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Chapter 9

Impact of Climate Change on Medicinal Plant Diversity, Indigenous Traditional Knowledge and Utilization Pattern in Joint Forest Management Areas of Mizoram

K. Lalhmingsangi and U.K. Sahoo*
Department of Forestry, School of Earth Science and Natural Resource Management, Mizoram University, Aizawl–796004, Mizoram, India
*E-mail: *uksahoo_2003@rediffmail.com*

INTRODUCTION

There is a growing concern of climate change over all over the globe. A serious concern on climate change is felt across the developing countries like India which does not have sufficient technology to mitigate the effect of climate change. The impact of climate change is more likely to adversely affect the developing countries due to their high dependency on climate sensitive livelihoods like rain-fed agriculture, water and forestry (Moorhead 2009). Several studies have shown that indigenous people are among the most valuable to this effect of climate change (Anon 2016). Such communities predict weather and climate by observing diverse bio-physical entity such as movements of insects, birds, livestock, use traditional knowledge to reduce the amount of greenhouse gases, reading clouds, the winds and nature (sprouting of vegetation and flowers) and personal physical/body experience to forecast the coming of rains and drought seasons. The women folk, who are part of the Joint Forest Management, are mostly affected by climate change as they collect nursery herbs, shrubs, non-timber forest products, medicinal plants for household subsistence from the areas. According to the Intergovernmental Panel on Climate Change IPCC (2007) world temperature has increased by 2°C on the earth's surface during the last fifty years. The impacts of climate change and their associated costs will fall disproportionately on developing countries threatening to undermine achievement of the Millennium Development Goals, reduce poverty and safeguard food security (Ansuategi *et al.* 2015).

Like all living members of biosphere, climate change also affects the life cycle and distributions of medicinal and aromatic plants (MAPs).The effects of climate on vegetation have been studied by numerous workers (Alongi 2015; Das 2015; Gogoi and Deka 2015; Roy and Roy 2016; Mishra 2016; Samita and Manna 2016; Sannigrahi 2014; Kunwar *et al.,* 2014; Kakyl and Gilbert 2017; Ramakrishnan 2015). Among the plant species group, the herbaceous vegetation are mostly affected due to climate change and uncertainty in weather, fluctuation in temperature and rainfall etc. Several studies also have proved that climate change can

drastically alter the distribution, phonological events in medicinal plants (Chestin 2001; McCarty 2001), these factors can also disrupt the pollinator affecting flowering, fruiting etc of different plant species. Due to climate change, many wild MAPs have either become extinct or under the verge of extinction, as evident from reviewing ecological process and species distribution trough herbarium collection (Li *et al*., 2013).Climatic variables are strong environmental factors affecting the distribution of the life cycle and distribution of medicinal plants (Whittaker 2002; Trivedi *et al.,* 2008). These changes affect the plant ecology e.g. drought and heat weaves affect on photosynthesis, respiration, transpiration etc. (Barbosa *et al.,* 2012; IPCC 2013) and it also increases the rate of plant mortality and extinction risk in many areas.

Medicinal plants have been used by the tribal folks of the North-eastern India including Mizoram since time immemorial for their health care needs. Over a period of time they have developed indigenous traditional knowledge (ITK) on the use of various medicinal plants and these knowledge are now integral parts of the culture and history of the tribal communities. These accumulated body of knowledge and beliefs are traditionally handed down through generations by cultural transmission about the relationship of the living being including human with one another and their environment. The climate change may affect even the practice of ITK (Parjuli and Maharjan 2017) as indigenous plants are expected to be highly susceptible and are reported to be shifting their bases as response to climate change (Parmasen and Yohe 2003; Telwala *et al.,* 2013) which would have direct impact on the tribal folks dependent on medicinal plants (Cavalier 2009).

An attempt has been made in the paper to compile the distribution of medicinal plants in Joint Forest management across the three agro-climatic zones, the use of Indigenous Traditional Knowledge and utilization pattern of medicinal plants.

MATERIALS AND METHODS

Study Site

A study was designed to understand the impact of climate change on medicinal plant diversity, indigenous traditional knowledge and utilization of medicinal plants in Joint Forest Management (JFM) areas of Mizoram. For the purpose, all the 25 JFM areas located in three agro-climatic zones of Mizoram were selected for the study. These are Saihapui K, Thingdawl, Chemphai, Kolasib, Lengte, Dapchhuah, Chungtlang, Chhippui/Kawnmawi, Tuahzawl falling under Agroclimatic Zone I, Sihphir, Muthi, Ailawng, Lungleng I, Neihloh, Ramlaitui, Baktawng, Samlukhai, Sumsuih, Serkhan falling under Agroclimatic Zone II and Ngopa, Kawlkulh, Khawhai, Khawzawl, Hliappui, falling under Agroclimatic Zone-III. These agroclimatic zones varied with respect to rainfall, temperature and humidity (Table 1). Agroclimatic Zone 3 had relatively lower temperature and experienced cooler time, though humidity was also high. Both primary and secondary data were obtained through semi-structured questionnaire, field observation, personal interview and group discussion with the villagers to generate information on to what extent they are involved in harvesting of medicinal plants. Semi-structured questionnaire covered approximately 10% of the household sample size from each villages to generate data on household characters such as family size, landholding, literacy rate, education level and income status of the family, it also included information on exploitation of medicinal plants as well as the consequences of climate change on the medicinal plants vegetation of community forest *i.e.,* VFDC plantation areas.

