

Strategies for High Conservation Networks and Biodiversity Indicators to be used for REDD+ Implementation in Mizoram



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On behalf of:



Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany



NORWEGIAN MINISTRY
OF FOREIGN AFFAIRS

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2018

Indian Council of Forestry Research and Education
(An Autonomous Body of Ministry of Environment, Forest and Climate Change, Government of India)
P.O. New Forest, Dehradun – 248006 (INDIA)



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Abbreviation Used

BMC	Biodiversity Management Committee
BSI	Botanical Survey of India
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COP	Conference of Parties
CBD	Convention on Biological Diversity
ICFRE	Indian Council for Forestry Research and Education
ICIMOD	International Centre for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
IW(P)A	Indian Wildlife (Protection) Act, 1972
LULUCF	Land Use, Land Use Change and Forestry
MDF	Medium Dense Forests
NBA	National Biodiversity Authority
NBAP	National Biodiversity Action Plan
OF	Open Forest
REDD+	Reducing Emissions from Deforestation and Forest Degradation, and role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SBB	State Biodiversity Board
SIS	Safeguards Information System
sq km	square kilometer
UNFCCC	United Nations Framework Convention on Climate Change
VDF	Very Dense Forest



The background of the page is a vibrant, high-angle photograph of a tropical forest. In the foreground, a tree is heavily laden with small, delicate white flowers, possibly from a species like Shorea. The rest of the image is filled with dense, multi-layered green foliage, including various types of leaves and branches, creating a rich, textured appearance. The lighting is bright, suggesting a sunny day, which highlights the different shades of green and the white of the blossoms.

Executive Summary

Indian Council of Forestry Research and Education in collaboration with International Centre for Integrated Mountain Development has implemented a trans-boundary landscape project titled “REDD+ Himalayas: Developing and using experience in implementing REDD+ in the Himalayas” in the state of Mizoram. District Mamit of Mizoram has been selected as a study site for implementation of the project activities. Shifting cultivation, fuel wood collection, over exploitation of non-timber forest products were identified as direct drivers of deforestation and forest degradation whereas unemployment, lack of industries, lack of knowledge and awareness, and low connectivity of roads were identified as indirect drivers of deforestation and forest degradation in the in the study area. These direct and indirect drivers of deforestation and forest degradation are also responsible for loss of biodiversity in the state of Mizoram. Views of the local communities of the Mamit District were taken for developing necessary strategies for high conservation networks and biodiversity indicators to be used for REDD+ implementation in Mizoram. Accordingly, in consultation with the local community and other stakeholders, and review of the published literature, a strategy document has been prepared which has identified suitable strategies for high conservation networks and biodiversity indicators to be used for REDD+ implementation in the state of Mizoram. Identified conservation strategies and biodiversity indicators may be helpful in addressing the biodiversity safeguard as well as helpful in monitoring and reporting the biodiversity benefits in implementation of the REDD+ actions.



1 Introduction

Climate change is recognized as a significant man-made global environmental challenge and also treated as threat to humankind. It directly and indirectly affects the growth and productivity of forests through changes in temperature, rainfall, weather and other factors. To withstand climate change, stability of forest ecosystem needs to be maintained over time and space. The stability maintains the demand and supply of ecosystem services which further helps in sustainable management of forests.

'Reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries' is collectively known as REDD+. This mechanism has been introduced as a climate change mitigation option in developing countries by United Nations Framework Convention on Climate Change (UNFCCC) in its thirteenth session of Conference of Parties (COP) held at Bali in 2007. Sixteenth session of COP to the UNFCCC held at Cancun in 2010 and adopted a set of decisions which is known as Cancun Agreement. As per Cancun Agreement, country Parties need to develop a national strategy or action plan, a national forest reference emission level and/or forest reference level, a national forest monitoring system and a system for providing information on how the safeguards are being addressed and respected throughout the implementation of REDD+ activities. Warsaw Framework for REDD+ recognizes the importance of incentivizing non-carbon benefits for the long term sustainability of the implementation of REDD+ activities.

Role of forest biodiversity in climate change mitigation and adaptation is well acknowledged and country Parties to the Convention on Biological Diversity (CBD) have recognized that REDD+ can provide considerable benefits for forest biodiversity. CBD adopted the 'Strategic Plan for Biodiversity for 2011-2020' in COP 10 which comprises of twenty targets. Out of which following four targets are relevant to REDD+

implementation:

1. The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced (Target 5).
2. Areas under forestry are managed sustainably and ensuring conservation of biodiversity (Target 7).
3. At least 17 per cent of terrestrial areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved (Target 11).
4. Ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation & adaptation and to combating desertification (Target 15).

CBD has also highlighted the risks of poorly designed REDD+ efforts on biodiversity, indigenous people and local communities (CBD, 2011). Potential risk of REDD+ implementation for biodiversity can be:

- The conversion of natural forests to plantations and other land uses of low biodiversity value
- Introduction and growing of biofuel crops
- The displacement of deforestation and forest degradation to areas of lower carbon value and high biodiversity value
- Increased pressure on non-forest ecosystems with high biodiversity value
- Afforestation in areas of high biodiversity value

CBD further highlighted (CBD, 2011) that above mentioned risks associated with the REDD+ implementation can be mitigated: (i) through application of safeguards as outlined in COP

decision 1/CP.16 of UNFCCC, including by ensuring that conversion of natural forests is avoided, and by ensuring full and effective participation of indigenous people and local communities; (ii) by ensuring that REDD+ follows a comprehensive approach to forest-based carbon storage; (iii) by setting appropriate baselines and reference scenarios; and (iv) by monitoring biodiversity impacts of REDD+ efforts.

As per Decision 1/CP.16 of COP to the UNFCCC, following safeguards should be promoted and supported while undertaking the REDD+ activities:

- Actions complement or are consistent with the objectives of national forest programme and relevant international conventions and agreements
- Transparent and effective national forest governance structures, taking into account national legislation and sovereignty
- Respect for the knowledge and rights of indigenous peoples and members of local communities
- Full and effective participation of relevant stakeholders, in particular, indigenous people and local communities
- Actions are consistent with the conservation of natural forests and biological diversity
- Actions to address the risks of reversals
- Actions to reduce displacement of emissions

Key opportunities of REDD+ implementation for biodiversity (CBD, 2011) can be: (i) opportunities for *in situ* conservation of forest biodiversity, (ii) opportunities for improved forest management, (iii) opportunities for improved forest governance and (iv) opportunities for improved monitoring and reporting of biodiversity benefits.

India is one of the mega-diverse countries, rich in biodiversity and associated traditional knowledge. It has 2.4 per cent of the global land area and accounts for nearly 7- 8 per cent of the global recorded species of fauna and flora. It supports about 18 per cent of human and almost 18 per cent of cattle population of the world.

The biodiversity in India is conserved through the establishment of Protected Area Networks (wildlife sanctuaries, National Parks, Biosphere Reserves and Conservation Reserve etc.). In India various acts and rules such as Indian Forest Act, 1927; Wildlife (Protection) Act, 1972; Forest (Conservation) Act, 1980; National Forest Policy, 1988; Biological Diversity Act, 2002; Biological Diversity Rules, 2004 and National REDD+ Strategy, 2018 are in place for addressing the issues related to conservation of forest biological diversity in India.

