District Level Climate Change Vulnerability Assessment of Mizoram: Biophysical and Socio-economic Sectors

Department of Science & Technology
Ministry of Science & Technology
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NMSHE NATIONAL MISSION FOR SUSTAINING THE HIMALAYAN ECOSYSTEM

Mizoram State Climate Change Cell
Mizoram Science, Technology & Innovation Council
Directorate of Science & Technology
Government of Mizoram

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Mizoram Science, Technology & Innovation Council (MISTIC)

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FOREWORD

It has been observed since the past few decades that the climate of Mizoram, following the trend all over the globe, has changed to a certain extent. The magnitude and intensity of such changes may be difficult to quantify without proper assessment of scientific data. But it has become undeniable fact even for a layman that the pattern of rainfall distribution is changing and surface temperature has increased significantly.

As per the latest economic survey report of Mizoram, the contribution of most vulnerable sector, i.e. agriculture & allied sector, to the state Gross State Value Added in 2018 to 2019 was 28.48 % with more than half of the population derived their majority of income from it. This implies that the socio-economic and livelihood of the majority of the population in Mizoram are already exposed to the impacts of climate change. Moreover, the societal structure and the biophysical system they inhabit with limited infrastructure development makes the state of Mizoram highly vulnerable to climate change.

Plans and project for climate change adaptation and mitigation have been formulated in the State in which a pre-requisite for a sound and reliable analysis like vulnerability assessment has been a major challenge due to financial and technical constraints. Realising the necessity, the Department of Science and Technology, Government of India through the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) of the India's National Action Plan on Climate Change (NAPCC), with its coordinated efforts with premier knowledge institutions in the country, have taken several initiatives through the State Climate Cell to build the technical capacity of different stakeholders in the State which has gradually improved since the past few years.

The effort of the Mizoram State Climate Change Cell to develop a scientifically robust vulnerability assessment presented in this report is a milestone achievement for the State. I believed that this report will be useful for reference by policy makers and planners as well as for other stakeholders in the State including academicians and research scholars.

Place: Aizawl
Date: 31.7.2020

(Dr. C. VANLALRAMSANGA)
Secretary
Planning and Programme Implementation Department
Government of Mizoram

सत्यमेव जयते
Government of Mizoram

PREFACE

The state of Mizoram, during the past recent years, has seen increasing incidents of disasters due to hazards caused by climate variability. We, Mizo's used to have different names for rainfall systematically by their temporal distribution pattern in a year. Naming of rainfall are now becoming difficult as pattern of rainfall are being changing. As a result, age old agriculture practice in the state which rely wholly on rainfall has also seen multiple failure years during the past decade.

The global rising temperature seems are also being felt at local level which is likely to be the reason why cases of vector borne diseases such as malaria and dengue are being reported at higher altitude areas where it was unheard of before. Suitable area for fruit orchards in the state has also shifted at higher altitude due to increase emergence of pests in lower altitude. Some areas in the eastern part of states has seen ripening of tropical fruits since only recently. These reported cases can be assumed to be a minute portion of climate change impacts on our society and our ecosystem because of limited information and unavailability of data.

There have been several government interventions to address these specific issues apart from the general climate change issues. Nonetheless, scientific knowledge based on robust research is still lacking which hinders the performance of adaptation plans and programmes formulated by the state. Therefore, there is an urgent need to conduct the scientific study on vulnerability assessment of the system which, according to scientific literatures, is a pre-requisite for every climate change adaptation plan.

Keeping these in mind, the Mizoram State Climate Change Cell has been conducting various climate science research to generate reliable data for the state for baseline information as well as formulating concrete document which can be used as reference for climate change adaptation planning, capacity building programmes and preparing awareness material.

This report on "District Level Climate Change Vulnerability Assessment of Mizoram: Biophysical and Socio-economic Sectors" is also a part of such endeavour by the Mizoram State Climate Change Cell in which robust methodology based on the Climate Change Vulnerability Assessment Framework designed by National Level Institutes is followed. The steps and approach of this study is meeting the recommendations of the Risk Assessment Framework proposed by the report published in 2014 by Working Group II of the Intergovernmental Panel on Climate Change (IPCC). Hence, the information generated in this report are believed to be informative and useful for policy and decision makers, students, researchers and general public, etc.

Place: Aizawl
Date: 31.7.2020

R.K. Lhanga

Dr. R.K. LALLIANTHANGA
Chief Scientific Officer & Member Secretary
Mizoram Science, Technology & Innovation Council

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We thank the Swiss Agency for Development and Co-operation (SDC), New Delhi, India for the Indian Himalayas Climate Adaptation programme (IHCAP) with which the development of Climate Vulnerability Assessment for the Indian Himalayan Region States has been facilitated and the capacity building training has been organized during 2018. We personally thank Dr. Mustafa Ali Khan, the then Team Leader, IHCAP and Dr. Divya Mohan, the then Science Policy Officer, IHCAP for the support and great relations that the Mizoram State Climate Change Cell had experienced during the IHCAP programme.

We would also like to thank Prof. Rabindranath and his team from IISC Bangalore for developing framework for climate change vulnerability assessment which we can comprehend and follow it with ease upon training provided by team of IIT-Guwahati and IIT-Mandi. We thank Dr. Anamika Baruah, Professor, Department of Humanities and Social Studies, IIT-Guwahati and her team, and Dr. Shyamashree Das Gupta, Assistant Professor, IIT Mandi and her team; Tashina Esteves, Independent Consultant, for their technical and logistic support during and after the training programme for which this vulnerability assessment work in this report has been possible.

We sincerely thank all the Mizoram Government Departments, other organizations and institutions from which we obtained our data free of cost and special thanks to Mizoram Remote Sensing Application Centre (MIRSAC), Health and Family Welfare Department, Government of Mizoram, Public Health Engineering Department, Government of Mizoram, Mizoram Rural Bank Head Office, Directorate of Economics and Statistics, Government of Mizoram for compiling their data specifically for our needs.

Finally, we thank all the officers and staff of Directorate of Science and Technology, Government of Mizoram, Mizoram Remote Sensing Application Centre (MIRSAC), Mizoram Science Centre (MSC) and Mizoram Science, Technology and Innovation Council (MISTIC) for their support to the activities of Mizoram State Climate Change Cell and their unconditional assistance while developing this report.

EXECUTIVE SUMMARY

Driven largely by economic and population growth, the concentrations of greenhouse gases mostly carbon dioxide, methane and nitrous oxide are higher than ever in the atmosphere. Their effects, together with those of other anthropogenic and natural drivers, have been detected throughout the Earth's climate system and are strongly believed to be the cause global warming which poses a clear and present danger to civilization as well as rapid and potential catastrophic changes in the near future. Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system in the future.

The extent of the impacts depends on the vulnerability of the system which are determined by the magnitude of climatic changes affecting the characteristics of the system (sensitivity), and the ability of people and ecosystems to deal with the resulting effects (adaptive capacities of the system).

The North East region of India, comprising of eight states within the Indian Eastern Himalayan region covers a geographic area of 26.2 million ha. The region with a population of about 40 million people is characterized by large rural population, scattered in low density, large proportion of indigenous tribal communities living in large area under forests that rely hugely on natural resources. The region is also characterized by diverse climate regimes which are highly dependent on the southwest monsoon. The region is highly vulnerable to climate variability and climate change exacerbated by poor infrastructure development.

It is evident from the science of climate change and the experiences of nations and communities that adaptation actions, together with mitigation responses, are required in order to address the wide-ranging impacts of projected climate change. The overarching recognition in all the literature is that climate change will have huge and largely detrimental impacts on vulnerable communities.

According to IPCC, the "first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability". Thus, there is a pressing need to assess the vulnerability of natural ecosystems and or socio-economic systems to current climate risks and long-term climate change as it is a vital preceding step to develop adaptation policies, strategies and practices. The IPCC Assessment Report 5 (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.

Keeping all of the above in mind, the district wise assessment of inherent vulnerability profile of Mizoram associated with climate change on integrated bio-physical and socio-economic sector is presented here in this report. The objective of this assessment is to rank and prioritise the most vulnerable districts in the State and to identify the drivers of vulnerability. Identification and prioritisation of most vulnerable districts by addressing the drivers of vulnerability is an essential first step for prioritizing investment in adaptation for policy makers and planners so that risk from impacts of climate change can be reduced.

A set of 18 indicators from socio-economic and livelihood, biophysical, infrastructure and health characteristics of Mizoram were used to measure the vulnerability of pre-existing eight districts of Mizoram. A series of 12 steps methodology were followed for the assessment using Tier 1 approach which utilizes entirely of secondary data collected from various published sources and geo-spatial data. Calculations were done based on assigning unequal and equal weights to the indicators. Unequal weights were done by consulting stakeholders from different background through online process. Districts were rank and categorized based on the Composite vulnerability indices determined by aggregating their corresponding weighted values of each indicators.

The composite vulnerability indices determined for pre-existing eight districts of Mizoram based on eighteen sets of indicators for both unequal assigned weight and equal weight reveals that the values are highest for Lawngtlai district (0.783 and 0.7469) followed by Lunglei district (0.609 and 0.5906) Mamit district (0.606 and 0.5900) interchanging position with weights, then Siaha district (0.583 and 0.5879), Serchhip district (0.434 and 0.4503), Champhai district (0.432 and 0.4273), Kolasib district (0.417 and 0.4272) and lastly, Aizawl district (0.367 and 0.3782) being the least vulnerable district.

Vulnerability is a relative measure which indicates that the above ranking based on vulnerability indices are a comparative analysis between districts. Hence, it does not imply that districts having lower value of vulnerability indices are not outright vulnerable, they are comparatively less vulnerable than districts having high vulnerability index values.

A brief analysis on the drivers of vulnerability suggested that the biophysical features such as horticulture output ratio to agriculture output and large area under rainfed agriculture in the states, including socio-economic features such as large number of farmers depending on agriculture as main employment are the dominant drivers of vulnerability.