Table 1: Climatic Variability of Rainfall, Temperature and Humidity Across the Three Agro Climatic Zone

Variables	AZ1	AZ2	AZ3
Altitude (m)	<800	800-1400	>1400
Rainfall(mm/year)	2000-3000	2500-3000	2000-3000
Mean temp. (min)	12 °C	12 °C	11 °C
Mean temp(max)	30 °C	30 °C	20 °C
Humidity	53-62%	58-76%	75-88%

Source: Mizoram Remote Sensing Application Centre (MIRSAC)

RESULTS AND DISCUSSION

A total of 116 plant species belonging to the 58 families are documented from the three agro-climatic zones of Mizoram (Table 2). They are classified into abundant, rare, least concerned and critically

endangered. A total of 103 medicinal plant species was found in agro-climatic zone 1 with 65 abundant species, 26 rare species and 11 least concerned and one critically endangered species. In agro-climatic zone 2, 113 plant species were documented under which 84 plant species fall under abundant status, 20 rare species, 9 least concerned species. In agro-climatic zone 3, 102 medicinal plant species were found and 67 plant species belong to the abundant status, 24 are rare species, 10 least concern and one critically endangered species (Table 2). Among the species *Datura suaveolens, Myrica esculenta* were found restricted to the JFM areas of AZ1, *Butea monosperma, Aegle marmelosa, Amaranthus spinosus, Canna indica, Mussaendra roxburghii* were restricted to AZ2 while Artocarpus chama was restricted to the JFM areas of AZ3. The effects of climate change are apparent within ecosystem around the world, including, medicinal plant populations. Some results have shown that the individual species either adapt to the increased temperature by modifying their structure and posture (Kelly and Coulden, 2008) or shift towards cooler climate/ higher altitude. Vegetation up-shift in response to climate change for various species have been reported (Kunwar 2011; Kunwar *et al.*, 2014). In view of the fact that changes in temperature, changing climate can affect health and bring various kind of diseases, it may be difficult to meet the growing requirements of medicinal herbs and other species that are susceptible to climate change. Due to the change in climatic conditions, medicinal plants in the study areas face challenges leading to the risk of genetic diversity loss. In the study area two critically endangered species are documented. Practice of indigenous traditional knowledge may get affected due to climate change.

Table 3: Category of Medicinal Plant in the Three Agro-climatic Zone based on the Status

Agro-climatic Zone	Abundant	Rare	Least Concerned	Critically Endangered	Total
AGZ-1	65	26	11	1	103
AGZ-2	84	20	9	-	113
AGZ-3	67	24	10	1	102

Table 4: Category of Medicinal Plants in the Three Agro-climate Zone based on the habit

Category/Attributes	AGZ-1	AGZ-2	AGZ-3
Trees	41	38	47
Shrubs	32	34	30
Herbs	26	36	22
Climbers	4	5	3
Family	31	39	42

The temperature and humidity varied from each other with respect to different agro-climatic zone. Higher the altitude cooler the climate and lower the altitude warmer the temperature. Agro-climatic zone 1 has the lowest altitude and got the minimum moisture (53-62%), agro-climatic zone 2 has the mid altitude and moisture. Agro-climatic zone 3 has the highest altitude and highest moisture content among all the three agro-climatic zones.

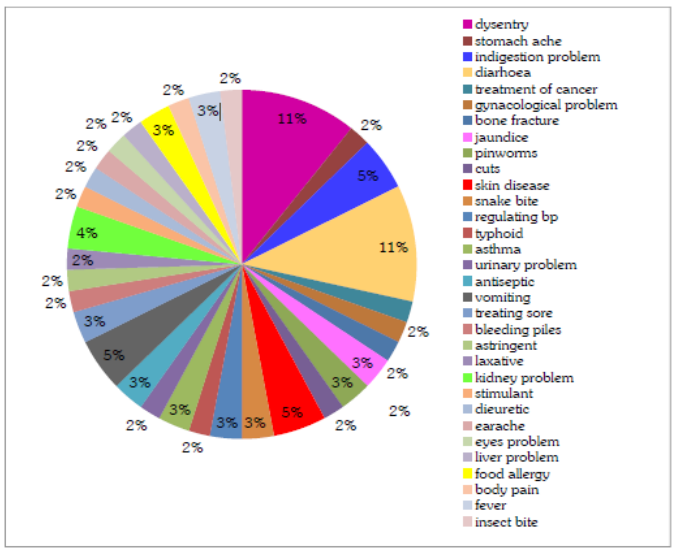

Fig. 1: Mode of Utilization of Medicinal Plants in Disease Wise

The 116 medicinal plants are being used for curing different 32 ailments. Dysentery and diarrhoea are treated most frequently using these medicinal plants (Fig. 1) followed by indigestion problem, skin disease, vomiting and kidney related problems. Based on the habit wise, leaves has the highest percentage of utilization among all the plant parts followed by bark, whole plant, fruits, seeds, roots/rhizome and least utilization from the stem (Fig. 2).

