VULNERABILITY ASSESSMENT OF HUMAN HEALTH UNDER CURRENT CLIMATIC CONDITIONS OF MIZORAM

DEPARTMENT OF SCIENCE AND TECHNOLOGY
Ministry of Science & Technology
Government of India

NMSHE National Mission For Sustaining the Himalalayan Ecosystem

MIZORAM STATE CLIMATE CHANGE CELL
Mizoram Science Technology & Innovation Council
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PREFACE

The Department of Science and Technology, Govt. of India, New Delhi catalyzed and supported the establishment of State Climate Change Cell and its activities in the Indian Himalayan Region (IHR) states through The National Mission for Sustaining the Himalayan Ecosystem (NMSHE), which is one of the eight major missions under the National Action Plan on Climate Change (NAPCC, Govt. of India). In Mizoram, the State Climate Change Cell was also established under the Mizoram Science, Technology and Innovation Council, Directorate of Science and Technology, Govt. of Mizoram. The Cell, through its project objectives and work plan, has been conducting a study on Vulnerability Assessment due to Climate Change in Mizoram on different sectors since late 2015. It has been felt the need to present the current achievement of the ongoing work in the form of a document so that the observations and findings are communicated to mainstream public, scientific communities and other stakeholders, etc. Thus, a report on **'Vulnerability Assessment of Human Health under current climatic conditions of Mizoram'** presented here in this booklet, it is hoped that this report serve as a sensitization material and baseline information about the vulnerability human health under current climatic conditions of different districts of Mizoram.

R.K.

Dated Aizawl (Dr. R.K LALLIANTHANGA)
The 18th February, 2021 Chief Scientific Officer & Member Secretary
Mizoram Science, Technology and Innovation Council

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Introduction

Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a *likely* range of 0.8°C to 1.2°C. Global warming is *likely* to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.

Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C.

The IPCC's *Global Warming of 1.5°C* report is inherently linked to the Paris Agreement. As its article 2 states, one of the goals of this agreement is to hold "the increase in the global average temperature to well below 2°C," and to pursue "efforts to limit the temperature increase to 1.5°C."

During the negotiations of the Paris Agreement, the inclusion of the 1.5°C reference in the text was requested by the parties most vulnerable to the effects of climate change, such as small island developing states, whose physical survival could depend on this 0.5°C difference.

In India, National Health Mission subsumes NRHM and NUHM the two sub-missions. The main goals of NHM are to reduced Infant Mortality Rate (IMR), Maternal Mortality Ratio (MMR) and Total Fertility Rate (TFR); thus, reducing growth rate in a population with a view to achieved gender and demographic balance, prevention and reduction of Anaemia in women aged 15-49 years. Apart from other NRHM goals, it aims to reduce household out-of- pocket expenditure on total health care expenditure.

A climate and health vulnerability assessment aims to identify the people and places that are most susceptible to hazardous exposures resulting from climate change. The value of a vulnerability assessment is that it allows health departments to understand the people and places in their jurisdiction that are more susceptible to adverse health impacts associated with the climate-related exposures modified by climate change. This assessment of people and place vulnerability can then be used to implement more targeted public health action to reduce harm to people.

There are three basic pathways by which climate change affects health (Figure 1), and these provide the organization for the chapter:

- Direct impacts, which relate primarily to changes in the frequency of extreme weather including heat, drought, and heavy rain.
- Effects mediated through natural systems, for example, disease vectors, water-borne diseases, and air pollution.
- Effects heavily mediated by human systems, for example, occupational impacts, undernutrition, and mental stress.

Vector-borne diseases (VBDs) rear most commonly to infections transmitted by the bite of the blood-sucking arthropods such as mosquitoes or ticks. Increased variations in temperature, when the maximum is close to the upper limit for vector and pathogen, tend to reduce transmission, while increased variations of mean daily temperature near the minimum boundary increase transmission (Paaijmans *et al.,* 2010). Analysis of environmental factors associated with the malaria vectors Anopheles gambiae and *A. funestus* in Kenya found that abundance, distribution, and disease transmission are affected in different ways by precipitation and temperature (Kelly Hope *et al.,* 2009). There are lag times according to the lifecycle of the vector and the parasite: a study in central China reported that malaria incidence was related to the average monthly temperature, the average temperature of the previous 2 months, and the average rainfall of the current month (Zhou *et al.,* 2010). Dengue is the most rapidly spreading mosquito-borne viral disease. The principal vectors for dengue, *Aedes aegypti* and *A. albopictus*, are climate sensitive. Distribution of *A. albopictus* in northwestern China is highly correlated with annual temperature and precipitation (Wu *et al.,* 2011). Temperature, humidity, and rainfall are positively associated with dengue incidence in Guangzhou, China, and wind velocity is inversely associated with rates of the disease (Lu & Lin, 2009; Li *et al.,* 2011). Many studies have reported associations between climate and tick-borne diseases (Okuthe & Buyu, 2006; Lukan *et al.,* 2010; Tokarevich *et al.,* 2011; Andreassen *et al.,* 2012; Estrada-Peña *et al.,* 2012; Jaenson *et al.,* 2012). However, the complex ecology of tick-borne diseases such as Lyme disease and TBE make it difficult to attribute particular changes in disease frequency and distribution to specific environmental factors such as climate (Gray *et al.,* 2009).