Biological Diversity Act, 2002 is most significant policy instrument for conservation of biological diversity. The main objectives of the Biological Diversity Act, 2002 are: conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising from the utilization of genetic resources. The Act envisages a three-tier structure to regulate access to the biological resources, comprising of National Biodiversity Authority (NBA) in national level, State Biodiversity Boards (SBBs) in state level and Biodiversity Management Committee (BMCs) at the local level. NBA performs facilitative, regulatory and advisory function for the Government of India on issues of conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources. SBBs focus on advising the State Governments on matters relating to the conservation of biological diversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources. BMCs are responsible for promoting conservation, sustainable use and documentation of biological diversity including preservation of habitats. One of the key mandates of BMCs is to prepare Biodiversity Register, which documents the elements of biodiversity in the areas, and issues pertaining to sustainable utilization and benefit sharing, and the traditional knowledge associated with biodiversity.

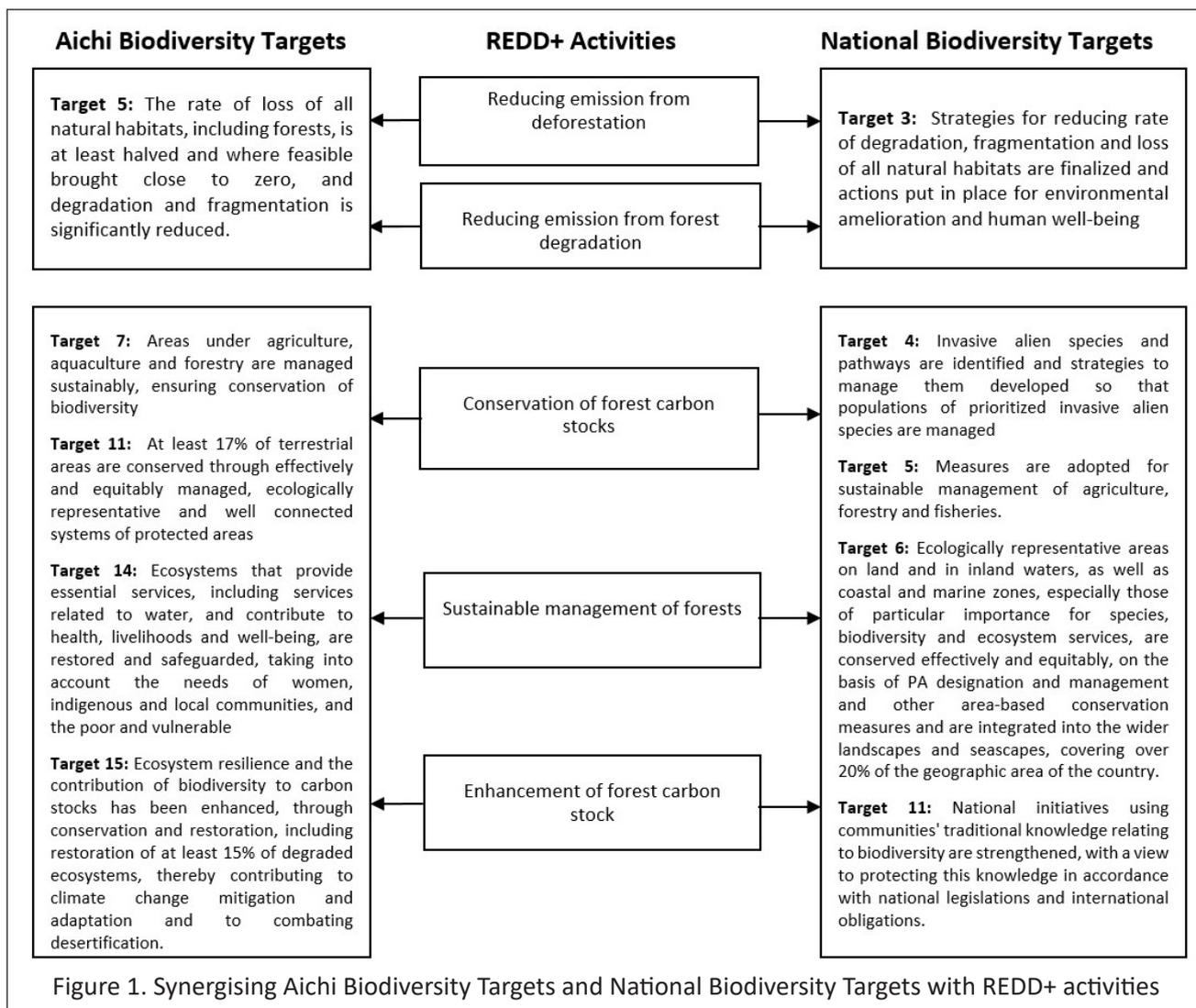
CBD mandates each Party to prepare a National Biodiversity Strategy and Action Plan for implementing the Convention at the national level. Accordingly, India has developed National Biodiversity Action Plan (NBAP) in 2008. NBAP 2008 was prepared prior to the adoption of the Strategic Plan for Biodiversity 2011-2020 and its

20 Aichi Biodiversity Targets. Therefore, India has broadly aligned its NBAP with the five Strategic Goals and the 20 Aichi Biodiversity Targets and prepared 12 National Biodiversity Targets. Out of 12 National Biodiversity Targets following five targets are directly relevant to REDD+ implementation:

1. Strategies for reducing rate of degradation, fragmentation and loss of all natural habitats are finalized and actions put in place for environmental amelioration and human well-being (National Biodiversity Target 3)
2. Invasive alien species and pathways are identified and strategies to manage them developed so that populations of prioritized invasive alien species are managed (National Biodiversity Target 4)
3. Measures are adopted for sustainable management of agriculture, forestry and

fisheries (National Biodiversity Target 5)

4. Ecologically representative areas on land and in inland waters, as well as coastal and marine zones, especially those of particular importance for species, biodiversity and ecosystem services, are conserved effectively and equitably, on the basis of Protected Area designation and management and other area-based conservation measures and are integrated into the wider landscapes and seascapes, covering over 20% of the geographic area of the country (National Biodiversity Target 6)
5. National initiatives using communities' traditional knowledge relating to biodiversity are strengthened, with a view to protecting this knowledge in accordance with national legislations and international obligations (National Biodiversity Target 11)



Synergies among Aichi Biodiversity Targets and National Biodiversity Targets with REDD+ activities are given in Figure 1.

North-Eastern states of India are gifted with rich forest resources and cover about 7.98 per cent of the geographical area of the country and accounts for nearly for one fourth of the forest cover of the country. It is the geographic gateway for variety of the living organisms, and constituting rich variation in the flora and fauna and as a consequence the region is identified as Indo-Burma hotspot and is one of the 35 global biodiversity hotspots (Myers, 1988). It consists of seven sister states and occupies 50 per cent of the flowering plants (around 8000 species) of which 2526 species are endemic.

Mizoram is one of the seven sister states in the North Eastern India. It is in the extreme eastern corner of the country and shares its boundaries with Assam, Manipur and Tripura and has very long international borders with Bangladesh and Myanmar. In the eastern part of India, Mizoram has the most variegated hilly terrain. The total geographical area of the state is 21,087 sq. km. It lies between 21°58' and 24°35'N latitudes and 92°15' and 93°29'E longitudes. The literal meaning of Mizoram is the land of the Mizo people which further means land of hill people.