In AGZ-2, more abundant species were found though in both AGZ-1 and 3, one critically endangered species was noticed (Table 3) The tree species was highest in agro-climatic zone 1 followed by zone 2 and least in zone 3. Shrubs was highest in agro-climatic zone 2 followed by zone 1 and least in zone 3. Herbs and climbers was highest in agro-climatic zone 2 followed by zone 1 and least in zone 3 (Table 4). All together 48 tree species was documented, 37 shrub species, 24 herb species and 7 climber species. Trees have the highest number because the VFDC plantation site has a large number of tree species which are grown naturally and some of them are planted.

The medicinal plants within the Joint Forest Management areas are degrading due to different reasons and climate change being one of the major causes. The herbaceous plant species are more likely to be effected by the extreme temperature and irregular rainfall caused by climate change. The effect of climate change on medicinal plants has not been well studied. At this situation, the consequences of climate change on medicinal plants may become a bigger issue for the herbal community all over the world. In present condition, climate change may not create a big threat to medicinal plants, but it will surely become a greater threat in future decades. Further research on the study of climate change effect on medicinal plants is essential for a better conservation strategy.

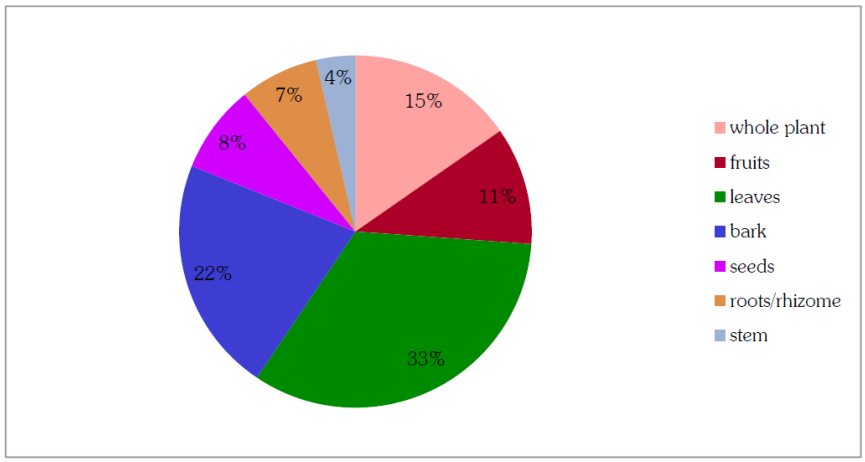

Fig. 2: Parts Wised Distribution of Medicinal Plants

Table 5: Distribution of the Medicinal Plants in 3 Agro-climatic Zone of Mizoram

Sl. No.	Scientific Name	Vernacular Name (Mizo)	Family	Agro-climatic Zone			Parts Used	Mode of Utilization
				1	2	3		
1	*Adiantum philippense* L.	Chakawkte	Adiantaceae	+	+	+	Whole plant	The whole plant is boiled and used in treatment of dysentery and stomach ulcers.
2	*Aegle marmelos* (L) Correa	Belthei	Rutaceae	-	+	-	Fruit	Decoction of the fruit is applied for dysentery, stomach-ache and indigestion problem.
3	*Ageratum conyzoides* L.	Vailenhlo	Asteraceae	+	+	+	Whole plant	The root is crush with *Callicarpa arborea* bark and rhizome of *curcuma longa* and the juice is drunk for the remedy of stomach cancer; stem and leaf as anti-diarrhoeal
4	*Albizia odoratissima* Benth.	Kangteknu	Mimosaceae	+	+	-	Leaf	The leaf is boiled in ghee and is used in remedy for cough
5	*Albizia procera* (Roxb.) Benth.	Kangtekpa	Mimosaceae	+	+	-	Bark	Bark is boiled with water and taken against pinworms
6	*Albizia chinensis* (Osb.) Merr.	Vang	Mimosaceae	+	+	+	Bark	Infusion of the bark is used for treating cuts and skin disease.
7	*Alocasia fornicata* (Roxb.) Schott	Baibing	Araceae	+	+	+	Whole plant	Juice of the plant is used for treating snake bite