While measuring the vulnerability using selected indicators, one should note that there can be other inherent characteristics that can be used as indicators to measure the vulnerability of the same study area. Therefore, the drivers of vulnerability mentioned above are not the only drivers of vulnerability for Mizoram nor it is homogeneous for all the districts. Districts may have specific problem or characteristics that needs to be addressed separately.

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PART I:
Introduction

1.1 Global warming and climate change

There is a very clear pattern from scientific evidence documenting that the earth is warming (Thompson, 2010). This warming of the earth is unequivocal, many of the observed changes since the past 50 years or so are becoming unprecedented ever than before. The Earth's surface has been significantly warmer successively during the last three decades than any preceding decade since observed data was available in the beginning of the industrial era. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased. The Earth's Northern Hemisphere has seen its the warmest 30-year period (1983–2012) during the last 1400 years (IPCC 2013).

Greenhouse gases that are captured in ice allow us to see the levels of greenhouse gases in the past. Since the onset of the Industrial Revolution, when fossil fuel use began to increase, CO2 concentration has increased about 38% (Forster et al., 2007). Between 1975 and 2005, CO2 emissions increased 70% and since then, there has been an increase in CO2 concentration by a level not seen at any time in 800,000 years. Due to human activity, eight billion metric tons of carbon are released to our planet's atmosphere in 2007 alone (Boden, Marland, & Andres, 2009). Methane raises temperature even more than CO2, and the amount of methane in the atmosphere, like that of CO2, is also at a level not seen in 800 millennia. Two thirds of current emissions of methane are by-products of human activity, things like the production of oil and natural gas, deforestation, decomposition of garbage and sewage, and raising farm animals. (Thompson, 2010) Driven largely by economic and population growth, the concentrations of greenhouse gases mostly carbon dioxide, methane and nitrous oxide are higher than ever in the atmosphere. Their effects, together with those of other anthropogenic and natural drivers, have been detected throughout the Earth's climate system and are strongly believed to be the cause of this unprecedented global warming and that it poses a clear and present danger to civilization as well as rapid and potential catastrophic changes in the near future (IPCC, 2013; Thompson, 2010). These statements emerge not simply from computer simulations, but from the weight and balance of the empirical evidence as well. (Thompson, 2010).

Climatologists while working to reconstruct past climate variations on regional and global scales, they also try to determine the mechanisms that drive climate change, called forcers. They recognize two basic categories of forcers. Natural forcers, which are recurring processes that have been around for millions of years; anthropogenic forcers that more recent processes caused by human activity. There is consensus among climatologists that the natural forcers such as changes in solar ouput, ENSO (*el nino*) and other natural forcers fail to explain the steady, rapid rise in the earth's temperature during the past 100 years or so. (Meehl et al., 2007; Thompson, 2010).

According to the Working Group I of the IPCC AR5 report 2013, the globally averaged combined land and ocean surface temperature data show a warming of 0.85°C over the period of 1880 to 2012. The warming of ocean surface has resulted in decreased acidity of ocean surface water by 0.1 pH since the industrial era. The average rate of ice loss from glaciers around the world was 226 Gigatonne per year over the period 1971 to 2009 and global mean sea level rose by 0.19m over the period of 1901 to 2010 (IPCC, 2013).

Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. It is predicted to continue to increase by a minimum of 0.3◦C–1.7◦C to a maximum of 2.6◦C–4.8◦C by 2100. This will result in continuous changes in the global water cycle; the contrast in precipitation between wet and dry regions and between wet and dry seasons is predicted to increase. Continuous warming of the global ocean will penetrate from the surface to the deep ocean and affect ocean circulation. Global mean sea level will continue to rise by 0.5 to 1 m by the end of this century (IPCC 2013).

Global warming is already affecting our climate and will present practical challenges for local ecosystems. These include the prospect of more severe weather, longer droughts, higher temperatures (milder winters), heat waves, changes in local biodiversity, and reduced ground and surface water quantity and quality. It is adversely impacting both bio-physical systems (mountains, rivers, forests, wetlands, etc.) and socio-economic systems (hill communities, coastal communities, agriculture, animal husbandry, etc.) (IPCC 2013). So, prevention is no longer an option. Three options remain for dealing with the crisis: mitigate, adapt, and

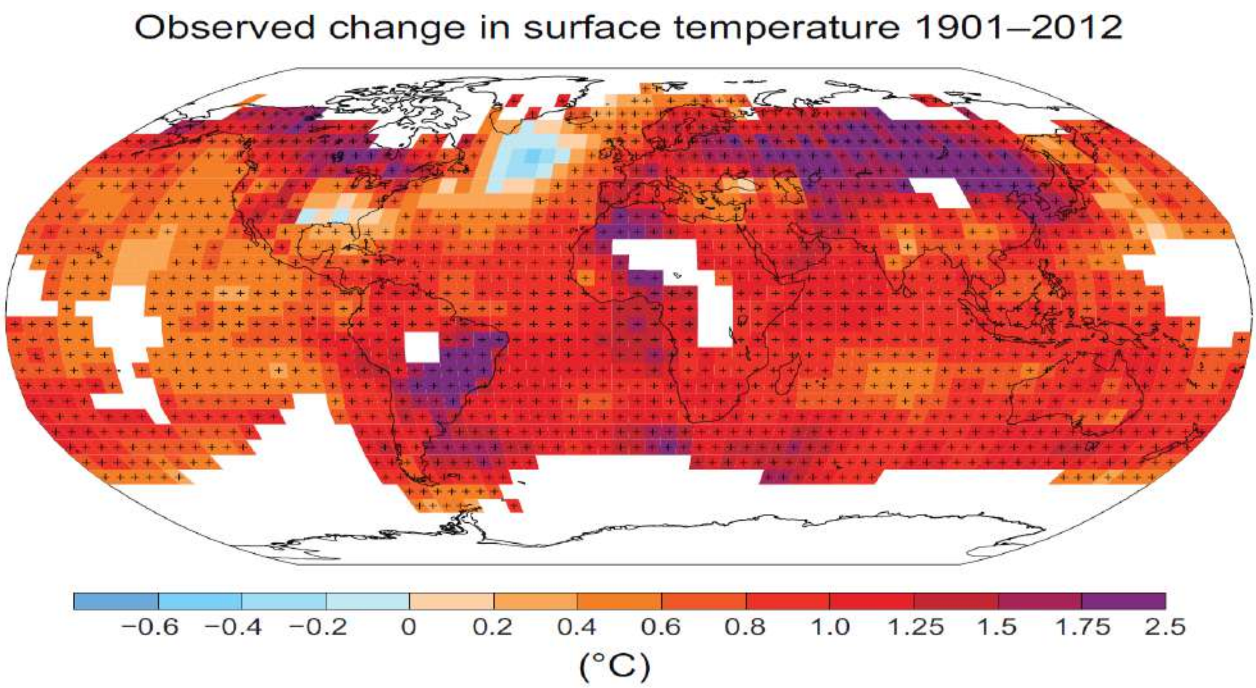


Figure 1. *Map of the observed global surface temperature change from 1901 to 2012 derived from temperature trends determined by linear regression. Trends have been calculated where data availability permits a robust estimate. Other areas are white. (IPCC 2014)*

suffer. Mitigation involves reducing the pace and magnitude of the changes by altering the underlying causes. E.g. Reducing the volume of greenhouse gas emissions, especially CO2 and methane. Adaptation involves reducing the potential adverse impacts resulting from the by-products of climate change. Common example includes changing agricultural practices to counteract shifting weather patterns, and strengthening human and animal immunity to climate-related diseases. Our third option, suffering, means enduring the adverse impacts that cannot be staved off by mitigation or adaptation (Thompson 2010).

The signs of climate change such as global temperatures rise with erratic weather patterns will impact water resources and affect human health by facilitating the spread of infectious diseases, frequency of natural hazards and disasters will also tend to increases (Singh et al. 2011). Everyone will be affected by climate change, but the impact, however, is not uniform across space and time (O'Brien and Leichenko, 2000). Those with the fewest resources for adapting will suffer most. The extent of the impact depends on the vulnerability of the system which are determined by the magnitude of climatic changes affecting the characteristics of the system (sensitivity), and the ability of people and ecosystems to deal with the resulting effects (adaptive capacities of the system) (IPCC,2013).

1.2 Climate change and mountains

Mountains are among the most fragile environments on Earth. They are rich repositories of biodiversity and water and providers of ecosystem goods and services on which downstream communities, both regional and global, rely (Hamilton 2002; Korner 2004). Mountains are also home to some of the poorest people, who are highly dependent on natural resources (Kollmair et al. 2005). But there is little knowledge about the vulnerability of mountain ecosystems to climate change. It is instinctively undeniable that mountains are likely to experience wide ranging effects on the environment, biodiversity, and socioeconomic conditions (Beniston 2003). Changes in the hydrological cycle may significantly change precipitation patterns leading to changes in river runoff and ultimately affecting hydrology and nutrient cycles along the river basins, including agricultural productivity and human wellbeing. Therefore, the fragile and poorly accessible landscapes with sparsely scattered settlements and poor infrastructure, imply that mountain areas will suffer most from climate change (Singh et al., 2011) and are in dire need of research and assessment. (Sharma et. Al, 2009).

The Indian Himalayan mountain ecosystem is fragile and diverse, it is home to over 51 million people who are dependent on hill agriculture and natural resources and are highly vulnerable to climate change. The Himalayan ecosystem, apart from its own extent, is also vital to the ecological security of the Indian landmass, through providing forest cover, feeding perennial rivers that are the source of drinking water, irrigation, and hydropower, conserving biodiversity, providing a rich base for high value agriculture, and spectacular landscapes for sustainable tourism. The Himalayan ecosystem is vulnerable and susceptible to the impacts and consequences of any changes on account of natural causes, climate change resulting from anthropogenic emissions and even developmental paradigms of the modern society. (NMSHE, 2010).