In order to implement the Biodiversity Act 2002, Mizoram State Biodiversity Board was constituted on 17 January 2006. The main functions of the Board are:

- a) Advise the State Government, subject to any guidelines issued by the Central Government on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of all benefits arising out of the utilization of biological resources
- b) Regulating by granting of approvals on otherwise requests for commercial utilizations on bio-survey and bio-utilization of any biological resources of the state

- c) Perform such other functions as may be necessary to carry out the provisions of this Act or as may be prescribed by the state Government

- d) Prepare its annual report, giving full account of its activities during the previous year

The Government of Mizoram enacted the Mizoram State Biological Diversity Rules, 2010 in exercise of its powers under section 63 (i) of the Biological Diversity Act, 2002 for bringing out the purpose of this Act in the state. This rule extends to the whole of Mizoram except the Autonomous District Council areas. Under section 41 of the Biological Diversity Act, 2002 and Rule 23 of The Mizoram State Biological Diversity Rules, 2010, State Biodiversity Board Mizoram has constituted 250 Biodiversity Management Committee (BMC) through village level local bodies in 250 villages. The State Biodiversity Board Mizoram has documented and published 5 People's Biodiversity Register (PBR) viz., Pamchung (2012), Thenhlum (2012), Pangzawl (2015), Laki (2016) and Mizoram, University, Tanhril (2017).

REDD+ Himalaya Project is implemented by Indian Council of Forestry Research and Education in collaboration with International Centre for Integrated Mountain Development in the state of Mizoram. District Mamit of Mizoram is the pilot area selected for implementation of project activities under REDD+ Himalayas Project and it includes 12 villages (Ailawng, Chungtlang, Hruiduk, Khawrihnim, Lengte, Nghalchawm, North Kanghmun, Rawpuichhip, Reiek, Rulpuihlum, Tuahzawl and West Lungdar) with 1583 households having the total population of 8174. About 72% of the population of the project area is dependent on agriculture for their main source of livelihoods (Rawat *et al.*, 2017). Development of strategies for high conservation networks and biodiversity indicators are required for implementation of REDD+ activities in the state of Mizoram.

2 Methodology

In order to identify the suitable strategies and biodiversity indicators to be used for REDD+ implementation in the state of Mizoram, views of the local communities of villagers of Ailawng, Chungtlang, Lengte, Khawrihnim, Reiek and West Lungdar villages under REDD+ pilot project were taken. Consultations with the forest department officials and village council members of the REDD+ project area in Mamit District (Mizoram) were also

made for identifying the suitable strategies and biodiversity indicators. All the relevant published reports and documents related to forests and biodiversity were consulted, reviewed and compiled for identifying the suitable strategies for high conservation networks and biodiversity indicators to be used in implementation of REDD+ in Mizoram.

3 Forest Resources of Mizoram

Among the North-East states, the forest cover of Mizoram is highest but forest carbon stocks per hectare of forest area is lowest. Mizoram state covers an area of 21,081 sq km constitutes 0.64 per cent of the geographical area of the country and also covers 2.33 per cent of India's forest and tree cover. Forest cover of Mizoram with respect to its total geographical area is high (88.48%) but the contribution of the open forest was also found to be highest (67.05 %) among all the North-eastern states. Considerable reduction

in forest cover was also found to be high (562 sq km) from the previous assessment of 2015. Decreasing trends of forest cover in different density classes have been reported for the state of Mizoram from the period of 2013 to 2017 (Table 1). This can be attributed to shifting cultivation and developmental activities. Increase in forest cover in certain pockets is due to regeneration of bamboo and other plantations have also been recorded (FSI, 2017).

Table 1. Trends of forest cover in different density classes in the state of Mizoram

S. No.	Class	Area (sq km)		
		2013	2015	2017
1.	Very dense forest	138	138	131
2.	Moderately dense forest	5900	5858	5861
3.	Open forest	13016	12752	12194
4.	Total forest cover	19054	18748	18186
5.	Tree cover	223	535	467
6.	Total forest and tree cover	19277	19283	18653

(Source: FSI, 2013, 2015 and 2017)

3.1 Forest types: According to Champion and Seth (1968) classification, six forest types have been identified in the state of Mizoram representing four major type groups i.e. Group 2-Tropical Semi-Evergreen Forests, Group 3-Tropical Moist Deciduous Forests, Group 8- Subtropical Broadleaved Hill Forests and Group 9- Sub Tropical Pine Forest (FSI, 2011).

The northern part of the state is dominated by Secondary Moist Bamboo Brakes along with the different species of trees and plants while on the other side eastern and southern part of the state is dominated by the East Himalayan Moist Mixed Deciduous forest. Total area (sq km) occupied by the different forest types of the Mizoram is given in Table 2.

Table 2. Forest Types of Mizoram State (according to Champion and Seth, 1968)

S. No.	Forest Type Group	Forest Type	Area (sq km)	Per cent
1.	Group 2 Tropical Semi-Evergreen Forest	2B/2S1 Pioneer Euphorbiaceous Scrub	280.75	1.50
2.	Group 2 Tropical Semi-Evergreen Forest	2B/C2 Cachar Tropical Semi-Evergreen Forest	4675.93	25.03
3.	Group 3 Tropical Moist Deciduous Forest	2/2S1 Secondary Moist Bamboo Brakes	8484.05	45.41
4.	Group 3 Tropical Moist Deciduous Forest	3C/C3b East Himalayan Moist Mixed Deciduous Forest	5120.17	27.40
5.	Group 8 Sub Tropical Broadleaved Hill Forest	8B/C1 East Himalayan Subtropical Wet Hill Forest	6.82	0.04
6.	Group 9 Sub Tropical Pine Forest	9/C2 Assam Subtropical Pine Forest	116.28	0.62
Total			18684.00	100

(Source: FSI, 2015)

There is broad consensus that species richness is generally highest in tropical rainforests compared to all other sub-tropical forest types (Mace *et al.*, 2005). Apart from species richness, species composition and distribution are also important aspect to consider species composition. Moreover, species distribution and the differences in species composition across similar forest types are also important biodiversity indicators to assess the level of endemism.

Tropical semi-evergreen forest type group is rich in valuable evergreen timber species in the top canopy. Timber species in the top canopy are *Dipterocarpus turbinatus*, *Artocarpus chaplasha*, *Terminalia myriocarpa*, *Amoora wallichii*, *Michelia champaca* and *Mesua ferrea*, etc. Bamboos also occur abundantly in the middle and lower storey and canes are conspicuously present in this type. Important bamboo species are *Melocana bambusoides*, *Dendrocalamus strictus*, *Bambusa tulda*, *Dendrocalamus giganteus* and *Dendrocalamus hamiltonii*, etc.

3.2 Protected Areas: The importance of protected areas is an essential indicator not for only environment assessments but also for long term biodiversity conservation. The number and expansion of protected areas are essential determinant to assess the effectiveness of the biodiversity coverage in terms of species, habitat and biogeographic classifications. The protected areas play an important role in mainstreaming the conservation by maintaining significant aesthetic, ecological and/or cultural values through recreational activities.

Historically, protecting natural areas include initiatives such as designating sacred groves by safeguarding the integrity of interactions at various levels from species to ecosystem level and maintaining the sustainable flow of ecosystem products and services naturally. The protected areas of Mizoram includes two national parks, seven wildlife sanctuaries and one tiger reserve. The percent contribution of protected area in Mizoram is 5.34 per cent of total geographical area of the state (Table 3).

Table 3: List of national parks and wildlife sanctuaries of Mizoram

S. No.	Name of the protected area	Area (sq km)	District
1.	Dampa Tiger Reserve	500	Mamit
2.	Murlen National Park	100	Champhai
3.	Phawngpui National Park	50	Lawngtlai
4.	Ngengpui Wildlife Sanctuary	110	Lawngtlai

5.	Khwanglung Wildlife Sanctuary	35	Lunglei
6.	Lengteng Wildlife Sanctuary	60	Champai
7.	Tawi Wildlife Sanctuary	35	Aizawl
8.	Thorangthang Wildlife Sanctuary	50	Lunglei
9.	Pualreng Wildlife Sanctuary	50	Kolasib
10.	Toklang Wildlife Sanctuary	250	Saiha
Total Protected Area		1090.75	

(Source: Sati et al., 2014)

3.3 Forest Biodiversity: Mizoram is one of the states fall under Indo-Burma biodiversity hotspots. A total of 2,358 species of plants have been reported from Mizoram (Singh, 1997). Out of the total species, 2,141 belong to angiosperms distributed over 176 families and 905 genera. Out of this, 1641 species belong to dicots and the remaining 500 are monocots. Six species of gymnosperms are found in Mizoram which are belonging to 6 genera and 4 families. Number of pteridophytes species are quite high i.e. 211 species distributed over 35 families and 66 genera.