Sl. No.	Scientific Name	Vernacular Name (Mizo)	Family	Agro-climatic Zone			Parts Used	Mode of Utilization
				1	2	3		
8	*Alstonia scholaris* (L.) R.Br.	Thuamriat	Apocynaceae	+	+	+	Bark and leaf	The bark and leaves are boiled and the water is taken for high blood pressure, dysentery, typhoid and asthma.
9	*Amaranthus spinosus* Linn.	Lenhling	Amaranthaceae	-	+	-	Whole plant	The leaves are boiled in water and the water is drunk for difficult urination. Juice of crushed leaves is used to stop bleeding from the nose
10	*Amaranthus viridis* L.	Len hling–hling neilo/Zamzo	Amaranthaceae	+	+	+	Whole plant	Decoction of the plant is used for treating dysentery and inflammations
11	*Amomum dealbatum* L. Roxb.	Aidu	Zingiberaceae	+	+	+	Bark	The crushed bark is boiled with water and used for antiseptic
12	*Anogeissus acuminata* (Roxb.) Wall.	Zairum	Combretaceae	+	+	+	Bark	Decoction of the bark is boiled and used for the treatment of stomach problems.
13	*Aporosa diotica* (Roxb.) Muell.Arg.	Chhawntual	Euphorbiaceae	+	+	+	Bark	Decoction of bark is used as a remedy of stomach ulcer and diarrhoea.
14	*Artemisia vulgaris* L.	Sai	Asteraceae	+	+	+	Stem	The agar extracted from the stem is used against vomiting
15	*Artocarpus lakoocha* Roxb.	Theitat	Moraceae	+	+	+	Seed and bark	The seed is used for purgative and the powder bark is applied to sores to draw out purulent matter, infusion is applied to pimples and cracked skin
16	*Artocarpus chama.* Butch.-Ham.	Tatkawng	Moraceae	-	-	+	Bark	Decoction of bark is taken against diarrhoea
17	*Averrhoa carambola* L.	Theiherawt	Averrhoaceae	+	+	+	Fruit	Fruits are consumed daily for jaundice, bleeding piles and as anti-scorbutic
18	*Baccaurea ramiflora* Lour.	Pang-kai	Euphorbiaceae	+	+	+	Bark	Infusion of bark is astringent and is taken for food allergy.
19	*Bauhinia variegata* L.	Vaube	Caesalpinaceae	+	+	+	Bark	Bark is carminative, tonic, astringent, antidiarrhoea, as blood purifier, as tonic, used in goitre; flower as laxative
20	*Begonia inflae* Cl.	Sekhupthur	Begoniaceae	+	+	+	Stem	Juice of the stem for treating pile related problem
21	*Bergenia ciliata* (Haw.) Sternb.	Khamdamdawi	Saxifragaceae	+	+	-	Whole plant	The plant is bruised to boiled is highly reputed for dissolving stones in the kidney
22	*Bidens pilosa* L.	Vawkpuithal	Asteraceae	+	+	+	Whole plant	The whole plant is boiled and taken orally for diarrhoea and dysentery.
23	*Bischofia javanica* Bl.	Khuangthli	Bischofiaceae	+	+	+	Leaf	Juice of leaves is considered cure for sore
24	*Blumea lanceolaria* (Roxb.) Druce.	Buarze	Asteraceae	+	+	+	Leaf	Decoction of leaves used for treating stomach pain and also to rejuvenate cancer patient
25	*Bombax ceiba* L.	Phunchawng	Bombacaceae	+	+	+	Whole plant	The root is used for stimulant. Gum is used for homeostatic astringent, tonic alternative used in diarrhoea and dysentery. Fruit and flower are also used as against in snake bite.
26	*Bombax insigne* Wall.	Pang	Bombacaceae	+	+	+	Bark	The bark is peeled off and chewed and the juice is swallowed as an effective remedy against tonsillitis
27	*Butea monosperma* (Lam.) Taub.	Tuahpui	Fabaceae	-	+	-	Seed	The seeds are taken to expel intestinal worms
28	*Callicarpa arborea* Roxb.	Hnahkiah	Verbenaceae	+	+	+	Bark and leaf	Decoction of the bark is used for treating stomach ulcer.
29	*Camellia sinensis* (L.) O. Kuntze.	Thingpui	Theaceae	+	+	+	Leaf	Leaf boiled is used as astringent, stimulant, diuretic.
30	*Canna indica* L.	Kungpuimuthi	Cannaceae	-	+	-	Seed	Seed juice relieves earaches. Root bark and stalks are used to the cattle suffering from poisoning.
31	*Carralia brachiata* (Lour.) Merr.	Theiria	Rhizophoraceae	+	+	+	Bark	Infusion of bark is applied on itches.
32	*Catharanthus roseus* (L.) G.Don.	Kumtluang	Apocynaceae	+	+	+	Leaf	The leaves are taken for the remedy of high blood pressure
33	*Centella asiatica* (L.) Urb.	Lambak/ Hnahbial	Apiaceae	+	+	+	Whole plant	The leaves are boiled and the water is taken for the remedy of asthma and eyes problems.
34	*Chromolaena odorata* (L.) King & Rob.	Tlangsam	Asteraceae	+	+	+	Leaf	Juice of leaves is applied on cuts and wounds as haemostatic
35	*Cinnamomum bejolghota* (Butch. Ham.) Sweet	Thakthingsuak	Lauraceae	+	+	-	Bark	Decoction of bark is taken for dyspepsia and liver complaints.
36	*Cinnamomum verum* Presl.	Thakthing	Lauraceae	-	+	-	Bark and root	The bark and roots are taken against nausea and vomiting.
37	*Clerodendrum colebrookianum* Walp.	Phuihnam	Verbenaceae	+	+	+	Leaf	Cold infusion of leaves is drunk against hypertension and to decrease breast milk.
38	*Clerodendrum viscosum* Vent	Phuihnamchhia	Verbenaceae	+	+	-	Root and leaf	The boiled water of the roots and leaves is applied on itches. Infusion of the leaves is also orally taken against dysentery and pin worm.
39	*Cordia dichotoma* Forst.	Muk	Boraginaceae	+	+	+	Bark	Decoction of bark is taken for strengthening the function of uterus.
40	*Costus speciosus* (Koenig) Sm.	Sumbul	Costaceae	+	+	+	Rhizome	Juice of crush roots given to kidney related problems.
41	*Curculigo capitulata* (Lour.) O. Kuntze.	Phaiphek	Hypoxidaceae	+	+	+	Tuber	Juice of tuber is used in stomach-ache.
42	*Curcuma longa* Roxb.	Aieng	Cucurbitaceae	+	+	+	Rhizome	Rhizome is crushed and the juice is used for antiseptic.
43	*Datura suaveolens* Hamb. & Bruph	Tawtawrawt par	Solanaceae	+	-	-	Leaf	Leaves are dried and smoked as tobacco for chest complaints, asthma while roasted leaf is applied on breast lump/ stony hard breast.