The Eastern Himalayas encompass Bhutan, the North East Indian states and north Bengal hills in India. The region has very different geo-political and socioeconomic systems than the rest of India, and contain diverse cultures and ethnic groups. The region also has complex topography and extreme altitudinal gradients creating diverse bioclimatic zones (near tropical to alpine shrubs and meadows). Climate controls river flow in the area and the monsoon from the Bay of Bengal produces heavy precipitation. With rising temperatures, areas covered by permafrost and glaciers are decreasing in much of the region. A greater proportion of precipitation appears to be falling as rain more than before in many areas. Snow masses which acted as a natural form of water storage are now releasing moisture slowly into the ground or rivers, water is increasingly only available at the time of precipitation. This affects river regimes, natural hazards, water supplies, people's livelihoods, and overall human wellbeing (Xu et al. 2007; Erickson et al. 2009). The Himalayan region has shown consistent warming trends during the past 100 years (Yao et al. 2006). The region is particularly vulnerable to climate change due to its ecological fragility and economic marginality. The high level of poverty linked pressure already brought indicative changes in forest quality. Apart from the global phenomena, land use and land cover changes also contribute to local and regional climate change (Chase et al. 1999). These result in changes in the hydrological cycle, increase in frequency and intensity of hazard and human health. The climate change impacts also affect the ability of biological systems to support human needs (Vitousek et al. 1997, Sharma et al. 2009).

World Bank's World Development Report points out that degraded ecosystems and natural resources in South Asia are more vulnerable to climate change. Further, the poorest people are the most vulnerable to adverse impacts of climate change because they often reside in high-exposure areas and also have low adaptive capacity to cope with climate risks (Ravindranath et al., 2011).

The North East region of India, comprising of eight states within the Indian Eastern Himalayan region covers a geographic area of 26.2 million ha. The North Eastern region with a population of about 40 million people is characterized by large rural population, scattered in low density, large proportion of indigenous tribal communities living in large area under forests that rely hugely on natural resources. The region is also characterized by diverse climate regimes which are highly dependent on the southwest monsoon. Over 60% of the crop area is under rainfed agriculture, and so is in areas highly vulnerable to climate variability and climate change exacerbated by poor infrastructure development. The natural resources in the North East states are also subjected to degradation and loss due to deforestation, unsustainable shifting cultivation practices, fragmentation and degradation which ultimately impact the biodiversity as well as forest biomass production. Increase in human and livestock population, increase pressure on forest resources, shortening of jhum cycle, conversion of natural forests into plantations for horticultural crops, mining, overgrazing, and forest fire are the major causes of deforestation in North East India. Due to the hilly terrain, cultivation of crops along the slopes and overgrazing by livestock, the soil resources of the region are subjected to erosion and loss. Many districts face severe water scarcity during the summer months (Ravindranath et al., 2011).

The overarching recognition in all literatures is that climate change will have huge and largely detrimental impacts on vulnerable communities. In fact, it has profound implications for social justice and gender equality because the climatic stressors compounded by socioeconomic drivers of change will result in social, political and economic vulnerabilities of people and society, setting back development and destroying livelihoods (Goodrich et al., 2017). There is a need for understanding the vulnerability of a system which is one of the critical steps to enhance adaptive capacity to combat climate change. (DST & SDC 2019).

1.3 Climate change adaptation:

It is evident from the science of climate change and the experiences of nations and communities that adaptation actions, together with mitigation responses, are required in order to address the wide-ranging impacts of projected climate change. The adaptation process consists different components such as the assessment of climate impacts and vulnerability; planning for adaptation; the implementation of adaptation measures; and monitoring and evaluation of adaptation actions. Each of these components is associated with and or supported by, relevant data and information, methods and tools, and practices (GIZ & MoEFCC, 2014).

An attempt to address adaptation to climate change requires inputs from many disciplines, and also an interdisciplinary perspective—it is arguably at the linkages between the physical, natural and social sciences that the greatest advances will be made in understanding the complexities of adaptation and developing credible and realistic ways of facilitating adaptation to climatic change. Local circumstances—geographical characteristics, current management practices and institutional structures—significantly affect what adaptation options are considered feasible, what information is likely to be used, what assessment techniques are adopted and, crucially, how adaptation decisions are actually made. This implies that it will be difficult to make generalised assessments of the potential contribution of adaptation to managing the risks posed by climate change and it is also challenging to construct generalised models of the adaptation process (Arnell et al. 2010).

Simple framework by Arnell et al. 2010 provided a structure for organising and assessing adaptation research. Specific research questions could include: What makes the "adapting agent" vulnerable or exposed to a changing climate? What influences preparedness to adapt?

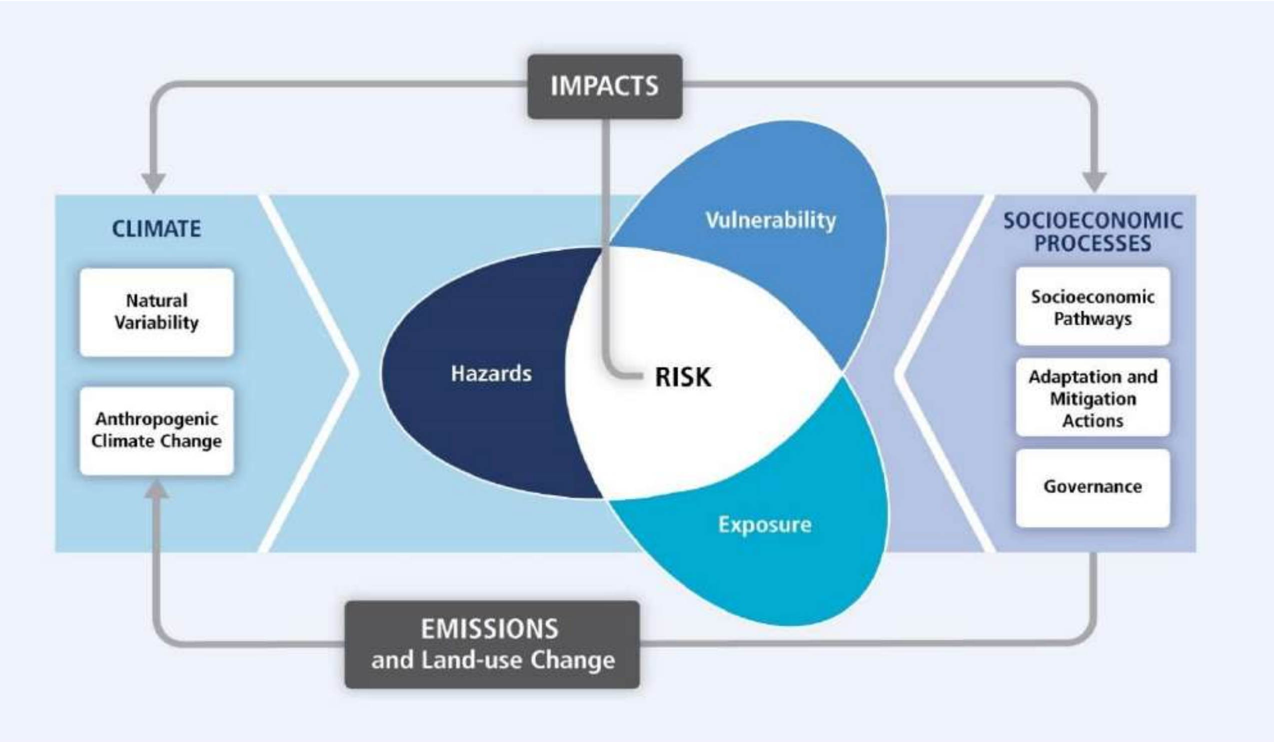


Figure 2: Risk management and assessment framework (Source: IPCC, 2014)

Decisions about adaptation priorities and planning must be based on a comprehensive risk assessment. In other words, a risk assessment must consider the three core components of hazard, vulnerability and exposure. There is no "cooking recipe" or a single approach to this assessment because climate-related risks are wide-ranging, and approaches must be tailored to specific local conditions. However, the use of a common risk assessment framework enables comparison of results across different districts or states, providing a sound basis for adaptation planning. (Allen et al., 2017)

The Intergovernmental Panel on Climate Change in its Fifth Assessment Report (AR5) published in 2014 proposed a framework designed based on the concept of Risk management and assessment framework (Figure 2) published in the 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.

1.4 Climate change vulnerability:

The "first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability". Thus, there is a pressing need to assess the vulnerability of natural ecosystems and or socio-economic systems to current climate risks and long-term climate change as it is a vital preceding step to develop adaptation policies, strategies and practices. (IPCC, 2014).

Assessing vulnerability to climate change is important for defining the risks posed by climate change and provides information for identifying measures to adapt to climate change impacts. It enables practitioners and decision-makers to identify the most vulnerable areas, sectors and social groups. In turn, this means climate change adaptation options targeted at specified contexts can be developed and implemented (GIZ & MoefCC 2014). Assessing vulnerability to climate change also provide a starting point for identifying measures to adapt to climate change impacts and to efficiently allocate financial and other resources to the most vulnerable regions, people and sectors. Furthermore, climate change vulnerability assessments can be used to monitor and evaluate the success of adaptation measures (GIZ 2014).

The impacts of and the vulnerabilities to climate change can vary across regions (e.g. global, national, subnational), economic sectors (e.g. agriculture, industry, shipping), social groups (e.g. urban populations, forest dwellers, coastal communities) or types of system considered (e.g. natural, social, economic, socio-ecological). Given these circumstances, the development of any one-size-fits-all solution for assessing vulnerability to climate change is problematic (Hinkel, 2011).

Over the past decades, methods of vulnerability assessment have been developed in a wide range of development-related fields, ranging from natural hazards research, food security research and poverty analysis, to sustainable livelihoods research and related fields. Experiences with these frameworks suggest that vulnerability is a complex subject that has many dimensions (economic, social, political and geographic), which may often have overlapping effects that make it difficult to tease out the precise cause-effect relationship. Consensus has been reached that vulnerability is bound to a specific location and context (Cutter, et al., 2003).

