climbers; and, 21 species of bamboo, orchids and ferns have been documented. Similarly, faunal variety comprising 93 species of birds, 11 species of mammals, 7 species of frogs, 5 species of lizards, 4 species of snakes and 42 species of butterfly are recorded within the buffer zone.

The biodiversity values of select species calculated on Shannon-Wiener index ranged from 1.5 to 3.5, which signifies medium to high diverse forest. On the Simpson index of diversity, the index was in the range of 0 to 1, which indicates higher diversity. On the Importance Value Index (IVI), *Macaranga peltata* (22.373) was found to be the most important species followed by *Trema orientalis* (19.45), *Duabanga grandiflora* (19.41), *Tectona grandis* (16.57), *Derris robusta* (12.46) and so on. The least IVI value was recorded for *Cinnamomum obtusifolium* (0.52). Percent species distribution in family *Euphorbiaceae* was found to be the highest followed by *Moraceae*, *Poaceae*, *Fabaceae*, *Verbinaceae* and *Lauraceae*.

On analysing Rare, Engangered and Threatened (RET) status of the recorded species as per the IUCN categories, it was found that most of the floral species were in the 'Not Evaluated' category. However, *Dipterocarpus indicus* (Endangered species) was found to be of high conservation importance. The RET assessment of fauna showed 90 species of birds in the category of 'Least Concern' and 3 species of birds in the 'Near Threatened' category. The 'Near Threatened' category species were the *White Cheeked Partridge*, *Ashy-headed Green Pigeon* and *Great Hornbill*. Amongst mammals, most of the species were in the category of 'least concern'. However, *Hoolock hoolock*, belonged to 'Endangered category', *Macaca assamensis* to 'Near Threatened' category, and *Macaca arctiodes*, *Trachypithecus pileatus* represented 'Vulnerable' category. The other recorded fauna were either in the categories of 'Least Concern' or 'Not Evaluated'.

The potential impacts of the transmission line on the biodiversity values of the buffer zone were also assessed and evaluated for both construction as well as the operational phase of the project. Some of the major identified impacts during the construction phase include:

- Removal/pruning of vegetation from the tower base and in RoW corridor of the transmission line;
- Change/gap/reduction in forest canopy and its influence on possible fragmentation of natural habitats;
- Construction related disturbances, including increased human presence, the resultant pollution, waste generation, increased noise level etc.;
- Fire Risk.

Similarly , some of the possible impacts during the operational phase include:

- Bird mortality due to collision and/or electrocution by the transmission lines;
- Disruption in the movement/migration of big mammals;
- Potential influx of invasive weeds in the cleared area.

The mitigation measures to reduce/manage such possible/identified direct and indirect impacts have been analysed and incorporated in the report.

The analysis of forest in the buffer zone indicates that in patches it is reasonably good but is not contiguous. This may be attributed to presence of many villages in the buffer zone and resultant biotic pressure as communities present in and around buffer are mostly dependent on forest for their livelihood. Moreover, practice of shifting cultivation or *Jhoom* is mostly prevalent in the area which plays a major role in fragmentation of forest. There are host of community rights on the forest resources and there is also a programmed extraction of resources, such as firewood, as per the working plans of both Mamit and Kwartha forest divisions (which together account for the buffer zone of Dampa Tiger Reserve).

Additionally, the buffer, though represented by a significant floral and moderate faunal biodiversity, is not a core tiger habitat¹. The assessment team did not spot any tigers in the buffer area while conducting the field assessment. The area is also not part of any corridor of flagship species such as elephants². Thus, the buffer is not an inviolate area. On the contrary, there is lot of economic and social development activities that take place in the buffer area, and the local communities have a wide level of interaction with it. There is also a discernible presence of various development departments in the buffer area like Public Works Department, Rural Development Department and Horticulture Department, etc. Well being of local communities and well being of forests in the buffer zone (as well as of core forest area) seem to be complementary to each other. However, it is pertinent to mention that local communities along with local NGO PRISM have filed an application with the Guwahati High Court challenging the Mizoram government notification under which the 500 km² including 488 km² buffer has been declared as Tiger Reserve.

The present species matrix in the project-affected zone does not subject itself to a “net loss of biodiversity” on account of the erection and operation of the transmission line. Two factors that are potentially contributing to this include:

- 1) The area to be affected/cleared is restricted to tower base and in RoW particularly in 3 m width below each conductor along proposed transmission line. Moreover, in hilly areas where adequate clearance is already available, minimum trees will be affected.
- 2) The present mix of species in the potentially affected area contains only limited number of Rare, Threatened or Endangered species, and most of the species are common to the region. Further, there is no major deviation in the species matrix along the length of the line, or in areas adjacent to the line.

As such, although the vegetation clearing activity would entail removal of identified/selected trees , but it will not result in any loss at a species level or at diversity level. On the other hand positive impacts associated with proposed transmission line outweigh the negligible and restricted/localised negative impact in RoW for which detailed mitigative measures have also been planned for implementation during

¹ Based on interview with the field director of Dampa Tiger Reserve.

² *Ibid.*

laying of transmission line in buffer area.

iii. Team of Contributors

Name	Profile
Assam State Biodiversity Board	
Shri. A. K. Johari, I.F.S.	A post graduate in Botany from Lucknow University, he worked on plant viruses at the National Botanical Research Institute before joining the Indian Forest Service in 1986. He has been awarded M. Phil by Punjab University on 'Forestry & Climate Change' and holds a Post Graduate Diploma in Public Administration. He trained as a trainer at the University of Edinburgh under the Colombo Plan and completed advanced course in Participatory Planning from the University of Wolverhampton, U.K. Apart from holding important assignments with the Assam Forest Department, he served the Government of India in the capacities of faculty member of forestry, Director in the Ministry of Environment & Forest and as D.I.G., Forestry Research, Training and Forest Protection. He is designated as the Country Focal Point for Forestry and Climate Change, Invasive Species Network and for the International Network for Bamboo & Rattan. Presently, Shri A. K. Johari, I.F.S. is the Member Secretary of the Assam State Biodiversity Board and Additional P.C.C.F. (Biodiversity & Climate Change) in the Assam Forest Department.
Dr. Ranjana Gupta, I.F.S.	Dr. Ranjana Gupta, I.F.S. has a Ph.D.in Forestry and M. Phil in Social Science, besides a Post Graduate Diploma in Public Administration. After completing her MSc. in Botany from Kerala University, she joined the Indian Forest Service in 1986. She has worked with government agencies, research & training institutions and coordinated with international agencies such as UNDP, AARDO, CIRDAP and UNFF. Dr. Ranjana Gupta is a natural resource manager, researcher, trainer, academician and social scientist. She has extensive experience in the fields of participatory forestry, rural development, tribal development and biodiversity conservation. Apart from working with the Assam Forest Department, she has held such important assignments with the Government of India as Deputy Inspector General of Forests, Ministry of Environment & Forests, New Delhi; Director, Ministry of Rural Development, New Delhi; and Deputy Director, Forest Survey of India, Dehradun. As Deputy Inspector General of Forests she looked after the portfolios of Forest Policy, International Forest Co-operation and was designated Country Focal Point for UNFF. She is presently posted as the Additional Chief Conservator of Forests (Wetlands) at the office of the Principal Chief Conservator of Forests and Head of Forest Force, Assam.

Dr. Oinam Sunanda Devi	A post graduate in Life Sciences from Gauhati University, she completed her Ph.D. on diversity and ecology of frugivorous birds in Eastern Assam. At present, she is working as Scientific Officer with the Assam State Biodiversity Board. She is involved in the implementation of Biological Diversity Act 2002 by way of generating awareness amongst various stakeholders, formation of Biodiversity Management Committees, preparation of Peoples' Biodiversity Registers and documentation of traditional knowledge. She is also coordinating the Biodiversity Research Associate Programme and is involved in various field research activities.
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Green Initiatives Certification & Inspection Agency (GICIA)

Mr. Manu Jose Mattam	Mr. Manu Jose Mattam is the director of the Natural Resources Division of Green Initiatives Certification & Inspection Agency. Formerly he was associated with Harrisons Malayalam Limited and the Forest Stewardship Council. He has led monitoring & evaluation projects for many centrally sponsored projects like 'Project Elephant', Climate Change Adaptation in North East Region and CAMPA activities. He has taken lead in consultation to Bihar and Assam State for preparing perspective plan for Green India Mission (GIM). He was also a team head for developing standards for carpet and dolls and toys industry for Handicraft and Carpet Sector Skill Council (HCSSC) for the National Skill Development Corporation (NSDC). He has travelled extensively throughout South Asia, South East Asia and the Middle East for his professional engagements and various forestry and climate change conference.
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Mr. Sachin Raj Jain	Mr. Sachin Raj Jain is a Natural Resource Management and Sustainable Development professional based out of Noida. He is the head of Green Initiatives Certification & Inspection Agency (GICIA), Scientific Certification Systems (India) Private Limited and Sara Abode Private Limited. He has has over 10 years of experience in directing projects on Sustainability, Life Cycle Assessment, LEED v4 Environmental Product Declarations (EPD), Starbucks Ethical Sourcing, Resilient Floor Covering Institute (RFCI) FloorScore® certification, BIFMA level® certificate, Climate Change Adaptation, Monitoring & Evaluation, Afforestation and Ecology & Biodiversity assessments. He is the lead auditor for certification systems of Forest Stewardship Council – Forest Management Certification, Forest Stewardship Council – Chain of Custody Program, Scientific Certification System – Legal Harvest Verification Program and ISO 9001:2008 Quality Management System.
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Mr. Ranir Pal Saini	<p>Mr. Ranir Pal Saini is a graduate in Civil Engineering and has also studied International Affairs at the master's level. At Green Initiatives Certification & Inspection Agency he works on project support, operations support and report drafting.</p>
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Power Grid Corporation of India Limited

Mr. Jayanta Bardhan	Mr. Jayanta Bardhan is a Deputy General Manager in POWERGRID. He is an engineer by training. At POWERGRID he oversees all environmental and social safeguards related issues of the North Eastern Region Power System Improvement Project (NERPSIP).
Mr. Dipjyoti Baruah	Mr. Dipjyoti Baruah is a Senior Environment Officer in POWERGRID. He is an environmental scientist by training. At POWERGRID he is responsible for all the ground level works pertaining to environmental and social safeguard issues related to the North Eastern Region Power System Improvement Project (NERPSIP).

iv. Abbreviations

APCCF	Additional Principal Chief Conservator of Forests
ASBB	Assam State Biodiversity Board
BU	Billion Units
CCF	Chief Conservator of Forests
DTR	Dampa Tiger Reserve
IUCN	International Union for Conservation of Nature
IWDP	Integrated Watershed Development Programme
MOEFCC	Ministry of Environment, Forests and Climate Change
NERPSIP	North-Eastern Region Power System Improvement Project
POWERGRID	Power Grid Corporation of India Limited
RET	Rare, Endangered and Threatened Species
RoW	Right of Way
T&D	Transmission and Distribution

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1 Background

The country's economic activities are critically dependent on energy resources. Electricity transmission lines are an essential part of India's development as it transmits and distributes power to domestic as well as industrial sectors.

India has set an ambitious target of generating 1,137.5 BU in the year 2015-2016 which is a growth of around 8.47% over actual generation of 1,048.6 BU in the previous year (2014-2015). Even with the current trend of technological progress, there is no cost-effective and technologically feasible way of storing electrical energy and therefore electricity needs to be carried long distances at high voltages. Transmission of electricity at low voltages leads to very high losses (transmission and distribution losses) of power.

It is therefore imperative that with increased installed capacity of power generation there is also a network for efficient transmission.

The Government of India with the financial assistance of the World Bank is implementing "North Eastern Region Power System Improvement Project" (NERPSIP) for six north east states (Assam, Manipur, Meghalaya, Mizoram, Tripura and Nagaland) for strengthening of Intra-State Transmission and Distribution Systems (33 kV capacity and above). Ministry of Power, Government of India, has appointed POWERGRID as the central implementing agency to the six north east states for the project. However, the ownership of the assets shall be with the respective state governments and/or state utilities, which upon progressive commissioning shall be handed over to them for taking care of operation and maintenance of assets at their own cost.

A 132 kV D/C transmission line from West Phaileng to Marpara is proposed to be laid under the NERPSIP in Mizoram. However, a portion of the proposed transmission line passes through the buffer zone of Dampa Tiger Reserve. As per provisions under section 38W of Wildlife (Protection) Act, 1972, prior approval of Standing Committee of National Board for Wildlife is mandatory. Further, since the area proposed to be diverted is more than 50 Ha, biodiversity impact assessment study is a mandated requirement.

However, it is necessary to ensure that any proposed infrastructure development activity in the vicinity or adjacent to any protected area needs to be carried out without compromising the long-term value of natural areas, their ecosystem services, and imperiling the prospects for more holistic development. The impacts of construction of power transmission lines on wildlife and other environmental resources is generally a matter of concern, since it usually requires the removal of a large number of trees when the transmission lines are passing through forest area. Further, some other issues that tend to come into prominence include mortality of birds due to collision and subsequent electrocution, fragmentation of forest patches, breaks in wildlife movement corridors etc. Such fragmentation alters the microclimate, isolates habitat patches and increases edge effects. However, the effects related to erection and operation of transmission lines in protected areas will not be as severe as those caused by broad and wide clear-felled areas in other types of projects since clearing of vegetation is limited to 3 m wide strip below each conductor in a corridor of 27 m.

In the context of the above and as part of statutory requirements to obtain necessary approvals to undertake activity in buffer zone of Dampa Tiger Reserve, POWERGRID proposed to undertake biodiversity impact assessment study by an Independent agency in order to minimise the impact on biodiversity values through implementation of suitable mitigation measures for identified impacts.

To undertake the above study, POWERGRID assigned this task to the Assam State Biodiversity Board in

August 2015. The Assam State Biodiversity Board, after a competitive bidding process, engaged Green Initiatives Certification & Inspection Agency, Noida, to support this study.

This report is based on the field study carried out by the Assam State Biodiversity Board, its partner in the project, Green Initiatives Certification & Inspection Agency and the local team of experts from Mizoram.

Objectives of the Study

The general objective of the study is to identify the potential impacts of the transmission line on the flora and fauna of Dampa Tiger Reserve buffer zone and to suggest suitable mitigation measures.

Whereas, the specific objectives of the study are:

- ✚ To prepare a baseline of biodiversity values of the project affected area.
- ✚ To study the impacts of power line construction on the biodiversity values in the affected buffer area.
- ✚ To plan/suggest suitable measures and strategies for mitigation/management of the anticipated impacts.

For meeting the above objectives, the study was carried out in the following three domains:

Biodiversity

- ❖ Field assessment to describe the faunal and floral biodiversity of Dampa Tiger Reserve buffer zone;
- ❖ Distribution and abundance of species over the area, for ascertaining dominant species;
- ❖ Listing of:
 - ❖ species having special conservation concerns;
 - ❖ Endangered species;
 - ❖ Threatened species;
 - ❖ Vulnerable species;
 - ❖ Species endemic to the region;
- ❖ Listing any conservation concerns of the region due to natural or anthropogenic factors.

Socio-Economic

- ❖ Record existence of settlements in the Dampa Tiger Reserve buffer zone and in particular along the proposed alignment of the transmission line;
- ❖ Look into the nature and extent of dependencies of the local communities on the forests and other natural resources in the area.

General Considerations

- ❖ Provide recommendations related to monitoring requirements and possible mitigation measures for avoiding/minimising identified negative impacts;

- ❖ Ecological or biodiversity uniqueness, if any, of the area that requires special attention or considerations.
-

2 The Project

2.1 Rationale

Mizoram is a sparsely populated state with hilly terrain. Mamit District is relatively remote and less developed in comparison to the rest of the state. West Phaileng and Marpara areas of Mamit district receive power from existing 33 kV West Phaileng substation that is supplied from 132 kV Zemabawk S/S (Aizawl) through 132 kV S/C line operated at 33 kV. These areas suffer low voltage and frequent power supply interruptions as well as heavy T&D losses due to lengthy and aged 11 kV lines. There are not enough transmission/sub-transmission networks to cover the entire stated area, but the energisation of villages is somehow managed by improvisation using extremely long distribution lines at 11 kV level.

In order to improve the power supply in this area, Government of Mizoram planned to charge the Zemabawk - West Phaileng 132 kV S/C line (presently operated at 33 kV) at rated voltage. For this, a 132 kV bay at Zemabawk would be constructed by the Government of Mizoram whereas a 132 kV substation at West Phaileng will be constructed under NERPSIP. Further, West Phaileng – Marpara 132 kV line (S/C strung on D/C tower) has been planned under the NERPSIP project. After this, Zemabawk - West Phaileng – Marpara 132 kV section will be under operation, which will enhance the availability and quality of power supply to even the remotest corner of West Phaileng and Marpara in Mamit district as described below:

- Construction of 132/33 kV, 2 x 12.5 MVA substation at West Phaileng to feed West Phaileng, Mamit, Rawpuichhip, Tuipubari and surrounding areas.
- Construction of 132/33 kV, 2 x 12.5 MVA substation at Marpara to feed Phuldungsei, Marpara and surrounding areas.
- Construction of 50 km 132 kV S/C transmission line from West Phaileng to Marpara will improve the voltage profile and power quality that will be distributed within North West sector of Mamit district.

The majority of 11 kV feeders exceed the permissible limit of voltage regulation. Besides, many feeders have line length of more than 60 km rendering the line prone to frequent faults. The poor voltage and frequent tripping/interruptions of power have huge impact on the revenue billing efficiency. Energy accounting of the past years clearly tell the T&D inefficiency. It is calculated that if the T&D loss is reduced to 15% by improving voltage regulation, the increase in annual revenue collection could jump up substantially in Mamit district.

Substantial load addition is about to happen in Mamit district due to implementation of Rajiv Gandhi Grameen Vidyutikaran Yojana (Rajiv Gandhi Village Electrification Scheme) and Indo-Bangladesh border lighting. Therefore, transmission, sub-transmission and distribution with transformer under this scheme will play a very vital role in the imminent load addition as stated above.

After completion of the above schemes, the north-western sector of Mizoram will enormously benefit as:

- Better and more reliable power supply will be available as the source of power supply will be from both Kolasib and Zuangtui 132 kV substations. Power could also be drawn from Bairabi Thermal Plant. Upcoming Tuirial Hydroelectricity Power Plant could also be utilised within the region.
- The voltage drops due to long distribution lines and frequent interruption of supply due to line faults will be substantially minimised.
- The overall system with more versatile network will enable better power supply in the region. With reliable power supply, small and large industry may come up in the area. Implementation of the above scheme will result in increased revenue

realisation, reduction in consumer supply interruption and reduction in T&D losses as well as improvement in quality and reliability of power supply.

2.2 Route Selection

For selection of optimum line route, the following points are generally taken into consideration;

- (i) The route of the proposed transmission & distribution lines does not involve any human resettlement and rehabilitation;
- (ii) Any monument of cultural or historical importance is not affected by the route of the transmission & distribution line;
- (iii) The proposed route of transmission & distribution line does not create any threat to the survival of any community with special reference to Tribal Community;
- (iv) The proposed route of transmission line does not affect any public utility services like playgrounds, schools, other establishments etc.;
- (v) The line route does not pass through any Sanctuaries, National Park etc.;
- (vi) The line route does not infringe with area of natural resources.