Sl. No.	Scientific Name	Vernacular Name (Mizo)	Family	Agro-climatic Zone			Parts Used	Mode of Utilization
				1	2	3		
44	*Dendrocnide sinuata* (Bl.) Chew.	Thakpui	Urticaceae	+	+	+	Root	The root is boiled along with crabs and the water is taken for the remedy of jaundice.
45	*Derris thyrsiflora* Benth.	Hul-hu	Fabaceae	+	+	+	Fruit	Decoction of fruit is taken for dysentery and stomach-ache.
46	*Dillenia indica* L.	Kawrthindeng	Dilleniaceae	+	+	+	Fruit	The fruit is boiled and the water is taken for remedy of stomach problem.
47	*Dillenia pentagyna* Roxb.	Kaihzawl/ Hnahkhauh	Dilleniaceae	+	+	+	Bark and leaf	The bark and leaves are boiled and the water is taken for diarrhoea and cancer. The bark is crushed and added to the pig food to remove sore-worms.
48	*Dinochloa compactiflora* (Kurz) McClure.	Sairil	Poaceae	-	+	+	Whole plant	The outer skin is scraped off and applied externally on cuts and bandaged to stop bleeding.
49	*Diplazium maximum* (D.Don.) C. Chatt.	Chakawkeichi	Athyriaceae	+	+	+	Leaf	The frond are crushed and applied externally on skin diseases.
50	*Dregea volubilis* Benth.	Ankhapui	Asclepediaceae	+	+	+	Leaf	External application of the paste of grinded leaves is used for the treatment against bone fracture and enlarged glands.
51	*Dysoxylum gobara* (Butch.-Ham.) Merr.	Thingthupui	Meliaceae	+	+	+	Leaf	Decoction of leaves and buds is used as against in diarrhoea and dysentery.
52	*Elaegnus caudata* Schl. Ex Mom.	Sarzukpui	Elaegnaceae	+	+	+	Root	The root is boiled and the water is taken for the remedy against retained placenta.
53	*Emblica officinalis* Gaertn.	Sunhlu	Euphorbiaceae	+	+	+	Fruit	The fruit is consumed for treating stomach problems and for treating the skin.
54	*Entada pursaetha* DC.	Kawi	Mimosaceae	+	+	+	Seed	The seed are soaked in water and the water is dropped into the nostrils against leech.
55	*Eryngium foetidium* L.	Bahkhawr	Apiaceae	+	+	+	Leaf	The crush root and leaves are taken for stomachic, and the leaves are taken for pinworms and food allergy.
56	*Erythrina stricta* Roxb.	Fartuah	Fabaceae	+	+	+	Bark	The bark is used as astringent and antidote to snake bite.
57	*Eurya acuminata* DC.	Sihneh (zik sen)	Theaceae	+	+	+	Leaf	Decoction of leaves is taken for colic and stomach-ache.
58	*Ficus bengalensis* Linn.	Hmawng	Moraceae	+	+	+	Bark	Infusion of bark is used as tonic, astringent, dysentery, diarrhoea and diabetes.
59	*Ficus hispida* Linn.	Paihte maian	Moraceae.	+	+	+	Leaf	Leaves is used to apply on eye for eye problems
60	*Ficus prostrata* Lam.	Theitit	Moraceae	+	+	+	Root	The root is crushed and the juice is applied for the remedy against poisoned snake bites
61	*Ficus semicordata* Butch.-Ham.	Theipui	Moraceae	+	+	+	Fruit	The young fruits are astringent and are taken for dysentery.
62	*Garcinia cowa* Roxb. Ex DC.	Chengkek	Clusiaceae	+	+	+	Leaf	The leaves are boiled and the water is taken for diarrhoea.