Within the conceptualization of climate change-related risk in IPCC 2014, vulnerability is clearly linked to the intrinsic conditions of a society or system, while the changes in the climate system contribute to hazards and trends. Vulnerable systems may or may not face climate change risk depending on their exposure to hazards. For example, weak infrastructure in areas exposed to floods faces higher risk of getting affected by floods. The differentiation between the basic concepts of risk, hazard, vulnerability and exposure provides a sound basis for the development of adaptation strategies that need to consider both the changes in frequency or magnitude of hazards due to climate change as well as societal dynamics that shape the exposure and vulnerability of people and social-ecological systems. (Allen et al., 2017)

The Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (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).

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 eg., 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 eg., an area with high forest cover will have better adaptive capacity in response to climate change.

Keeping all of the above in mind, the district wise assessment of inherent vulnerability profile of Mizoram associated with climate change on integrated bio-physical and socio-economic sector is presented here in this report.

The objective of this assessment is to rank and prioritise the most vulnerable districts in the State and to identify the drivers of vulnerability. Identification and prioritisation of most vulnerable districts by addressing the drivers of vulnerability is an essential first step for prioritizing investment in adaptation for policy makers and planners so that risk from impacts of climate change can be reduced. This assessment also aims to act as baseline information for further vulnerability assessment at finer resolution. The approached methodology of this assessment can also be used for different sectors provided that relevant indicators are selected and weights are given with extreme caution with the help of experts and stakeholder consultations so that real life situations are reflected well.

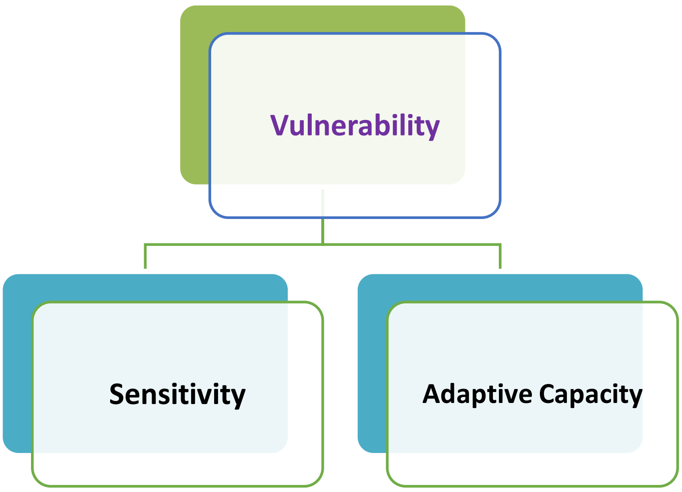


Figure 3: Components of vulnerability

PART II:
Study area: Mizoram

2.1 Physical features and Land Use Pattern

Mizoram is the southern most states among the seven sisters of the north-east India in the eastern Himalayan region. It falls within the geographical coordinates 21° 58' & 24° 35' N latitude and 92° 15' & 93° 29' E longitude. Mizoram shared a national boundary with Tripura, Manipur and Assam and 722 km long international boundary with Bangladesh in the west and Myanmar in the east and south.

The total geographical area of Mizoram is 21,087 sq. kms, which is divided into 11

Table 1: *Land use pattern in '000 ha*

<table>
<tr><th rowspan="2">Districts</th><th rowspan="2">Geographical Area</th><th colspan="2">Forests</th><th rowspan="2">Area not available for cultivation</th><th rowspan="2">Net area sown</th><th rowspan="2">Cropping Intensity</th></tr>
<tr><th>Area</th><th>%</th></tr>
<tr><td>Aizawl</td><td>357.6</td><td>307.9</td><td>86.10</td><td rowspan="8">83.218</td><td rowspan="8">218.61</td><td rowspan="8">110%</td></tr>
<tr><td>Champhai</td><td>318.5</td><td>248.8</td><td>78.09</td></tr>
<tr><td>Kolasib</td><td>138.2</td><td>115.3</td><td>83.40</td></tr>
<tr><td>Lawngtlai</td><td>255.7</td><td>220.0</td><td>86.04</td></tr>
<tr><td>Lunglei</td><td>453.6</td><td>402.2</td><td>88.67</td></tr>
<tr><td>Mamit</td><td>302.5</td><td>271.7</td><td>89.81</td></tr>
<tr><td>Serchhip</td><td>142.1</td><td>116.2</td><td>81.75</td></tr>
<tr><td>Siaha</td><td>139.9</td><td>118.5</td><td>84.74</td></tr>
</table>

Source of data: ISFR, 2017 (Geographical area and forest cover), Statistical Abstract of Mizoram 2017 (Area not available for cultivation, net area sown), pers. comm. (cropping intensity).

Table 2: *District wise net area irrigated by sources in '000 ha*

Districts	Total crop land	Gross command area under Irrigation project	Culturable command area	Net Irrigated Area
Aizawl	15.23	2.56	2.38	1.82
Champhai	22.27	3.92	3.80	2.44
Kolasib	11.58	4.10	3.74	3.04
Lawngtlai	9.67	1.41	1.32	0.49
Lunglei	15.77	2.64	2.19	0.82
Mamit	17.40	1.76	1.63	1.08
Serchhip	8.94	2.68	2.53	1.26
Siaha	3.91	0.70	0.62	0.35

Source of data: Statistical Abstract of Mizoram 2017

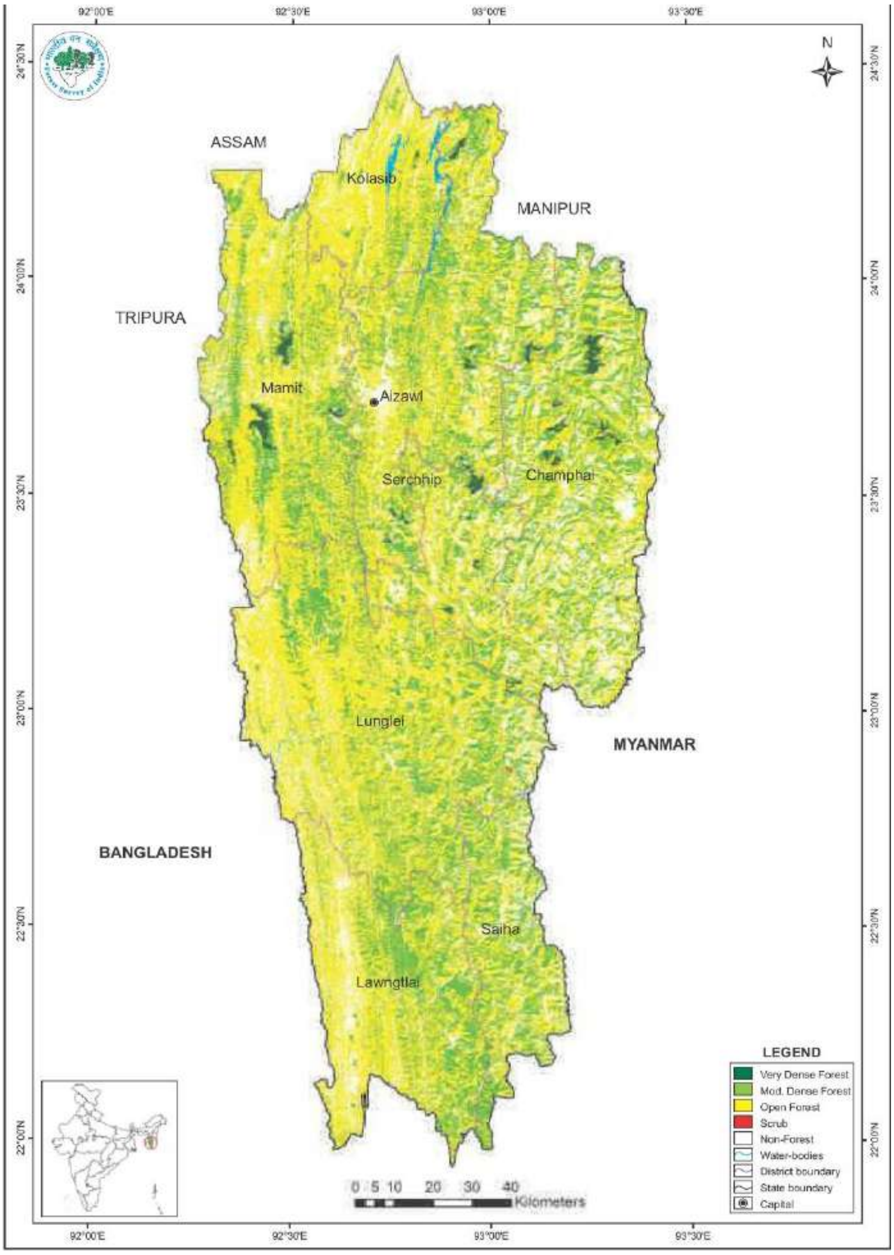


Figure 4: Forest Cover Map of Mizoram (India State of Forest Report 2019)

administrative districts, out of which 3 were newly created with data not yet available.

The state of Mizoram falls within the Patkai hill range of the southern foothills of the Eastern Himalayas. The topography is hilly with rugged terrain, steep slopes and deep valleys. The altitude ranges from 50 to slightly above 2000 m above sea level.

The Indian State of Forest Report 2019 states that of the total geographical area, forest covers 85.41 %, of which very dense forest accounts for 157.05 sq. kms, and the rest are moderately dense and open forest. The report also states that there is a decrease of 180.49 sq. kms since 2017 assessment which can be attributed to shifting cultivation and other developmental activities.

2.2 Biological features

The forests of Mizoram according to Champion and Seth (1968) can be classified as Tropical wet evergreen, Tropical semi-evergreen and Sub-tropical hill forest. Singh et. al., (2002) also describe the vegetation types of Mizoram based on altitude and rainfall broadly into Tropical Wet-evergreen forest, Montane Sub-tropical forest and Temperate forest.