Owing to its strategic location, it has a very rich diversity of faunal species. Mizoram harbors 8 species of primates out of the 15 primates species. Among these seven species are endemic to the region viz., hoolock gibbon (*Hauhuk*), pig-tailed macaque (*Zawng grengte*), stump-tailed macaque (*Zawng mawt*), phayre's leaf monkey (*Dawr*), capped langur (*Ngau*) and slow loris (*Sahuai*). Of the five big cats in India, Mizoram have 3 of them. Out of the 11 smaller cats, the state harbours 5 species, of which golden cat and marbled cat are endemic to this region and are extremely rare. Malayan Sun Bear, which was thought to be extinct in the wild from Indian sub-continent, is recently reported from Dampa Tiger Reserve. The bird diversity is also quite high and 215 species have been reported from Dampa Tiger Reserve. The important floral and faunal components of biodiversity of Mizoram are described below:

Timber Species: There are about 125 good timber yielding species reported from the state (Singh et al., 2002). Some of the common timber species of the Mizoram are *Albizia lebbeck* (*Thingri*), *Albizia odoratissima* (*Kangtek*), *Artocarpus chama* (*Lamkhuang*), *Chukrasia tabularis* (*Zawngtei*), *Haldinia cordifolia* (*Lungkhuap*), *Michelia champaca* (*Ngiau*), *Morus lavigata* (*Lungli*), *Phoebe goalparensis* (*Lawngthintha*), *Schima wallichii*

(*Khiang*) and *Terminalia myriocarpa* (*Char*) etc.

Wild Relatives of Cultivated Crop Plants: There are many wild relatives of the cultivated crops, which have been preserved since long by the local community. Some of the important species are *Artocarpus chama*, *Citrus indica*, *C. medica*, *Camellia caudata*, and species of *Alpinia*, *Ammomum*, *Cajanus*, *Cinnamomum*, *Cissus*, *Colocasia*, *Curcuma*, *Garcinia*, *Ipomoea*, *Musa*, *Piper*, *Saccharum* and *Zingiber* etc. (Singh et al., 2002). These species might be very useful in evolving the new varieties of desired characters. There are at least 489 accessions of rice germplasm which were collected under PL480 scheme and 220 accessions of maize were collected from Mizoram (Roy et al., 2015).

Orchids: Orchids are very common in this region and about 251 species have been reported from the state (Singh et al., 2002). They are mainly used for medicinal purposes. Some of the common ornamental species of orchid found in the state are *Coelogyne barbata*, *Cymbidium elegans*, *C. mastersii*, *Dendrobium chrysanthum*, *D. densiflorum*, *D. fimbriatum*, *Eria paniculata*, *Paphiopedilum villosum*, *Phaius flavus*, *Thunia alba*, *Vanda coeudea*, *Renantheraim schootiana* and *Rhynchostylis retusa*. Kumar et al. (2013) reported new distributional record of fourteen noteworthy species of orchids from Mizoram viz.: *Bulbophyllum crassipes*, *Crepidium purpureum*, *Dendrobium thyrsoiflorum*, *Dendrobium stuposum*, *Dendrobium wardianum*, *Dendrobium williamsonii*, *Gastrochilus obliquus*, *Habenariar eniformis*, *Phreatia elegans*, *Smitinandia micrantha*, *Streochillus hirtus*, *Sunipia andersonii*, *Tainiaviri difusca* and *Vanda pumila*.

Medicinal Plant Resources of Mizoram: Lalramnghinghlova and Jha (1999) reported around 60 per cent people living in the interior parts of the

state depends upon herbal medicine. It is also reported that more than 200 plant species are used to cure diseases like bleeding from nose, fever, malarial fever, asthma, tuberculosis, calculi, stones in kidney and gall bladder etc. So far,

about 500 species under 383 genera have been recorded from the state, which have medicinal and ethno-botanical uses (Lalramnghinglova and Jha, 1997 and Singh *et al.*, 2002). Some of the medicinal plants of state are listed in Table 4.

Table 4. Medicinal plants and their local use

S. No.	Scientific Name	Local Name	Plant Part Used
1	<i>Alstonia scholaris</i>	Thuamriat	Bark is used for malaria, diarrhea, heart diseases and hypertension.
2	<i>Aporosa octandra</i>	Chhawntual	Bark used for stomach ulcer.
3	<i>Artemisia indica</i>	Sai	Whole plant is used for diarrhea, dysentery and abdominal pains. Paste of plant is used to treat wounds.
4	<i>Blumea lanceolaria</i>	Buarze	Leaves used for stomach ulcer.
5	<i>Calamus tribuloides</i>	Thingsia	Leaf used in stomach pain.
6	<i>Dysoxylum gobara</i>	Thingthupui	Leaf & bud decoction used in diarrhea and dysentery.
7	<i>Hedyotis scandens</i>	Laikingtuibur	Infusion of leaves is good for removal of kidney stone and treating urinary tract infection.
8	<i>Hedyotisce pitellata</i>	Lawminutuibur	Whole plant used for stomach pain
9	<i>Mikania micrantha</i>	Japanhlo	Leaf juice used for dysentery, as haemostatic. Leaves boiled with <i>Vitex peduncularis</i> are taken against fever.
10	<i>Oroxylum indicum</i>	Archangkawn	Bark used in fever.
11	<i>Phyllanthus fraternus</i>	MithiSunhlu	Plant for Liver ailments and fever.
12	<i>Schima wallichii</i>	Khiang	Fruit decoction used against snake and insect bites.

Bamboos: Mizoram contributes about 2.08 per cent bamboo bearing area of the country and dominated by bamboo in terms of natural resource which has proved a major contribution towards the socio-economic development in the state and it covers about 3267 sq km of bamboo bearing area (FSI, 2017). Bisht and Naithani (2010) reported 34 species of bamboos from the state of Mizoram out of which, 20 species are indigenous to the state, while 14 species have been introduced from outside. *Bambusa*

tulda (Rawthing), *Dendrocalamus longispathus* (Rawnal), *D. hamiltonii* (Phulrua), *Melocanna baccifera* (Mautak), *Melocalamus compactiflorus* (Sairil) and *Sinarundinaria griffithiana* (Phar) are the main species of the bamboos found in the state contributing 29 per cent of the total forest cover in the state. Approximately 80 per cent of the total bamboo area is occupied by *Melocanna baccifera* (Bisht *et al.*, 2011). Common species of bamboo are given in Table 5.