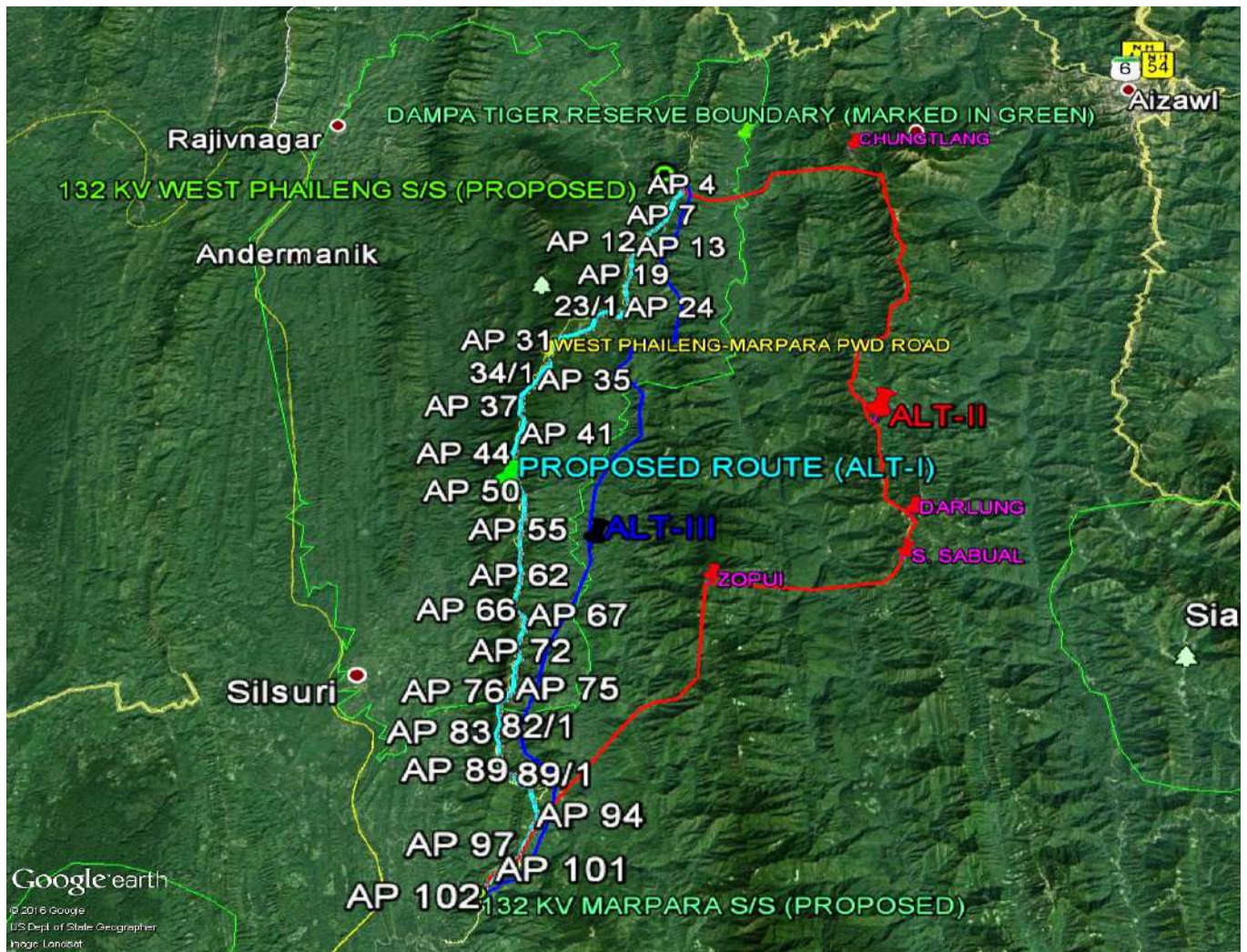
In order to achieve this, the route selection for individual transmission and distribution lines has been carried out in close consultation with representatives of concerned Forest Department and the Department of Revenue and Local Village councils. As a general practice, at least three (3) nos. of transmission routes are explored for attaining the optimum route considering all the technical, construction and environmental factors. However, where avoiding of protected areas are not at all possible due to practical reasons, it is to ensure that the route so selected involve minimum protected areas. Additionally, a pre impact assessment studies (Biodiversity Assessment) are carried out through independent agency before implementation of the project so that the mitigation measures are put on ground during project execution. In the instant case, the proposed route (Alt.-I) of the transmission line has to be routed through the buffer zone of Dampa Tiger Reserve(DTR) since no other alternatives are found feasible from construction point of view. The line has to be routed along the existing West Phaileng -Marpara PWD road which is the only direct connectivity between the two areas (i.e. substations). Although alternatives routes (Alt.-II & III) avoiding the Buffer zone of the tiger reserve have been rigorously explored by PEDM/POWERGRID but all these routes involve virgin dense forest having high biodiversity value which may inflict maximum damage to vegetation and ecosystem as no approach/access to such virgin area are in place. The summary of analysis of alternatives studied is as follows:

S.N	Description	Alternative-I	Alternative-II	Alternative-III
1.	Route particulars			
i.	Route Length (km)	50	70.7	51
ii.	Terrain			
	Hilly/Undulated	100 %	100 %	100%
	Plain	Nil	Nil	Nil
2.	Involvement of protected/sensitive areas			
i.	Forest involvement in Ha	Approx. 33 km i.e. 90 ha.) is passing through the buffer zone of the Dampa Tiger Reserve.	Approx. 4 km i.e. 10.8 is passing through buffer zone of Dampa Tiger Reserve. Another 2 km section of the route is passing through Tut RRF (Riverine Reserved Forest).	Approx. 21 km i.e. 56.7 ha.) is passing through the buffer zone of the Dampa Tiger Reserve
		However, as per the notification of buffer zone, it comprises both private land and forest land. The actual status of land within the RoW of the proposed route will be ascertained after joint survey with Forest Deptt. for which the process is already initiated by PEDM/ POWERGRID.		
ii.	Type of Forest (RF/PF/Mangrove/Wildlife Area/ Elephant corridor/ Biodiversity Hotspots/Biosphere Reserve/Wetlands or any other environmentally sensitive area.)	Reserve Forest	Reserve Forest including riverine reserved forest (RRF) along the Tut river	Reserve Forest including riverine reserved forest (RRF) along the Tut river
iii.	Type of flora	<i>Macaranga peltat</i> , <i>Dipterocarpus indicus</i> <i>Trema orientalis</i> , <i>Duabanga grandiflora</i> , <i>Tectona grandis</i> , <i>Derris robusta</i> , Bamboo species like <i>Bombax insigne</i> , <i>Bombax</i>	<i>Macaranga peltat</i> , <i>Dipterocarpus indicus</i> , <i>Trema orientalis</i> , <i>Duabanga grandiflora</i> , <i>Tectona grandis</i> , <i>Michelia champaca</i> , <i>Derris robusta</i> , Bamboo species like <i>Bombax insigne</i> ,	<i>Macaranga peltat</i> , <i>Dipterocarpus indicus</i> , <i>Albizia procera</i> , <i>Erythrina variegata</i> , <i>Trema orientalis</i> , <i>Duabanga grandiflora</i> , <i>Tectona grandis</i> , <i>Derris robusta</i> , Bamboo species

iv.	Type of fauna	<i>Treron phayei, Buceros bicornis, Macaca assamensis, Macaca arctiodes, Trachypithecus pileatu, Orthotomus sutorius, Gracula religiosa, Felis chaus, Draco maculates.</i>	<i>Arborophila atrogularis, Treron phayei, Buceros bicornis, Great Hornbill, Macaca assamensis, Pteropus giganteus, Trachypithecus pileatu, Orthotomus sutorius, Felis chaus, Draco maculates.</i>	<i>Arborophila atrogularis, Treron phayei, Buceros bicornis, Great Hornbill, Macaca assamensis, Pteropus giganteus, Trachypithecus pileatu, Orthotomus sutorius, Felis chaus, Draco maculates.</i>
v.	Historical/cultural monuments	Nil	Nil	Nil
3.	Major Crossing			
i.	Highway (National/State)	Nil	Nil	Nil
ii.	Power line	Nil	Nil	Nil
iii.	Railway line	Nil	Nil	Nil
iv.	River crossing	Nil	2	2
4.	Overall Remarks	Most optimum route selected for detailed survey since the line route is running almost parallel to the existing West-Phaileng -Marpara State PWD road	Spared as the most of the locations are inaccessible due to steep terrain, dense forest and non availability of approach road	Not considered due to very steep terrain, dense vegetation and nearly no approach roads for movement of man and machinery

As evident from above, the route length of the proposed alignment is approximately 50 km. The proposed route of the transmission line (Figure 1 and Figure 2) is running almost parallel to the existing West Phaileng – Marpara state PWD road. However, a portion of the route (approximately 33 km) has to traverse through the notified buffer zone of the Dampa Tiger Reserve as no other suitable alternative routes for the transmission line is found feasible (refer Figure 2).

Figure 1: Route Alignment of West Phaileng - Marpara 132 kV Transmission line

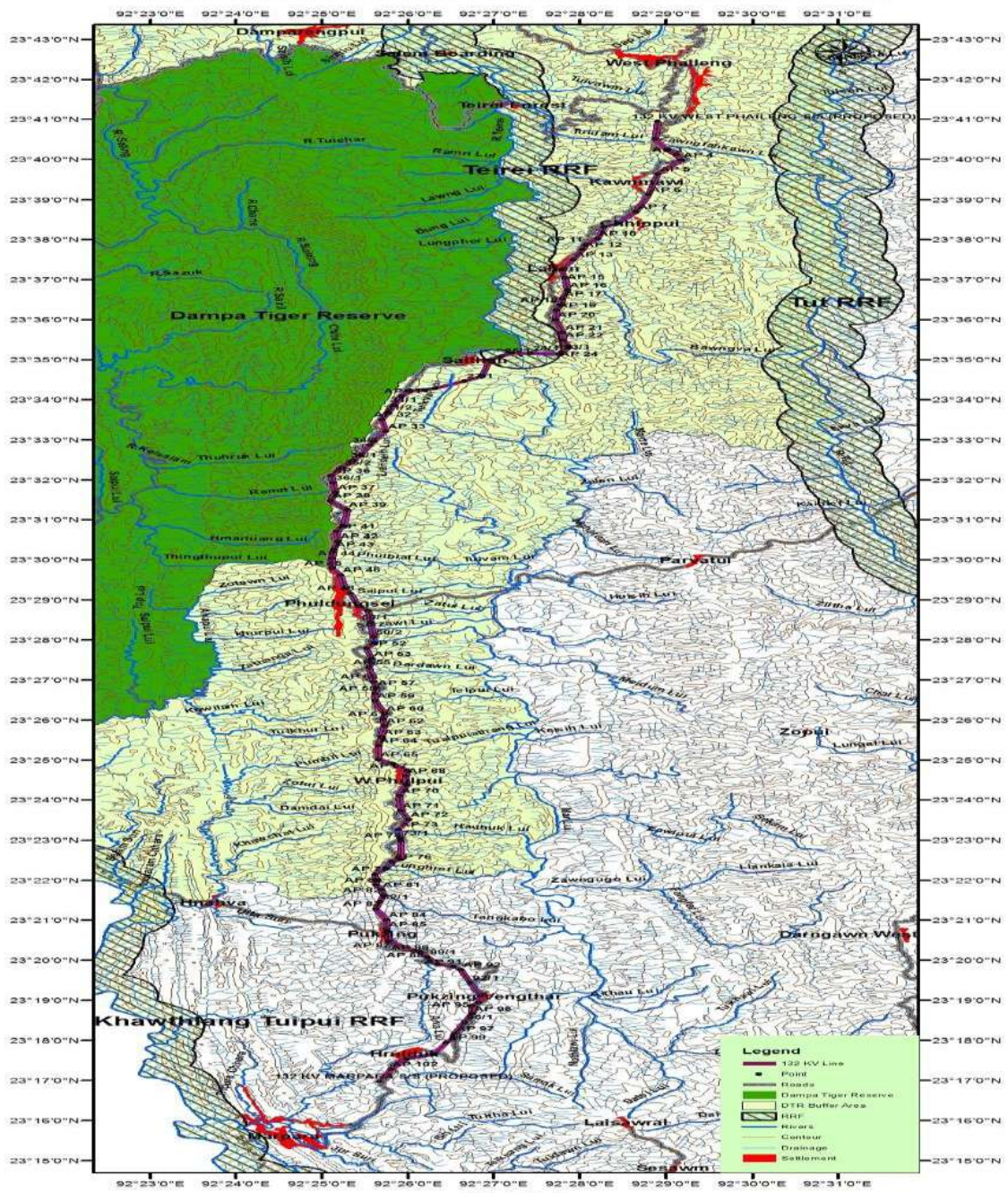


The proposed 132 kV power line will start from the 132 kV West Phaileng (new) substation (the substation land is proposed within the campus of the existing 33 kV substation owned by Power and Electricity Department, Government of Mizoram) and will terminate at 132 kV Marpara (new) substation (the proposed land for Marpara substation land is already available and under the possession of Power and Electricity Department, Government of Mizoram). The GPS coordinates of the starting point and end point of the proposed 132 kV Line are as follows:

- ❖ 132 KV West Phaileng substation at 23°40'29.50" N, 92°28'50.01" E;
- ❖ 132 KV Marpara substation at 23°16'58.19" N, 92°25'39.52" E.

From the West Phaileng end, the buffer zone area falls to the east of the West Phaileng - Marpara Public Works Department road that is adjacent to most of the proposed line except for a small patch near Saitah village. However, within the buffer zone the proposed route mainly passes through jhum cultivated land owned by village councils and some minor agricultural farms. Details of route alignment of proposed line corresponding to area of Dampa Tiger Reserve are depicted in Figure 2.

Figure 2: Map of West Phaileng – Marpara 132 kV Transmission Line



Prepared by
GIS Cell, E&E Dept, Mizoram

2.3 Design Specifications and Area of Influence of 132 kV transmission line

As explained earlier, impact of transmission line is not far reaching and mostly localised to RoW. In total, approximately 102 towers of 30.883 m in height are to be erected for construction of proposed line out of which around 78 towers falls within the buffer zone.

The plan of transmission line tower footings showing actual ground positions is given in the drawing in Figure 3. A schematic diagram indicating area of influence/impact for 132 kV D/C transmission line is presented in Figure 4 and Figure 5 respectively.

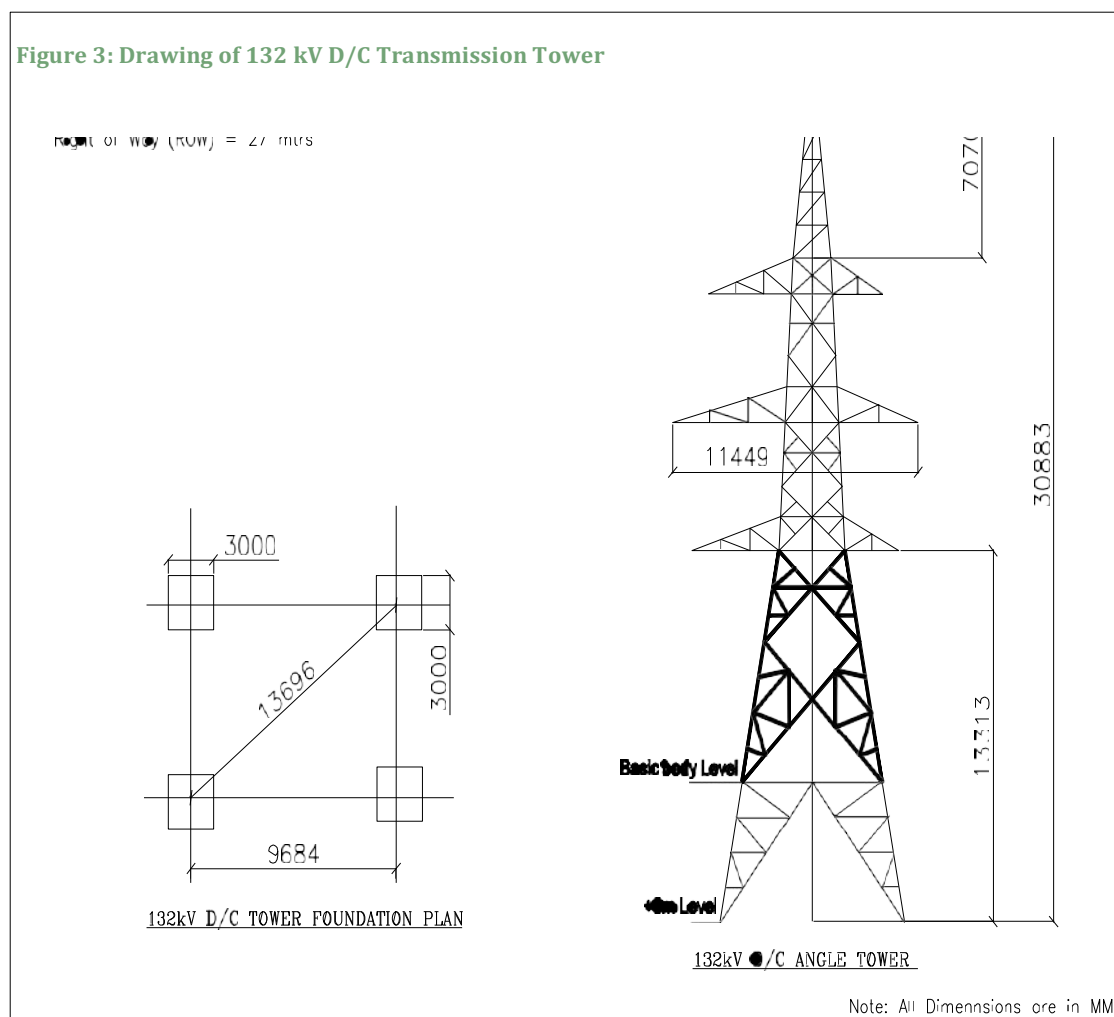
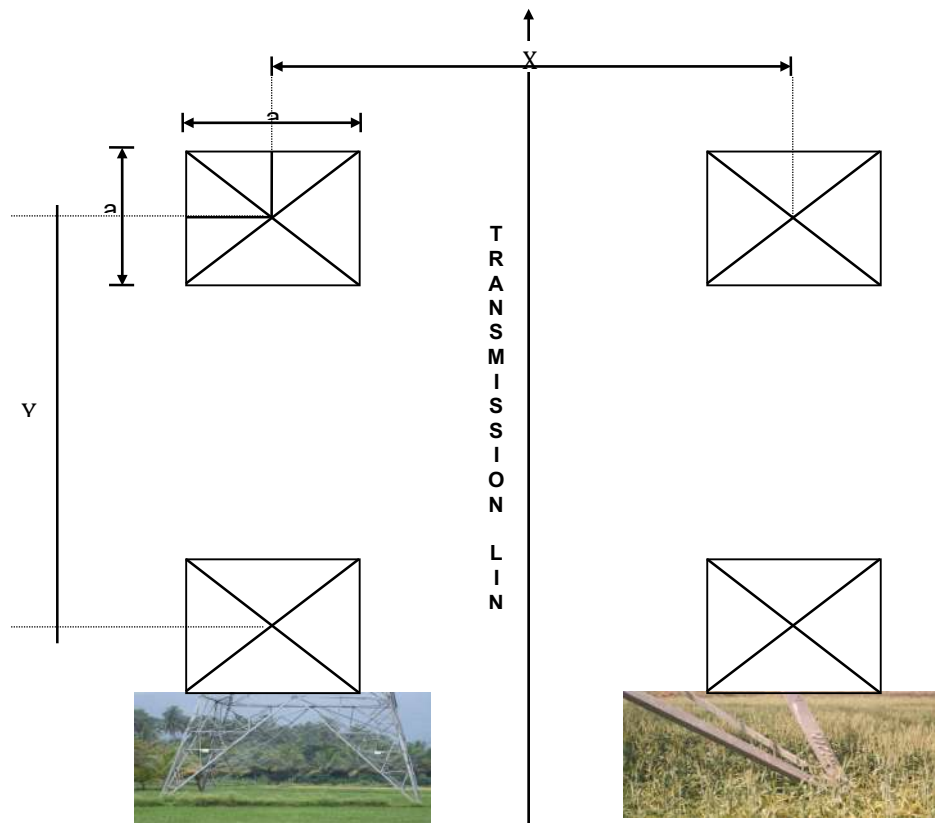


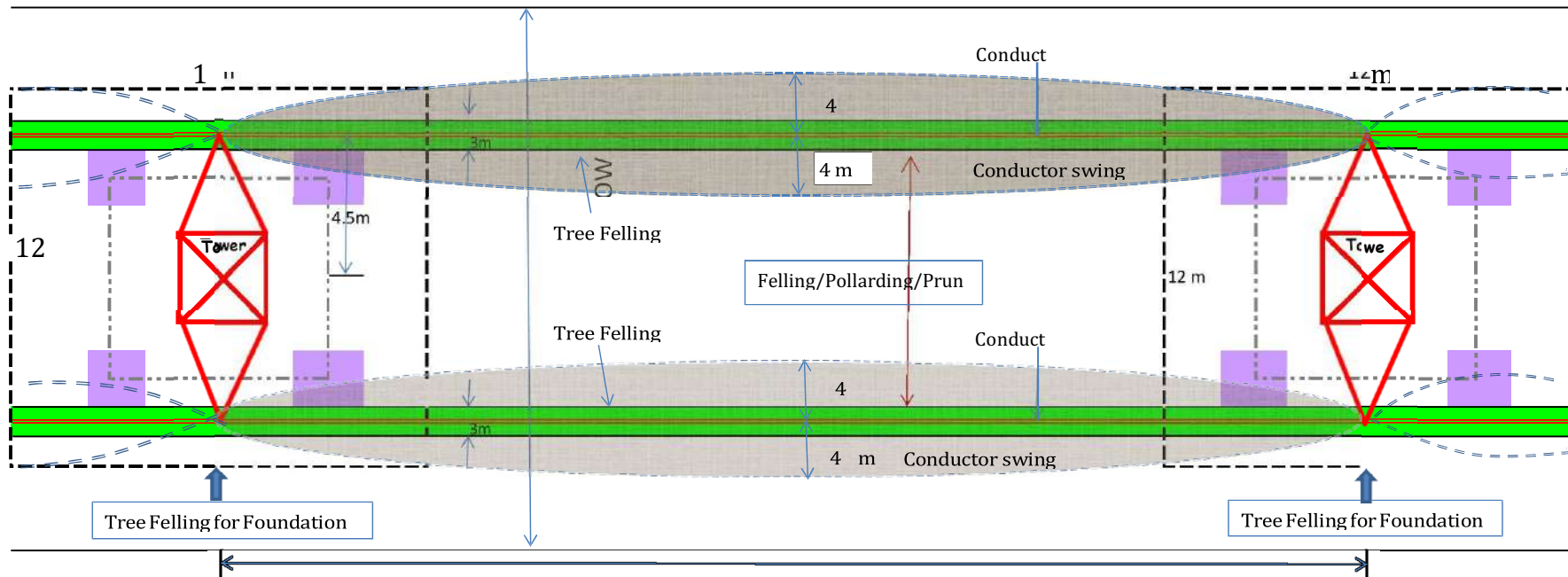
Figure 4: Typical Plan of Transmission Line Tower Footings Showing Actual Ground Position And Extent Of Impacts



ACTUAL POSITION ON GROUND

INDICATIVE MEASURES
X & Y = 10-15 METERS
a = 300- 450 mm

Figure 5: Schematic diagram indicating area of influence/impacts for 132 kV D/C Transmission Line



2.4 Key Construction Related Activities

A total of 102 towers are to be constructed in the project out of which 78 will fall within the buffer area. Estimated time taken for foundation, erection of one tower and stringing of one span of conductor is around 20 to 30 days by a mobile gang of 10 to 15 people. As informed by PGCIL, likely nos. of gang shall be in the range 6-8 and they will be simultaneously working at different locations. As per this, the total time required for construction of said line would be around 12-15 months.