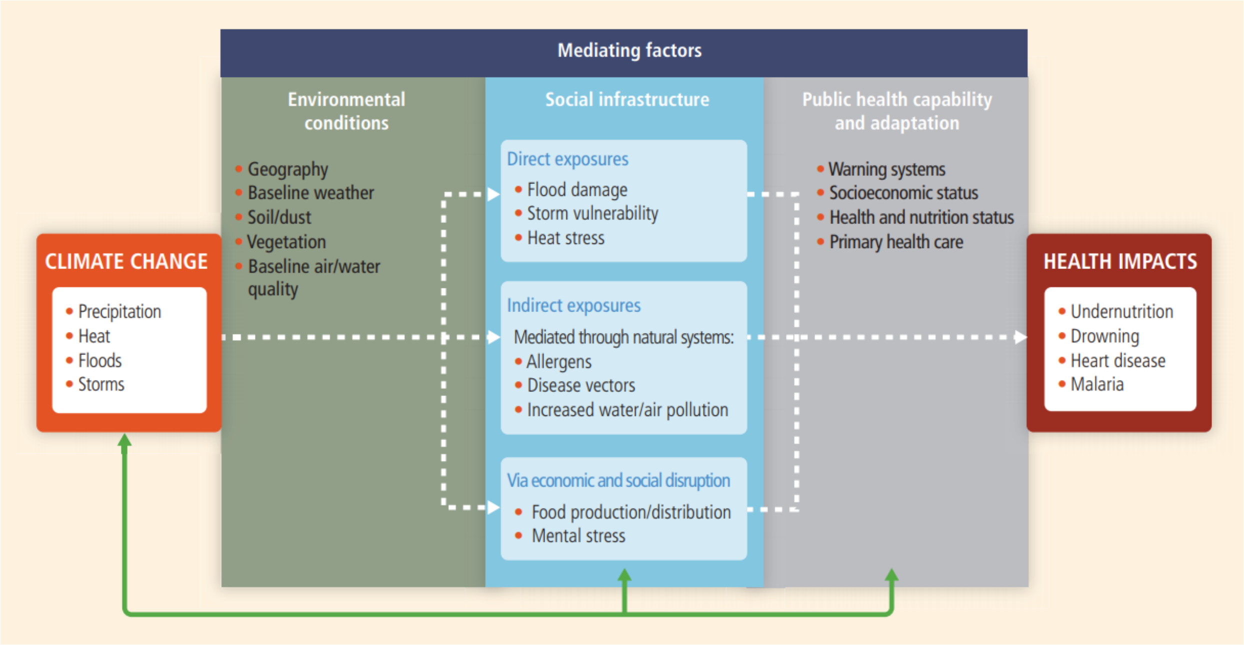


Figure 1: Conceptual diagram showing three primary exposure pathways by which climate change affects health IPCC (WGII) 2014.

Study Area

Mizoram is a landlocked state in North East India. The Tropic of Cancer runs midway through the State dividing it to Northern and Southern Mizoram where the southern part shares 722 kilometers long International borders with Myanmar and Bangladesh, and northern part share domestic borders with Manipur, Assam and Tripura.

Socio-economic features

According to 2011 census of India report, the total population of Mizoram is 10,91,014 with a population density of 52 persons per square kilometers. There has been 23.48 % growth rate since 2001 census. Mizoram has a sex ratio of 976 females to 1000 males with a literacy rate 91.58% coming at third highest in the country. Majority of the people in the state belongs to a population of scheduled tribe consisting of 94.4% of the total population.

According the economic survey 2016-2017 by Govt. of Mizoram, the per capita income of Mizoram at 2011-2012 was Rs. 57654/- which increased to Rs. 125107/- against the national average of Rs. 103219/- in the year 2016-2017. In 2016 - 2017, the sectoral contribution to GSDP of Mizoram was highest for Service sector (43.5 %), followed by Agri. & allied sector (31.72%) and Industry sector (24.78%).

Despite of all the facts and figures, it is estimated that more than 70% of the total population is engaged in some form of agriculture. The age-old practice of Jhum cultivation is carried out annually by a large number of people living in the rural areas. It is estimated that only 5% of the total area is under cultivation and about 11.47% of the total cultivated area is under irrigation. Total area of land having slope of 0 to 15% where there is a possibility of Wet Rice Cultivation (WRC) is 74,644 Ha which is merely 2.8% of Mizoram, and total area of land having slope of 10 to 33% is only 5,09,365 Ha (RKVY State Extension Work Plan 2016 - 2017).

Table 1: Social profiles of the districts in the State.

Districts	Population (2011)	Sex Ratio[1](2011)	% Population BPL (2011)	Infant Mortality Rate per thousand (2016)
Aizawl	400309	1009	8.76	15.5
Champhai	125745	984	9.35	12
Kolasib	83955	956	17.50	20
Lawngtlai	117894	945	21.37	24
Lunglei	161428	947	30.10	15
Mamit	86364	927	35.64	17
Serchhip	64937	977	12.79	15
Siaha	56574	979	31.64	24

Source: Census of India 2011 (Population & Sex ratio), Economics & Statistics Dept., Govt. of Mizoram (BPL population), NHM-HMIS report 2016 (Infant Mortality Rate).

Health Scenario of Mizoram

The changing climate is linked to increases in a wide range of non-communicable and infectious diseases. There are complex ways in which climatic factors (like temperature, humidity, precipitation, extreme weather events, and sea-level rise) can directly or indirectly affect the prevalence of disease. Identification of communities and places vulnerable to these changes can help health departments assess and prevent associated adverse health impacts.