Table 5. Common bamboo species of Mizoram state

S. No.	Species	S. No.	Species
1	<i>Bambusa balcooa</i>	18	<i>Dendrocalamus manipureanus</i>
2	<i>B. bambos</i>	19	<i>D. sikkimensis</i>
3	<i>B. dampeana</i>	20	<i>D. strictus</i>
4	<i>B. mizoramiana</i>	21	<i>Melocalamus compactiflorus</i>
5	<i>B. multiplex</i>	22	<i>Melocanna baccifera</i>
6	<i>B. nagalandiana</i>	23	<i>Neomicrocalamus mannii</i>
7	<i>B. nutans</i>	23	<i>Phyllostachys edulis</i>
8	<i>B. tulda</i>	25	<i>P. manni</i>
9	<i>B. vulgaris</i>	26	<i>Schizostachyum dullooa</i>
10	<i>B. vulgaris</i> var. <i>vittata</i>	27	<i>S. fuchsianum</i>
11	<i>B. vulgaris</i> var. <i>waminii</i>	28	<i>S. mannii</i>
12	<i>Dendrocalamus asper</i>	29	<i>S. munroi</i>
13	<i>D. giganteus</i>	30	<i>S. pergracile</i>
14	<i>D. hamiltoni</i>	31	<i>S. polymorphum</i>
15	<i>D. hookeri</i>	32	<i>Sinarundinaria falcata</i>
16	<i>D. laetiflorus</i>	33	<i>S. griffithiana</i>
17	<i>D. longispathus</i>	34	<i>Thyrsostachys oliveri</i>

(Source: Bisht, 2016)

Fungi: Mizo people are very fond of eating wild fungi. *Cantharellus tropicalis* (Maupa), *Schizophyllum commune* (Pasi) and *Termitomyces* spp. (Pasawntlung) are commonly seen species of fungi in the market. Bisht (2011) has reported 52 species of wood decaying fungi from the state and about 200 species of mushrooms are reported from the state. Mushroom belonging to different genera such as *Ganoderma lucidum* followed by *Cantharellus tubaeformis*, *Agaricus bisporus*, *Schizophyllum commune*, *Auricularia delicata*, *Boletus luteus*, *Cantharellus cibarius*, *Lycoperdon cladopus*, *Termitomyces clypeatus*, *Auricularia auricula*, *Lentinus edodes*, *Laetiporus sulphureus*, *Morchella esculanta*, *Termitomyces mammiformis*, *Auricularia polytricha*, *Calvatia gigantea*, *Cantharellus cibarius* and *Russulain tegr*a, etc.

3.4 Threatened Taxa of Mizoram: Although the state of Mizoram is rich in forest biodiversity however, number of taxa fall under different categories of threat. In exercise of the power conferred by Section 38 of the Biological Diversity Act 2002, the Central Government through the Ministry of Environment, Forest and Climate Change in consultation with the

Government of Mizoram, vide notification No. 1600 dated October 5, 2009 in The Gazette of India, Extraordinary, has notified the 'rare, threatened and endangered plant and animal species of Mizoram', which are either extinct or are on the verge of extinction from the state. Notified threatened plant species are *Jasminum wengeri* (Jasmine), *Mantisia wengeri* (Dancing girl), *Paphiopedilum spicerianum* (Lady's slipper), *Paphiopedilum villosum* (Lady's slipper), *Aquilaria malaccensis* (Agarwood), *Hydnocarpus kurzii* (Chaulmoogra), *Dalbergia pinnata* var. *acaciifolia* and *Cinnamomum aromaticum* (Cassia or Chinese cinnamon). Notified threatened animal species are *Rhinoceros sondaicus* (Javan Rhinoceros), *Dicerorhinus sumatrensis* (Sumatran Rhinoceros), *Felis marmorata* (Marbled Cat), *Pardofelis temminckii* (Asiatic Golden Cat or Temminck's Golden Cat), *Arctictis binturong* (Binturong or Asian or Palawan Bearcat), *Prionodon pardicolor* (Spotted Linsang), *Mustela kathiah* (Yellow-bellied weasel) and *Ursus malayanus* (Sun bear).

Threatened Endemic Plant Species: Mizoram is one of the micro-endemic centres in India

(Sharma and Singh, 2000) and numbers of plant species have been reported as an endemic to the state of Mizoram. The wild population of the endemic plants of the state have been on a rapid decline caused by a number of factors such as destruction of ecological habitat, biotic interference, over exploitation, unscientific collection, shifting cultivation and developmental activities. The population decline in case of many of these species has brought these species on the verge of extinction. Conservation status of endemic species as assessed by different national and international organizations for the state of Mizoram is given in Table 6.

Table 6. Conservation status of endemic species of Mizoram

S. No.	Species name	Status	Assessed by
1.	<i>Acampe ochracea</i>	Rare	BSI
2.	<i>Amooora walichii</i>	Rare	IUCN
3.	<i>Arundina chinensis</i>	Rare	BSI
4.	<i>Arundinaria phar</i>	Rare	BSI
5.	<i>Begonia lushaiensis</i>	Rare	BSI
6.	<i>Begonia wengeri</i>	Rare	IUCN
7.	<i>Begonia watti</i>	Endangered	BSI
8.	<i>Bulbophyllum parryae</i>	Endangered	BSI
9.	<i>Coelogyne rossiana</i>	Vulnerable	IUCN, (Nayar and Sastry, 1987)
10.	<i>Coelogyne nitida</i>	Endangered	BSI
11.	<i>Coelogyne ovalis</i>	Endangered	BSI
12.	<i>Crotalaria kurzii</i>	Rare	BSI
13.	<i>Cymbidium eburneum</i>	Vulnerable	BSI
14.	<i>Cymbidium macrorrhizum</i>	Rare and endangered	BSI
15.	<i>Dendrobium devonianum</i>	Endangered	CITES (Appendix-II)
16.	<i>Dendrobium falconeri</i>	Rare	BSI
17.	<i>Dendrobium pycnostachyum</i>	Endangered	CITES (Appendix-II)
18.	<i>Dendrobium wardianum</i>	Endangered	CITES (Appendix-II)
19.	<i>Dysoxylum alliaria</i>	Rare	IUCN
20.	<i>Embelia ribes</i>	Near Threatened	CITES (Appendix-II)
21.	<i>Gastrochilus calceolaris</i>	Critically endangered	IUCN
22.	<i>Lobelia nicotianaefolia</i>	Rare	IUCN
23.	<i>Mahonia nepalensis</i>	Rare	IUCN
24.	<i>Mantisia sphaulata</i>	Vulnerable	IUCN
25.	<i>Mantisia wengeri</i>	Rare and endangered	BSI
26.	<i>Morus australis</i>	Rare	IUCN
27.	<i>Paphiopedilum charlesworthi</i>	Critically endangered	BSI
28.	<i>Paphiopedilum hirsutissium</i>	Rare	Nayar and Sastry, 1987
29.	<i>Paphiopedilum villosum</i>	Vulnerable	IUCN
30.	<i>Renanthera imschootiana</i>	Endangered; Critically endangered	IUCN; BSI and CITES (Appendix-II)
31.	<i>Rhododendron johnstoneanum</i>	Endangered	BSI
32.	<i>Rhododendron wattii</i>	Rare and endangered	BSI
33.	<i>Rhododendron witchianum</i>	Rare	BSI

34.	<i>Synotis lushaensis</i>	Rare	BSI
35.	<i>Xylia xylocarpa</i>	Rare	IUCN

(Source: http://www.bsienviis.nic.in/Database/E_3942.aspx#divMizoram; accessed on 9-12-2018)

Threatened Medicinal Plant Species: The state of Mizoram is rich in medicinal plants and wild populations of the medicinal plants are under different categories of threat mainly due to destruction of ecological habitat, biotic interference, over exploitation, unscientific

collection, shifting cultivation and developmental activities. The population decline in case of many of these species has brought these species on the verge of extinction. Some of the threatened taxa of medicinal plants are given in Table 7.