The key construction activities are:

1) Transportation of raw materials and equipment

This involves movement of trucks, tractors, earth excavators, and miscellaneous vehicles for delivering manpower and materials such as tower parts, conductors, cement, concrete, etc to the location of erection of the towers. This activity continues till the completion of construction of tower and stringing of conductors.

2) Casting of Foundation

This involves excavation of pits either manually or by using earth excavators. The casting of foundation will be open cast or pile foundation with Reinforced Cement Concrete followed by backfilling. The foundation would remain underground after construction of tower.

3) Erection of towers

It is done using tower parts, nuts and bolts. The height of tower will be approximately 30.883 m. The erection of one tower takes at least 3 days to one week. The tower foundations (approximately 3 x 3 x 3 m³) after completion will remain underground and the raised chimneys will occupy very less space above ground level. Self-supporting latticed bolted steel towers, fabricated from structural steel angle section will be used. Normally, the following four types of tower shall be used in these lines:

- a) 'A/DA' type suspension towers for 0-degree angle of deviation with suspension insulator strings.
- b) 'B/DB' type suspension towers for up to 15-degree angle of deviation with suspension insulator strings for S/C line and tension towers up to 15-degree angle of deviation with tension insulator string for D/C line.
- c) 'C/DC' type tension towers for up to 30-degree angle of deviation with tension insulator strings.
- d) 'D/DD' type tension towers for up to 60-degree angle of deviation with tension insulator strings.

In addition to the above, special towers for major river crossings, power line crossings and the places where the terrain is particularly different such as approach to the substation, forest stretches, etc will also be used. All towers will be designed in accordance with latest edition of IS-802 standard and considering necessary improvements and reinforcements evolved as per suggestions/recommendations of Central Electrical Authority's expert committee based on the experience of previous tower failures in the country.

4) Stringing of conductors

This is done using conventional ACSR type conductor. These conductors have been considered based on system requirements, as these are most common type of conductors with proven technology having low cost and easy availability. The space between phase conductors is kept at approximately 3.9 m and a minimum ground clearance of 6.1 m will be maintained. ACSR Panther Conductor (30/3.0 Aluminium and 7/3.0 mm steel) of overall diameter 21.00 mm will be used per phase for 132 kV D/C line.

2.5 Legal Context of the Study

It is important to understand that as per the Constitution of India, electricity is in the 'concurrent list' of subjects. Therefore, the responsibility for administration/legislation of electricity is shared between the Central Government and respective state governments. Generation, transmission and distribution of electricity in the country is primarily governed by the Indian Electricity Act, 1910, Electricity (Supply) Act, 1948, and the recently enacted Electricity Act, 2003. However, there are other overarching legislations that have a critical role in governing and setting up of electricity generation and transmission projects. Some of these acts include Water Act, 1974, Air Act, 1981, Forest (Conservation) Act, 1980, Wildlife (Protection) Act, 1972, Environment (Protection) Act, 1986, Factories (Amendment) Act, 1988, Town and Country Planning Act, 1952 etc. In addition to these, The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, also has serious bearing on the establishment of electricity generating stations/projects.

Although, while approving any power project, issues such as transmission of power from the project are looked into, yet no formal approvals are required for transmission lines from the environmental approval point of view. In a way, construction of new power transmission lines is exempted from the Environmental Impact Assessment requirement. However, it is mandatory for such projects to get necessary approvals from the Ministry of Environment, Forests and Climate Change if these lines pass through forest areas and/or protected areas.

Forest (Conservation) Act, 1980

When transmission projects pass through forestland, clearance has to be obtained from relevant authorities under the Forest (Conservation) Act, 1980. This act was enacted to prevent rapid deforestation and environmental degradation. State governments cannot de-reserve any forestland or authorise its use for any non-forest purposes without approval from the Central Government. Since the proposed 132 kV West Phaileng - Marpara transmission line will pass through Dampa Tiger Reserve buffer zone along its alignment, Power and Electricity Department, Government of Mizoram with assistance from POWERGRID will require prior forest clearances for such areas under Forest (Conservation) Act, 1980. All prescribed procedures need to be followed up by Power and Electricity Department, Government of Mizoram, to divert those forest areas for non-forest usages, i.e. laying of power transmission lines across them.

Wildlife (Protection) Act, 1972

Since the proposed 132 kV West Phaileng - Marpara transmission line will pass through parts of buffer zone of Dampa Tiger Reserve, it will also require clearance under Section-29 of Wildlife (Protection) Act, 1972, from MoEFCC. A set procedure needs to be followed for diverting parts of protected areas for laying transmission line. A proposal will be processed through State Board for Wildlife and National Board for Wildlife. Both the boards will see to the merits of the case and provide their judgments based on the scale and types of impacts it will exert on protected areas.

3 Project Area

3.1 General Features

Mizoram, is one of seven north eastern states of India, collectively known as 'Seven Sisters'. It shares international borders with Bangladesh and Myanmar in the south and domestic borders with Manipur, Assam and Tripura on the north. The area of the state is 21,090 km² which is 0.64% of the country's geographical area. The state lies between 21°56' N and 24°31'N latitudes and 92°16' E and 93°26' E longitudes. The average altitude ranges from 500 m to 800 m with the maximum reaching 2,157 m in Blue Mountain (Phawngpui). The Tropic of Cancer runs through the state nearly at its middle.

The project area falls in Mamit district, which is bounded on the north by Hailakandi district of Assam state, on the west by North Tripura district of Tripura state and Bangladesh, on the south by Lunglei district and on the east by Kolasib and Aizawl districts. The district occupies an area of 3025.75 km². It is 4th largest district in Mizoram and 395th largest in India in terms of total area. Mamit town is the administrative headquarters of the district. Mamit district is located at 23.925°N latitude and 92.4913°E longitude with an average elevation of 718 m.

Forests of Mizoram

The recorded forest area of the state is about 16,717 km², which is about 79.30% of its geographical area. Out of this recorded area, reserved forests constitute 47.31%, protected forests 21.34% and un-classed forests 31.34%. The state has 0.65% very dense forests, 27.99% moderately dense forests and 61.74% open forests. The state has a climate ranging from moist tropical to moist subtropical (State of Forests Report, 2013).

Based on past studies as well as from the field observations, Singh *et al.* (2002) described the forest types of the state based mainly on altitude, rainfall and dominant species composition. The classification is as follows:

1) Tropical Wet Evergreen and Semi-Evergreen Forests

These forests usually occur below an altitude of 900 m and form one of the major forest types of the state with rich species diversity. Patches of these forests can be seen usually on the steep slopes, rocky and steady riverbanks and areas not suitable for shifting cultivation. The exact distinction between the evergreen and semi-evergreen forests is difficult as they occur in the areas of similar characteristics where rainfall averages between 2,000 – 2,500 mm annually and temperature varies between 20°C to 22°C. Tropical wet evergreen forests are met usually in southern and western part of Mizoram, while semi-evergreen forests occur in northern, north- western and central part of state.

The tropical wet evergreen forests exhibit clear zonation or canopies consisting of an admixture of numerous species with dense and impenetrable herbaceous undergrowth. Most of the species of the top canopy are evergreen trees with tall boles. Cauliflory is rather common. The middle and lower canopies are dense, evergreen and diverse. Epiphytes and parasites are few. Tree ferns, aroides, palms, ferns, orchids, bryophytes and lichens are fairly common. Lianas are frequent and conspicuous, sedges and grasses are common in humid places or along the banks of rivers and rivulets. Species of *Musa* are also common along the streams on hilly slopes.

In exposed and drier areas, having a thin layer of soil, deciduous elements along with some evergreen trees are found. Sometimes these are grouped as distinct type, referred as tropical moist deciduous forests. The distinction between the tropical evergreen forests and tropical moist deciduous forests is

difficult as they are found in the small hill ranges.

The third storey of canopy consists of smaller trees and shrubs with maximum floristic diversity.

2) Montane Sub-Tropical Forests

These forests are usually found between 900 m and 1,500 m altitude in the eastern fringes bordering Chin Hills of Myanmar, and places which are cooler and have less precipitation. Sub-tropical vegetation shows mixed pine forests. The common species of these forests are *Castanopsis purpurella*, *Duabanga grandiflora*, *Myristica* spp., *Phoebe goalparensis*, *Pinus kesiya*, *Podocarpus neriifolia*, *Prunus cerasoides*, *Quercus acutissima*, *Q. semiserrata*, *Schima wallichii*, etc.

3) Temperate Forests

These forests usually occur above the elevation of 1,600 m in areas like Lengtung, Naunuarzo, Pharpak, Thaltlang, Phawngpui reserve forests and display impenetrable virgin primary forests. These forests are not typical temperate forests as found elsewhere in eastern Himalaya. The predominant arboreal elements in the forests are *Pinus kesiya*, *Actinodaphne microptera*, *Betula alnoides*, *Exbucklandia populnea*, *Elaeocarpus serratus*, *Dillenia pentagya*, *Michelia doltsopa*, *M. Champaca*, *Garcinia anomala*, *Schisandra neglecta*, *Photinia intergrifolia*, *Litsea salicifolia*, *Myrica esculenta*, *Lithocarpus dealbata*, *Rhododendron arboreum*, etc.

4) Bamboo Forests

Bamboos usually grow as an under-storey to the tree species in tropical evergreen and sub-tropical mixed-deciduous forests, whereas *Melocanna baccifera* forms dense or pure forests in certain areas in the State. Large tracts of bamboos are seen throughout Mizoram but their distribution is somewhat restricted to about 1,600 m and below. They occur mostly between 40 m and 1,520 m in tropical and sub-tropical areas respectively. Few species occur in temperate areas in Blue Mountain and Mount Chalfih. It appears that bamboos have resulted from jhumming system of cultivation (Deb and Dutta, 1987). For practicing jhum cultivation the forests are burnt and tree species are destroyed but the bamboo rhizomes throw out new culms as soon as favourable temperature and seasonal monsoon arrive. Therefore, in abandoned jhumland they are the first coloniser and grow rapidly. Some important associates found growing along with bamboos are *Emblica officinalis*, *Litsea monopetala*, *Pterospermum acerifolium*, *Terminalia myriocarpa*, *Caryota mitis*, *Artocartus chama*, *Duabanga grandiflora*, *Albizia procera*, *Gmelina arborea*, *Syzygium* species (Singh et al., 2002).

5) Quercus Forests

These forests are mostly found intermingled in sub-tropical and temperate areas. Pure patches or predominate *Quercus griffithiana* is present near Champhai-Baite hill ranges and its distribution is restricted to other small areas in the eastern part of Mizoram. *Lithocarpus dealbata* is other main species (Singh et al., 2002).

6) Jhumland

Jhumlands are very common in Mizoram. They are classified variously as current jhumland, old jhumland and abandoned jhumland. Jhumlands are more prevalent in eastern Mizoram where extensive and intensive jhumming is practiced. Similarly, the areas in western side in Lunglei district towards Bangladesh have also jhumlands.

3.1.1 Dampa Tiger Reserve

The Dampa Tiger Reserve is located in the western part of Mizoram, in Mamit district. It is surrounded by Chittagong hill tracts of Bangladesh to the West, Tripura state, Mamit and Kawrthah forest divisions to the North, and Mamit forest divisions to the South and East. The area lies in the Lushai hills, a series of parallel mountain ranges allied to Arakhan Yoma arc. Dampa Tiger Reserve lies between 92°16'08" E to 92°27'41" E and 23°18'27" N to 23°43'50" N. The Tropic of Cancer passes through Dampa Tiger Reserve near the range office at Phuldungsei.

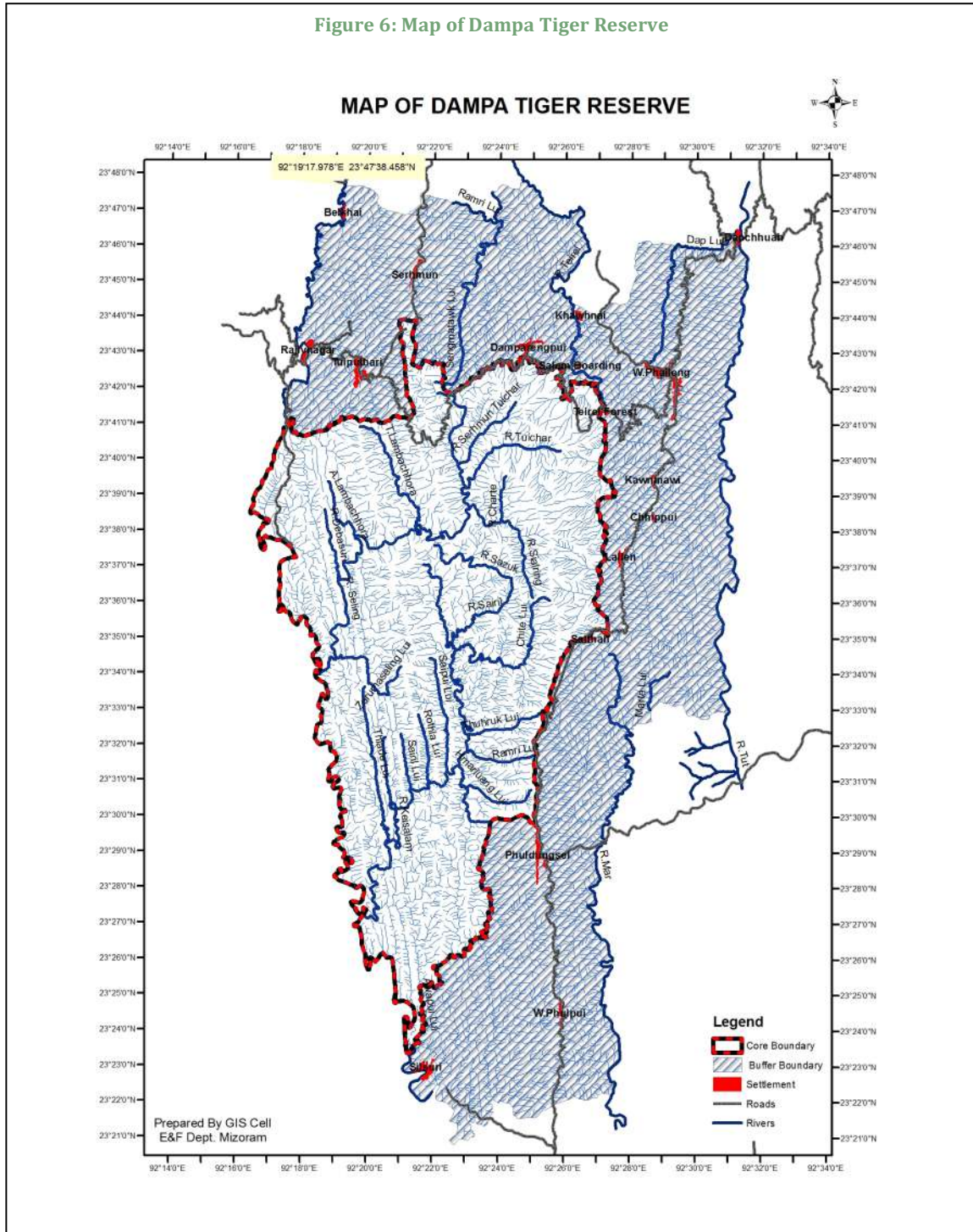
The riverine area towards the east and the west of Dampa, along the Khawthland Tuipui (also known as Sazalui or the Tui-lianpui river towards west and the Teirei river towards east) was declared as Reserved Forest in 1952. Beginning in the early 1960s, small hamlets began to be established in Dampa for intensive cultivation in the lower reaches, which had a detrimental effect on the biodiversity of the area. Dampa was declared a Wildlife Sanctuary in 1974 and re-notified in 1985 with a view to conserve the fast deteriorating natural wealth. Dampa was declared as a Tiger Reserve vide Government of Mizoram gazette notification No. B-11011/14/90-FST, on 7th December 1994, after its approval from the Government of India. The total area of Dampa Tiger Reserve is 988 km² out of which 500 km² area is core zone or critical tiger habitat and 488 km² area is buffer zone Area (vide Notification No.B.12011/14/2009-FSTdt. 16.3.2011). Details of core zone and buffer zone is shown in Figure 6.

Major fauna that are found in the reserve include Tiger, Leopard, Clouded Leopard, Wild Dog, Sambar, Barking Deer, Gaur, Sloth Bear, Hoolock Gibbon, Bunturon, Procupine, Slow Loris, Jungle Cat, Pangolin, Black Bear, Giant Squirrel, Common Langur, Rhesus Macaque, Wild Pig and Otter. There are no records of direct sighting of tigers in the Dampa Tiger Reserve. However, there are collateral evidences such as pugmarks and scats that indicate presence of Tigers in the area. Furthermore, there is a prey-base available for the Tiger in the reserve that supports possibilities of surviving tiger population.

The main flora consists of vegetation such as *Dipterocarpus turbinatus*, *D. macrocarpus*, *Artrocarpus chalpasa*, *Adina cordinifolia*, *Duabanga sonneratiodes*, *Chukrasia tabularis*, *Amoora wallichii*, *Syzygium cumini* and *Toona ciliate*. Bamboo *Bombax ceiba* and cane is also found. Based on Champion and Seth Classification, the vegetation of Dampa Tiger Reserve can be categorised into the following forest types:

- 1) Tropical Evergreen and Semi Evergreen Forests;
- 2) Tropical Moist Deciduous Forests;
- 3) Sub - Montane type.

Figure 6: Map of Dampa Tiger Reserve



3.1.2 Buffer Zone

3.1.2.1 About the Area

Legal Status, or Constitution

The Government of Mizoram as provided under section 38V of the Wild Life (Protection) Act, 1972, as amended in 2006, notified an area of 488 km² as the buffer zone of Dampa Tiger Reserve, as inclusive agenda vide Notification No. B.12011/14/2009 - FST dated 16.3.2011. However a petition is pending in the Gauhati High Court for denotification of the Dampa Tiger Reserve.

Location

The buffer zone of Dampa Tiger Reserve is located in the Mamit district of Mizoram along the western limit of the state. It spans across two community development blocks – Zawlnuam and West Phaileng. The area is located approximately between 23°47'62"– 23°20'72" N and 92°19'37"– 92°31'44" E, and lies in the Lushai Hills, a series of parallel north-south oriented ranges allied to the Rakhine - Yoma arc. The terrain is mountainous and is well dissected by numerous drainage channels.

Geology

Terrain of buffer zone is highly undulating and rugged in nature consisting of alternating ridges and valleys with a tendency to taper at both ends.

Extent

The total buffer covers an area of 488 km².

3.1.2.2 Land-use Patterns

All land in the buffer zone belongs to the state but the village councils exercise complete control over them. The following land use classifications are identified from the buffer zone of Dampa Tiger Reserve:

Primary Forests

These forests are confined to the steep slopes and hilltops and have remained untouched, as it is practically impossible to fell and transport timber from such areas or convert it for shifting cultivation. These forests provide a range of non-timber forest produce in the form of edible vegetables and herbs. A number of VCs such as Lallen, Saitha, Phuldungsei, Chhippui/Kawnmawi and Serhmun still have such primary forests. Biodiversity Conservation and Rural Livelihoods Improvement Project identified many of these forests as Biologically Significant Areas due to their high biodiversity values.

Non-Primary (Predominantly Tree) Forests

These forests are predominantly tree forests punctuated by bamboo. They are a source of timber and non-timber forest produce for the locals, as large quantities of such products are extracted from these forests. All local demands (subsistence as well as commercial) of timber are met from this category of forests. These forests are also thought to provide significant refuge to wild animals.

Current Jhum and Bamboo Forests³

Shifting cultivation is the dominant land use category in the buffer zone of the Dampa Tiger Reserve. This category of land use includes current jhum fields and regenerating fallow and forestlands, where bamboo forests are generally dominated and with lower density of standing trees in the more advanced successional stages.

Plantations and Orchards

This category of land use represents artificially generated tree cover and includes plantations under eco-development schemes as well as private orchards and teak plantations. A small proportion of the village council land has been brought under such plantations. The area under private fruit orchards is relatively large and scattered. Plantations undertaken by Eco-development Committees or Village Forest Development Committees are owned by the community while orchards and other teak plantations are privately owned. Since 2007, a number of oil palm and rubber plantations are being established (Plate 1) in erstwhile community/village lands that were earlier cultivated for jhum or valley rice cultivation. These lands have gone from community/village to private ownership, including by 'periodic patta' and are hence reducing village land available to jhumias.

Habitation and Infrastructure

This category includes human settlements (concrete buildings, thatched roof and bamboo houses) and infrastructures (such as roads, schools, churches, etc). The villages in the buffer zone are divided into vengs or localities. A household compound normally has a house, a backyard garden and a pigsty.

³ Source: Raman et al. 1998

Plate 1: Oil Palm: seeds (above) and plantation (below)



Plate 2: Habitat of Dampa Tiger Reserve: (Clockwise from top left) - Bamboo thicket; Clearing for *Jhum Cultivation*; A Typical habitat of Dampa Tiger Reserve with the dominant tree {*Dipterocarpus Indiicus*} and a landscape of Dampa Tiger Reserve.



3.1.2.3 Status of Tiger and Co-Predators

Not much is known of the distribution of tigers and its co-predators in the buffer zone of Dampa Tiger Reserve although there are frequent sightings of leopards and wild dogs from this area. Even tigers were occasionally heard, reported and recorded through pugmarks in areas such as Phullu Ram, Varihaw, Zopui and Herhsel⁴, but there is no direct sighting of tigers in the buffer zone.

No systematic study has been carried out to know the status of tigers and co-predators in the buffer zone of Dampa Tiger Reserve.

Nothing is known of the prey-predator relationship in the buffer zone of Dampa Tiger Reserve.