Along with the sister states in North-east India, Mizoram also lies in Indo-Burma Region, which is one of the four biodiversity hotspots in India. As such, the state is endowed with dense forests and diverse species of the flora and fauna. Mizoram has a reported floral resources of 2141 species of flowering plants which includes 905 genera, 176 families and 6 species of gymnosperms and 211 species of pteridophytes (Singh et al., 2002 and Sinha et al., 2012). According to Chaudhuri & Sarkar, 2003, there are 30 species of endemic flowering plants reported from Mizoram. Mizoram has 20 species of bamboos, and one species *Melocanna baccifera* dominates with more than 75% of the area under bamboo forest. Other key bamboo species include *Dendrocalamus longispathus* and *Oxytenanthera parreifollia.*

The Zoological survey of India 2009 reported that Mizoram has 84 species of Mammals belonging to 61 genera of 25 families, 350 species of birds belonging to 205 genera of 59 families, 84 species of herpetofauna belonging to 55 genera of 20 families, variety of insects, molluscs, etc. Many scientific research and papers are being reporting new species and new report within Mizoram since then.

2.3 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 kilometres. 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 Extention Work Plan 2016 - 2017).

Table 3: *Social profiles of the districts in the State.*

Districts	Population (2011)	Sex Ratio (2011)	% Population BPL (2011)	Infant Mortality Rate per thousand (2016)
Aizawl	400309	1009	8.76	17
Champhai	125745	984	9.35	24
Kolasib	83955	956	17.50	25
Lawngtlai	117894	945	21.37	27
Lunglei	161428	947	30.10	18
Mamit	86364	927	35.64	25
Serchhip	64937	977	12.79	23
Siaha	56574	979	31.64	20

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

2.4 Climate

Mizoram enjoys moderate climate. In the lower altitude at foot hills and the valleys, typical tropical climate is obtained while in the mid region with large expanse, the subtropical moist climate is experienced. Mizoram receives average rainfall of 2519.3 mm every year. Rainfall data from 1986 to 2019 shows variability ranging from 1930.3 in 2019 to 3121.9 in 2007 with a linear decreasing trend of 9.19 mm every year (Figure 5). Onset of monsoon generally starts at end of May and retreats from the month of October. The high rainfall with moist climate is conducive for the vigorous growth of varied types of vegetation.

The temperature of Mizoram is quite pleasant with an average of 11° to 21° C during winter and 20° C to 30° C during summer. Over the past 32 years since 1986 up to 2017 data, Mizoram experience slight increasing rate in the yearly average maximum (0.01°C), mean (0.04°C) and minimum (0.08°C) temperatures (SCCC, 2018).

Table 4 below shows the departure of monsoon rainfall in 2019 from the average normal rainfall for different districts of Mizoram which indicates that by averaging all the districts rainfall reading, monsoon rainfall in 2019 decreases by a margin of 7.61 % from the normal average rainfall during the past 33 years.

Table 4: *Normal Monsoon rainfall and percentage departure of rainfall in 2019 from the normal for the districts in the States*

Districts	Normal Monsoon Rainfall in mm	% Departures of Monsoon rainfall in 2019
Aizawl	1486.5	-23.71
Champhai	1459.7	28.13
Kolasib	1706.6	-35.34
Lawngtlai	1062.8	5.62
Lunglei	2176.0	-39.74
Mamit	1714.3	-12.76
Serchhip	1439.5	11.61
Siaha	1710.1	5.29
MIZORAM TOTAL	1594.4	-7.61

Source: State Meteorological Centre, Directorate of Science & Technology, Govt. of Mizoram

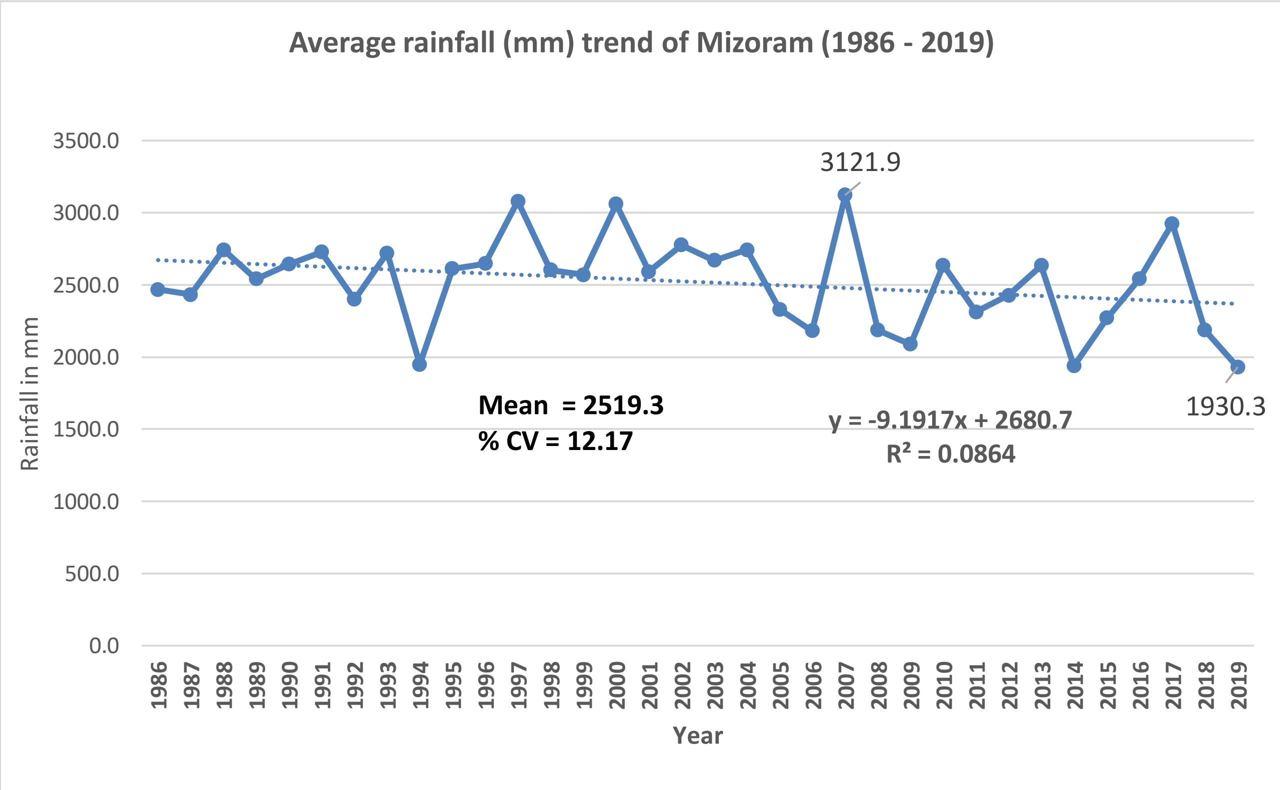


Figure 5: *Polygraph representing rainfall variability in Mizoram (simple linear regression) from 1986 to 2019*

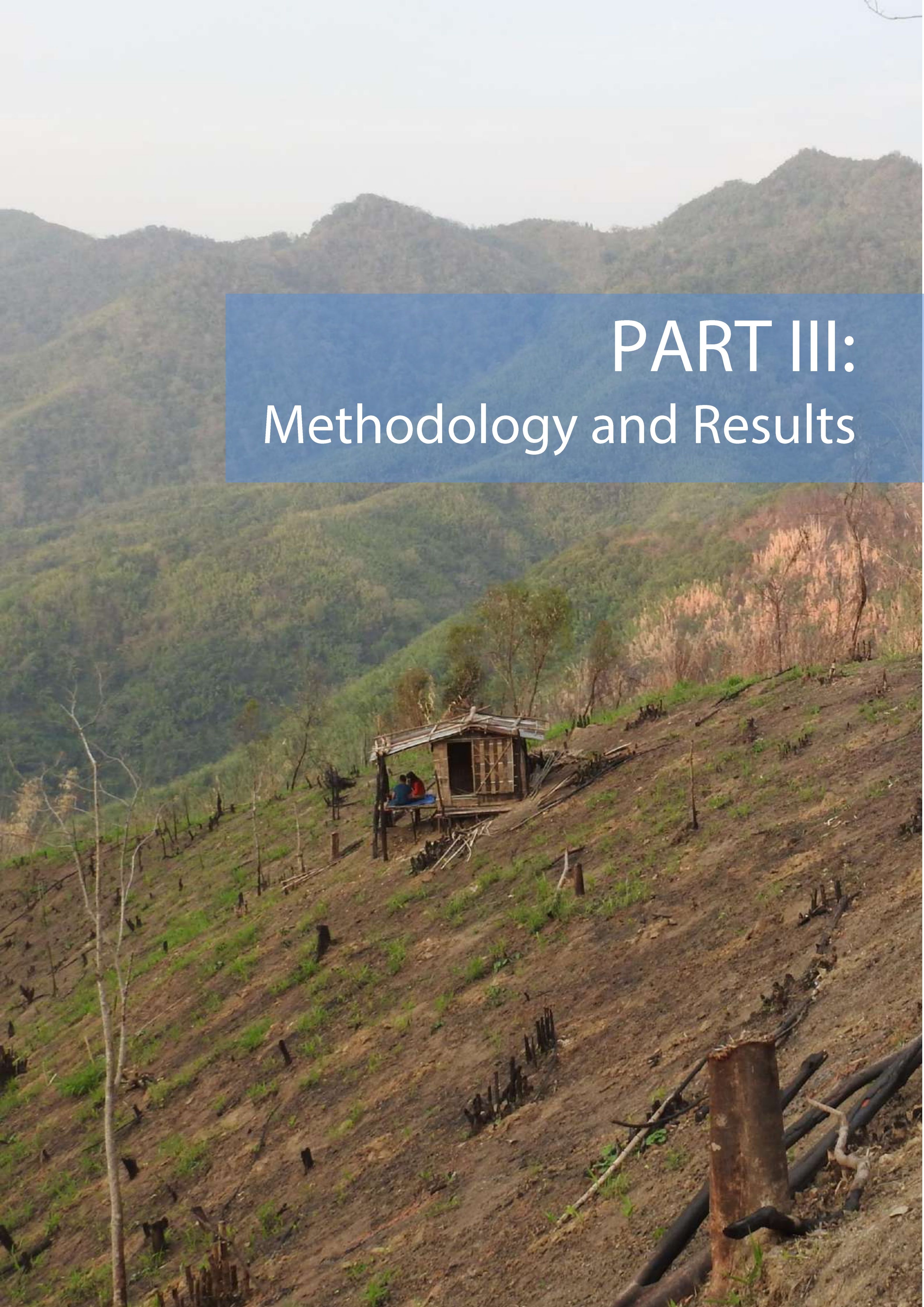
(Source: State Meteorological Centre, Directorate of Science & Technology, Govt. of Mizoram)