63	*Garcinia paniculata* (G.Don) Roxb.	Vawmva	Clusiaceae	+	+	+	Seed	The seed is used to treat roundworm.
64	*Girardinia palmata* (Forsk) Gaud.	Kangthai	Urticaceae	+	+	+	Root	The root is crushed and the juice is taken against food allergy.
65	*Gmelina arborea* Roxb.	Thlanvawng	Verbenaceae	+	+	+	Fruit	Roasted fruit is applied externally in itches.
66	*Hedychium spicatum* Ham. ex Sm.	Aithur	Zingiberaceae	+	+	+	Rhizome	The rhizome is crushed and the juice is taken for liver complaints and body pain
67	*Hedyotis scandens* (Roxb.)	Laikingtuibur/ Kelhnamtur	Zingiberaceae	+	+	+	Whole plant	The whole plant is boiled and the water is taken for the remedy against swollen and kidney problem.
68	*Helianthus annus L.*	Nihawipar	Asteraceae	+	+	-	Seed	Seed-diuretic, expectorant, febrifuge and stomach-ache.
69	*Helicia robusta* (Roxb.) R.Br. ex Wall	Pasaltakaza	Proteaceae	+	+	+	Root and stem	Decoction of root and stem is taken internally for stomach-ache, flatulence, kidney problems.
70	*Hodgsonia macrocarpa* (Bl.) Cogn.	Khaum	Cucurbitaceae	+	+	+	Seed	The seeds are boiled and taken for placental disorder.
71	*Homalomena aromatica* Schott.	Anchiri	Araceae	-	+	+	Leaf and stem	Leaves and stem are cooked along the fodder of pigs to increase their breast milk.
72	*Imperata cylindrica* (L.) Beauv.	Di	Poaceae	+	+	+	Root	Decoction of roots used for expelling thread worms from the body.
73	*Inula cappa* DC.	Buarthau	Asteraceae	+	+	+	Leaf	Juice is taken orally for diabetes and jaundice.
74	*Jatropha curcas* L.	Kangdamdawi	Euphorbiaceae	-	+	+	Stem	Stem is used as tooth brush in swollen gums.
75	*Lagerstroemia speciosa* Pers.	Thlado/ Chawnpui	Lythraceae	+	+	+	Root	Decoction of root is taken for jaundice and infusion of bark is taken for diarrhoea and dysentery.
76	*Lindernia ruelloides* (Colsm.) Pennell.	Thasuih	Scrophulariaceae	-	+	+	Leaf	Leaves used for Rheumatism, sciatica, skin worms, wounds.
77	*Lonicera macrantha* (D. Don) Spreng	Leihruisen	Caprifoliaceae	-	+	+	Leaf	Decoction of leaves is taken for dysentery and stomach-ache.
78	*Maesa ramentacea* Wall.	Arngengpui	Myrsinaceae	+	+	+	leaf	The pounded leaf is applied on itches and skin diseases.
79	*Maesa indica* (Roxb.) DC.	Arngeng	Myrsinaceae	+	+	+	Leaf	Leaves are eaten against dysentery and other stomach problems.
80	*Mangifera indica* L.	Theihai	Anacardiaceae	+	+	+	Leaf	Decoction of the leaves taken for treating diarrhoea.
81	*Melastoma malabathricum* L.	Builukham	Melastomataceae	+	+	+	Leaf and bark	Bark and leaf is used as wound healer; leaf as antidiarrheal, antiseptic.
82	*Melocanna baccifera* (Roxb.) Kurz	Mautak	Poaceae	-	+	+	Stem	The outer skin is scraped off and applied on cuts as haemostatics.
83	*Mesua ferrea* Linn.	Herhse	Clusiaceae	+	+	+	Leaf and flower	Flower is used as astringent, stomachic while flower and leaves are also used against as snakebite & scorpion sting.