Moreover, some threats have been assessed that are common to tigers and co-predators in the buffer zone. These are:

Poaching/Hunting

Hunting/poaching are the main threats to the Tiger and its co-predators in the buffer zone of the reserve. Hunting of Tigers and its co-predators has not been reported so far although their prey is frequently hunted. Villagers usually hunt crop-raiding 'problematic' ungulates, which are also the main prey base of these predators, particularly along the eastern and northern areas of the buffer.

Shifting Cultivation

Shifting cultivation is still a predominant form of agriculture in the buffer area. Although its intensity has reduced in the buffer area, partly due to the New Land Use Policy initiative of the Government of Mizoram that encourages farmers to adopt alternative agricultural practices, it still remains active in many villages. Although patches of forest are cleared and burnt every year, the shifting cultivation system requires that for each hectare that is cultivated, around 5 to 10 Ha is retained as regenerating forests in the landscape (for cultivation in subsequent years). This allows the persistence of substantial areas under regenerating bamboo and secondary forests, which provide forest cover and wildlife habitat as corridor in the landscape.

Roads

The road network in the buffer zone of the reserve is a constant threat as animals might get mowed down by speeding vehicles. The roads also facilitate the growth of invasive species such as *Eupatorium*, *Mimosa*, *Lantana* and *Mikania*.

Wild Fires

Wild fire is another threat to the habitats of tiger and co-predator in the buffer zone of the reserve. Jhum fires are generally well contained, but occasionally 'escape' leading to fire spreading through the leaf litter in a wider area. Teak plantations established in the landscape are also prone to fire as the trees are deciduous and the dry leaf litter during summer is susceptible to fires.

⁴ Source: Biodiversity Conservation and Rural Livelihoods Improvement Project, 2007.

3.1.2.4 History of Management

Conservation and Forest Management History

The buffer area of Dampa Tiger Reserve comes under two Territorial Forest Divisions: Kawrthah and Mamit. While Kawrthah division is managed by a Working Plan, which was approved by the MoEFCC in 2006, the Mamit Division continues to be administered on the basis of a Working Scheme. A brief conservation and forest management history of each Forest Division is given below:

Kawrthah Forest Division

Past History and Current Practices

There are five notified forests under Kawrthah Forest Division with total area of 747 km². Parts of these forests fall within the buffer zone of the Tiger Reserve. Out of these five Reserved Forests, three Reserved Forests, namely, Teirei Riverine forest, Langkaih Riverine forest and Khawthlangtuipui Riverine forest (not in buffer zone) were notified on 19th May, 1965, Tut–Langkaih Protected Council Reserved Forest on 24th June, 1970 and Rengdil Pond Reserved Forest (which falls outside the buffer zone of the reserve) was pre-notified on 12th August, 1984. Assam Government notified all Reserved Forests except Rengdil Pond Reserved Forest when Mizoram was still a part of Assam.

Riverine reserves usually comprise half a mile (800 m) on both sides of an entire length of a river. Tut-Langkaih Protected Reserve covers about 94.5% of the entire geographical area of Kawrthah Division, thus, overlaps with all other Reserved Forests.

The villagers under the Tut-Langkaih Council Reserved Forest was given the customary jhuming right at the rate of 5 acres (2 ha) per household per year on five-year cycle. They were further granted rights to collect minor forest produce for domestic purpose but the commercial use of these products was prohibited. Timber from unreserved species has also been granted for subsistence use only.

The Working Plan of Kawrthah was approved in 2006. Earlier, when Kawrthah Division did not have any Working Plan, the extraction and movement of forest produce was governed as per the provisions of Mizoram (Forest) Act, 1955. There was a system of leasing out bamboo, non-timber forest produce, fishery, sand, etc on Mahal system but timber produce was controlled on royalty basis. Royalty varied from species to species, which were classified in the Mizoram (Forest) Act, 1955.

The Mizoram State Government notified Joint Forest Management (JFM) resolution on 18th September 1998. Since then all afforestation programmes were carried out under the umbrella of Joint Forest Management Committee. As per the guidelines, Village Forest Development Committees and Forest Development Agency have been formed at village and divisional level respectively. Guidelines for constitution of Forest Development Agency in the state of Mizoram were notified on 5th November 2001 and are presently functioning in Kawrthah Forest Division. Total 10 of Village Forest Development Committees have been formed under Kawrthah Forest Development Agency with a target area of 600 Ha for plantation during the current five-year plan with a financial target of Rs. 53.94 lakhs.

Mamit Forest Division

Past History and Current Practices

Mamit Forest Division is one of the most important suppliers of timber to Aizawl, the capital of Mizoram. Except Lengpui range, all other five ranges had extracted timber unsustainably in the past, especially

Saithah Range. After T. N. Godaverman case of December 1996, the harvesting was stopped but the damage done was already beyond repair. The MoEFCC thereafter put all afforestation schemes under an umbrella scheme called National Afforestation Programme, which began in 2002. Mamit Forest Division has been implementing the National Afforestation Programme schemes through 26 Village Forest Development Scheme. Main activity of majority of the Village Forest Development Committees is creation of plantations.

3.2 Socio-economic Profile

Mizo, Reang or Bru and Chakma are three major ethnic communities in the buffer area of Dampa Tiger Reserve. Apart from these communities; the buffer also has significant population of people from Dumka district of Jharkhand, Nepal, Myanmar and ethnic Mizo people from Manipur and Bangladesh.

3.2.1 Locations of Villages

The table below indicates the GPS locations of the villages in the study area. The elevation range of the sampled villages was found to be in range of 700m to 900m. Actual site photo of villages are given in Plate 2.

Table 1: Locations of Villages

Name of Village	GPS Location of the village	Elevation (m)
West Phaileng	23 ^o 26.888' N and 92 ^o 25.702' E	736
Phuldungsei	23 ^o 28.425' N and 92 ^o 25.538' E	893
Saithah	23 ^o 34.881' N and 92 ^o 28.659' E	787
Lallen	23 ^o 37.251' N and 92 ^o 27.762' E	759
Kawnmawii	23 ^o 39.189' N and 92 ^o 28.716' E	705

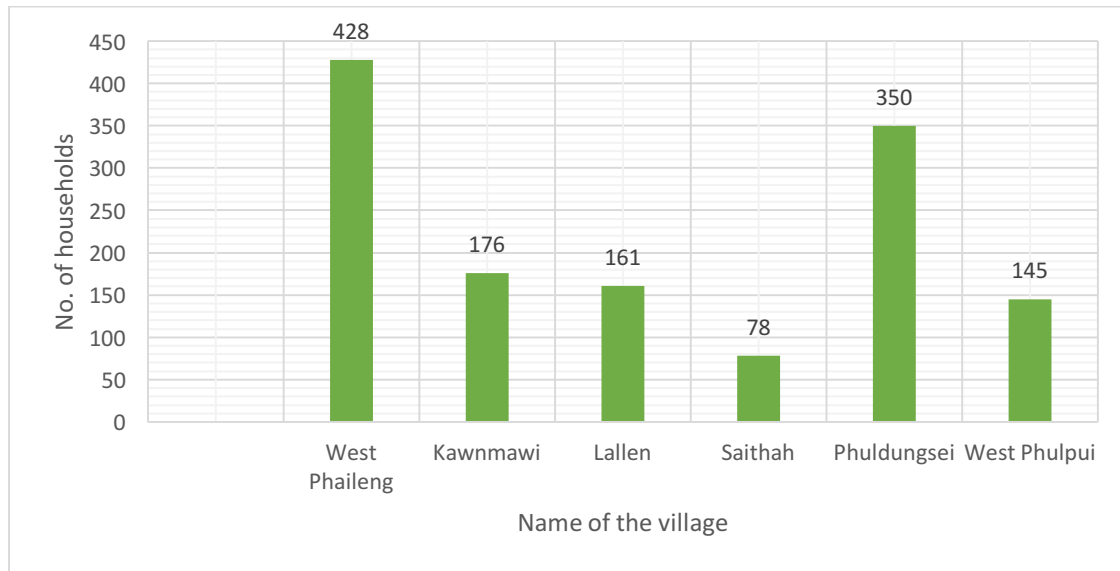
Plate 3: Villages in the Study Area: Clockwise from top left: Kawnmawi Village; Phulpui village; Saithat Village; Phuldungsei Village; West Phaileng village and Lallen Village.



3.2.2 Demographics

The chart below shows the demographic profile for all six villages under the study area. The total number of households in all these villages is 1338.

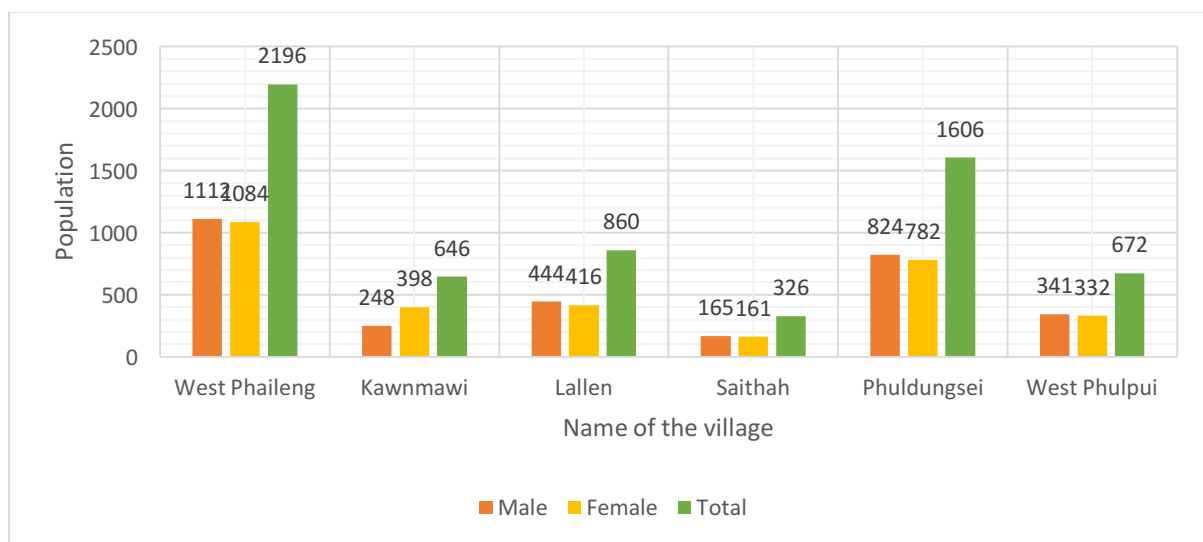
Figure 7: Demographic Profile of Six Villages in Buffer Area of Dampa Tiger Reserve



Population details

According to the 2011 census, the total population of the villages is 6306, out of which West Phaileng is the largest village and Saithah is the smallest village in the area.

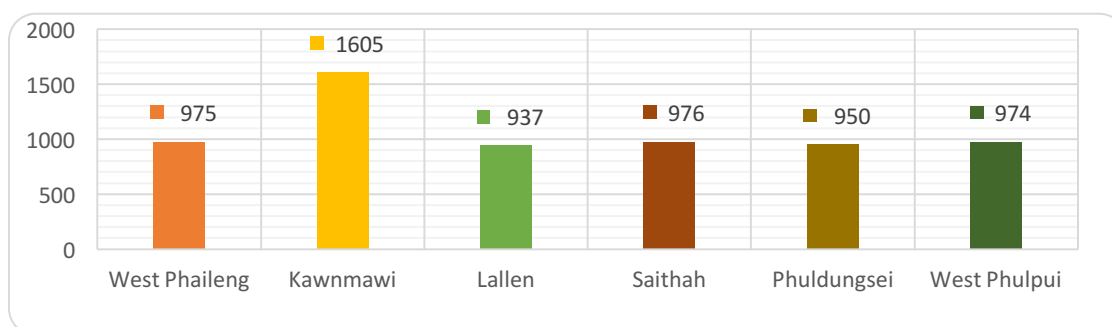
Figure 8: Population Details of Six Villages in Buffer Area of Dampa Tiger Reserve



3.2.3 Gender Ratio

The overall gender ratio in all the six villages is 1013 females to every 1000 male. This is in fact greater than the gender ratio of the state, which is 975 females per 1000 males (2011 census). The individual village-wise gender ratio is shown in the chart below.

Figure 9: Gender Ratios



3.2.4 Livelihood

The economy of the buffer area is predominantly agrarian. However, the region has strong economic linkages with cities such as Aizawl, Karimganj and Silchar despite being remote and rural. Typical livelihood of people in the buffer zone of Dampa Tiger Reserve consists of the following activities⁵:

Salaried Employment: People who are employed in the government/non-government sectors fall into this category. Apart from generating income from the salary, many of them are also engaged in petty trade and are contractors for different projects. The Biodiversity Conservation and Rural Livelihoods Improvement Project found that on average 10% families in Mizo villages had some form of regular income. This figure fell to 5% in Bru and Chakma villages pointing to the marginalisation of these communities within this landscape.

Agriculture and Allied Activities: More than 90% of the population is engaged in shifting cultivation or jhum, though it may or may not be their primary source of income. Few of them are also engaged in horticulture, wet rice cultivation and fisheries.

The majority of farmers in the area are involved in farming of cash crops. Some of the major cash crops grown in the area are Paddy, Sugarcane, Pumpkin, Chilli, Papaya, Paan, Parkia, Guava, Orange, Jackfruit, Mango, Citrus, Pumpkin, Areca nut, Palmoil, Coffee. Oilpalm etc. It is a usual practice for the farmers to grow multiple crops together with paddy. Some of the most common crops mixed with paddy are maize, brinjal, chilli, sesame, peas, pumpkin and white pumpkin.

Wage Labour: Wages from occasional as well as contractual labour are a substantial source of income for weaker sections of the community in the buffer area. The category of households that depend on wages for sustenance is large and includes all those families who either cannot produce enough from agriculture and allied activities or do not have an alternate source of permanent income such as a salaried job or a shop, etc. According to a village survey carried out by the Biodiversity Conservation and Rural Livelihoods Improvement Project, 400 families were found to be dependent on wage labour for sustenance. The wage labour can be categorised as jhum and orchard labour, BRTF labour and other contractual labour in Government Departments. The employment situation has improved after the implementation of the

⁵ Source: Biodiversity Conservation and Rural Livelihoods Improvement Project, 2007.

Mahatma Gandhi National Rural Employment Guarantee Act and more arrays of livelihoods in other developmental activities.

Craftsmanship: Almost every family in the buffer zone is engaged in the manufacture of bamboo and cane handicrafts as well as weaving. Such practices are very common among the tribes who live in the buffer zone. However, the market for such products is very limited.

Collection of Non-timber Forest Produce: Collection of non-timber forest produce such as bamboo, bamboo-shoot, cane, cane- shoot, herbs, edible plants, crabs and fish is common from the adjoining forests. However, there is only a limited market for cane-shoots, fishes, prawns and crabs while no market exists for the other products. With time however, these products continue to become rare. Bamboo shoot and bamboo are the most abundant non-timber forest produce and are used heavily by the marginalised sections of the local community.

Primary data survey reveals that majority of the population in the area is engaged in agriculture, followed by wage earning in the nearby towns. Most of the farmers are having marginal land-holdings; agriculture activities are mainly self-sustaining in nature. The income details for five sampled households in the area are provided below in Table 2.

Table 2: Livelihood Details

Name of Village	Head of the Family	Family Details			Total land holding of the family (ha)	Annual Income ('000 INR)	Major Source of Income
		Male	Female	Total			
Phungdunsei	Vanlalrua	3	3	6	2.5	200 - 250	Agriculture
Phungdungsei	J.H Lalthanpuia	3	2	5	3.0	300-400	Agriculture
Saithah	C. Vanramduah	3	2	5	2.5	300-350	Agriculture
Lallen	F. Alsawmzuala	3	3	6	3.5	300-400	Agriculture
Kawnmawii	Vanlalruati (widow lady)	1	2	3	1.5	150-200	Agriculture

4 Impact Assessment

4.1 Study Approach or Methodology

The assessment of any of impacts of developmental activities on biodiversity including flora and fauna depends on a first hand understanding of the proposed activities, its magnitude/extent, scale and ecological conditions in the surrounding area. Collection of comprehensive baseline information on flora and fauna is therefore a prerequisite for assessment of impacts of development activities. It would also help in advance planning and mitigate the impacts and ultimately managing the natural habitats and resources. The detailed methodology used for data collection and logical analysis in order to achieve the objectives of the study is discussed in this chapter.

In order to get the first hand information about the project settings and biodiversity status in the area adjoining the proposed transmission line, field surveys were conducted. Further, as part of the data collection process, the assessment team undertook a review of the relevant literature also, in addition to interviews with the concerned stakeholders, including forest department officials, POWERGRID's officials and villagers in the vicinity of Dampa Tiger Reserve. The field assessment and survey/sampling was conducted during post-monsoon period between October, 2015, to January, 2016, after obtaining the requisite permission from the Chief Wildlife Warden, Mizoram. (Annexure 1)

Sampling Strategy

As per the route alignment survey, the total line length of the proposed 132 kV West Phaileng to Marpara is 55 km including 33 km inside buffer zone of Dampa Tiger Reserve from West Phaileng substation to the border of Dampa Tiger Reserve.

Based on the discussions with the POWERGRID officials, it was understood that the RoW of 132 kV Transmission Line would be approximately 27 m. It was further decided that the width of the patch of forest to be covered east of the road in the buffer zone will be 30 m. And the total length of the line that was covered in the buffer zone while our team conducted the field assessment came out to be 44 km taking into consideration that the road abutting the transmission line route alignment was winding and sloping. Thus, the total area covered for the field assesment of the project comes around 13,20,000 m².

Forest in this stretch is mostly evergreen, dense in patches especially towards West Pulpui and moderately dense and open in rest of the areas. Considering the forest type and canopy density, a sampling intensity of 1% was selected, bringing the total sample size to 13,200 m². A standard quadrat size of 20 m by 30 m will yield around 22 quadrats. Later, the number of quadrats was increased to 30 after fixing of the final point at West Phaileng (for details refer Plate 4). Each quadrat was laid at a distance of 1.5 km along the patch considering the villages, farm lands (orange, oil palm, and ginger), jhum lands and watershed project areas coming in between. Table 3 shows details of coordinates and elevations of the quadrats laid during field study/sampling.

Plate 4: Assessment Teams: Assam Biodiversity Board and Power Grid assessment team (above) and GICIA assessment team (below)



Plate 5: Locations of Field Quadrats along the Transmission Line in the Buffer Zone

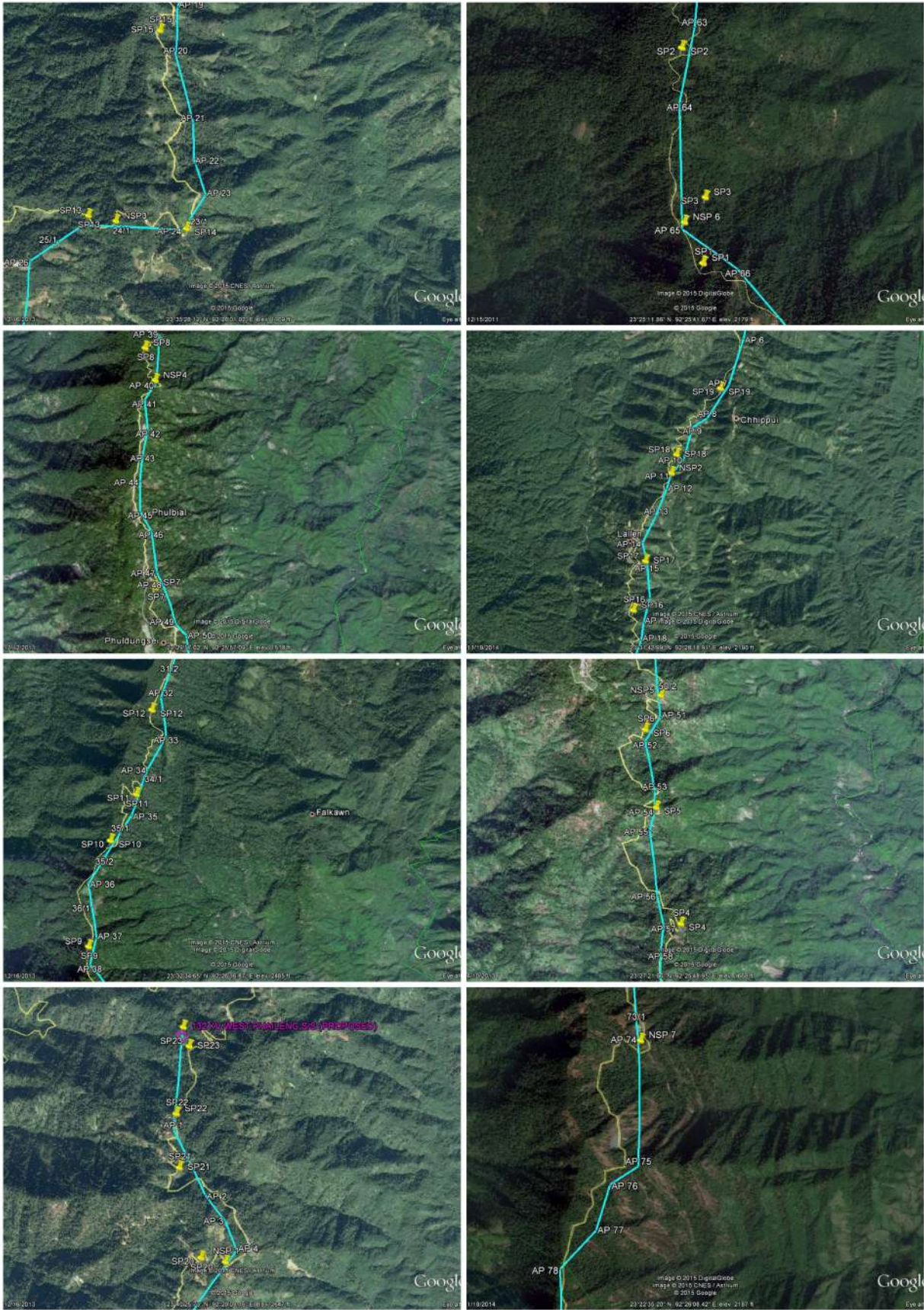


Table 3: GPS positions of field quadrats

Quadrats	Coordinates	Altitude Ranges (M)
1	23°24.911' N 92°25.711' E - 23°24.919' N 92°25.702' E	703-729
2	23°25.496' N 92°25.648' E - 23°25.499' N 92°25.665' E	698-719
3	23°25.086' N 92°25.719' E - 23°25.128' N 92°25.744' E	697-708
4	23°26.777' N 92°25.719' E - 23°26.793' N 92°25.722' E	670-690
5	23°27.403' N 92°25.573' E - 23°27.417' N 92°25.605' E	630-652
6	23°27.821' N 92°25.511' E - 23°27.860' N 92°25.521' E	680-693
7	23°29.104' N 92°25.235' E - 23°29.132' N 92°25.231' E	794-820
8	23°31.099' N 92°25.144' E - 23°31.135' N 92°25.188' E	825-865
9	23°31.573' N 92°25.074' E - 23°31.601' N 92°25.079' E	821-838
10	23°32.379' N 92°25.264' E - 23°32.367' N 92°25.278' E	879-913
11	23°32.728' N 92°25.476' E - 23°32.816' N 92°25.480' E	905-917
12	23°33.359' N 92°25.609' E - 23°33.407' N 92°25.629' E	926-931
13	23°35.185' N 92°27.232' E - 23°35.163' N 92°27.261' E	714-743
14	23°35.120' N 92°27.761' E - 23°35.155' N 92°27.790' E	736-749
15	23°36.087' N 92°27.625' E - 23°36.101' N 92°27.638' E	772-789
16	23°36.586' N 92°27.679' E - 23°36.613' N 92°27.654' E	739-769
17	23°37.029' N 92°27.794' E - 23°37.056' N 92°27.747' E	758-772
18	23°38.007' N 92°28.108' E - 23°38.018' N 92°28.131' E	724-746
19	23°38.618' N 92°28.550' E - 23°38.630' N 92°28.567' E	635-660
20	23°39.920' N 92°28.992' E - 23°39.906' N 92°28.072' E	719-738
21	23°40.318' N 92°28.888' E - 23°40.350' N 92°28.872' E	738-760
22	23°40.556' N 92°28.874' E - 23°40.572' N 92°28.873' E	736-748
23	23°40.858' N 92°28.934' E - 23°40.869' N 92°28.951' E	713-725
24	23° 39.900' N 92° 29.110' E - 23° 39.888' N 92° 29.116' E	730-733
25	23° 37.838' N 92° 28.056' E - 23°37.836' N 92°28.066' E	724-728