Table 2: Total Malaria cases in Mizoram for the year 2018 (NHM_HMIS)

Name of District	Population	No. of Fever Cases	No. of RDT Performed	No. of BSE Performed	Total Blood Examination	Total Malaria Cases	Pv Cases	Pf Cases	Total No. of Death
Aizawl East	**271762**	59990	13578	46106	59684	12	5	7	0
Aizawl West	**183145**	30736	11695	19041	30736	43	20	23	0
Lunglei	**160399**	22676	15991	6585	22576	1067	78	989	0
Saiha	**61667**	6628	6551	77	6628	98	22	76	0
Kolasib	**89007**	14237	11810	2327	14237	35	5	30	0
Mamit	**88582**	16781	12691	4079	16770	737	26	711	0
Champhai	**142174**	14411	6805	7507	14312	6	2	4	0
Lawngtlai	**137307**	33091	18813	8031	26844	2044	179	1865	0
Serchhip	**67293**	14236	7506	6747	14253	8	2	6	0
TOTAL	**1201336**	**212786**	**105440**	**100500**	**206040**	**4050**	**339**	**3711**	**0**

Table 3: Scrub typhus data of Mizoram (As on 24th January 2019)

Sl. No.	District	Total. No of Cases								Total No. of Death								Grand Total	
		2012	2013	2014	2015	2016	2017	2018	2019	2012	2013	2014	2015	2016	2017	2018	2019	Cases	Death
1	Aizawl East	98	28	85	34	7	101	715		5	2	2	4	0	1	4		1068	18
2	Aizawl West	112	54	50	44	20	17	393		9	0	1	2	1	0			690	13
3	Lunglei	0	47	38	6	7	9	323		0	2	1	1	0	0	1		430	5
4	Saiha	9	10	2				8		0	0	0		0	0			29	0
5	Champhai	20	26	4		41	6	33		2	0	0		0	0			130	2
6	Kolasib	6	0	0				20		0	0	0		0	0			26	0
7	Serchhip	4	3	1	2	12	8	505	127	0	0	0		0	0	2		662	2
8	Mamit	3	7	0				66		0	0	0		0	0	1		76	1
9	Lawngtlai	0	0	3	2	3		116	4	0	0	0		0	0			128	0
10	SRH, Falkawn				62								1	0	0			62	1
		252	**175**	**183**	**150**	**90**	**141**	**2179**	**131**	**16**	**4**	**4**	**8**	**1**	**1**	**8**	**0**	**3301**	**42**

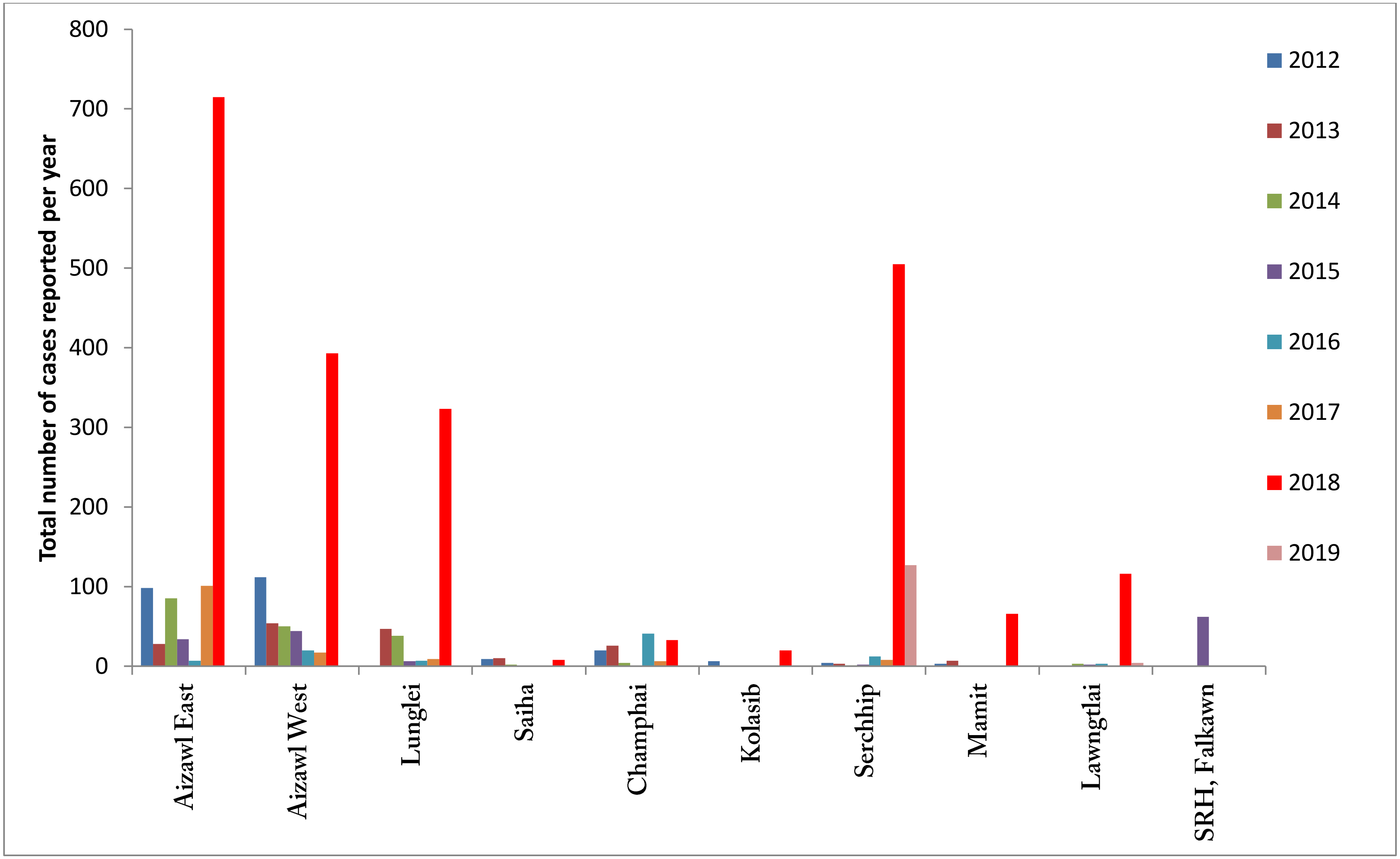


Figure 2: Bar diagram of Scrub typhus cases reported

Vulnerability Framework Adopted

The approach methodology of the present Vulnerability Assessment is adopted from the framework designed based on the concept of Risk management and assessment framework (Figure 4) published in the Fifth Assessment Report (AR5) of IPCC (2014).