***Table 5:** Variability in the trend of Rainfall (mm) and temperature (°C) of different districts of Mizoram (1986-2017)*

DISTRICTS	RAINFALL (MM)		TEMPERATURE VARIABILITY (° C)			REMARKS/ DATA RANGE
	Average	Variability	Maximum	Minimum	Average	
Aizawl	2394.96	- 3.99	+ 0.05	- 0.12	- 0.04	1986 - 2017
Champhai	2161.66	- 1.66	- 0.28	- 0.34	- 0.31	8 years data (not included in calculation for Mizoram)
Kolasib	2787	- 2.8	- 0.01	+ 0.09	+ 0.04	1986 - 2011
Lawngtlai	2361.12	- 29.17	+ 0.03	+ 0.15	+ 0.09	1986 - 2011
Lunglei	3204.73	+ 8.53	- 0.03	+ 0.13	+ 0.05	1996 - 2011
Mamit	2649.38	+ 19.19	NA			2010 only
Serchhip	2369.48	- 28.03	NA			2010 only
Siaha	2486.55	+ 5.77	NA			
MIZORAM	2551.88	- 5.22	+ 0.01	+ 0.08	+ 0.04	Average of Aizawl, Kolasib, Lawngtlai and Lunglei District

***Note:** Data availability are not consistent across districts*

PART III:
Methodology and Results



There are twelve steps in the assessment of vulnerability which are briefly explained below along with results obtained for each of the steps:

3.1 Scoping of vulnerability assessment (VA)

The whole state of Mizoram is vulnerable to natural disasters, coupled with the impact of climate change and climate variability. This calls for a scientific and robust assessment of vulnerability of the state at different levels to identify most vulnerable areas and their drivers of vulnerability for policy makers and planners so that they can prioritize areas for adaptation plans and investment at limited resources.

3.2 Selection of type of vulnerability assessment

This assessment will be vulnerability assessment of Mizoram at district level on integrated Biophysical and Socio-economic Sectors.

3.3 Selection of Tier methods

This assessment was conducted using Tier 1 approach which utilizes mainly secondary data from various sources and geo-spatial data (Sharma et al., 2011).

3.4 Selection of Spatial scale and period for vulnerability assessment

The spatial scale for this assessment is the political boundary of the pre-existing eight districts of Mizoram. This assessment will be inherent vulnerability under current climate condition. Therefore, data were collected one time during variable years for each unit of measurement to represent the current scenario.

Figure 6: *Map of Mizoram showing eight districts of Mizoram (Map not to scale)*

3.5 Identification, definition and selection of indicators for vulnerability assessment

Identification of indicators was done through literature review, stakeholders and expert consultations. The screening and selection of such identified indicators based on their importance and relevancy to indicate vulnerability were determined through the same processes (Table 6a to 6d).

Table 6a: List of indicators and sub-indicators for Socio-economic & livelihood characteristics, their rationale for selection, type of indicator in vulnerability and sources of data

Indicators/ Sub-indicators	Rationale for selection	Type of indicator in vulnerability	Source of data
Socio-economic & livelihood indicators *(Climate change has profound implications for social justice and gender equality because the climatic stressors compounded by socioeconomic drivers of change will result in social, political and economic vulnerabilities of people and society, setting back development and destroying livelihoods (ICIMOD 2017))*			
% BPL household w.r.t total no of household	Poverty directly corresponds to higher sensitivity against any change in the system; for instance, when climate change negatively affects their livelihood.	Sensitivity	Eco & Stats Dept., Govt. of Mizoram (2015-2016)
% population mainly employed in agriculture	More than 70 % of the population in Mizoram are engaged wholly or in some form of agriculture. Majority of the agriculture system in Mizoram are rainfed. Therefore, greater the number of people in an area who depend wholly on agriculture indicate higher sensitivity to climate change for that area.	Sensitivity	Mizoram Remote Sensing Application Centre (2011-2012)
Total Number of Livestock per 1000 rural populations	Livestock provide eggs, meat, milk, etc which can be a reliable alternate source of income as a means of adapting to agriculture and horticulture crop failure due to climate change	Adaptive Capacity	20th Livestock Census http://www.dahd.nic.in/
% of landless, marginal and small farmers (land <5 acre)	Small and marginal land holding most likely indicate limited economic and physical resources, it may also indicate maximum climate change impacts in proportion to the size of land holdings. These ultimately corresponds to higher sensitivity.	Sensitivity	Statistical abstract of Mizoram 2017
Female Workforce Participation	Women are regarded as more vulnerable than men to the impacts of climate change, because they usually have less access than men to resources that would enhance their capacity to adapt to climate change. Therefore, increasing workforce of female and their access to resources enhance the adaptive capacity of the system where both men and women live together as community.	Adaptive Capacity	Census of India 2011

Table 6b: List of indicators and sub-indicators for Biophysical characteristics, their rationale for selection, type of indicator in vulnerability and sources of data

Indicators/ Sub-indicators	Rationale for selection	Type of indicator in vulnerability	Source of data
Biophysical indicators *(The biophysical environment is a key factor in climate change 'hotspots' areas where strong climate signal and high concentrations of vulnerable people are present. Their geographical location and exposure to climatic pressures are an intrinsic element of their vulnerabilities (Smit et al. 2001; De Souza et al. 2015))*			
Forest area per 1000 rural population	Forest provide livelihood opportunities for majority of people living in rural areas such as timber collection, NTFP such as medicinal plants, food plants and animals, etc. It has been serving as alternate source of livelihood. It also provides water resources in hilly areas. Forest cover also provide seed banks for self-regeneration which makes it more resilient in terms of biogeography.	Adaptive Capacity	India State of Forest Report 2019
Value of output of total horticulture (only perennial) / value of agricultural output	Apart from consumption, horticulture output accounts for reliable income in terms of cash crops. Therefore, less the ratio of horticulture to agriculture output, income become more diverse and adaptation options increased.	Adaptive Capacity	Statistical abstract of Mizoram 2017
% of rainfed agriculture	More than 60 % of the agriculture in Mizoram are rainfed which are highly vulnerable to climate variability and climate change	Sensitivity	Statistical abstract of Mizoram 2017
Variability in food grain crop yield (tonne/ha)	Even though more than 50% of staple food (rice) consumption in Mizoram are imported from other states and neighbouring countries, consistency of food crop yield within the state play a crucial role to the survival and well-being of people living in rural areas.	Sensitivity	Area and Production Statistics, Ministry of Agriculture http://www.aps.dac.gov.in/
Groundwater availability	Accessibility and availability of groundwater resources are very crucial in areas where surface water is limited enhancing the availability of alternate water resources for domestic and agriculture purposes.	Adaptive Capacity	Public Health Engineering Department, Government of Mizoram

Table 6c: List of indicators and sub-indicators for Institutional & Infrastructure characteristics, their rationale for selection, type of indicator in vulnerability and sources of data

Indicators/ Sub-indicators	Rationale for selection	Type of indicator in vulnerability	Source of data
Institutional and infrastructure indicators *(The poor infrastructure and the weak connectivity (lack of proper road network density) make those living under such condition victims of climate hazards (Singh et al. 2018))*			
Road density (road length/geographical area)	Ability of a system to adjust, repair, and respond to damage or disruption depend on many factors; one important factor being accessibility of the area and degree of connectivity by road. Good connectivity also corresponds to lesser investment in time, money and other resources.	Adaptive Capacity	Mizoram Remote Sensing Application Centre (MIRSAC)
Rural bank / 1000 rural population	Cash at hand are easy to spend. People in rural areas with banks are more inclined to income savings.	Adaptive Capacity	Head Office, Mizoram Rural Bank, Aizawl
MGNREGA (person days employment generated per 100 days)	It is probably one of the best and in many cases the only alternative source of income for people living in rural areas. There is a scarcity of employment opportunities in rural areas, many families in Mizoram are now depending on this scheme for their stable income in addition to other inconsistent sources of livelihood. Removing this component will make them highly vulnerable.	Adaptive Capacity	http://nrega.nic.in (5 yrs average)
% piped water connection per total number of households	Piped water connection to household indicate availability of infrastructure to withstand water stress such as erratic rainfall, surface water limitations, etc	Adaptive Capacity	Public Health Engineering Department, Government of Mizoram

Table 6d: List of indicators and sub-indicators for Health characteristics, their rationale for selection, type of indicator in vulnerability and sources of data

Indicators/ Sub-indicators	Rationale for selection	Type of indicator in vulnerability	Source of data
Health indicators *(Climate change can result in damage to sanitation infrastructure resulting in the spread of disease or threatening a community's ability to maintain its economy, geographic location and cultural tradition, leading to mental stress, Warren et al. 2005))*			
Cases of vector borne diseases per 1000 Population (Dengue & Malaria)	Areas with more cases of vector borne diseases are already more sensitive than areas having less cases. As vector population tends to increase with increasing temperatures, cases are very likely to increase also.	Sensitivity	Health and Family Welfare Department, Government of Mizoram
Cases of Water Borne Diseases per 1000 population (Hepatitis & Diarrhea)	Areas with more cases of water borne diseases are more sensitive against the impacts of climate change which will very likely to worsen the situation due to several factors such as poverty, public hygiene, topography, etc.	Sensitivity	Health and Family Welfare Department, Government of Mizoram
No of doctors, specialists, health assistants & health Workers per 1000 population	Availability of medical personnel and especially doctors of different speciality are very crucial for the general public health in an area.	Adaptive Capacity	Health and Family Welfare Department, Government of Mizoram
Infant Mortality Rate per 1000 birth	It is the best indicator among the available data for health system performance. It represents a status of wider health of a population	Sensitivity	Health and Family Welfare Department, Government of Mizoram

3.6 Quantification and measurement of indicators

All indicators were expressed in terms of numerical numbers that quantifies the values for each district so that mathematical operations can be applied to them.