26	23° 35.157' N 92° 27'056" E - 23° 35.836' N 92° 27'668" E	706-710
27	23° 30.827' N 92° 25'.242" E - 23° 30.831' N 92° 25'252" E	864-869
29	23° 25.195' N 92° 25.655' E - 23° 25.135" N 92° 25.661' E	707-710
30	23° 22.55' N 92° 25.55.2' E - 23° 22.961' N 92° 25'.957' E	767-762

Habitat Survey

The habitat survey was done through quadrats and transects method. Coordinates of all the 30 quadrats from the starting point to the end point were noted. Other features encountered along the way such as existing villages, farmlands, jhum lands etc (Table 4) were also noted.

In each quadrat all the tree species above 10 cm girth were noted at breast height and width. The number of species in each quadrat and number of individuals for each species were recorded. In each quadrat, 5 m by 5 m regeneration plots were laid to count the number of herb species, climbers, ferns, orchids, seedlings etc.

Considerations of tree, shrub and herb was based on their height from ground level. A plant of less than 0.5 m was considered herb, while plant from 0.5 m to 2.0 m in height and less than 10 cm girth at base was considered shrub. Whereas tall plants with more than 10 cm girth at base and more than 1.5 m in height were categorised as trees. Sighting of mammals, reptiles, birds and butterflies or their signs were also recorded.

Table 4: GPS positions of farmlands along West Phaileng – Marpara 132 kV Transmission Line

S. No	Farm Land	Coordinates	Elevation
1	Jhum land	23 ⁰ 26.888' N - 92 ⁰ 25.702' E	645 m
2	Orange Farm	23 ⁰ 27.22' N - 92 ⁰ 25'395" E	626 m
3	Jhum land	23 ⁰ 27.264' N - 92 ⁰ 25.479' E	628 m
4	Orange Farm	23 ⁰ 27.325' N - 92 ⁰ 25.520' E	634 m
5	Oil Palm	23 ⁰ 27.799' N - 92 ⁰ 25.432' E	659 m
6	Agroforestry land	23 ⁰ 28.926' N - 92 ⁰ 25.595' E	684 m
7	Agroforestry Land	23 ⁰ 28.367' N - 92 ⁰ 25.519' E	739 m
8	Mixed Farm	23 ⁰ 30.790' N - 92 ⁰ 25.222' E	890 m
9	Mixed Farm	23 ⁰ 31.231' N - 92 ⁰ 25.260' E	835 m
10	Watershed Project (IWDP)	23 ⁰ 34.367' N - 92 ⁰ 25.519' E	739 m
11	Mixed Farm	23 ⁰ 30.790' N - 92 ⁰ 25.222' E	890 m
12	Mixed Farm	23 ⁰ 31.231' N - 92 ⁰ 25.260' E	835 m
13	Watershed Project (IWDP)	23 ⁰ 34.231' N - 92 ⁰ 25.942' E	889 m
14	Orange Plantation (IWDP)	23 ⁰ 34.303' N - 92 ⁰ 25.991' E	865 m

15	Jhum Land	23 ⁰ 34.528' N - 92 ⁰ 26.094' E	844 m
16	Orange Plantation (IWDP)	23 ⁰ 34.604' N - 92 ⁰ 26.132' E	821 m
17	Orange Plantation (IWDP)	23 ⁰ 34.868' N - 92 ⁰ 26.554' E	791 m
18	Orange Plantation (IWDP)	23 ⁰ 35.156' N - 92 ⁰ 26.772' E	757 m
19	Orange Plantation (IWDP)	23 ⁰ 35.193' N - 92 ⁰ 26.817' E	762 m
20	Fish Pond (IWDP)	23 ⁰ 35.227' N - 92 ⁰ 27.205' E	715 m
21	Oil Palm	23 ⁰ 35.782' N - 92 ⁰ 27.696' E	766 m
22	Ginger cultivation	23 ⁰ 35.999' N - 92 ⁰ 27.670' E	790 m
23	Oil Palm & Orange	23 ⁰ 36.817' N - 92 ⁰ 27.659' E	744 m
24	Oil Palm	23 ⁰ 37.906' N - 92 ⁰ 28.045' E	737 m
25	Oil Palm (IWDP)	23 ⁰ 39.990' N - 92 ⁰ 29.039' E	749 m
26	Old Age Home Proposed Land	23 ⁰ 40.572' N - 92 ⁰ 28.873' E	748 m

Plate 6: Photographs of Field Recordings



Impact Assessment

The team attempted to assess and evaluate the impacts of the construction and operation of the transmission line on the biodiversity values within the Dampa Tiger Reserve. The impact assessment is majorly restricted to impacts on the biodiversity values, and does not take into account any possible impacts on the ecological services offered by the forest tract in consideration. Such a study will involve collection of multi-year data, and the viability of the same can be accessed only after the specific changes to the project area are undertaken as part of the project establishment. The major impacts were identified based on point of action as belonging to 3 categories viz:

Direct impacts: impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

Indirect impacts: are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.

Cumulative impacts: are those impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

Data Analysis

All the data with respect to the floral and faunal biodiversity was collected and analysed. A checklist of the available flora and fauna of the project area was prepared.

Checklist of flora will have the following information:

Common and botanical name of the species, family name, habitat (tree, shrub, herb, climber, fern, grass etc) of the species, Rare Endangered and Threatened status as per the IUCN red data book and any other special remark.

Checklist of fauna is separately prepared for mammals, reptiles, birds, butterflies, and their zoological name, common name, family and conservation status.

Further, a relative measure of biodiversity with the baseline was undertaken using the following indices:

Calculation of Importance Value Index (IVI)

Importance Value Index is helpful to know the predominant tree species of the area along with the predominant family of plants.

Importance Value Index has three components namely Relative Dominance, Relative frequency and Relative density given by the following formulae:

- Relative Dominance= basal area of species A/ basal area of all species x 100
- Relative Density= number of individuals of species A/ total no. of all individuals x 100
- Relative frequency= frequency value of species A/ frequency value of all species x 100

- Importance Value Index = Relative Dominance + Relative Density + Relative Frequency

Species Richness

Richness R simply quantifies how many different types the dataset of interest contains. For example, species richness (usually notated S) of a dataset is the number of different species in the corresponding species list. Richness is a simple measure, so it has been a popular diversity index in ecology, where abundance data are often not available for the datasets of interest. Because richness does not take the abundances of the types into account, it is not the same thing as diversity, which does take abundances into account. However, if true diversity is calculated with $q = 0$, the effective number of types (OD) equals the actual number of types (R).

Shannon Index

The Shannon index has been a popular diversity index in the ecological literature, where it is also known as Shannon's diversity index, the Shannon–Wiener index, the Shannon–Weiner index and the Shannon entropy. The Shannon entropy quantifies the uncertainty (entropy or degree of surprise) associated with this prediction. It is most often calculated as follows:

Where, p_i is the proportion of characters belonging to the type of letter in the string of interest. In ecology, p_i is often the proportion of individuals belonging to the species in the dataset of interest. Then the Shannon entropy quantifies the uncertainty in predicting the species identity of an individual that is taken at random from the dataset.

Simpson Index

The Simpson index was introduced by Edward H. Simpson to measure the degree of concentration when individuals are classified into types.

The measure equals the probability that two entities taken at random from the dataset of interest represent the same type.

This also equals the weighted arithmetic mean of the proportional abundances p_i of the types of interest, with the proportional abundances themselves being used as the weights. Proportional abundances are by definition constrained to values between zero and unity, but their weighted arithmetic mean, and hence $\lambda \geq 1/R$, which is reached when all types are equally abundant.

After compiling the data from all the quadrats the above-mentioned analysis will be done. Among them Importance Value Index is calculated manually and for the other three parameters suitable statistical software like PAST will be used.

4.2 Field Observations and Data Analysis

Habitat and Vegetation Zones

Based on the various plant assemblages, canopy density and other features of the proposed site, the following four major vegetation zones can be broadly identified in the proposed project site in Dampa buffer zone.

- Very Dense Forest with Good Ground Cover:** found in most parts of West Pulpui area, small parts of Phungdungsui and Kawnmawi areas.

- ii. **Moderate Dense Forest with Good Ground Cover:** found in small parts of West Pulpui, Pungdungsui and Lallen, Saithai and Kawnmawi areas.
- iii. **Open Forest with Good Ground Cover:** found in most parts of Lallen, Saithai and parts of Kawnmawi areas.
- iv. **Open Forest with Weeds:** found in small parts of Phungdungsui, Saithai and many parts of Lallen, Kawnmawi areas.

Flora

A total of 203 species of plants belonging to 160 genera and 73 families were documented from the study site. Out of this, 96 species of trees; 86 species of herbs, shrubs and climbers; and 21 species of bamboo, orchids and ferns were documented. Details of tree species are provided in Table 6; herbs, shrubs and climbers in Table 7; and bamboo, orchids and ferns in Table 8.

Total 79 species occurring within 30 sample plots were considered for calculation of diversity indices and Importance Value Index. Details of relative frequency, density, dominance and Importance Value Index of identified species is presented in Table 9 and percentage wise distribution of species is shown in Figure 8.

During present study the actual tree enumeration in the complete corridor was not carried out. However, total tree count has been extrapolated based on density/nos. of trees recorded in 30 sampling quadrats. The analysis of the same depicts that 7370 trees may be impacted during construction of said transmission line in buffer zone for construction of 78 towers considering an area of 12m x 12m for each tower base and 6m below conductor for 33km stretch of line. Details of quadrat-wise tree count is placed as annexure 2.

Table 5: Identified Tree species in the sampling areas

Name of the Species	Common Name	Family	IUCN Status
<i>Acrocarpus fraxinifolius</i>	Ngan bawm	Caesalpiniaceae	Not assessed ⁶
<i>Alangium chinense</i>	Arsarimnam	Alangiaceae	Not assessed
<i>Albizia chinensis</i>	Vang	Mimosaceae	Not assessed
<i>Albizzia procera</i>	Kangtek	Mimosaceae	Not assessed
<i>Alphonsea lutea</i>	Zawngbalhla	Annonaceae	Not assessed
<i>Alstonia scholaris</i>	Thuamriat	Apocynaceae	Lower risk
<i>Anthocephalus chinensis</i>	Banphar	Rubiaceae	Not assessed
<i>Apourosa octandra</i>	Chhawn tual	Euphorbiaceae	Not assessed
<i>Areca catechu</i>	Kuhva-kung	Arecaceae	Not assessed
<i>Artocarpus chama</i>	Tatkawng	Moraceae	Not assessed
<i>Artocarpus heterophyllus</i>	Lamkhuang	Moraceae	Not assessed
<i>Artocarpus lakoocha</i>	Theitat	Moraceae	Not assessed
<i>Baccaurea ramiflora</i>	Pangkai	Euphorbiaceae	Not assessed
<i>Balacata baccata</i>	Thing-vawk-pui	Euphorbiaceae	Not assessed
<i>Bauhinia variegata</i>	Vaube	Cesalpiniaceae	Least concern
<i>Beilschmedia roxburghiana</i>	Khuang hlang	Lauraceae	Not assessed
<i>Betula cylindrostachya</i>	Hriang- zau	Betulaceae	Not assessed
<i>Bischofia javanica</i>	Khuangthli	Phyllanthaceae	Not assessed
<i>Boehmeria rugulosa</i>	Len-lang	Urticaceae	Not assessed
<i>Bombax ceiba</i>	Phunchawng	Bombacaceae	Not assessed
<i>Bombax insigne</i>	Pang	Bombacaceae	Not assessed
<i>Bridelia retusa</i>	Thing-phak-tel	Euphorbiaceae	Not assessed
<i>Callicarpa arborea</i>	Hnahkiah	Verbenaceae	Not assessed

⁶ Not-assessed/not-evaluated means the taxon has not yet been assessed or evaluated against the IUCN criteria. For details of IUCN categorisation please refer annexure 3.

<i>Caryota urens</i>	Tum	Arecaceae	Not assessed
<i>Cassia fistula</i>	Ngaingaw	Caesalpiniaceae	Not assessed
<i>Cassia javanica</i>	Mak-pa-zang-kang	Caesalpiniaceae	Not assessed
<i>Castanopsis tribuloides</i>	Then mim	Fagaceae	Not assessed
<i>Celtis timorensis</i>	Thingmarcha	Ulmaceae	Not assessed
<i>Choerospondias axillaris</i>	thei-khuang-chawn	Anacardiaceae	Not assessed
<i>Chukrasia velutina</i>	Zawng tei	Meliaceae	Not assessed
<i>Cinnamomun obtusifolium</i>	Thakthibngsuak	Lauraceae	Not assessed
<i>Cinnamomun verum</i>	Thakthing	Lauraceae	Not assessed
<i>Colona floribunda</i>	Hnah-thap	Tiliaceae	Not assessed
<i>Cordia fragrantissima</i>	Mukpui	Boraginaceae	Not assessed
<i>Dalbergia obtusifolia</i>	Bianghrei	Fabaceae	Not assessed
<i>Dendrocnide sinuate</i>	Thak-pui	Urticaceae	Not assessed
<i>Derris robusta</i>	Thingkha	Papilionaceae	Not assessed
<i>Dipterocarpus indicus</i>	Lawngthing	Dipterocarpaceae	Endangered
<i>Duabanga grandiflora</i>	Zuang	Sonneratiaceae	Not assessed
<i>Dyospyros stricta</i>	Thing sam kir	Ebenaceae	Not assessed
<i>Dysoxylum binectariformum</i>	Sa ha tah	Meliaceae	Not assessed
<i>Elaeocarpus serratus</i>	Vantha	Elaeocarpaceae	Not assessed
<i>Emblica officinalis</i>	Sun hlu	Euphorbiaceae	Not assessed
<i>Erythrina variegata</i>	Fartuah	Fabaceae	Least concern
<i>Eurya cerasifolia</i>	Sihneh	Theaceae	Not assessed
<i>Eurya japonica</i>	Sihneh	Theaceae	Not assessed
<i>Ficus auriculata</i>	Theibal	Moraceae	Not assessed
<i>Ficus elastica</i>	Thialret	Moraceae	Not assessed
<i>Ficus hirta</i>	Sazutheipui	Moraceae	Not assessed
<i>Ficus hispida</i>	Paihtemaian	Moraceae	Not assessed

<i>Ficus racemose</i>	Chhohe	Moraceae	Not assessed
<i>Ficus semicordata</i>	Theipui	Moraceae	Not assessed
<i>Gmelina arborea</i>	Thlanvawng	Verbenaceae	Not assessed
<i>Gmelina oblongifolia</i>	Vawngthla	Verbenaceae	Not assessed
<i>Grewia laevigata</i>	Varitabelkang	Tiliaceae	Not assessed
<i>Heteropanax fragrans</i>	Changkhen	Araliaceae	Not assessed
<i>Knema linifolia</i>	Thingthi	Myristicaceae	Not assessed
<i>Ligustrum robustum</i>	Chawmzil	Oleaceae	Not assessed
<i>Lithocarpus pachyphyllus</i>	Thil	Fagaceae	Not assessed
<i>Litsea cubeba</i>	Sernam	Lauraceae	Not assessed
<i>Macaranga indica</i>	Hnahkhar	Euphorbiaceae	Not assessed
<i>Macaranga peltata</i>	Kharduap	Euphorbiaceae	Not assessed
<i>Macaranga pustulata</i>	Hnahkharpa	Euphorbiaceae	Not assessed
<i>Mallotus paniculatus</i>	Khar-pa	Euphorbiaceae	Not assessed
<i>Mangifera indica</i>	Theihai	Anacardiaceae	Not assessed
<i>Manihot esculenta</i>	Pangbal	Euphorbiaceae	Not assessed
<i>Mesua ferrae</i>	Herhse	Guttiferae	Not assessed
<i>Michelia champaca</i>	Ngiau	Magnoliaceae	Not assessed
<i>Neolitsea umbrosa</i>	Thakthing-suak	Lauraceae	Not assessed
<i>Neonauclea purpurea</i>	Lungkhup	Rubiaceae	Not assessed
<i>Olea dioica</i>	Sevuak	Oleaceae	Not assessed
<i>Oroxylum indicum</i>	Archangkawm	Bignoniaceae	Not assessed
<i>Parkia timoriana</i>	Zawngtah	Mimosaceae	Not assessed
<i>Persea villosa</i>	Bul bawn	Lauraceae	Not assessed
<i>Phoebe hainesiana</i>	Bul-eng	Lauraceae	Not assessed
<i>Protium serratum</i>	Bil	Burseraceae	Not assessed
<i>Rhus semialata</i>	Khawm hma	Anacardiaceae	Not assessed

<i>Sapium baccatum</i>	Thing vak pui	Euphorbiaceae	Not assessed
<i>Sapium eugeniaefolium</i>	Thingvawkpuikungmam	Euphorbiaceae	Not assessed
<i>Saraca asoca</i>	Mual hawih	Caesalpiniaceae	Not assessed
<i>Schima wallichii</i>	Khiang	Theaceae	Not assessed
<i>Securinega virosa</i>	Sai siak	Phyllanthaceae	Not assessed
<i>Spondias pinata</i>	Tawitaw	Moraceae	Not assessed
<i>Sterculia alata</i>	Thing van dawl	Sterculiaceae	Not assessed
<i>Sterculia urens</i>	Pang khau	Sterculiaceae	Not assessed
<i>Sterculia villosa</i>	Khaupui	Sterculiaceae	Not assessed
<i>Stereospermum chelonoides</i>	Zihngal	Bignoniaceae	Not assessed
<i>Syzygium clariflorum</i>	Pichilimim	Myrtaceae	Not assessed
<i>Syzygium cumini</i>	Lenhmui	Myrtaceae	Not assessed
<i>Tectona grandis</i>	Tlawr	Verbenaceae	Not assessed
<i>Terminalia myriocarpa</i>	Char	Combretaceae	Not assessed
<i>Tetrameles nudiflora</i>	Thingdawl	Datisceae	Lower risk
<i>Toona ciliata</i>	Teipui	Meliaceae	Lower risk
<i>Trema orientalis</i>	Belphuar	Cannabaceae	Not assessed
<i>Vitex peduncularis</i>	Thing khawi lu	Verenaceae	Not assessed
<i>Wendlandia budleioides</i>	Batling	Rubiaceae	Not assessed

Plate 7: Some Identified Tree Species in the Study Area: Clockwise from top left : *Ficus Spp.* (Strangler fig) ; *Canarium striatum* (Black Dammar) and *Artocarpus Heterophyllus*