Table 7. Conservation status of medicinal plants of Mizoram

S.No.	Species Name	Family	Local Name	Status
1.	<i>Aegle marmelos</i>	Rutaceae	Belthei	Endangered
2.	<i>Bergenia ciliate</i>	Saxifragaceae	Pan-damdawi	Rare
3.	<i>Begonia inflata</i>	Saxifragaceae	Sehupthur-hmul	Rare
4.	<i>Blumea lanceolaria</i>	Asteraceae	Buarze	Rare
5.	<i>Cautleya gracillis</i>	Zingiberaceae	Pale	Vulnerable and rare
6.	<i>Clerodendrum wallichii</i>	Verbenaceae	Tratuba	Vulnerable and rare
7.	<i>Dalbergia pinnata</i>	Fabaceae	Tengterehru	Very rare
8.	<i>Desmos longiflorus</i>	Annonaceae	Chiripi	Rare
9.	<i>Elaeagnus pyriformis</i>	Elaeagnaceae	Sarzukpui	Vulnerable
10.	<i>Elsholtzia blanda</i>	Lamiaceae	Nauhri	Rare
11.	<i>Flemingia macrophylla</i>	Fabaceae	Tuisithinglalram	Rare
12.	<i>Garcinia lancaefolia</i>	Clusiaceae	Pelhte	Rare
13.	<i>Garcinia pedunculata</i>	Clusiaceae	Theipumlian	Rare
14.	<i>Gardenia coronaria</i>	Rubiaceae	Rul-hluah, lalran	Rare
15.	<i>Gynocardia odorata</i>	Flacourtiaceae	Saithei	Rare
16.	<i>Hedychium coronarium</i>	Zingiberaceae	Ailalnu	Rare
17.	<i>Ixora nigricans</i>	Rubiaceae	Thainurual	Rare
18.	<i>Ocimum tenuiflorum</i>	Lamiaceae	Runhmui-dum	Rare
19.	<i>Pajenela longifolia</i>	Bignoniaceae	Ram-archangkawm	Rare
20.	<i>Pentapetes phoenicea</i>	Sterculiaceae	Parsenbial	Very rare
21.	<i>Raphidophora hookeri</i>	Araceae	Thiallawn	Rare
22.	<i>Rubia cordifolia</i>	Rubiaceae	Rawngsen	Rare
23.	<i>Saraca asoca</i>	Caesalpiniaceae	Mualhawih	Endangered
24.	<i>Senecio scandens</i>	Asteraceae	Sai-ek-hlo	Rare
25.	<i>Solanum khasianum</i>	Solanaceae	Athlo	Rare
26.	<i>Thumburgia grandiflora</i>	Acanthaceae	Zawngafian	Rare
27.	<i>Tinospora cordifolia</i>	Menispermaceae	Theiswantlung	Rare
28.	<i>Trapa natans</i>	Trapaceae	-	Critically endangered
29.	<i>Woodfordia fruticosa</i>	Lythraceae	Ainawn	Rare
30.	<i>Zanthoxylum armatum</i>	Rutaceae	Arhikreh	Rare
31.	<i>Zingiber purpureum</i>	Zingiberaceae	Pale	Vulnerable

(Source: Lalfakzuala *et al.*, 2007 and Rai and Laramnghinglov, 2010)

Threatened Wild Edible Plant Species: Wild edible fruits are collected from the forests and are sold in the market and due to this they have low distribution range and have thin population density and face several threats. Euphorbiaceae family have been categorized as threatened and included in CITES appendices. Some threatened wild edible plant species are given in Table 8.

Table 8. Conservation status of wild edible fruits and plants of Mizoram

S. No.	Botanical Name	Family	Local/Mizo Name	Threat Status
1.	<i>Antidesma bunius</i>	Euphorbiaceae	Tuai-tit	Threatened
2.	<i>Aporosa octandra</i>	Euphorbiaceae	Chhawntual	Threatened
3.	<i>Baccaurea ramiflora</i>	Euphorbiaceae	Pangkai	Threatened
4.	<i>Bridelia squamosa</i>	Euphorbiaceae	Thing-phak-tel	Threatened
5.	<i>Carallia branchiate</i>	Rhinophoraceae	Theiria	Rare
6.	<i>Elaeagnus pyriformis</i>	Elaeagnaceae	Sarzukpui	Vulnerable
7.	<i>Flacourtia jangomas</i>	Binaceae	Sakhithei	Rare
8.	<i>Mangifera sylvestris</i>	Anacardiaceae	Haifawvang	Rare
9.	<i>Arenga pinnata</i>	Aracaceae	Thangtung	Rare
10.	<i>Lepionurus sylvestris</i>	Alocarea	Anpangthuam	Rare

(Source: Issues and Trends of Wildlife Conservation in Northeast India)

Threatened Faunal Species: Mizoram is also home for variety of wildlife species, which have a significant influence on the tradition and culture of local communities. Mizoram species is rich in species biodiversity but poor in abundance. Around 29% of Mizoram wildlife are fall under IUCN Red List of threatened species of mammals, 49 species belongs to IW(P)A schedule I and II and 38 species falls under CITES Appendix I and II (Lalthanraza, 2017). Threatened faunal species of Mizoram is given in Table 9.

Table 9. Conservation status of faunal species of Mizoram

S. No.	Scientific Name	Common Name	Mizo Name	IUCN Status	CITES Status
1.	<i>Aonyx cinereus</i>	Asian small-clawed otter	Sahram (Hrampui)	Vulnerable	II
2.	<i>Arctictis binturong</i>	Bear cat	Zamphu	Vulnerable	III
3.	<i>Arctonyx collaris</i>	Greater hog badger	Phivawk	Vulnerable	-
4.	<i>Axis porcinus</i>	Hog deer	Sapeng	Endangered	I
5.	<i>Bos gaurus</i>	Indian bison	Ramsial	Vulnerable	I
6.	<i>Capricornis rubidus</i>	Red serow	Saza	Near threatened	I
7.	<i>Capricornis thar</i>	Himalayan serow	Saza hang	Near threatened	I
8.	<i>Catopuma temminckii</i>	Golden cat	Keisen	Near threatened	I
9.	<i>Cuon alpinus</i>	Indian wild dog	Chinghnia	Endangered	II
10.	<i>Dicerorhinus sumatrensis</i>	Sumatran rhinoceros	Samakkihnihnei	Critically endangered	I
11.	<i>Elephas maximus</i>	Indian/ Asian elephant	Sai	Endangered	I
12.	<i>Harpiocephalus mordax</i>	Greater hairy winged bat	Baklulian	Near threatened	-
13.	<i>Helarctos malayanus</i>	Sun bear	Mangte	Vulnerable	I
14.	<i>Hylobates hoolock</i>	Western hoolock	Hauhuk	Endangered	I