Sl. No.	Scientific Name	Vernacular Name (Mizo)	Family	Agro-climatic Zone			Parts Used	Mode of Utilization
				1	2	3		
84	*Michelia champaca* L.	Ngiau	Magnoliaceae	+	+	+	Leaf	Infusion of leaves is taken with honey for colic.
85	*Mikania micrantha* Kunth.	Japanhlo	Asteraceae	+	+	+	Leaf	Juice of the leaves is applied to cuts as antiseptic.
86	*Mimosa pudica* L.	Hlonuar	Mimosaceae	+	+	+	Leaf and root	Leaves and root are used for pile and fistula.
87	*Mirabilis jalapa* Linn.	Aratukkhuan	Nycaraginaceae	+	+	+	Leaf	Infusion of leaves is used for itching by applying externally. Sprain and bone fracture are treated with this plant by bandaging over the injured area with the leaves.
88	*Musa acuminata* Colla	Changel	Musaceae	+	+	+	Stem	The sap of the stem is applied for antiseptic.
89	*Musa glauca* Roxb.	Saisu	Musaceae	+	+	+	Whole plant	The seeds are made into beads and used as necklace by children against convulsion associated with fever. The sap of the cut stem is taken orally for dysentery and as coolant.
90	*Mussaendra roxburghii* Hk. F.	Vakep	Rubiaceae	_	+	_	Bark	The bark is crushed and the juice is effectively used in snake bite.
91	*Myrica esculenta* Butch.-Ham. Ex D. Don.	Keifang	Myricacea	+	_	_	Bark	The bark is crushed and the juice is taken for fever and cough.
92	*Oroxylum indicum* (L.) Vent.	Archangkawm	Bignoniaceae	+	+	+	Fruit	The fruit and juice of the bark boiled with water and the juice is used for treating kidney stone.
93	*Osbeckia nepalensis* Hook.	Builukhampa	Melastometaceae	+	+	+	Leaf	Decoction of leaves is taken for diarrhoea and dysentery.
94	*Paederia scandens* (Lour.) Merr.	Vawihuihhrui	Rubiaceae	+	+	+	Whole plants	The whole plants are boiled with water and the juice is used for treating breathing problem.
95	*Parkia roxburghii* D. Don.	Zawngtah	Mimosaceae	+	+	+	Fruit	The skin of fresh pod is scrapped off and made into paste and applied on scabies.
96	*Phrynium capitatum* Wild	Hnahthial	Marantaceae	+	+	+	Leaf and stem	The young shoot and leaves or stem is used for burns and itches. It is applied externally on the wounded surface as a paste.
97	*Phyllanthus acidus* (L.) Skeels.	Kawlsunhlu	Euphorbiaceae	+	+	+	Root	The root is considered antidote to viper venom.
98	*Polygonum chinensis* L.	Taham	Polygonaceae	+	+	+	Whole plant	Juice of the whole plant is used as tonic.
99	*Polygonum plebeium* R. Br.	Bakhate	Polygonaceae	+	+	+	Whole plant	Decoction of the plant is taken against cirrhosis of liver and gastric complain.
100	*Pratia nummularis* Kurz.	Choakthi	Campanulaceae	+	+	+	Leaf	The leaves are crushed and the juice is taken for the remedy of dysentery and vomiting.
101	*Prunus cerasoides* D.Don	Tlaizawng	Rosaceae	+	+	+	Bark	The bark is boiled and the water is taken against fever.
102	*Pteridium acquilinum* (v) Kuhn.	Katchat	Pteridiacea	+	+	+	Rhizome	Decoction of rhizome is given in chronic spleen disorder.
103	*Saraca asoca* (Roxb.) de Wilde	Mualhawih	Caesalpinaceae	-	+	+	Stem	The stem is boiled and the water is taken for easy delivery and diuretic.
104	*Schima wallichii* (DC.) Korth.	Khiang	Theaceae	+	+	+	Fruit	Decoction of fruit is used for snake bite and insect bite
105	*Scoparia dulcis* Medic.	Perhpawng chaw	Scrophulariaceae	+	+	+	Whole plant	The whole plant is crushed and the juice is taken for the remedy of kidney stone and jaundice.
106	*Securinega virosa* (Roxb.) Baillon	Saisiak	Euphorbiaceae	+	+	+	Leaves	Decoction of the leaves used for bath in case of measles and chickenpox.
107	*Solanum nigrum* Linn.	Anhling	Solanaceae	+	+	+	Whole plant	Infusion of the plant is prescribed for liver problem.
108	*Solanum torvum* Sweet	Tawkpui	Solanaceae	+	+	+	Seeds	The crushed seed is applied to toothache and tooth decay.
109	*Spondias pinnata* (L.f) Kurz	Taitaw	Anacardiaceae	+	+	+	Bark	The bark is useful in dysentery, gourd and mixed with water rubbed in both auricular and muscular rheumatism.
110	*Strobilanthes cusia* (Nees) Imlay	Ting	Acanthaceae	-	+	+	Leaf	The crushed leaves applied on rat-bite.
111	*Tamarindus indica* L.	Tengtere	Caesalpinaceae	+	+	+	Leaf	Infusion of the pulp is taken against diarrhoea.
112	*Tetrameles nudiflora* R.Br.	Thingdawl	Tetramelaceae	-	+	+	Bark	The sap or juice of crushed bark is used for the bite of grey-wood tick by external application or dropped into the year.
113	*Trevesia palmata* (Roxb.) Vis.	Kawhtebel	Anacardiaceae	+	+	+	Leaf	The leaf is crushed and the juice is taken as an effective remedy for colic, stomach-ache and high blood pressure.
114	*Vitex peduncularis* Wall. Ex Schauer	Thingkhawilu	Verbenaceae	+	+	+	Bark	The bark is boiled and the water is drunk against for typhoid fever.
115	*Zanonia indica* Linn.	Lalruanga dawibur	Cucurbitaceae	+	+	+	Fruit	The ripened fruit is boiled and the water is taken against stomach problem.
116	*Zanthoxylum rhetsa* (Roxb.) DC	Chingit	Rutaceae	+	+	+	Root	The paste of the grinded roots is used for treating fever.