Table 6: Identified Herbs and Shrubs in sampling area

Name of the Species	Common Name	Family	IUCN Status	Remarks
<i>Abelmoschus manihot</i>	Ui chu hlo	Malvaceae	Not assessed	Herb
<i>Acacia gageana</i>	Khang hu	Mimosaceae	Not assessed	Climber
<i>Acacia pruinescens</i>	Khang Pawl	Mimosaceae	Not assessed	Climber
<i>Achyranthus aspera</i>	Bu chhawl	Amaranthaceae	Not assessed	Herb
<i>Achyranthus bidentata</i>	Vangvat hlo	Amaranthaceae	Not assessed	Herb
<i>Acmella paniculata</i>	An sa te	Asteraceae	Not assessed	Herb
<i>Acmella uliginosa</i>	An sa te	Asteraceae	Not assessed	Herb
<i>Adenia trilobata</i>	Cho ak a um suak	Passifloraceae	Not assessed	Shrub
<i>Aeschynomene indica</i>	Hlo nuar suak	Fabaceae	Not assessed	Herb
<i>Ageratum conyzoides</i>	Vaihlen-hlo	Asteraceae	Not assessed	Herb
<i>Alternanthera philoxeroides</i>	Ngha-te-ril	Amaranthaceae	Not assessed	Herb
<i>Alternanthera sessilis</i>	An-ngha-ril	Amaranthaceae	Not assessed	Herb
<i>Amaranthus viridis</i>	Len-hling-hling-nei-lo	Amaranthaceae	Not assessed	Herb
<i>Ammomum maximum</i>	Ai-du	Zingiberaceae	Not assessed	Herb
<i>Anisochilus pallidus</i>	Phunglengser	Lamiaceae	Not assessed	Herb
<i>Argyreia splendens</i>	Phel-phek	Convolvulaceae	Not assessed	Climber
<i>Arisaema album</i>	Mitthi-vai-mim	Araceae	Not assessed	Herb
<i>Bauhinia scandens</i>	Zawng-alei-lawn	Caesalpiniaceae	Not assessed	Climber

<i>Borassus flabellifer</i>	Sial-lu	Arecaceae	Not assessed	Palm
<i>Bridelia Montana</i>	Phaktel	Euphorbiaceae	Not assessed	Shrub/small tree
<i>Bridelia stipularis</i>	Hrui-phak-tel	Euphorbiaceae	Not assessed	Shrub
<i>Bridelia tomentosa</i>	Se-be-hliang	Euphorbiaceae	Not assessed	Shrub
<i>Byttneria pilosa</i>	Sa-zuk-nghawng-hlap	Sterculiaceae	Not assessed	Climber
<i>Centella asiatica</i>	Lam-bak	Apiaceae	Not assessed	Herb
<i>Cheilocostus speciosus</i>	Sum-bul	Zingiberaceae	Not assessed	Herb
<i>Chromolaena odorata</i>	Tlang-sam	Asteraceae	Not assessed	Shrub
<i>Cissampelos pareira</i>	Hnah-bial-hrui	Menispermaceae	Not assessed	Climber
<i>Cissus japonica</i>	Sa-nghar-hmai	Vitaceae	Not assessed	Climber
<i>Cissus repens</i>	Hrui-pawl	Vitaceae	Not assessed	Climber
<i>Clausena excavate</i>	Arpa-sen-til	Rutaceae	Not assessed	Shrub
<i>Clerodendron infortunatum</i>	Phui-hnam-chhia	Verbenaceae	Not assessed	Shrub
<i>Codariocalyx gyroides</i>	Hmei-thai-sa-rawh-t	Fabaceae	Not assessed	Shrub
<i>Colebrookiana oppositifolia</i>	Kawih-thuang-suak	Lamiaceae	Not assessed	Shrub
<i>Colocassia affinis</i>	Lep-lawp	Araceae	Not assessed	Herb
<i>Colquhounia coccinea</i>	Zumzuk	Lamiaceae	Not assessed	Shrub
<i>Combretum indicum</i>	--	Combretaceae	Not assessed	Climber
<i>Connarus paniculatus</i>	Hmeh-keh-rep	Connaraceae	Not assessed	Climber

<i>Crassocephalum crepidioides</i>	Buar-thau	Asteraceae	Not assessed	Herb
<i>Crotalaria micans</i>	Di-ral	Fabaceae	Not assessed	Shrub
<i>Cryptolepis dubia</i>	Thei-kel-ki-suak	Asclepiadaceae	Not assessed	Climber
<i>Cyanotis cristata</i>	Vawm-kur	Commelinaceae	Not assessed	Herb
<i>Daemonorops jenkinsiana</i>	Rai-chhawk	Arecaceae	Not assessed	Palm
<i>Dalbergia pinnata</i>	Saizawl	Fabaceae	Not assessed	Shrub
<i>Debregeasia longifolia</i>	Leh-ngo	Urticaceae	Not assessed	Shrub
<i>Dendrobium triangulare</i>	Se-be-hliang	Fabaceae	Not assessed	Shrub
<i>Dendrophthoe falcate</i>	Thikhthli-ek-bawm-chi-khat	Loranthaceae	Not assessed	Bushy parasite
<i>Dioscorea alata</i>	Ba-chhim	Dioscoriaceae	Not assessed	Climber
<i>Dioscorea glabra</i>	Hra-kai	Dioscoriaceae	Not assessed	Climber
<i>Dioscorea hispida</i>	li-liam	Dioscoriaceae	Not assessed	Climber
<i>Dioscorea pentaphylla</i>	Vawk-pui-ba-hra	Dioscoriaceae	Not assessed	Climber
<i>Entada purseatha</i>	Khawihrui	Fabaceae	Not assessed	Climber
<i>Gallinsoga parviflora</i>	Sazu-pui-chaw	Asteraceae	Not assessed	Herb
<i>Ipomoea hederifolia</i>	Ni-pui-par	Convolvulaceae	Not Assessed	
<i>Jasmenium elongatum</i>	Hlo-kha	Oleaceae	Not assessed	Climber
<i>Jasmenium laurifolium</i>	Kangfimhrui	Oleaceae	Not assessed	Climber
<i>Jasmenium multiflorum</i>	Hlo-kha	Oleaceae	Not assessed	Climber

<i>Jasmenium nervosum</i>	Hrui-kha	Oleaceae	Not assessed	Climber
<i>Jasmenium scandens</i>	Hrui-dam-dawi	Oleaceae	Not assessed	Shrub
<i>Leea compactiflora</i>	Kum-tin-tuai	Leeaceae	Not assessed	Shrub
<i>Lepionurus sylvestris</i>	Anpangthuam	Olacaceae	Not assessed	Shrub
<i>Maesa indica</i>	Arngeng	Myrsinaceae	Not assessed	Shrub
<i>Melastoma malabathricum</i>	Bui-lu-kham	Melastomaceae	Not assessed	Shrub
<i>Merremia umbellata</i>	Thian-pa	Convolvulaceae	Not assessed	Climber
<i>Mussanda macrophylla</i>	Va-kep	Rubiaceae		Shrub
<i>Nervilia arangoana</i>	Hnah-khat	Orchidaceae	Not assessed	Climber
<i>Osbeckia stellata</i>	Bui-lu-kham-pa	Melastomaceae	Not assessed	Shrub
<i>Oxyspora paniculata</i>	Kham-par	Melastomaceae	Not assessed	Shrub
<i>Pavetta indica</i>	Thai-nu-ruai	Rubiaceae	Not assessed	Shrub
<i>Pericampylus glaucus</i>	Khau-chhim	Menispermaceae	Not assessed	Climber
<i>Polygonum chinense</i>	Diktawn	Polygalaceae	Not assessed	Herb
<i>Pothos chinensis</i>	Liking-chang-dam	Araceae	Not assessed	Climber
<i>Pothos scandens</i>	Laiking-tai-rua	Araceae	Not assessed	Climber
<i>Premna coriacea</i>	Kuam	Verbinaceae	Not assessed	Climber
<i>Rhododendron johnstonanum</i>	Chhawkhleipar-var	Ericaceae	Not assessed	Shrub
<i>Rubia cordifolia</i>	Saphit	Rubiaceae	Not assessed	Climber

<i>Rubus alceifolius</i>	Siali-nu-chhu	Rosaceae	Not assessed	Shrub
<i>Saccharum arundinaceum</i>	Rai- Ruang	Poaceae	Not assessed	Grass
<i>Sarcochlamys pulcherrima</i>	Leh-ngo	Urticaceae	Not assessed	Shrub
<i>Sida acuta</i>	Khing-khih	Malvaceae	Not assessed	Shrub
<i>Smilax glabra</i>	Tluang-ngil	Smilacaceae	Not assessed	Climber
<i>Smilax ovalifolia</i>	Kai-ha-pui	Smilacaceae	Not assessed	Climber
<i>Stachyphrynium placentarium</i>	Hnah-thial-pa	Marantaceae	Not assessed	Herb
<i>Tadehagi triquetrum</i>	Ui-fawm-a-ring	Fabaceae	Not assessed	Herb
<i>Thysanolaena maxima</i>	Hmunphiah	Poaceae	Not assessed	Grass
<i>Triumfetta rhomboidea</i>	Se-hnap-suak	Tiliaceae	Not assessed	Shrub
<i>Urena lobata</i>	Se-hnap	Malvaceae	Not assessed	Shrub

Table 7: Identified Bamboo, Orchids and Ferns in Sampling Area

Name of the Species	Common Name	Family	IUCN Status	Remarks
<i>Adiantum phillippense</i>	Lungpui-sam	Adiantaceae	Not assessed	Fern
<i>Aerides rosea</i>	Nauban	Orchidaceae	Not assessed	Orchid
<i>Aglaomorpha coronans</i>	Tuai-bur	Polypodiaceae	Not assessed	Fern
<i>Bambusa tulda</i>	Rawthing	Poaceae	Not assessed	Bamboo
<i>Bulbophyllum lobbi</i>	Hnankhat	Orchidaceae	Not assessed	Orchid
<i>Cyathea chinensis</i>	Kawk-pui	Cyatheaceae	Not assessed	Tree fern
<i>Dendrobium chrysanthum</i>	Danghang	Orchidaceae	Not assessed	Orchid
<i>Dendrobium falconeri</i>	Lenpatkungbawl	Orchidaceae	Not assessed	Orchid
<i>Dendrobium formosum</i>	Nauban parvar	Orchidaceae	Not assessed	Orchid
<i>Dendrobium nobile</i>	Nauban	Orchidaceae	Not assessed	Orchid
<i>Dendrobium wattii</i>	Nauban parvar	Orchidaceae	Not assessed	Orchid
<i>Dendrocalamus dampnensis</i>	Dampa mau	Poaceae	Not assessed	Bamboo
<i>Dendrocalamus hamiltonii</i>	Phulrua	Poaceae	Not assessed	Bamboo
<i>Dendrocalamus longispathus</i>	Rawnal	Poaceae	Not assessed	Bamboo
<i>Dicranopteris linearis</i>	Ar-thla-dawn	Gleicheniaceae	Not assessed	Fern
<i>Dinochloa compactiflora</i>	Sairil	Poaceae	Not assessed	Bamboo
<i>Drynaria quercifolia</i>	Tui bur suak	Polypodiaceae	Not assessed	Fern
<i>Dryopteris sp.</i>	Katchatpui	Polypodiaceae	Not assessed	Fern
<i>Lygodium flexuosum</i>	Dawnzempui	Lygodiaceae	Not assessed	Fern
<i>Melocanna baccifera</i>	Mautak	Poaceae	Not assessed	Bamboo
<i>Schizostachyum</i>	Rawthla	Poaceae	Not assessed	Bamboo

dullosa

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Plate 8: Some Identified Herbs and Shrubs in the Study Area: Clockwise from top left- *Broom grass*, *Cissampelos perera*, *Cissus javanica*, *Parkia roxburghiana*, *Cromolena odorata* and *Cissus discolor*



Table 8: Important Value index for Identified Tree species

Name of the Species	Relative frequency	Relative density	Relative dominance	IVI
<i>Acacia gigante</i>	0.673401	0.486216	0.301175	1.460791
<i>Alangium chinense</i>	0.673401	0.324144	0.523937	1.521482
<i>Albizia chinensis</i>	1.010101	0.972432	1.725072	3.707604
<i>Albizia procera</i>	2.020202	1.620719	3.42163	7.062551
<i>Alphosea lutea</i>	0.3367	0.162072	0.11643	0.615203
<i>Alstonia scholaris</i>	0.673401	0.324144	0.684326	1.681871
<i>Anthocephalus chinense</i>	0.3367	0.162072	0.60829	1.107062
<i>Artocarpus chama</i>	2.020202	0.972432	1.512503	4.505137
<i>Artocarpus heterophyllus</i>	0.673401	1.458647	3.614097	5.746145
<i>Artocarpus lakoocha</i>	1.010101	1.458647	3.079467	5.548215
<i>Baccaurea ramiflora</i>	0.3367	0.162072	0.282308	0.781081
<i>Bauhinia variegata</i>	2.693603	3.241439	2.328609	8.263651
<i>Beilschmedia roxburghiana</i>	0.3367	0.162072	0.152072	0.650845
<i>Bischofia javanica</i>	0.673401	0.486216	1.026489	2.186105
<i>Bombax ceiba</i>	1.346801	1.134503	2.012584	4.493889
<i>Bombax insigne</i>	2.020202	1.458647	1.7322	5.21105
<i>Bridelia montana</i>	0.3367	0.162072	0.085541	0.584313
<i>Callicarpa arborea</i>	2.356902	1.134503	1.347267	4.838673
<i>Caryota urens</i>	0.3367	0.162072	0.11643	0.615203
<i>Cassia fistula</i>	1.346801	0.81036	0.427704	2.584865
<i>Cassia japonica</i>	0.673401	0.324144	0.118807	1.116351
<i>Celtis timorensis</i>	0.3367	0.81036	0.190091	1.337151
<i>Cinnamomun obtiosifolium</i>	0.3367	0.162072	0.021385	0.520157

<i>Cinnamomun verum</i>	0.3367	0.162072	0.038018	0.53679
<i>Cordia fragranlissima</i>	0.673401	0.324144	0.200783	1.198328
<i>Dalbergia pinnata</i>	0.673401	0.486216	0.231602	1.391218
<i>Dendrocantie sinerata</i>	0.673401	1.134503	0.215563	2.023467
<i>Derris robusta</i>	4.713805	6.158733	1.592769	12.46531
<i>Dipterocarpus indicus</i>	0.3367	0.162072	0.287512	0.786284
<i>Duabanga grandiflora</i>	4.040404	5.672517	9.700321	19.41324
<i>Dysoxylum binectariformum</i>	0.3367	0.162072	0.214446	0.713218
<i>Elaeocarpus serratus</i>	1.010101	0.972432	1.369222	3.351755
<i>Emblica officinalis</i>	0.3367	0.162072	0.100392	0.599164
<i>Erythrina variegata</i>	4.040404	2.755223	1.266763	8.06239
<i>Eurya cerasifolia</i>	1.010101	0.648288	0.209955	1.868344
<i>Eurya japonica</i>	0.3367	0.162072	0.048117	0.546889
<i>Ficus auriculata</i>	2.356902	3.079367	3.339036	8.775305
<i>Ficus elastic</i>	0.3367	0.162072	0.342163	0.840935
<i>Ficus hirta</i>	0.673401	1.296575	2.300096	4.270072
<i>Ficus hispida</i>	1.683502	1.134503	1.201729	4.019734
<i>Ficus racemose</i>	1.683502	1.296575	1.156511	4.136588
<i>Ficus semicordata</i>	1.010101	1.782791	0.251181	3.044073
<i>Gmelina arborea</i>	1.683502	1.458647	1.849605	4.991754
<i>Gmelina oblongifolia</i>	0.3367	0.162072	0.16766	0.666432
<i>Grewia laevigata</i>	0.673401	0.324144	0.048663	1.046208
<i>Heteropanax fragrans</i>	1.010101	0.648288	0.401566	2.059955
<i>Lepionurus sylvestris</i>	0.3367	0.162072	0.050279	0.549051
<i>Ligustrum robustum</i>	0.3367	0.972432	0.328476	1.637608
<i>Lithocarpus pachyphyllum</i>	2.020202	1.944863	1.242052	5.207117
<i>Litsea cubeba</i>	0.3367	0.162072	0.057051	0.555823

<i>Macaranga indica</i>	0.673401	2.593151	2.081872	5.348423
<i>Macaranga peltata</i>	5.723906	8.589812	8.05984	22.37356
<i>Macaranga pustulata</i>	0.3367	1.296575	0.878979	2.512254
<i>Mangifera indica</i>	0.3367	0.162072	0.179849	0.678622
<i>Mesua ferrea</i>	1.010101	0.486216	0.400972	1.897289
<i>Michelia champaca</i>	2.693603	2.917295	4.44983	10.06073
<i>Neonauclea perpurea</i>	1.346801	0.81036	1.309843	3.467004
<i>Oroxylum indicum</i>	0.3367	0.162072	0.247213	0.745985
<i>Parkia timoriana</i>	1.683502	1.296575	1.67964	4.659717
<i>Protium seratum</i>	0.673401	0.324144	0.194653	1.192197
<i>Rhus simialata</i>	3.030303	1.782791	0.439371	5.252465
<i>Sapium baccatum</i>	0.3367	0.324144	0.165426	0.82627
<i>Sapium insigne</i>	0.673401	0.324144	0.114102	1.111646
<i>Schima wallichii</i>	2.693603	2.431079	2.514898	7.63958
<i>Securinega virosa</i>	0.3367	0.162072	0.034311	0.533084
<i>Spondias pinnata</i>	0.3367	0.162072	0.188213	0.686986
<i>Sterculia alata</i>	0.673401	1.296575	1.127047	3.097023
<i>Sterculia urens</i>	0.3367	0.162072	0.196767	0.69554
<i>Sterculia villosa</i>	1.010101	0.486216	0.616535	2.112852
<i>Stereospermum personatum</i>	2.356902	2.917295	1.807048	7.081245
<i>Steriospermum</i>	0.673401	0.648288	0.389305	1.710994
<i>Syzygium clariflorum</i>	0.3367	0.324144	0.239562	0.900406
<i>Syzygium cummuni</i>	0.673401	1.458647	1.368652	3.5007
<i>Tectona grandis</i>	4.040404	6.158733	6.371075	16.57021
<i>Terminalia myriocarpa</i>	0.3367	0.162072	0.137245	0.636018
<i>Tetrameles nudiflora</i>	2.020202	1.782791	5.344847	9.147841

<i>Toona ciliate</i>	3.367003	1.944863	1.478144	6.790011
<i>Trema orientalis</i>	6.060606	9.076028	4.32323	19.45986
<i>Wendlandia budleindes</i>	0.3367	0.162072	0.022835	0.521607

Biodiversity Indexing

As per Shannon-wiener index of diversity, the values $H' = 3.457$ and 5.373 (Figure 10) was found for the tree species and others plants (herbs, shrubs, climbers) respectively. The values of Shannon-wiener index usually ranges from 1.5 to 3.5. An ecosystem with H' value greater than 2 has been regarded as medium to high diverse in terms of species (Barbour *et al.* 1999). Therefore, the current study area can regarded as medium to highly diverse forest.

As per Simpson index of dominance: The values $D = 0.036$ and 0.0481 (Figure 11) was found for the tree species and others plants (herbs, shrubs, climbers) respectively. Simpson index values range from 0 to 1. The Simpson index of diversity is given as $1-D$ which again indicates higher diversity values in the study area.

In case of Importance Value Index (IVI) for tree species *Macaranga peltata* (22.373) was found to be the most important species followed by *Trema orientalis* (19.45), *Duabanga grandiflora* (19.41), *Tectona grandis* (16.57), *Derris robusta* (12.46) and so on. The least Importance Value Index value was observed for *Cinnamomum obtiosifolium* (0.52).

Percent species distribution in family Euphorbiaceae was found to be highest followed by Moraceae, Poaceae, Fabaceae, Verbinaceae and Lauraceae.