Numerical numbers for certain indicators are input directly from the source of data. For other indicators, further calculations from the data sources were required which utilizes simple mathematical formula to complex Geo-spatial techniques using GIS software.

3.7 Normalization of indicators

Different indicators were expressed in different units thus cannot be simply used for calculations. To address these issues, indicator values were normalized across all units of measurement. Normalized values are unit free, and they all lie between 0 and 1 (0 implies least vulnerability and 1 implies the highest vulnerability) and can be used for ranking and comparison.

The following formulae were used for normalization which depends on whether the indicator has positive (**sensitivity indicators**) or negative relationship (**adaptive capacity indicators**) with vulnerability.

Case I: The indicator has positive relationship with vulnerability

$$NV = \frac{(\text{Actual I.V} - \text{Minimum I.V})}{(\text{Maximum I.V} - \text{Minimum I.V})}$$

Case II: The indicator has negative relationship with vulnerability

$$NV = \frac{(\text{Maximum I.V} - \text{Actual I.V})}{(\text{Maximum I.V} - \text{Minimum I.V})}$$

Where NV= Normalised value
I.V= Indicator value

Table 7a: *Sub-indicator functional relationship with vulnerability, actual values and normalised values for the main indicator Socio-economic & livelihood characteristics*

SUB INDICATORS →	% BPL household w.r.t total no of household		% population mainly employed in agriculture		Total Number of Livestock per 1000 rural households		% of landless, marginal and small farmers (land <5 acre)		Female Workforce Participation	
RELATIONSHIP WITH VULNERABILITY →	Positive		Positive		Negative		Positive		Negative	
DISTRICTS ↓	AV	NV	AV	NV	AV	NV	AV	NV	AV	NV
Aizawl	8.76	0.00	12.66	0.00	263.35	0.00	92.76	0.91	40.08	0.56
Champhai	9.35	0.02	35.12	0.96	236.32	0.15	90.86	0.85	43.44	0.03
Kolasib	17.50	0.33	28.48	0.67	258.24	0.03	61.33	0.00	38.01	0.88
Lawngtlai	21.37	0.47	27.43	0.63	91.43	0.95	95.93	1.00	37.42	0.97
Lunglei	30.10	0.79	34.75	0.94	82.85	1.00	90.76	0.85	40.95	0.42
Mamit	35.64	1.00	36.15	1.00	110.66	0.85	72.79	0.33	38.95	0.73
Serchhip	12.79	0.15	17.44	0.20	156.32	0.59	83.03	0.63	43.63	0.00
Siaha	31.64	0.85	35.55	0.97	256.61	0.04	86.29	0.72	37.25	1.00

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

Table 7b: *Sub-indicator functional relationship with vulnerability, actual values and normalised values for the main indicator Biophysical characteristics*

SUB INDICATORS →	Forest area (in Ha) per 1000 rural population		Value of output of total horti/ value of agri output		% of rainfed agriculture		Variability in food grain crop yield		Groundwater availability	
RELATIONSHIP →	Negative		Negative		Positive		Positive		Negative	
DISTRICTS↓	AV	NV	AV	NV	AV	NV	AV	NV	AV	NV
Aizawl	359.87	0.36	4.77	0.72	88.03	0.67	21.25	0.47	0.39	1.00
Champhai	322.19	0.54	2.27	1.00	89.02	0.72	7.61	0.00	0.43	0.96
Kolasib	310.85	0.59	4.41	0.76	73.69	0.00	7.73	0.00	1.29	0.11
Lawngtlai	226.66	1.00	2.73	0.95	94.96	1.00	34.04	0.92	1.40	0.00
Lunglei	434.00	0.00	3.19	0.90	94.82	0.99	28.46	0.72	1.14	0.26
Mamit	380.17	0.26	3.81	0.83	93.80	0.95	21.06	0.47	1.40	0.00
Serchhip	352.89	0.39	2.55	0.97	85.96	0.58	23.65	0.56	0.53	0.87
Siaha	376.78	0.28	11.30	0.00	91.00	0.81	36.43	1.00	0.63	0.77

Table 7c: *Sub-indicator functional relationship with vulnerability, actual values and normalised values for the main indicator Institutional and infrastructure characteristics*

SUB INDICATORS →	Road density (road length/geographical area)		Rural bank / 1000 rural population		MGNREGA (Average person days employment generated)		% piped water connection per total number of households	
RELATIONSHIP →	Negative		Negative		Negative		Negative	
DISTRICTS↓	AV	NV	AV	NV	AV	NV	AV	NV
Aizawl	10.09	0.87	0.16	0.27	86.23	0.22	4.52	1.00
Champhai	22.90	0.00	0.10	0.60	85.14	0.36	13.10	0.00
Kolasib	17.09	0.40	0.08	0.73	80.36	0.99	10.39	0.32
Lawngtlai	20.92	0.13	0.04	0.95	87.89	0.00	8.54	0.53
Lunglei	8.42	0.99	0.06	0.82	85.09	0.37	5.68	0.86
Mamit	14.89	0.55	0.08	0.71	81.11	0.89	12.72	0.04
Serchhip	8.21	1.00	0.21	0.00	80.25	1.00	5.79	0.85
Siaha	8.72	0.97	0.03	1.00	81.28	0.87	5.96	0.83

Table 7d: *Sub-indicator functional relationship with vulnerability, actual values and normalised values for the main indicator Health characteristics*

SUB INDICATORS →	Cases of vector borne diseases per 1000 Population (Dengue & Malaria)		Cases of Water Borne Diseases per 1000 population (Hepatitis & Diarrhea)		No of doctors, specialists, health assistants & health Workers per 1000 population		Infant Mortality Rate per 1000 birth	
RELATIONSHIP →	Positive		Positive		Negative		Positive	
DISTRICTS↓	AV	NV	AV	NV	AV	NV	AV	NV
Aizawl	0.63	0.02	15.41	0.43	5.07	0.08	17.00	0.00
Champhai	0.15	0.00	9.83	0.20	4.14	0.37	24.00	0.70
Kolasib	1.54	0.06	29.45	1.00	3.97	0.43	25.00	0.80
Lawngtlai	25.24	1.00	12.69	0.31	2.15	1.00	27.00	1.00
Lunglei	9.27	0.36	5.03	0.00	4.32	0.32	18.00	0.10
Mamit	9.10	0.36	10.39	0.22	3.80	0.48	25.00	0.80
Serchhip	0.15	0.00	20.57	0.64	5.07	0.08	23.00	0.60
Siaha	3.39	0.13	6.20	0.05	5.32	0.00	20.00	0.30

3.8 Assigning weights to indicators

First, un-equal weights were assigned to each main indicator and their corresponding sub-indicators according to their importance in determining vulnerability of a system. Experts and stakeholders from different backgrounds were invited to fill up an online form for weighing main indicators and sub-indicators based on their opinion on actual importance and relevance of different indicators to climate change. Preparation of online form for weighing were done so that the total weight of all the main indicators adds up to 100 and the total weight of sub-indicators under one main indicator also sums up to 100.

Note that all sub-indicators without main indicators are to be taken into account for calculation of vulnerability indices. But weights of each main indicator were used to calculate the final weight of their corresponding sub-indicators.

The final weight of a sub-indicator was calculated by taking its assigned weight as percent score from the assigned weight of its corresponding main indicator (Table 8).

Assigning proper weights is very crucial for obtaining reliable (reflecting the reality most) results. However, there can be inconsistency and bias among stakeholders upon assigning weights. Thus, for this assessment, unequal weights assigned by stakeholders and equal weight assigned to each indicator will be used separately for comparison to make the case free from bias.

So, for equal weighing, main indicators are discarded and all sub-indicators are considered as uncategorized indicators. Weights were assigned for each indicator as 100/total numbers of indicators (For e.g. A total 18 indicators were taken into account, the final weight assigned were approximately 5.55 for all indicators).

Table 8: Unequal weights assigned to indicators and sub-indicators and the calculated actual weights to be to be used for composite vulnerability index calculation.

Main indicators	Weight assigned	Sub-indicators	Weight assigned	Calculated Final weight
Socio-economic & livelihood	28	% BPL household w.r.t total no of household	18	5.04
		% population mainly employed in agriculture	24	6.72
		Total Number of Livestock per 1000 rural households	20	5.6
		% of landless, marginal and small farmers (land <5 acre)	19	5.32
		Female Workforce Participation	19	5.32
		SUB TOTAL	**100**	
Biophysical	29	Forest area per 1000 rural population	22	6.38
		Value of output of total horticulture (only perennial) / value of agricultural output	22	6.38
		% of rainfed agriculture	22	6.38
		Variability in food grain crop yield (tonne/ha)	20	5.8
		Groundwater availability	14	4.06
		SUB TOTAL	**100**	
Institutional and infrastructure	21	Road density (road length/geographical area)	34	7.14
		Rural bank / 1000 rural population	22	4.62
		MGNREGA (Average person days employment generated per 100 days)	20	4.2
		% piped water connection per total number of households	24	5.04
		SUB TOTAL	**100**	
Health	23	Cases of vector borne diseases per 1000 Population (Dengue & Malaria)	28	6.44
		Cases of Water Borne Diseases per 1000 population (Hepatitis & Diarrhea)	24	5.52
		No of doctors, specialists, health assistants & health Workers per 1000 population	26	5.98
		Infant Mortality Rate per 1000 birth	22	5.06
		SUB TOTAL	**100**	
TOTAL	**100**			

3.9 Aggregation of indicators and development of vulnerability index

The normalized values of each indicator were multiplied with its calculated final weight which produces weighted values for all indicators across all units of measurements. The vulnerability index of each district was determined by aggregating their respective weighted values across all indicators.