This framework explains that 'Risk' arises from interaction of hazard, exposure and vulnerability. It is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Therefore, in order to reduce the risk from the impacts of climate change, we need to address vulnerability and exposure to present climate variability, which is the first step in adaptation to future climate change. But if we consider the possibility in real life, exposure offers limited opportunity and low manageability as a system or area cannot be moved or removed from climate exposure. Whereas, vulnerability offers higher manageability and greater scope for reduction because one can improve their adaptive capacity and address their sensitivity of their system to climate change or variability. Therefore, it is much easier and meaningful to address vulnerability rather than to deal with exposure.

The IPCC AR5 (2014) defines vulnerability as the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. Vulnerability is endogenous characteristic of a system and is determined by its sensitivity and adaptive capacity.

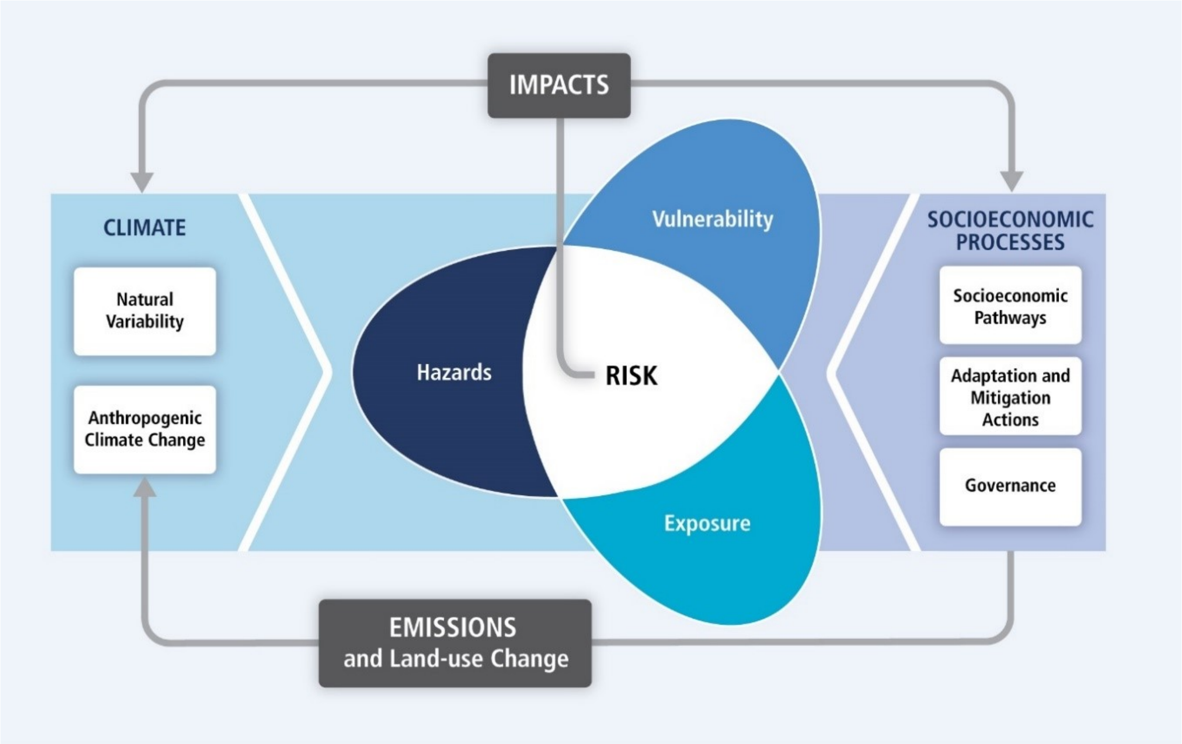


Figure 3: Risk management and assessment framework (Source: IPCC, 2014)

Sensitivity may be defined as degree to which a system is affected by or responsive to climate stimuli. It may also be termed as lack of adaptive capacity. For e.g., an area having steep slope will be sensitive than gentle slope to climate stimuli.

Adaptive capacity can be defined as the potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects or impacts. For e.g., an area with high forest cover will have better adaptive capacity in response to climate change.

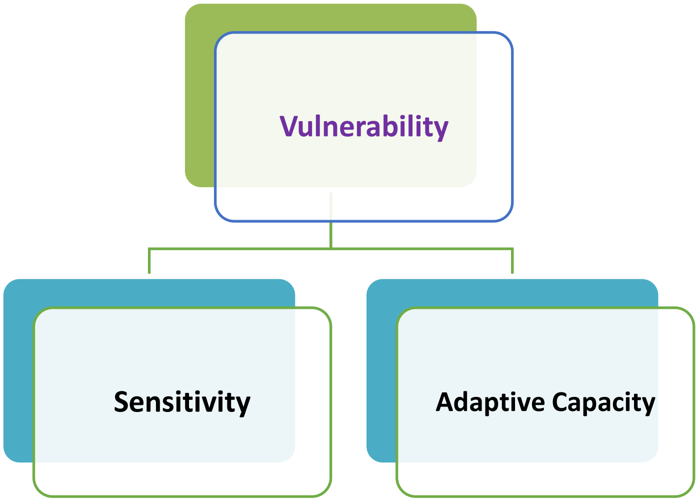


Figure 4: Components of vulnerability

Methodology

The following figure shows steps for assessing the climate change vulnerability assessment.