Figure 11: Shannon - Weiner Indices H'

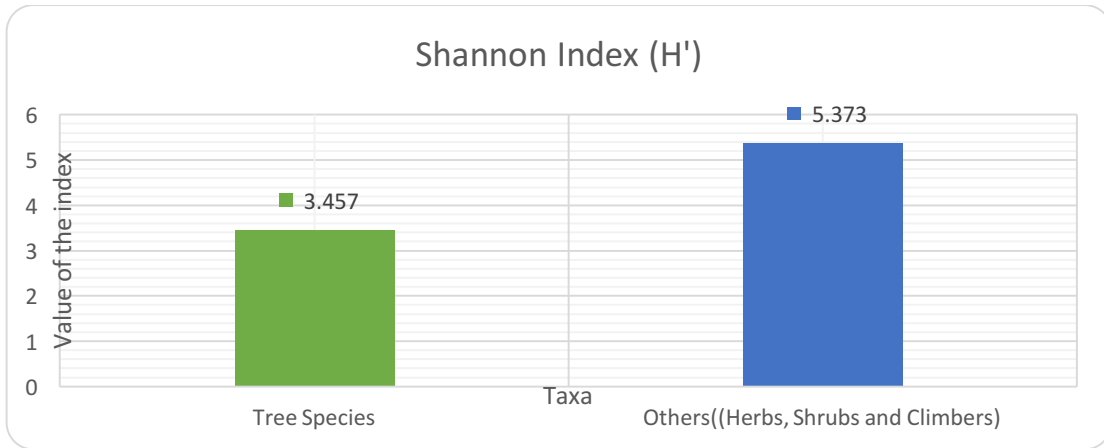
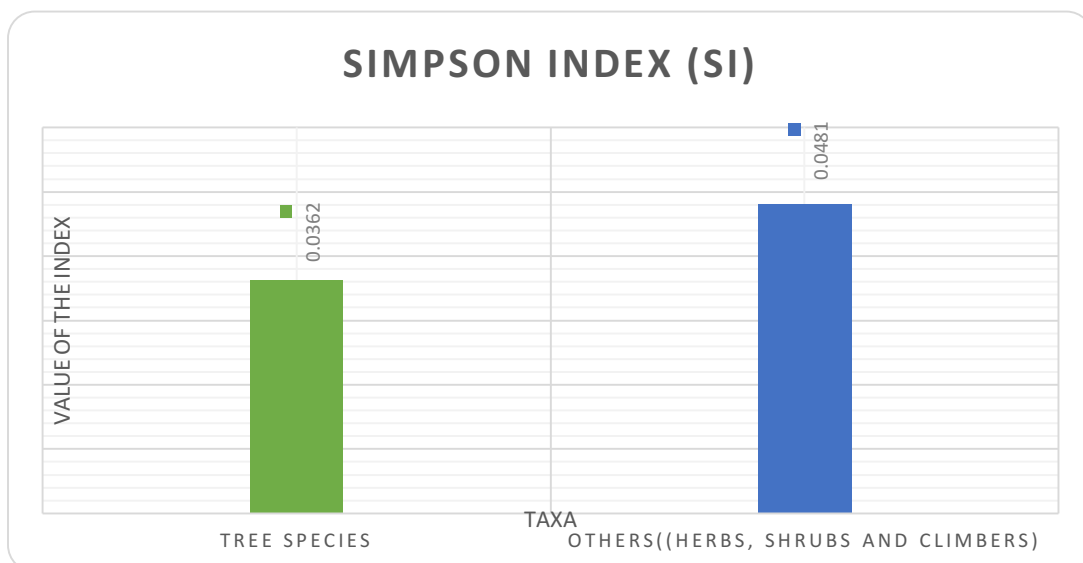


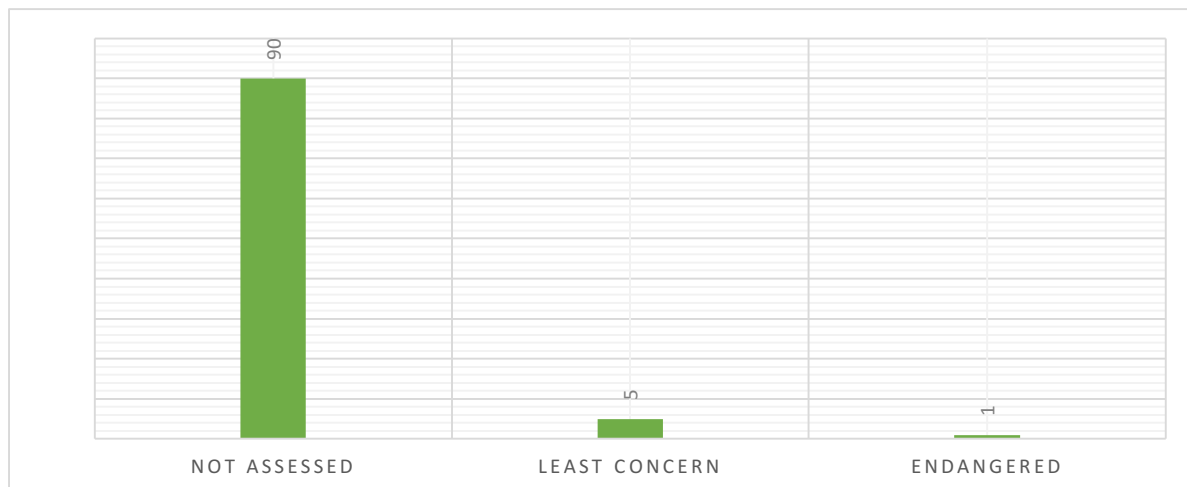
Figure 12: Values of Simpson Indices



RET Species

A total number of 96 species were found in the quadrats laid in the area. On the basis of Rare, Endangered, Threatened assessment of the species, it was found that most of the species were in the category of 'Not Evaluated' in the IUCN category list. However one species was found in the category of high conservation importance i.e. *Dipterocarpus indicus* (Endangered category). The illustrative chart of the Rare, Endangered and Threatened species assessment is details below and complete list of the species is provided in the chart below.

Figure 13: RET Results of Flora



Fauna

A checklist based on the field study, secondary literature and interactions with local people and forest officials has been prepared. This comprises of 93 bird species (Table 9), 11 mammal species (Table 10), 5 amphibians (Table 11), 9 reptiles (Table 12), and 42 butterfly species (Table 13).

RET Status Study

Mammals

Chart below reveals the mammals found in the biodiversity assessment of the area. A total of 11 species were recorded and categorized into the various IUCN Categories. On analysis it was found that most of the species were in the category of least concern. However, there is one endangered species viz. *Hoolock hoolock*. *Trachypithecus pileatus* and *Macaca arctiodes* were found in the vulnerable category. The complete list of species is provided in Chart 5.

Table 9: Identified Birds in Sampling Area

S. No	Common Name	Scientific Name	IUCN Status
1	White cheeked Partridge	<i>Arborophila atrogularis</i>	Near Threatened
2	Mountain bamboo Partridge	<i>Bambusicola fytchii</i>	Least Concern
3	Red jungle fowl	<i>Gallus gallus</i>	Least Concern
4	Striated heron	<i>Butorides stariata</i>	Least Concern
5	Cattle egret	<i>Bubulcus ibis</i>	Least Concern
6	Mountain hawk eagle	<i>Nisaetus nipalensis</i>	Least Concern
7	Spotted dove	<i>Streptopelia chinensis</i>	Least Concern
8	Ashy-headed green pigeon	<i>Treron phayei</i>	Near Threatened
9	Wedge tailed green pigeon	<i>Treron sphennurus</i>	Least Concern
10	Mountain scops owl	<i>Otus spilocephalus</i>	Least Concern
11	Oriental scops owl	<i>Otus sunia</i>	Least Concern
12	Silver backed Needle tail	<i>Hirundapus cochinchii</i>	Least Concern
13	House swift	<i>Apus nipalensis</i>	Least Concern
14	Red head trogon	<i>Harpactes erythrocephalus</i>	Least Concern
15	Oriental dwarf kingfisher	<i>Ceyx erithaca</i>	Least Concern
16	Stork billed kingfisher	<i>Pelargopsis capensis</i>	Least Concern
17	Blue eared kingfisher	<i>Alcedo meneiting</i>	Least Concern
18	Blue beared bee eater	<i>Nyctyornis athertoni</i>	Least Concern
19	Indian roller	<i>Coracias benghalensis</i>	Least Concern
20	Eurasian hoopoe	<i>Epupa epops</i>	Least Concern
21	Great hornbill	<i>Buceros bicornis</i>	Near Threatened
22	Wreathed hornbill	<i>Aceros undulatus</i>	Least Concern
23	Great barbet	<i>Megalaima virens</i>	Least Concern
24	Grey capped woodpecker	<i>Dendrocopos canicapillus</i>	Least Concern

25	Rufous woodpecker	<i>Celeus brachyurus</i>	Least Concern
26	Pied falconet	<i>Microhierax melanoleucos</i>	Least Concern
27	Eurasian kestrel	<i>Falco tinnunculus</i>	Least Concern
28	Large woodshrike	<i>Tephrodornis gularis</i>	Least Concern
29	Short billed minivet	<i>Pericrocotus brevirostris</i>	Least Concern
30	Scarlet minivet	<i>Pericrocotus speciosus</i>	Least Concern
31	Grey backed shrike	<i>Lanius tephonotus</i>	Least Concern
32	Black hooded oriole	<i>Oriolus xanthornus</i>	Least Concern
33	Ashy drongo	<i>Dicrurus leucophaeus</i>	Least Concern
34	Crow billed Drongo	<i>Dicrurus annectans</i>	Least Concern
35	Black naped Monarch	<i>Hypothymis azurea</i>	Least Concern
36	Common green magpie	<i>Cissa chinensis</i>	Least Concern
37	Large billed crow	<i>Corvus macrorhynchos</i>	Least Concern
38	Grey headed canary- Flycatcher	<i>Culicipa ceylonensis</i>	Least Concern
39	Black crested bulbul	<i>Pycnonotus flaviventris</i>	Least Concern
40	Red vented bulbul	<i>Pycnonotus cafer</i>	Least Concern
41	Scaly breasted/pygmy cupwing	<i>Pnoepyga albiventer</i>	Least Concern
42	Grey billed Tesia	<i>Tesia cyaniventer</i>	Least Concern
43	Slaty bellied tesia	<i>Tesia olivea</i>	Least Concern
44	Yellow bellied warbler	<i>Abroscopus superciliaris</i>	Least Concern
45	Black faced warbler	<i>Abroscopus schisisticeps</i>	Least Concern
46	Yellow brown/Hume's Warbler	<i>Phylloscopus inornatus</i>	Least Concern
47	Eastern crowned leaf warbler	<i>Phylloscopus trochiloides</i>	Least Concern
48	Golden spectacled warbler	<i>Seicerus burkii</i>	Least Concern
49	Blyth's reed warbler	<i>Acrocephalus dumoteum</i>	Least Concern

50	Wastern crowned warbler	<i>Phylloscopus occipitalis</i>	Least Concern
51	Thick billed warbler	<i>Phragmaticola aedon</i>	Least Concern
52	Common tailorbird	<i>Orthotomus sutorius</i>	Least Concern
53	Refescent prina	<i>Prinia rufescens</i>	Least Concern
54	Oriental white eye	<i>Zosteropus palpebrosus</i>	Least Concern
55	Pin striped tit Babbler	<i>Mixornis gularis</i>	Least Concern
56	Rufous-fronted Babbler	<i>Cyanordema rufirons</i>	Least Concern
57	White browed Scimitar- Babbler	<i>Pomatorhinus schisticeps</i>	Least Concern
58	Large scimitar babbler	<i>Megapomatorhinus hypoleucos</i>	Least Concern
59	Grey throated babbler	<i>Stachyris nigriceps</i>	Least Concern
60	White hooded babbler	<i>Gampsorhynchus rufulus</i>	Least Concern
61	Puff throated babbler	<i>Pellornum ruficeps</i>	Least Concern
62	Eyebrowed wren babbler	<i>Napothera epilepidota</i>	Least Concern
63	Nepal fulvetta	<i>Alcippe nipalensis</i>	Least Concern
64	White crested laughingthrush	<i>Garrulax leucolophus</i>	Least Concern
65	Greater Necklaced Laughingthrush	<i>Lanthocincla pectoralis</i>	Least Concern
66	Asian fairy bluebird	<i>Irena puella</i>	Least Concern
67	Brown breasted flycatcher	<i>Muscicapa muttui</i>	Least Concern
68	Oriental magpie Robin	<i>Copsychus saularis</i>	Least Concern
69	White tailed flycatcher	<i>Cornis concretus</i>	Least Concern
70	Verditer flycatcher	<i>Eumyias thalassinus</i>	Least Concern
71	Blue whistling thrush	<i>Myophonus caureleus</i>	Least Concern
72	Spotted forktail	<i>Enicurus maculatus</i>	Least Concern
73	Black backed forktail	<i>Enicurus immaculatus</i>	Least Concern
74	Siberian rubythroat	<i>Calliope calliope</i>	Least Concern

75	Little pied flycatcher	<i>Ficedula westermanni</i>	Least Concern
76	Rufous gorgeted flycatcher	<i>Ficedula strophciata</i>	Least Concern
77	White capped redstart	<i>Phoenicurus leucocephalus</i>	Least Concern
78	Blue rock- thrush	<i>Monticola solitarius</i>	Least Concern
79	Grey bushchat	<i>Saxicola ferreus</i>	Least Concern
80	Dark sided flycatcher	<i>Muscicapa sibirica</i>	Least Concern
81	Dark sided thrush	<i>Zootgera marginata</i>	Least Concern
82	Common hill myana	<i>Gracula religiosa</i>	Least Concern
83	Common myana	<i>Acridotheres tristis</i>	Least Concern
84	Golden fronted leafbird	<i>Chloropsisaurifrons</i>	Least Concern
85	Plain flowerpecker	<i>Dicaeum minullum</i>	Least Concern
86	Ruby cheeked sunbird	<i>Chalcoparis singalensis</i>	Least Concern
87	Little spiderhunter	<i>Arachnothera longirostra</i>	Least Concern
88	Streaked spiderhunter	<i>Arachnothera magna</i>	Least Concern
89	Grey wagtail	<i>Motacilla cinerea</i>	Least Concern
90	Forest wagtail	<i>Dendronanthus indicus</i>	Least Concern
91	Eurasian tree sparrow	<i>Passer montanus</i>	Least Concern
92	Black stork	<i>Ciconia nigra</i>	Least Concern
93	Himalyan bluetail	<i>Tarsiger cyanurus</i>	Least Concern

Plate 9: Some Identified Bird Species in the Study Area: Clockwise from top left – Common Magpie Robin, Jungle Babbler, Indian Roller, Street Spider Hunter, Hill Mynah and Oriental Pied Hornbill



Table 10: Identified Mammals in Sampling Area

	Common Name	Scientific Name	Vernacular Name	IUCN status
Mammals	Western Hoolock gibbon	<i>Hoolock hoolock</i>	Hauhuk	Endangered
	Rhesus macaque	<i>Macaca mulatta</i>	Zawng	Least Concern
	Assamese macaque	<i>Macaca assamensis</i>	Zo/Khan Zawng	Not Threatened
	Stump tailed macaque	<i>Macaca arctiodes</i>	Zawnghmaisen	Vulnerable
	Capped leaf monkey	<i>Trachypithecus pileatus</i>	Ngau	Vulnerable
	Flying fox	<i>Pteropus giganteus</i>	Not known	Least Concern
	Short-nosed fruit bat	<i>Cynopterus sphnix</i>	Not known	Least Concern
	Rat-headed bat	<i>Tylonycteris pachypus</i>	Not known	Least Concern
	House-mouse	<i>Mus musculus</i>	Not known	Least Concern
	House rat	<i>Rattus rattus</i>	Not known	Least Concern
	Jungle cat	<i>Felis chaus</i>	Sauak	Least Concern

Plate 10: Some Identified Mammal Species in the Study Area: *Hoolock Gibbon* (above) and *Rhesus Macaque* (below)



Table 11: Identified Amphibians in Sampling Area

	Family	Scientific Name	IUCN Status
Frogs	Bufonidae	<i>Bufo melanostictus</i>	Least Concern
	Megophryidae	<i>Xenophrys parva</i>	Least Concern
	Ranidae	<i>Amolops marmoratus</i>	Least Concern
	Ranidae	<i>Rana danielli</i>	Least Concern
	Rhacophoridae	<i>Philautus sp.</i>	Least Concern
		<i>Rhacophorus bipunctatus</i>	Least Concern
		<i>Rhacophorus maximus</i>	Least Concern

Table 12: Identified Reptiles in Sampling Area

	Family	Scientific Name	IUCN Status
Lizards	Agamidae	<i>Draco sp.</i>	Least Concern
	Agamidae	<i>Draco maculates</i>	Least Concern
	Agamidae	<i>Ptyctolaemus gularis</i>	Not assessed
	Gekkonidae	<i>Gekko gekko</i>	Not assessed
	Scincidae	<i>Mabuya multifasciata</i>	Not assessed
Snakes	Colubridae	<i>Amphiesma xenura</i>	Not assessed
		<i>Xenochrophis piscator</i>	Not assessed
	Viperidae	<i>Trimeresurus cf. stejnegeri</i>	Not assessed
	Elapidae	<i>Bungarus fasciatus</i>	Least Concern

Plate 11: Some Identified Reptile Species in the Study Area: *Eutropis multifasciata* (above) and *Gecko Gecko* (below)



Plate 12: Some Identified Amphibian Species in the Study Area: *Duttaphrynus melanostictus* (above) and *Bunaarus fasciatus* (below)



Table 13: Identified Butterflies in Sampling Area

	Family	Scientific Name	Common Name	IUCN Status
Butterflies	Papilionidae	<i>Pailio paris</i>	Pari peacock	Not assessed
		<i>Graphium doson</i>	Common jay	Not assessed
		<i>Graphium xenocles</i>	Great zebra	Not assessed
		<i>Graphium megarus</i>	Spotted zebra	Not assessed
		<i>Papilio polytes</i>	Common Mormon	Not assessed
		<i>Graphium eurypylus</i>	Great Jay	Not assessed
		<i>Papilio castor</i>	Common mime	Not assessed
		<i>Papilio nephelus</i>	Yellow helen	Not assessed
		<i>Byasa dasarada</i>	Great windmill	Not assessed
	Pieridae	<i>Catopsilia pyranthe</i>	Mottled emigrant	Not assessed
		<i>Catopsilia pomona</i>	Lemon emigrant	Not assessed
		<i>Eurema andersoni</i>	One spot grass yellow	Not assessed
		<i>Cepora nerissa</i>	Common gull	Not assessed
		<i>Appias indra</i>	Plain buffin	Not assessed
		<i>Delias pasithoe</i>	Red-base jezebel	Not assessed
		<i>Eurema hecabe</i>	Common grass yellow	Not assessed
		<i>Gandaca harina</i>	Tree yellow	Not assessed
		<i>Pieris canidia</i>	Asian cabbage white	Not assessed
	Nymphalidae	<i>Apatura ambica</i>	Indian purple emperor	Not assessed
		<i>Mimathyma chevana</i>	Sergeant emperor	Not assessed
<i>Athyma cama</i>		Orange staff sergeant	Not assessed	
<i>Symbrenthia hypselis</i>		Spotted jester	Not assessed	
<i>Euploea core</i>		Common crow	Not assessed	
<i>Danaus chrysippus</i>		Plain tiger	Not assessed	
<i>Parantica aglea</i>		Glassy tiger	Not assessed	

	<i>Athyma asura</i>	Studded sergeant	Not assessed
	<i>Pantoporia hordonia</i>	Common lascar	Not assessed
	<i>Junonia atlites</i>	Grey pansy	Not assessed
	<i>Melanitis zitenius</i>	Great evening brown	Not assessed
Lycanidae	<i>Cheritra freja</i>	Common Imperial	Not assessed
	<i>Pithecopa corvus</i>	Forest quaker	Not assessed
	<i>Remelana jangala</i>	Chocolate royal	Not assessed
	<i>Caleta elna</i>	Elbowed pierrot	Not assessed
	<i>Leptotes plinius</i>	Zebra blue	Not assessed
	<i>Heliophorus epicales</i>	Purple sapphire	Not assessed
	<i>Hypolycaena erylus</i>	Common tit	Not assessed
Hesperiidae	<i>Iton semamura</i>	Common wight	Not assessed
	<i>Tagiades japedus</i>	Common snow flat	Not assessed
	<i>Odontoptilum angulata</i>	Chestnut angle	Not assessed
	<i>Hasora vita</i>	Plain banded awl	Not assessed
	<i>Lambrix salsala</i>	Chestnut bob	Not assessed
	<i>Sarangesa dasahrara</i>	Common small flat	Not assessed

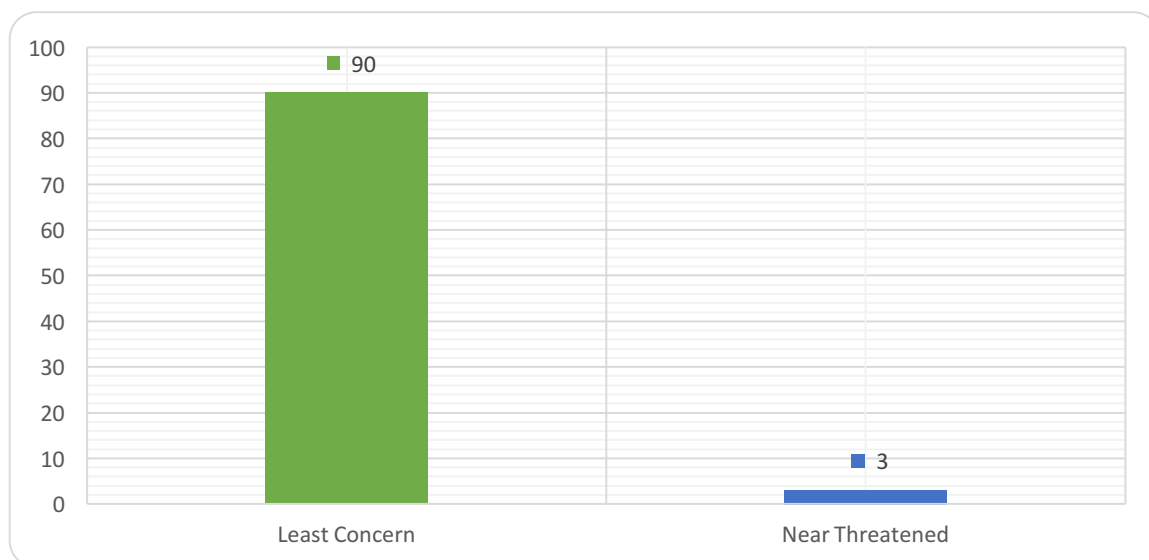
Plate 13: Some Identified Butterfly Species in the Study Area: Clockwise from top left- Yellow Helen, Grass Yellow, Mormon Papilio Polytes, *Lascar Pantoporia hordonia*, Red Base Jexebel and Jay *Graphium doson* Axion



RET STATUS

Avian Species

Figure 14: RET results for Avian species



On assessment of avian diversity in the area, a sample of 93 species was found. The Rare, Endangered and Threatened species assessment of the species reveals that 90 number of the species were in the category of 'Least Concern', followed by 3 number of species which were found in the 'Near Threatened category'. The 'Near Threatened category' of species is White Cheeked Partridge, Ashy-headed green pigeon and Great hornbill. The complete list of species is provided in the Table 9.