15.	<i>Lutrogale perspicillata</i>	Smooth- coated otter	Sahram	Vulnerable	II
16.	<i>Macaca assamensis</i>	Assamese macaque	Zo-zawng	Near threatened	II
17.	<i>Macaca arctoides</i>	Bear macaque	Zawngmawt	Vulnerable	II
18.	<i>Macaca leonina</i>	Pig-tailed macaque	Zawngbakbuk	Vulnerable	II
19.	<i>Manis pentadactyla</i>	Chinese pangolin	Saphu	Critically Endangered	I
20.	<i>Martes flavigula</i>	Yellow-throated marten	Safia	Least concern	III
21.	<i>Melursus ursinus</i>	Sloth bear	Savawmbakbuk	Vulnerable	I
22.	<i>Mustela kathiah</i>	Yellow-bellied weasel	Sarivaithun	Least concern	III
23.	<i>Naemorhedus griseus</i>	Chinese goral	Sathar	Vulnerable	I
24.	<i>Neofelis nebulosa</i>	Clouded leopard	Kelral/Zawngral	Vulnerable	I
25.	<i>Nycticebus bengalensis</i>	Slow loris, Bengal slow loris, ashy loris	Sahuai	Vulnerable	I
26.	<i>Paguma larvata</i>	Himalayan palm civet	Sazaw	Least concern	III
27.	<i>Panthera tigris</i>	Royal Bengal tiger	Keipui	Endangered	I
28.	<i>Panthera pardus</i>	Leopard	Keite/kawlkei	Vulnerable	I
29.	<i>Pardofelis marmorata</i>	Marbled cat	Pavak	Near threatened	I
30.	<i>Prionailurus viverrinus</i>	Fishing cat	Ngharbawr	Vulnerable	II
31.	<i>Ratufa bicolor</i>	Black giant squirrel	Awrrang	Near threatened	II
32.	<i>Rhinoceros unicornis</i>	Indian rhinoceros	Samak	Vulnerable	I
33.	<i>Rhinoceros sonadaicus</i>	Javan rhinoceros	Samak	Critically endangered	I
34.	<i>Rhizomys erythrogenys</i>	Red-cheeked bamboo rat	Buipui	Near threatened	-
35.	<i>Rucervus eldii</i>	Thamin	Sangai	Endangered	I
36.	<i>Rusa unicolor</i>	Sambhar	Sazuk	Vulnerable	-
37.	<i>Trachypithecus phayrei</i>	Phayre's leaf-monkey	Dawr/kawrNgau	Endangered	II
38.	<i>Trachypithecus pileatus</i>	Capped langur	Ngau/ Ngaubuang	Vulnerable	I
39.	<i>Ursus thibetanus</i>	Himalayan black bear	Savawm	Vulnerable	I
40.	<i>Viverra zibetha</i>	Large Indian civet	Tlumtui	Least concern	III
41.	<i>Viverricula indica</i>	Small Indian Civet	Tlumtherh	Least concern	III

(Source: Lal thanzara, 2017)





4

Drivers of Biodiversity Loss in Mizoram

A study was conducted for identification of drivers of deforestation and forest degradation in the Mamit District of Mizoram by Rawat *et al.*, 2017. The study has identified shifting cultivation, fuel wood collection, over exploitation of non-timber forest products as direct drivers of deforestation and forest degradation whereas unemployment, lack of knowledge and awareness, and less connectivity of roads as indirect drivers of deforestation and forest degradation. These identified drivers of deforestation and forest degradation are also responsible for biodiversity loss in the Mamit District of Mizoram.

Trend of Shifting Cultivation: Shifting cultivation is variably known as *jhum* cultivation/ *jhumming* or slash burn agriculture practice and it is an age old practice of farming in all the northeastern states of India. In shifting cultivation each family clears a patch of forest by cutting down whatever is growing in that patch of forest and burns it after drying. The ashes left behind thus become the fertilizer. Due to population pressure, the unscientific farming system necessitates the new patch of land to be cleared and burnt year after year. This resulted in patchy deforestation, soil and nutrient loss, moisture loss, and loss of indigenous biodiversity. This has also resulted in drying up of springs and rivers as well as depletion of underground water reserves. The principal crops grown is paddy and other crops are maize, cucumber, beans, arum, ginger mustard, sesame, cotton, cowpea and rice beans etc. are cultivated. In addition to this, ginger (*Zingiber officinalis*) and turmeric (*Curcuma longa*) are frequently planted in recently burned sites because they grow well on steep slopes and are high value crops.

In Mizoram, about 1.5 % of total forest area is being affected by shifting cultivation annually (Maithani, 2005) and responsible for huge loss of forest resources (Lalkhana, 1985). This age old practice being a major driver of deforestation and forest degradation (Rawat *et al.*, 2017) which resulted into clearing of the primary forest and altered the habitat of avi-fauna. Raman (2001) reported that the abundances of a number of

Himalayan bird species, including three (Grey Peacock Pheasant, Oriental Pied Hornbill and Great Hornbil) were considered endangered within India, were negatively related to degree of habitat alteration due to *jhum*. These endangered species, and others such as Streaked Wren Babbler, Red-headed Trogon, Green-billed Malkoha, and Snowy-browed Flycatcher, were absent or occurred at lower densities in successional bamboo and secondary forests.

New Land Use Policy was implemented on 14 January 2011 by the Government of Mizoram and highlighted the issues of providing stable economy for the state along with the environment protection, land reforms and reclamation. Out of several objectives, one of its main objectives is restoration of land by reforming land use policy and promoting permanent farming systems and protection of state's environment.

Land Use and Land Cover Change of Mizoram: Land use and land cover change holds interest for environmental analysis (Bradley and Mustard, 2005) since land use change may contribute to environmental degradation (Hunsaker *et al.*, 1994) and is considered one of the most important variables of global ecological change (Houet *et al.*, 2010). It has a capability to affect biodiversity to hydrological cycles, aerosols etc. (Skole *et al.*, 2012). Its change results from complex relationship of multiple factors including abiotic and biotic of which disturbance, succession and human use of the land are key drivers (Turner, 2005). Land-use change is projected to have the largest global impact on biodiversity by the year 2100, followed by climate change, nitrogen deposition, species introductions and changing concentrations of atmospheric CO₂ (Rai, 2012). Land use change is of a particular importance in the tropics especially in case of climate change which is likely to be important at high latitudes, and a multitude of interacting causes will affect other biomes (Rai and Panda, 2014). Therefore, the links between land use and land cover change and landscape pattern are pivotal to understand for effective land management and environmental sustainability by generating landscape metrics

to understand the relationship between habitat loss, fragmentation and population viability for different species for its successful conservation management (Fahrig, 2001).

With the growing concern of climate change due to continuous anthropogenic interference the consequences have also increased. The stability of the ecosystem increases by balanced growth of the land cover/use classes and further participates in the structure and function of the landscape

and explains the system's heterogeneity. In the land use and land cover statistics for two time periods (2005-06 and 2011-12) of Mizoram has shown that the built-up area for both urban and rural area has increased. Between the two time periods, both forest area and scrub area has increased. But major increment was observed in barren land, wasteland and unculturable land making the area more fragile and less stable (Table 10).

Table 10. Land Use Land Cover Information of 2005-06 and 2011-12 for Mizoram

S. No.	Land Use Land Cover Classes	Area (sq km)	
		2005-06	2011-12
1.	Built-up Urban	60.62	65.24
2.	Built-up Rural	112.77	124.33
3.	Cropland	860.27	181.69
4.	Agriculture, current shifting cultivation	1028.98	790.39
5.	Plantation (Agriculture)	70.17	83.5
6.	Deciduous forest	6886.48	7233.43 (4.80)
7.	Evergreen forest	6651.67	6984.55 (4.76)
8.	Scrub forest	4932.22	5093.17
9.	Plantation (forest)	86.17	105.84
10.	Grass/Grazing	122.18	112.18
11.	Barren/unculturable/ wastelands, scrub land/ barren rocky	37.73	144.82
12.	Wetlands/Water Bodies, Reservoir/Lakes/Ponds/rivers/ stream/canals/inland wetland	231.73	161.58

(Source: <https://bhuvan-noeda.nrsc.gov.in/gis/thematic/index.php>; accessed on 9-12-2018)

Invasive Alien Species: Inventory of invasive alien species is also one of the important indicators of the area representing hotspots areas of India. Invasive species is inextricably linked to biodiversity and sustainable development of that area. Such synthesis of information is essential in the face of mounting pressure of deforestation and forest degradation to regulate and mitigate the climate change. International Union for Conservation of Nature (IUCN) defines alien invasive species as an alien species which becomes established in natural or semi-natural ecosystems or habitat, an agent of change, and threaten to native biological diversity. The varying types of forest in Mizoram have an immense potential value to rural people. Land use change in Mizoram through shifting cultivation has

exacerbated the problem of biological invasions (Rai, 2009). In high disturbance areas of Mizoram, *Lantana camara*, *Mikania micrantha* and *Ageratum conizoides* were phyto-sociologically dominant invasive weeds (Rai, 2015). The most important characteristic of invasive species is that it covers the upper canopy of most of the small plants/ seedlings angiosperms (small plants and seedlings) therefore producing the shade effect which may hamper the photosynthesis. In general the trait of the invasive species is the production of large number of light weighted seeds and its long term viability which helps them to disperse to the interior of the forest and discourages the regeneration of the native species (Chandra Sekar, 2012).