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REFERENCES

[1] Alongi, D. M. (2015). The impact of climate change on mangrove forests. Ecological Impacts of climate change. *Current Climate Change Report*, 1: 30-39.

[2] Anon (2016). *Indigenous knowledge and climate change*. Summaries, 2-3 November 2016, Marrakesh, Morocco, UNESCO, CNRS (France) in Partnership with IPACC at Tebtebba.

[3] Ansuategi, A., Greno, P., Houlden, V., Markandya, A., Onofri, L.,Picot, H.,Tsarouchi, G. M., Walmsley, N. (2015). The impact of climate change on the achievement of the post-2015 sustainable development goals. *Metroeconomica*, May 2015.

[4] Barbosa, J.P.R.A.D., Rambal, S., Soares, A.M. Mouillot, F., Nogueira, J.M.P and Martins, G.A. (2012). Plant physiological ecology and the global changes. *Cienciae Agrotechnologia*, 36: 253-269.

[5] Carty Mc, J.P. (2001). Ecological consequences of recent climate change. *Conservation Biology,* 15(2): 320-331.

[6] Cavaliere, C. (2009). The effect of climate change on medicinal and aromatic plants. *Herbalgram*, 81: 44-57.

[7] Chestin, I. (2001). *WWF Eco-regional climate change and biodiversity decline*. No. 1. Atlai-sayan Eco-region, Mt Belukha, Russia.

[8] Das, D. (2015). Changing climate and its impacts on Assam, Northeast India. *Bandung: Journal of the Global South.* 2:26.

[9] Gairola, S., Shariff, N. M., Bhatt, A. and Kala, A. (2010). Influence of climate change as introduction of secoundary chemicals in high altitude medicinal plants: issue needs immediate attention. Journal of Medicinal Plants Research, 4 (18): 1825-1829.

[10] Gogoi, B. and Deka, J. (2015). Resilience of climate change through medicinal and aromatic plants. *International Journal of Innovative Research in Science, Engineering and Technology*, 4(6): 4389-4393.

[11] Intergovernmental Panel on Climate Change (IPCC) (2007). Climate change: Synthesis report. Valencia: IPCC.

[12] Intergovernmental Panel on Climate Change (IPCC). (2013). Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change. In T.F. Stoker, D. Qin, G.K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (Eds.). Cambridge and New York: Cambridge University Press.

[13] Kakyl, E. and Gilbert, F. (2017). Predicting the distributions of Egypt's medicinal plants and their potential shifts under future climate change. *Public Library of Science,* 12(11): 1–19.

[14] Kelly, A. E. and Goulden, M. L. (2008). Rapid shifts in plant distribution with recent climate change. *Proceedings of the Academy of Sciences of the United States of America*, 105 (33): 11823–11826.

[15] Kunwar, R. M., Pandey, M. L., Kunwar, L. M. and Bhandari, A. (2014). Medicinal plants and Ethno-medicine in Peril: A case study from Nepal Himalaya. *Evidence-based Complementary and Alternative Medicine*, doi: 10.1155/2014/792780.

[16] Kuriwar, R. M. (2011). *Assessment of climate change impacts on non-timber forest products (NTFPs), medicinal and aromatic plants (MAPs) and important tree species (ITS) in the sacred Himalayan landscape*, *Nepal*. WWF Nepal Programme, Kathmandu, Nepal.

[17] Li.Z., Wu, N., Gao, X., Wu, Y. And Oli, K. P. (2013). Species-level phonological responses to global warming as evidenced by herbarium collectors in the Tibetan Autonomous region. *Biodiversity Conservation,* 22: 141-152.

[18] Mishra, T. (2016). Climate change and production of secoundary metabolites in medicinal plants. *International Journal of Herbal Medicine*, 4(4): 27-30.

[19] Moorhead, A. (2009). Climate, agriculture and food security: a strategy for change. Alliance of the CGIAR Centers.

[20] Parjuli, D. R. and Maharjan, P. (2017). Coping strategies to climate change through indigenous technology knowledge in agriculture. *International Journal of Agricultural Science and Research,* 7(5): 143-162.

[21] Parmeson, C. And Yohe, G. (2003). A globally coherent fingerprint of climate change impacts across natural system. *Nature*, 421 (6918): 37-42.

[22] Ramakrishna, N., Rajani, A., Saidulu.Ch. and Sunitha, E.M. (2015). Climate change and public health in the treatment of fever in Adilabad district, Telangana state, India. IOSR *Journal of Pharmacy and Biological Sciences*, 10(1):53-57.

[23] Roy, S. K. and Roy, D. K. (2016). Use of medicinal plant and its vulnerability due to climate change in northern part of Bangladesh. *American Journal of Plant Sciences*, 7: 1782-1793.

[24] Samita, M and Manna, C. K. (2016). Influence of climate change on the biodiversity of the medicinal plants for the sustainability of the Santal and Lodha tribal people in the district Paschim Midnapore, West Bengal, *India Journal of Medicinal Plants ctudies*, 4(6): 279-282.

[25] Sannigrahi, N. (2014). Traditional knowledge of medicinal plants and self help group: a key to sustainable development. *Journal of Medicinal Plant Studies*, 2(3): 14-24.

[26] Telwala, Y., Brook, B.W., Manish, K. and Pandit, M. K. (2013). Climate induced elevation shifts and increase in plant species richness in a Himalayan biodiversity epicentre. Public Library of Science, 8: Article ID e57103.

[27] Trivedi, M., Berry, P. M., Morecroft, M. D and Dawson, T. P. (2008). Spatial scale affects bio climate model projections of climate change impacts on mountain plants. *Global Change Biology,* 14: 1089–1103.

[28] Willis, K. J and Whittaker, R. J. (2002). Species diversity scale matters. *Science,* 295: 1245–1248.

[29] Zobayed, S. M. A., Afreen, F. And Kozai, T. (2005). Temperature stress can alter the photosynthetic efficiency and secoundary metabolite concentrations in St. Johns wort. *Plant Physiology and Biochemistry,* 43(10-11): 977–984.