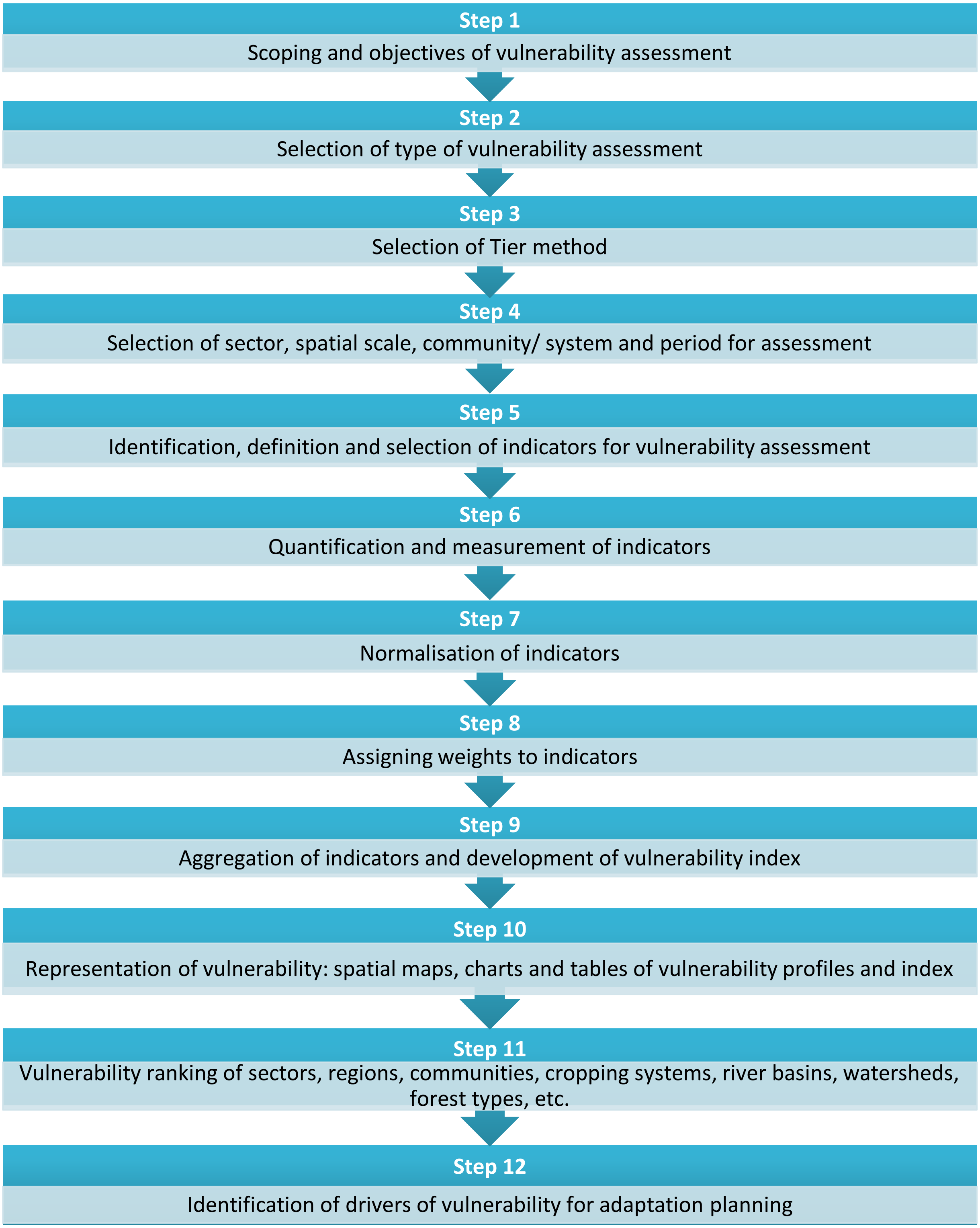


Figure 5: Steps in vulnerability assessment

Results

a. Steps adopted

Table 4: Approach and methodology adopted to assess vulnerability of districts in the State

	Steps in vulnerability assessment	Details of Vulnerability Assessment of Districts in the State
1	Scoping of vulnerability assessment	To identify, rank vulnerable districts in Mizoram
2	Selection of type of vulnerability assessment	Integrated assessment of inherent socio-economic and biogeographic vulnerability to climate change
3	Selection of Tier methods	Tier-1
4	Selection of Spatial scale and period for vulnerability assessment	Scale of assessment is district level with available data for the selected indictors during variable years mentioned in the following table 6
5	Identification, definition and selection of indicators for vulnerability assessment	8 indicators were identified and chosen based on the availability of data from the common indicators selected for the 12 IHR states.
6	Quantification and measurement of indicators	Secondary data from various sources were collected for each indicator
7	Normalization of indicators	As all the indicators are having different units of measurements, they were normalised and were given scores to their representative values between 0 to 1 (to make them unit-less).
8	Assigning weights to indicators	Weights were assigned to each indicator by perception and experience-based knowledge sharing in consultation with line departments, academicians which sums up to 100.
9	Aggregation of indicators and development of vulnerability index	Normalized value of each districts was multiplied by the weight assigned to their corresponding indicator to produce weighted value for each district across all indicators. The process is repeated for all the indicators. Then, weighted values of a district across all indicators were then sum up to calculate