5

Strategies for High Conservation Networks and Biodiversity Indicators

REDD+ has the potential to provide the social and environmental co-benefits besides the carbon benefit however, it can also pose some social and environmental risks. These benefits and risks will depend on a number of factors related to national circumstances – such as how REDD+ actions are designed and executed. As per Cancun Agreements seven safeguards are in place for addressing the risks in implementation of REDD+ actions. REDD+ actions should be consistent with the conservation of natural forests and biological

diversity. Identification of conservation strategies and biodiversity indicators are needed for safeguarding the biodiversity by implementing REDD+ actions. Identified conservation strategies and biodiversity indicators may be helpful in monitoring and reporting the biodiversity benefits of REDD+ actions.

Accordingly, conservation strategies and biodiversity indicators to be used in implementation of REDD+ activities in the state of Mizoram are identified and given below:

Conservation Strategy	Biodiversity Indicators
1. <i>In-situ</i> conservation of forest biodiversity through strengthening of the existing Protected Areas	<ul style="list-style-type: none"> • Trends in strengthening of protected areas (National Park, Wildlife Sanctuary, Conservation Reserves and Community Reserves) for conservation of forest biodiversity
2. Management of forest biodiversity within or outside protected areas with a view to ensure their conservation	<ul style="list-style-type: none"> • Trends in conservation of floral and faunal species within the protected areas • Trends in conservation of floral and faunal species outside the protected areas
3. Protection of forest ecosystems, natural habitats and the protection of viable population of indigenous species	<ul style="list-style-type: none"> • Trends in protection of forest ecosystems and natural habitats • Trends in protection of viable populations of indigenous species
4. Promotion of sustainable management in forest fringe areas adjacent to protected areas for conservation of biodiversity by indigenous species	<ul style="list-style-type: none"> • Trends in sustainable management of forest fringe areas • Trends in conservation of biodiversity of indigenous species in forest fringe areas
5. Restoration of degraded forests for conservation of indigenous biodiversity	<ul style="list-style-type: none"> • Trends in restoration of degraded forests • Application of indigenous plant species in restoration of degraded forests • Trends in conservation of indigenous biodiversity of flora and fauna in the restored degraded forests
6. Measures for recovery, rehabilitation and reintroduction of threatened species into their natural habitats	<ul style="list-style-type: none"> • Threat assessment of rare, endangered and threatened species • Trends in measures adopted for recovery of threatened species • Trends in recovery of threatened species from the verge of extinction • Monitoring of rare, endangered and threatened species through periodical surveys and inventory

7. Expansion of conservation and community reserve areas for conservation of indigenous forest biodiversity	<ul style="list-style-type: none"> • Trends in number and extent of conservation and community reserves areas • Trends in biodiversity of indigenous floral and faunal species in conservation and community reserve
8. Control and management of invasive alien species	<ul style="list-style-type: none"> • Trends in invasive species control and management • Trends in development of management plans for control of prioritized invasive species • Trends in change in area affected by invasive species • Trends in reduction in population of invasive alien species
9. Establishment of preservation plots in different forest types for monitoring of forest biodiversity of indigenous species	<ul style="list-style-type: none"> • Trends in establishment of preservation plots • Trends in monitoring of forest biodiversity of indigenous species
10. Identification and strengthening the areas of high endemism of genetic resources/ biodiversity hotspots for forest biodiversity conservation	<ul style="list-style-type: none"> • Trends in identification of the areas of high endemism • Trends in conservation of endemic species in biodiversity hotspots
11. Formulation and implementation of programmes for conservation of threatened species in biodiversity hotspots	<ul style="list-style-type: none"> • Trends in formulation of programmes for conservation of threatened species • Trends in implementation of programmes for conservation of threatened species in biodiversity hotspots
12. <i>Ex-situ</i> conservation of rare, endangered and threatened species	<ul style="list-style-type: none"> • Trends in <i>ex-situ</i> conservation of rare, endangered and threatened species • Trends in conservation status of rare, endangered and threatened species
13. Conservation, management and sustainable utilization of forest biodiversity of bamboo and other non-timber forest produces	<ul style="list-style-type: none"> • Trends in biodiversity of bamboo species • Trends in sustainable utilization of non-timber forest products
14. Regular monitoring of keystone, umbrella and endemic species	<ul style="list-style-type: none"> • Trends in threat assessment of keystone, umbrella and endemic species
15. Effective implementation of Biodiversity Act, 2002	<ul style="list-style-type: none"> • Strengthening of Mizoram State Biodiversity Board • Preparation of State Biodiversity Action Plan • Establishment of Biodiversity Management Committees • Preparation of People Biodiversity Registers
16. Afforestation and restoration of open forests through indigenous and endemic plant species	<ul style="list-style-type: none"> • Trends in afforestation and restoration of open forests • Change in proportion of forest cover in different forest categories (VDF, MDF, OF and Scrub) • Trends in forest carbon stocks • Trends in assisted natural regeneration • Trends in change in forest fragmentation

<p>17. Capacity building and awareness on conservation of biodiversity of the stakeholders</p>	<ul style="list-style-type: none"> • Trends in organization of capacity building programmes on biodiversity conservation • Trends in development of capacities of the stakeholders in biodiversity conservation • Trends in awareness generation on biodiversity conservation
<p>18. Promoting terrace farming/ settled farming for addressing the shifting cultivation</p>	<ul style="list-style-type: none"> • Trends in adoption of permanent terrace and settled farming • Trends in up-scaling of best practices for terrace/ settled farming • Capacity building of the local community on terrace and settled farming
<p>19. Eco-restoration/ eco-rehabilitation of shifting cultivation areas</p>	<ul style="list-style-type: none"> • Trends in eco-restoration/ eco rehabilitation of abandoned shifting areas through suitable indigenous REDD+ species • Trends in capacity building of the local community and frontline staff of State Forest Department on eco-restoration of abandoned shifting areas
<p>20. Sustainable management of forest and conservation of biodiversity</p>	<ul style="list-style-type: none"> • Development of working plans for sustainable management of forests with incorporation of component on REDD+ and associated safeguards • Development of conservation areas for conservation of floral and faunal biodiversity
<p>21. Conservation and sustainable utilization of non-timber forest products</p>	<ul style="list-style-type: none"> • Trends in promotion of <i>in-situ</i> conservation of non-timber forest products yielding species • Trends in cultivation of medicinal plant species of high demand in private lands • Trends in sustainable harvesting practices of non-timber forest products • Capacity building and awareness of the local communities on cultivation, scientific collection, storage and sustainable utilization of non-timber forest products • Develop a fair and equitable benefit sharing mechanism for distributing the benefits of conservation and sustainable utilization non-timber forest products • Value addition of non-wood forest products
<p>22. Development of Safeguard Information System for conservation of forest biodiversity in implementation of REDD+ in Mizoram</p>	<ul style="list-style-type: none"> • REDD+ Safeguard Information System developed for the state of Mizoram • Provisions of the safeguard information system addressed, respected and reported



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