Figure 15: RET results of Mammals

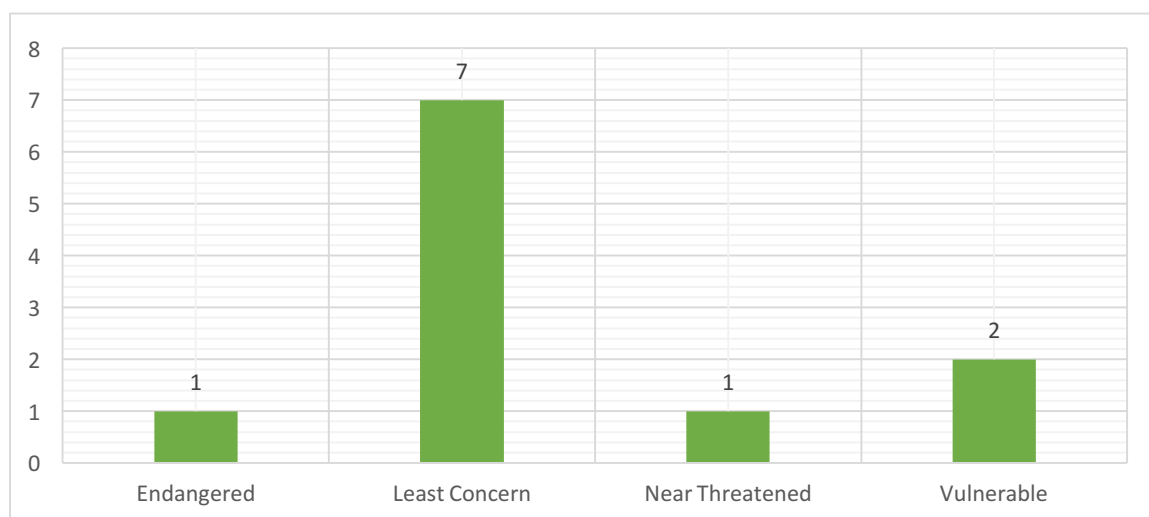
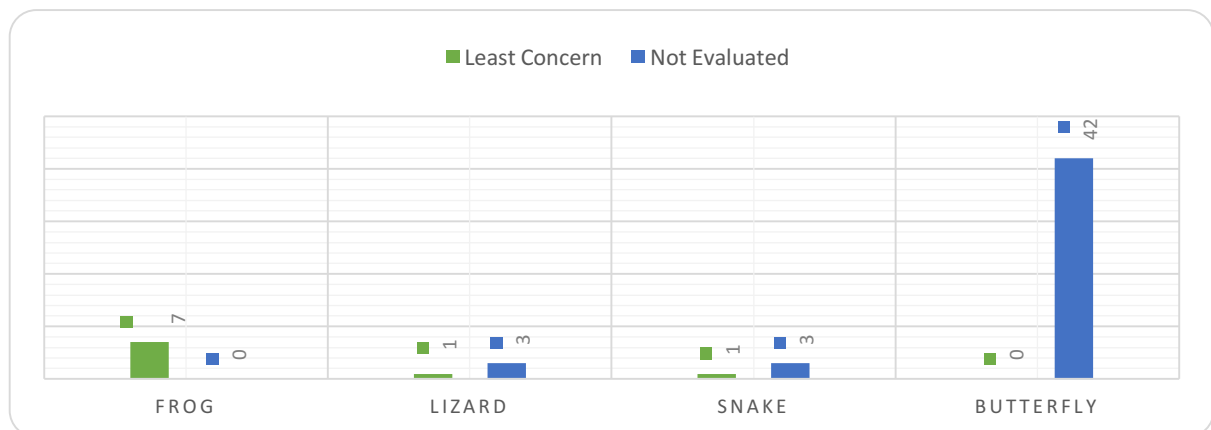


Chart above reveals the mammals found in the biodiversity assessment of the area. A total of 11 species were recorded and categorized into the various IUCN Categories. On analysis it was found that most of the species were in the category of least concern. However, there were two endangered species also viz. *Hoolock hoolock* and *Trachypithecus pileatus*. Two species were also found in the Endangered and Vulnerable category i.e. *Macaca assamensis* and *Macaca arctiodes* respectively. The complete list of species is provided in Table 10.

Others

Figure 16: RET results for other species



In the others category, four fauna families were assessed. These are Frog, Lizards, Snake and Butterfly. A total number of 57 species were found in all these categories. On Rare, Endangered and Threatened species assessment of the species; it was found that all of the species were in the category of 'Least Concern' and 'Not Evaluated'. Chart above details the numbers of species found in the above two categories and detailed list is mentioned in Table 11, Table 12 and Table 13.

4.3 Impacts and Mitigation Strategies

Based on an assessment of the terrestrial biodiversity and socio-economic status of the area along the proposed powerline as well as the extent of vulnerability or benefits of these resources, the team has attempted to evaluate the possible impacts that might occur to biodiversity values as well as to socio-economic aspects along the project site; both during the construction as well as the operational phase of the project.

The study does not take into account any possible impacts on the ecological services offered by the forest tract in consideration. Such a study would involve an evaluation of multi- year data, and the viability of the same can be accessed only after the specific changes to the project area are undertaken as part of the project establishment.

The impact matrix showing all possible impacts (both positive as well as negative) in terms of their nature, extent, duration, intensity and likelihood is presented in Table 15. The details of proposed mitigation measure to be adopted to minimize identified negative impacts have been discussed subsequently.

Table 14: Identified Project Impacts

Possible Impacts	Details of Impact	Extent	Duration	Intensity	Likelihood
Positive					
Improved power supply in the area and its allied development benefits	The area is affected with poor or limited power, which is a limiting factor for any development activity	Regional	Long term	High	High
Reduction in T&D losses	The existing 11 kV line is having a high T&D losses and also unable to meet the current power demand of the area	Regional	Long term	High	High
Generation of livelihood opportunities during construction and maintenance phases of the phase	The line construction activity is a labor intensive operation and will generate man days in the local area during the construction phase as well as some work for annual maintenance during the operation phase	Local	Short term	High	Moderate
Increase in watch and ward in the buffer area	Due to the existence of a transmission line in the buffer area, the area would be subject to intermittent visits for inspection, maintenance works etc. These infrequent inspections and the consequent watch and ward in the area would act as a deterrent for any illegal activities in the area.	Local	Long term	Moderate	Low
Negative					
Construction Phase					
Felling of trees for the construction of line	Trees felled along the line cause opening up of canopy in few places but mostly they are isolated	Local	Long term	High	High
Clearance of ground during the	Shrubs and herbs will be cleared below tower base and also for	Local	Short	High	High

construction works	movement of machinery		term		
Generation of dust and noise	Increase in SPM, RPM and noise level in the site due to movement of vehicles, equipment and due to construction activity etc. Expected to be high during the construction phase, but would be negligible during the operational phase.	Local	Short term	High	Moderate
Sedimentation, and changed discharge regimes into water bodies	Risks due to movements of vehicles, downloading of conductors and other construction materials, vehicle maintenance including change of oil & grease. Impact more during the construction phase and expected to be negligible in the operational phase.	Regional	Short term	Moderate	Moderate
Landslides and soil erosion	Vehicle movement would cause soil disturbance and compaction. Due to hilly terrain excavation along uprooting and land clearing at the tower base would lead to accumulation of loose soil that may lead to soil erosion and landslides..	Local	Long term	High	High
Disturbance to wildlife and Man-animal conflicts	Increased human presence during construction activity may temporarily affect normal activity of wildlife in the project area and sometime leads to man-animal conflicts.	Local	Short term	High	Moderate
Increased risk of fires	Vehicular and human movement would enhance risk of any deliberate or accidental fires	Local	Short term	Moderate	Moderate
Incomplete removal of project materials	Risk of soil, water, waste impacts from residuals left after project completion	Local	Long term	High	High
Operational Phase					
Injury or death of birds	Electrocution and collision of birds with transmission line	Local	Long term	High	High

Alteration and physical disturbance in fauna movements	May divert movement due to presence of structures	Local	Short term	Low	Low
Any natural disasters - floods, earthquake etc.	Risks and hazards from catastrophes. The risk is due to any structural damage that may occur to the transmission line and subsequent damage to flora and fauna.	Local	Short term	Moderate	Low
Conduits for invasive alien species	Removal of vegetation and soil disturbance due to construction activities would increase chances of proliferation of invasive species.	Local	Long term	Moderate	Moderate
Man-animal conflicts	Conflicts due to sudden encounters in the line of the animal, especially during periodic inspections and maintenance works.	Local	Short term	Low	Low

Mitigation or Management Measures

This section outlines some of the possible mitigation or management measures that can be implemented in order to compensate or minimise negative impacts having high/moderate value in the project area. The aim of adopting these measures is to ensure that the projects activities explicitly incorporate biodiversity values in its works. Thus, it is designed in such a way that there occurs minimum or no harm to the existing ecological integrity of the area.

Table 15: Possible Impacts and Proposed Mitigation/Management Measures

<i>Nature of the impact</i>	<i>Significance</i>		<i>Confidence level</i>	<i>Proposed mitigation/management measures</i>
	(No Mitigation)	(With mitigation)		
Felling of trees for the construction of structures along RoW	High	Low	Moderate	<p>The construction of line will require removal of trees during the construction works. In order to compensate the losses, the following measures can be adopted:</p> <ul style="list-style-type: none"> • Minimum possible vegetation should be cleared • Removal of native trees should be avoided as much as possible; • Vegetation must be cleared in consultation with forest department. In case of presence of any high conservation values species (RET or any species of local and traditional importance) in the construction site, proper conservation measures including translocation or in-situ conservation aspects should be adopted in consultation with forest authority/ecologist/botanist before its removal. • Compensatory afforestation should be carried with native species in degraded patches of roads and powerlines passing near villages and community forest in consultation with forest department.

Clearance of ground vegetation during construction works	High	Low	High	<ul style="list-style-type: none"> • Must ensure that minimum possible ground vegetation should be removed below tower base and for movement of machinery during construction works. All such clearing work is sensitive to local natural vegetation types and must be carried out in consultation with forest department. • It must be ensured that as far as possible native species providing ground cover is retained as cutting of native species seedlings and saplings and opening up of habitats may lead to proliferation of invasive alien species in the area, that thrive in opened areas, leading to disturb the existing ecosystem of the area., • Clearing should not be undertaken in such a manner that there is slashing of all understory vegetation without regard to native and alien species. • In the instant case some locations are critical on accessibility issue. These are at AP-16, AP-35 and AP-77 where access road is 200m to 300m away. All due precautions and measures as listed above, including statutory clearance from MoEFCC and other prescribed guidelines for road construction shall be followed.
Generation of dust and noise by movement of vehicles and construction machinery	Moderate	Low	High	<ul style="list-style-type: none"> • All vehicles delivering loose construction material and any such material gathered at the site must be covered by appropriate material such as tarpaulins to prevent dust spreading, pollution, or wastage. • Movement of vehicles should be strictly restricted to existing roads and tracks and along the RoW, creation of new roads and tracks or off-roading should be prohibited in connection with roads and powerlines in natural areas.

				<ul style="list-style-type: none"> • It must be ensured that minimum noise is generated during the works by using well-oiled and greased machinery. • Water should be sprayed over the construction area.
Sedimentation and changed in discharge regimes into water bodies	Moderate	Low	High	<ul style="list-style-type: none"> • Excavation activity should not be undertaken during rainy season. • Vehicle maintenance including change of oil and grease shall not be done inside buffer area. • All excavated materials from tower base should be properly stored and should be used for refilling material as soon as construction is over. • Storage of loose excavated material should not be kept in slope area. • No material including earth should be used from the buffer area. • The towers should be placed well out of major drainage channel/river to avoid flash flood related accidents.
Landslides and soil erosion	Moderate	Low	High	<ul style="list-style-type: none"> • Excavation activity should not be undertaken during rainy season. • Tower should not be placed along any major drainage. • Storage of loose excavated material should not be kept in slope area. • In steep slope terrain, the back cut slopes and downhill slopes should be treated with revertment. • In case of active erosion and landslides prone area, both biological and engineering treatment like provision of breast wall and retaining walls and sowing soil binding grasses around site.

Disturbance to wildlife and man-animal conflicts	High	Low	Moderate	<ul style="list-style-type: none"> • The construction work must be completed in stipulated timelines and any prolonged delay should be avoided. • Avoiding work during nights to facilitate movement of faunal species, especially large mammals and carnivores. • The construction related camps should not be made in Buffer area. Additionally, management strategy must delineate to detect and prevent encroachments or construction of new structures and homesteads along the proposed line of works in the area. • Presence/use of domestic animals should be avoided. • Provide basic training to the workers for any unforeseen conflict management.
Partial Removal of infrastructural waste generated during construction activities	High	Low	High	<ul style="list-style-type: none"> • All outside material left over after construction or repair (including stones, sand, cement, packaging material, papers, cartons, oils, cans, bags, wires, metal objects, housing sheds, plastics and glass) should not be left on site. These should be immediately removed and carried away outside the natural area and safely disposed of or reused elsewhere. • Garbage and other refuse material (especially those that could be ingested by wildlife or livestock) should be removed daily and disposed off in environmentally safe manner. • Awareness training should be imparted to workers on issues of environmental protection, waste management, etc.
Injury or mortality of avifauna due to	High	Low	Moderate	Collisions and electrocutions of birds with power lines have long represented a major conservation issue. and in the proposed work also it would be an important ecological impact. The phenomenon of bird hit and/or electrocution by electric lin

collision/electrocution				<p>is usually reported during landing/takeoff near the waterbodies and fly path of birds. Moreover, due to absence of such sensitive areas nearby the proposed line and also no earlier reported incidence in the project area, the anticipated impact could not be detailed out at present. The mitigation or management measures are based on the speculative figures to the best available information. In order to compensate and minimise such impacts, the following precautionary mitigation measures can be adopted:</p> <ul style="list-style-type: none"> • Marking of powerline wires with flight-diverters/reflectors/bird-guards that will prevent birds or bats collisions and deaths. • In highly susceptible locations, tower can be retrofitted by installing elevated perches/insulating jumper loops/ placing obstructive perch deterrents (e.g. insulated "V's")/ changing the location of conductors, and / or using raptor hoods. • Budgetary provision for such measures shall be inbuilt in the project cost. • Monitoring of powerlines for any deaths of birds/bats and effectiveness of implemented measures.
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In addition to above, a calendar month of permitted/restricted activities is designed to restrict the negative impacts of construction within the designated zone, which shall be applied in the instant project to minimise disturbance to wildlife and natural cycle of regeneration.

Table 16 Calendar Months for Permitted/Restricted Activities

Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Site Mobilization	Permitted	Permitted	Permitted	Permitted	Permitted	Permitted	Restricted	Restricted	Restricted	Permitted	Permitted	Permitted
Tower Foundation	Permitted	Permitted	Permitted	Restricted	Restricted	No go	No go	No go	No go	Restricted	Restricted	Permitted
Tower Erection	Permitted	Permitted	Permitted	Restricted	Restricted	No go	No go	No go	No go	Restricted	Restricted	Permitted
Stringing of Conductor	Permitted	Permitted	Permitted	Restricted	Restricted	No go	No go	No go	No go	Restricted	Restricted	Permitted
O & M	Permitted	Permitted	Permitted	Permitted	Permitted	No go	No go	No go	No go	Permitted	Permitted	Permitted

Legend	Colour	Action
No go	No go	No activity is permitted
Restricted/ Controlled	Restricted/ Controlled	Activity permitted if it doesn't involve any tree felling
Permitted	Permitted	Activity permitted
	No go. However, in case of emergency, activity may be undertaken after due permission and required protection measures.	

Some Other Points to Consider

Increase in grazing activity: The removal of big trees during the construction phase will open the canopy of the region. It is anticipated that this may further lead to increase in cattle grazing due to opening up of grazing land.

The Power and Electricity Department, Government of Mizoram and the Power Grid Corporation of India can undertake a voluntary carbon footprint estimation of its project works in the area. The estimated carbon footprint can be offset through plantation of the same mosaic of species in the degraded patches. This afforestation activity will be over and above the activities planned under Compensatory Afforestation Management Planning Authority works to further enhance the ecosystem values of the area.

Compliance To The Policy Priority Schema (Generic As Well As Specific Guidelines Of MoEFCC)

While it will be incumbent on the Project Implementing Agency (Power Grid Corporation of India Limited or its leased partner) to follow all such instructions/directions as content in the Policy Priority Guidelines of MoEFCC, the following observations are apparent in this proposal:

- 1) The proposed alignment is the least disturbance causing alignment, as there is an existing transmission line of 33 kV along the proposed 132 kV line.
- 2) Since the surrounding/adjoining areas are also forested lands on hilly terrain, any alternative route for the transmission line shall entail fresh clearing of area and disturbances.
- 3) The proposed alignment, though passing through the buffer of Dampa Tiger Reserve, is not likely to cause any fresh disturbance as there are settlements all along the road that exist alongside the proposed alignment. There is also no dislocation of the local communities involved on account of the proposed line.
- 4) Restoration of natural areas along the existing routes that are or may come to disuse shall have to be taken up.

5 Recommendations

The proposed transmission line alignment is through the buffer area of the Dampa Tiger Reserve. This area is stocked with reasonably good forests but is also checkered with a large number of villages. There are different communities living in this buffer area with diverse livelihoods, both dependent on and independent of the forests. There is also a distinguishable presence of various development departments like Public Works Department, Rural Development and Horticulture etc. Also, there are visible outcomes of various projects implemented in the buffer area, such as, the Integrated Watershed Development Program.

The buffer, though represented by a significant floral and moderate faunal biodiversity, is not a core tiger habitat. There has been no direct sighting of any tigers in the buffer. The area is not a corridor for any flagship species such as elephants. There are a host of community rights on the resources and there is also a programmed extraction of resources, such as firewood, as per the prescriptions of the working plans of both Mamit and Kwartha Forest Divisions.

Shifting cultivation is a common practice in the buffer, apart from other traditional agricultural practices.

Thus, the buffer is not an inviolate area. On the contrary it has a wide interface with local communities and is open to developmental activities. Well being of local communities and wellbeing of forests in the buffer (as well as of core forest area) seem complementary to each other.

The proposed activity of laying of a 132 kV transmission line entails possible positive as well as negative impacts. However, if the prescribed mitigation measures for possible negative impacts are undertaken, the positive impacts heavily outweigh the negative impacts. Availability and reliability of power supply act as a primary enabler for development activities. There is a pressing need for infrastructure development in the project area (i.e. Mamit district). Considering these factors, the implementation of project is recommended with prescribed mitigation measures.

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3. *The Book Of Indian Animals*: S H Prater
4. *The Birds Of Indian Subcontinent*: Grimmet et al.
5. *The Book Of Indian Reptiles*: J. C. Daniel.

7 Annexure 1 – Letter of Permission from Chief Wildlife Warden

Copy of letter of permission from the Chief Wildlife Warden, Mizoram, for carrying out of Biodiversity Assessment Study in Buffer Zone of Dampa Tiger Reserve.

GOVERNMENT OF MIZORAM
OFFICE OF THE CHIEF WILDLIFE WARDEN
ENVIRONMENT & FOREST DEPARTMENT
MIZORAM :: AIZAWL

No.B.17012/2 /2015-CWLW/84 : Dated Aizawl, the 13th Oct/2015

To,

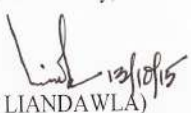
✓ The Deputy General Manager
NERPSIP, Aizawl
Powergrid Corporation of India Ltd.
B.P.O Tanhril, Ramrikawn
Aizawl – 796009
Mizoram

Subj: Permission for carrying out associated field work in connection with biodiversity assesemnt study of proposed of 132 KV West Phaileng – Marpara Transmission Line Passing through buffer zone and core area of Dampa Tiger Reserve.

Ref: No. NERPSIP/Aizawl, dt.03.10.2015

Sir,

Reference above, permission is hereby granted for carrying out associated field work in connection with biodiversity assesemnt study of proposed of 132 KV West Phaileng – Marpara Transmission Line passing through buffer zone and core area of Dampa Tiger Reserve to start field work at the earliest.

Yours faithfully,

(LIANDAWLA)
Chief Wildlife Warden
Mizoram :: Aizawl
Dated Aizawl, the 13th Oct/2015

No.B.17012/2 /2015-CWLW/84 :
Copy to :

Field Director, Dampa Tiger Reserve for information and necessary action to detail supporting field staff to cooperate with the team for carrying out field work/biodiversity assesemnt study as above.

Chief Wildlife Warden
Mizoram :: Aizawl

8 Annexure 2 – Quadrat-wise Tree Count

Species/Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Acacia gigante		1																												2
Alangium chinense		1							1																					
Albizia chinensis												1	4									1								
Albizia procera							1			1			1	1	5							1								
Alphosea lutea											1																			
Alstonia scholaris		1																												1
Anthocephalus chinense											1																			
Artocarpus chama				1	1			1				1									1	1								
Artocarpus heterophyllus								7																				2		
Artocarpus lakoocha							1					7														1				
Baccaurea ramiflora			1																											
Bauhinia variegata							5					1		1	3						1	7					4	2		
Beils schmedia roxburghiana				1																										
Bischofia javanica					2																	1								
Bombax ceiba		3											1																1	3
Bombax insigne						4								1	1	1						1	1							
Bridelia montana		1																												
Calicarpa arborea					1					1				1	1		1	1	1											
Caryota urens	1																													
Cassia fistula														1		1						1	2							
Cassia japonica											1											1								

9 Annexure 3 – Description of IUCN Red List of Ecosystems Categories

EXTINCT (EX) - A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW) - A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR) - A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN) - A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU) - A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT) - A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC) - A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD) - A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE) - A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

Not Evaluated Category is defined as a category on the IUCN Red List of Threatened Species that indicates that a taxon has not yet been evaluated against the criteria⁷. This involves any of the 1.6 million species described by scientists but not assessed by the IUCN. The category 'Not Evaluated' does not indicate a level of risk⁸. However, site operations related to removal of flora and fauna species must be observed by qualified botanist and zoologist to guide the proper remove procedures thus to least damage to the flora and fauna species.

⁷ International Union for Conservation of Nature (IUCN) 2012.

⁸ Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria, Version 1.0, International Union For Conservation of Nature.