		the vulnerability index value for that district. The process is repeated for every district so that each and every district have their vulnerability index values. The vulnerability index values of each districts were then divided by 100 to represent them by decimal points for easier reference.
10	Representation of vulnerability; spatial maps, charts and tables of vulnerability profiles and index	Districts were first ranked and categorised in tabular form based on their corresponding vulnerability index values. District with high index value mean high rank or vice versa; districts were also categorised into low, medium and high vulnerability. Two geo-spatial maps; one of ranking and another of category were then produced to represent district wise vulnerability.
11	Vulnerability ranking of the districts in the state	Districts were ranked by way of highest vulnerability index value attaining Rank 1 and so on, Rank 1 being the most vulnerable district. The range of vulnerability index value was divided into 3 equal intervals; districts falling within highest interval value are categorised into high category, likewise, they are categorized into medium and low categories.
12	Identification of drivers of vulnerability for adaptation planning	The weighted values across all districts were averaged for each indicator. The average weighted values for each indicator were normalized so that their sum added up to 100 thereby representing them in terms of percentage. The percentage scored of the averaged weighted values for each indicator were then considered as their corresponding contributions to the overall vulnerability (drivers of vulnerability); higher percent score means higher contribution to vulnerability.

b. Indicators selected, rationale for selection and source of data

Table 5: List of indicators for Tier 1 vulnerability assessment relevant to districts, rationale for selection, functional relationship with vulnerability and sources of data

Indicators	Rationale for selection	Adaptive Capacity or Sensitivity	Functional relationship with Vulnerability	Source of data
Malaria (API rate) per 1000 persons	**Higher the API rate of Malaria, higher will be its vulnerability due to climate change in human health**	Sensitivity	Positive	NHM-HMIS 2017-18
Dengue (per 1000 persons)	**Higher the cases of Dengue, higher will be its vulnerability due to climate change in human health**	Sensitivity	Positive	NHM-HMIS 2017-18
Scrub Typhus (per 1000 persons)	**Higher the cases of Scrub typhus, higher will be its vulnerability due to climate change in human health**	Sensitivity	Positive	NHM-HMIS 2017-18
No of Hospitals/PHC/CHC etc	**Hospitals and Health centres are the places where most health-related problems are diagnosed and treated. As such, more number of such centres establishments creates better resilience to health of the population of that area.**	Adaptive Capacity	Negative	NHM-HMIS 2017-18
No of Doctors/Nurse/HW etc	**More number of Doctors/Nurse/HW etc more people could be treated at a time and hence higher resilience to climate change**	Adaptive Capacity	Negative	NHM-HMIS 2017-18
Infant Mortality Rate (per 1000 live births)	**Higher the Infant mortality rate, higher will be its vulnerability due to climate change in human health**	Sensitivity	Positive	NHM-HMIS 2017-18

c. Indicator and Normalised Indicator Values

This section presents the actual sub-indicator values used and their normalized scores for each of the indicators, for all the districts in the states. Normalization is done depending on the indicators’ functional relationship with vulnerability (either positive or negative relationships) and the corresponding formulae are used.

1. Normalization method for indicators with positive relationship with vulnerability

$$x_{ij}^{P} = \frac{Xij - Min\ i\ \{Xij\}}{(Max\ i\ \{Xij\} - Min\ i\ \{Xij\}}$$

2. Normalization method for indicators with negative relationship with vulnerability

$$x_{ij}^{n} = \frac{Max\ i\ \{Xij\} - Xij}{Max\ i\ \{Xij\} - Min\ \{Xij\}}$$

Where Xij is indicator value for a district; Min I {Xij} is minimum indicator value across all districts; and Max I {Xij} is maximum indicator value across all districts.

Table 6: Actual Value of the selected indicators

Sl No.	Indicators (2017-18)	Mamit	Kolasib	Aizawl	Champhai	Serchhip	Lunglei	Lawngtlai	Siaha
1	Malaria (API rate) per 1000 persons	9.27	1.35	0.69	10.04	0.14	9.18	20.41	3.11
2	Dengue (per 1000 persons)	0.012	0.119	0.252	0.103	0.015	0.111	0.017	0
3	Scrub Typhus (per 1000 persons)	0.764	0.238	2.767	0.262	7.776	2.001	0.984	0.141
4	No of Hospitals/PHC/CHC etc	51	43	206	106	44	108	71	44
5	No of Doctors/Nurse/HW etc	328	333	2028	520	329	697	253	301
6	Infant Mortality Rate (per 1000 live births)	25	25	26	24	23	18	27	20

Table 7: Actual values and normalised scores for the indicators

Districts	Indicators											
	Malaria (API rate) per 1000 persons		Dengue (per 1000 persons)		Scrub Typhus (per 1000 persons)		No of Hospitals/PHC/CHC etc		No of Doctors/Nurse/HW etc		Infant Mortality Rate (per 1000 live births)	
	AV	NV	AV	NV	AV	NV	AV	NV	AV	NV	AV	NV
Mamit	9.27	0.45	0.01	0.05	0.76	0.24	51	0.95	328	0.95	25	0.77
Kolasib	1.35	0.06	0.12	0.47	0.24	0.04	43	1	333	0.95	25	0.77
Aizawl	0.69	0.02	0.25	1.00	2.77	1.00	206	0	2028	0	26	0.88
Champhai	10.04	0.48	0.10	0.41	0.26	0.05	106	0.61	520	0.84	24	0.66
Serchhip	0.14	0	0.02	0.06	7.78	2.91	44	0.99	329	0.95	23	0.55
Lunglei	9.18	0.44	0.11	0.44	2.00	0.71	108	0.60	697	0.74	18	0
Lawngtlai	20.41	1	0.02	0.07	0.98	0.32	71	0.82	253	1	27	1
Siaha	3.11	0.14	0.00	0.00	0.14	0.00	44	0.99	301	0.97	20	0.22

* here, AV = actual value and NV = normalized value

d. Weights assigned

Weights are assigned to each indicator in consultation with different concerned officials. Each of these officials assign weights to the indicators and the resulting weights are averaged.

Table 8: Weights assigned to indicators

Indicators	Weights (W)
Malaria (API rate) per 1000 persons	10
Dengue (No of Cases)	10
Scrub Typhus (No of cases)	5
No of Hospitals/PHC/CHC etc	20
No of Doctors/Nurse/HW etc	20
Infant Mortality Rate (per 1000 live births)	30
Total	100

Table 9: Weights multiplied with normalizes scores.

Districts	Indicators											
	Malaria (API rate) per 1000 persons		Dengue (per 1000 persons)		Scrub Typhus (per 1000 persons)		No of Hospitals/PHC/CHC etc		No of Doctors/Nurse/HW etc		Infant Mortality Rate (per 1000 live births)	
	W1	NV1	W2	NV2	W3	NV3	W4	NV4	W5	NV5	W6	NV6
Mamit	10	0.45	10	0.05	5	0.24	20	0.95	20	0.95	35	0.77
Kolasib		0.06		0.47		0.04		1		0.95		0.77
Aizawl		0.02		1.00		1.00		0		0		0.88
Champhai		0.48		0.41		0.05		0.61		0.84		0.66
Serchhip		0		0.06		2.91		0.99		0.95		0.55
Lunglei		0.44		0.44		0.71		0.60		0.74		0
Lawngtlai		1		0.07		0.32		0.82		1		1
Siaha		0.14		0.00		0.00		0.99		0.97		0.22

Table 10: Aggregated vulnerability index and ranking of districts based on weights assigned.

Districts	Aggregated vulnerability index (NV1*W1+NV2*W2+NV3*W3+NV4*W4+NV5*W5+NV6*W6/6)	Rank
Mamit	11.92405	4
Kolasib	11.9705	3
Aizawl	7.730408	6
Champhai	10.30114	5
Serchhip	12.26854	2
Lunglei	6.573479	8
Lawngtlai	13.97345	1
Siaha	8.096575	7

Table 11: Vulnerability profile and ranking of Districts

Districts	Vulnerability Index Value	Vulnerability Ranking	Vulnerability Scale
Mamit	11.92405	4	High
Kolasib	11.9705	3	High
Aizawl	7.730408	7	Low
Champhai	10.30114	5	Medium
Serchhip	12.26854	2	High
Lunglei	6.573479	8	Low
Lawngtlai	13.97345	1	High
Siaha	8.096575	6	Low

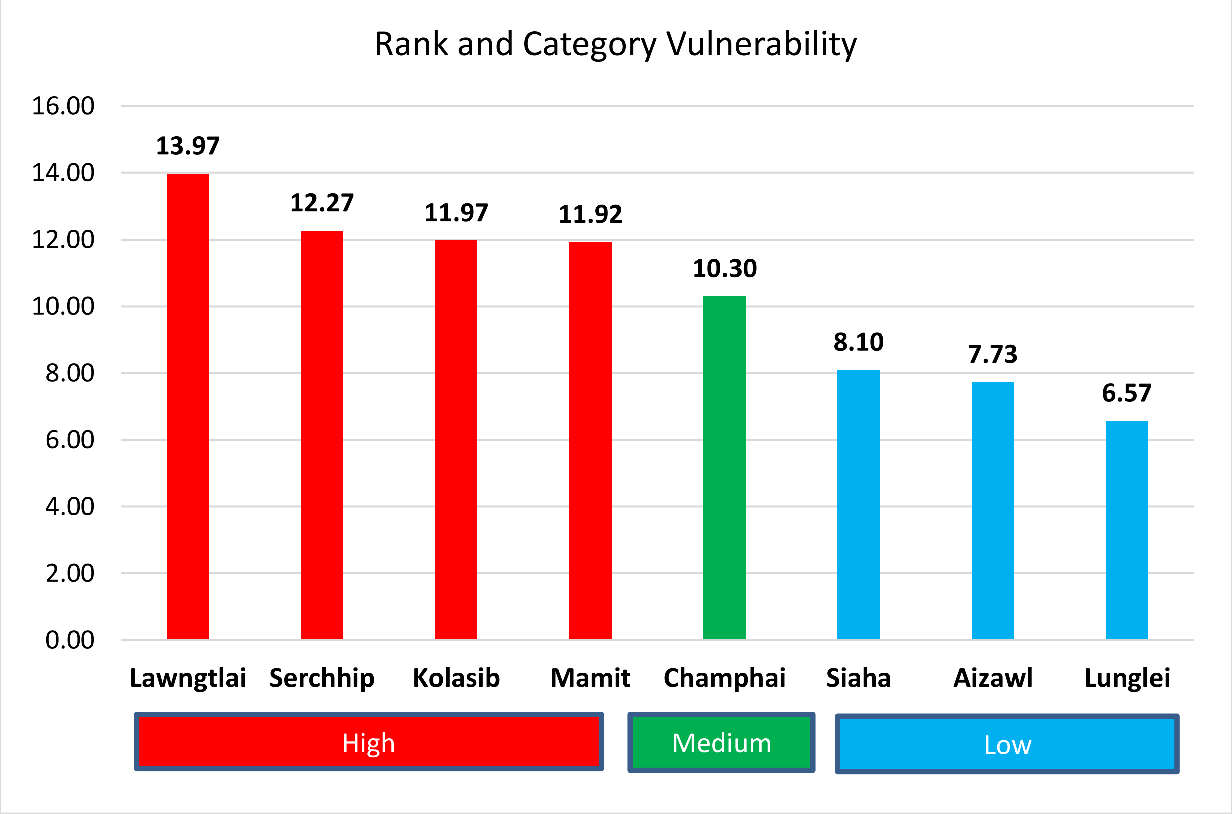
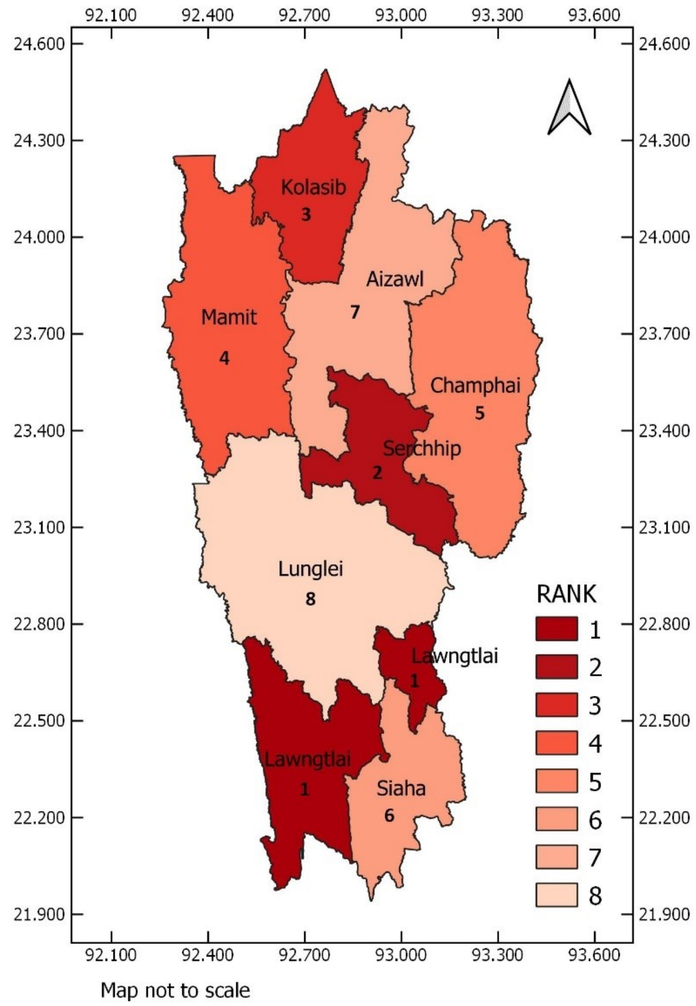


Fig 6: Composite Vulnerability index (CVI) value, Vulnerability Rank and Category of different districts of Mizoram



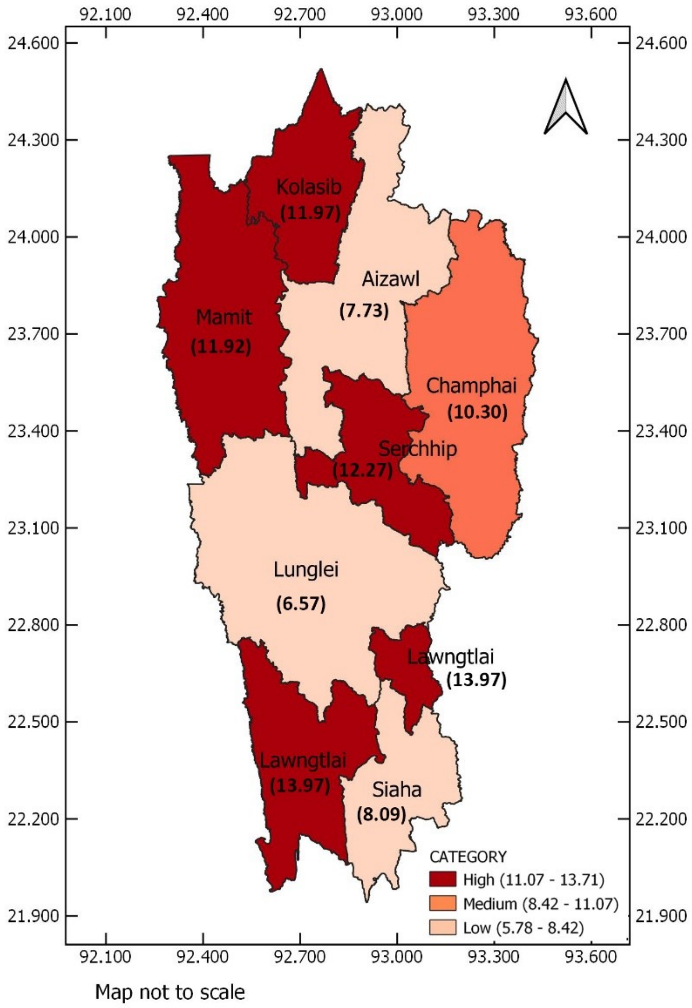


Fig 7: Vulnerability Rank of different districts of Mizoram

Fig 8: Vulnerability Category of different districts of Mizoram

Discussion

The present assessment reveals that Lawngtlai district is the most vulnerable within the state. This is due to the fact that Lawngtlai district has the highest Annual Parasitic Incidence of Malaria, coupled with low number of health workers and the highest Infant Mortality Rate within the state.

The results shows that four districts (Lawngtlai, Serchhip, Mamit & Kolasib) fall under high vulnerable category, one district (Champhai) under medium vulnerability and three districts (Aizawl, Lunglei & Siaha) under low vulnerable category. However, districts falling under low vulnerable category are not to be assumed non vulnerable as the assessment done is comparative and not absolute.

This report provides the first ever insights at the present condition of health-related vulnerability and how local vulnerabilities is assessed at the district level for the state of Mizoram. A climate and health vulnerability assessment allows policy makers and concerned departments along with the community leaders to understand the people and places in their jurisdiction that are more susceptible to adverse health impacts associated with climate change. This assessment of people and place vulnerability can then be used to implement targeted public health interventions to reduce the burden of public health impacts.

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