3.10 Vulnerability ranking of the districts in the state

Once Vulnerability Indices (VI) are calculated for all the districts, a comparative ranking was carried out based on the index value. Higher the value of VI of a district, higher will be its rank in vulnerability; rank 1 being the most vulnerable district.

3.11 Representation of vulnerability; spatial maps, charts and tables of vulnerability profiles and index

The basic idea behind representation of vulnerability is to convey the information about the state of vulnerability and the associated risks to the policy making bodies and other stakeholders. Spatial maps with gradient of colours indicating the level of vulnerability will be used along with graphs, charts and tables.

The different spatial units measured were also represented below categorically based on their Vulnerability Index relative value between 1 to 4; 1 being low to 4 being very high vulnerability.

Table 9*: Composite Vulnerability Index (CVI) value, Vulnerability Rank and Category of different districts of Mizoram for both unequal weight and equal weight*

DISTRICTS	UNEQUAL WEIGHT			EQUAL WEIGHT		
	CVI	RANK	CATEGORY	CVI	RANK	CATEGORY
Lawngtlai	0.783	1	High	0.7469	1	High
Lunglei	0.609	2	Medium	0.5906	3	Medium
Mamit	0.606	3	Medium	0.5900	2	Medium
Siaha	0.583	4	Medium	0.5897	4	Medium
Serchhip	0.434	5	Medium	0.4503	5	Medium
Champhai	0.432	6	Medium	0.4273	6	Medium
Kolasib	0.417	7	Medium	0.4272	7	Medium
Aizawl	0.367	8	Low	0.3782	8	Medium

CVI: Composite Vulnerability Index Value

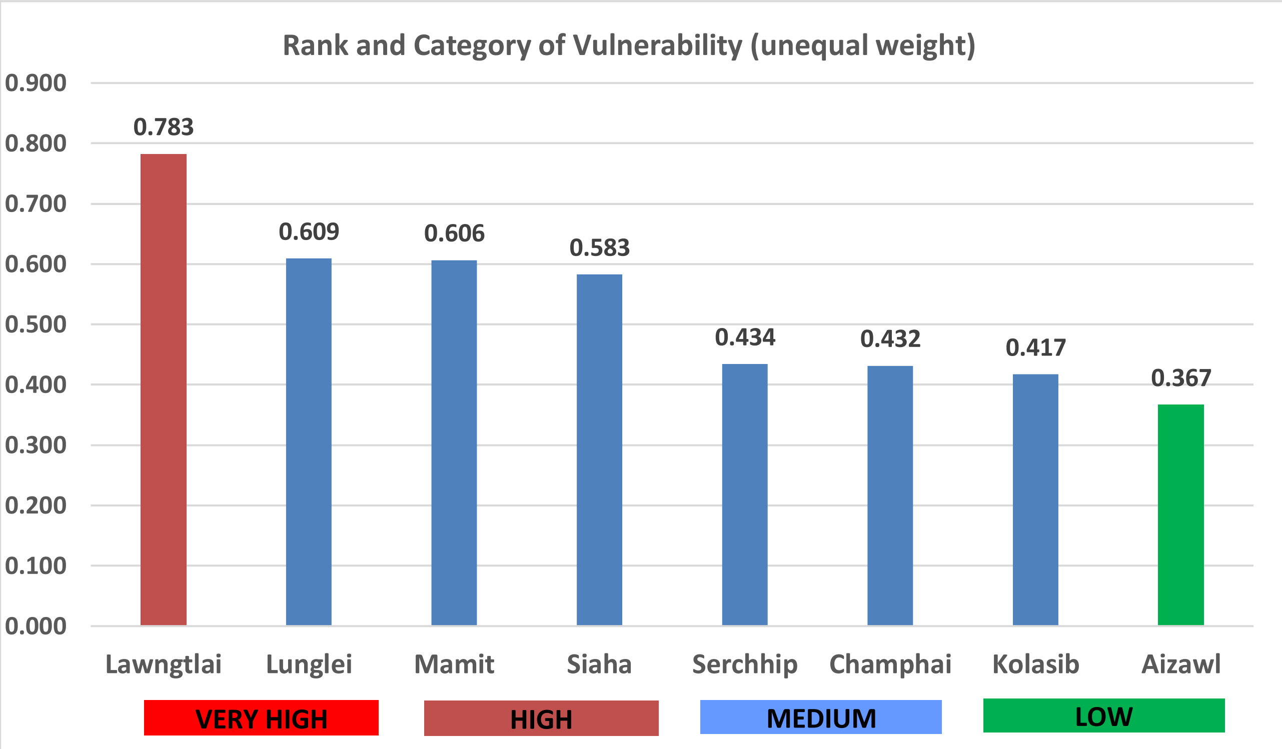


Figure 7a: Composite Vulnerability Index (CVI) value, Vulnerability Rank and Category of different districts of Mizoram for both unequal weight

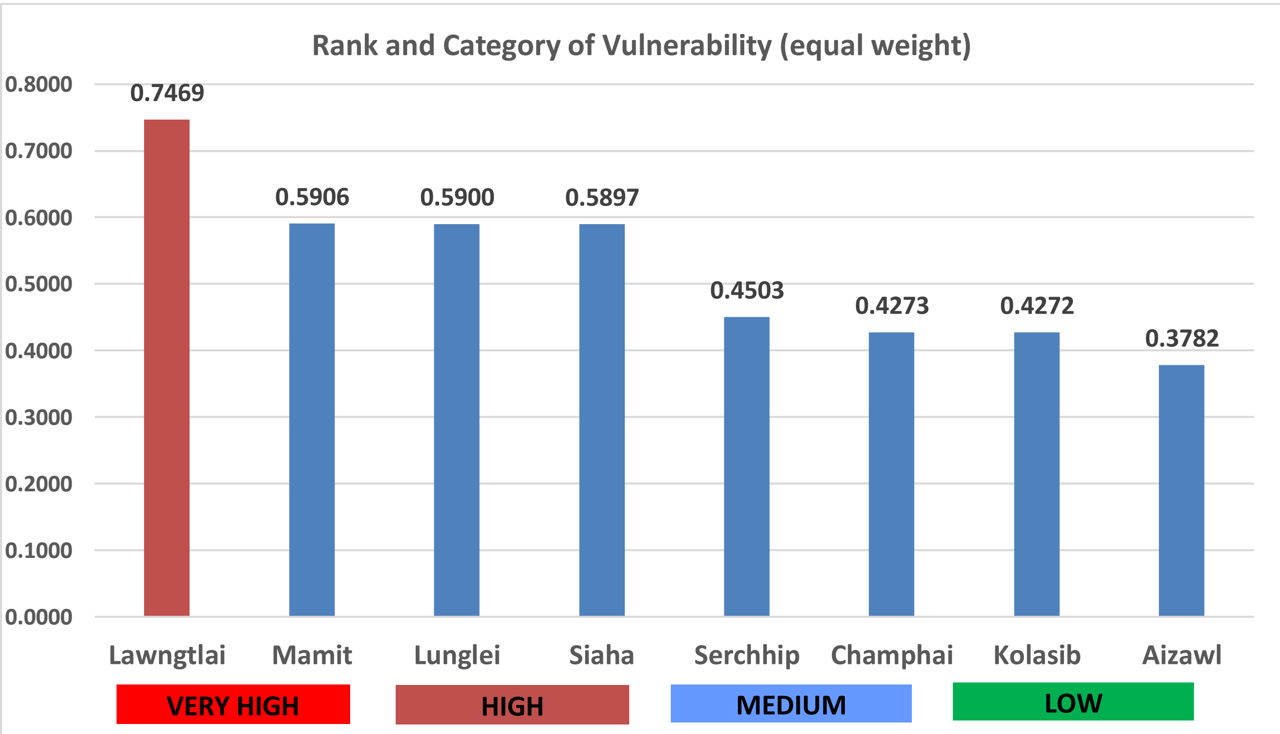


Figure 7b: Composite Vulnerability Index (CVI) value, Vulnerability Rank and Category of different districts of Mizoram for equal weight

Table 9 and Figure 7 (a and b) above shows the Rank and vulnerability of different districts of Mizoram based on the Composite Vulnerability Index (CVI). Lawngtlai district rank the highest and was placed in High vulnerability category for both unequal and equal weight. This could be attributed to the district's standing first for six different indicators, second in four (both unequal and equal) as worst score out of eighteen indicators. With both unequal and equal weight, Lawngtlai district score the highest percent of farmers with limited land holdings, least forest cover, highest number of rainfed agriculture, most number of vector borne diseases, fewest medical personnel in proportion to population and highest infant mortality rate.

Lunglei district was place in 2nd rank in vulnerability with unequal weight, while it was placed in 3rd rank with equal weight. Lunglei districts position in vulnerability ranking interchanged with Mamit district with difference in weights assigned to indicators. Mamit district ranked 2nd with equal weight whereas it was placed in 3rd rank with unequal weight. Both these districts were placed in medium vulnerability category.

The interchanging rank position for Lunglei district and Mamit district with unequal and equal weights is due to minute difference in the aggregation of weighted values in which one supersede the score of the other or vice versa by a fraction of decimal points depending on the weights assigned to the indicators.

For both unequal weight and equal, Lunglei district has the least livestock to rural household ratio among all district. It also scores second worst in four indicators (rainfed areas, road density, household piped water connection and cases of vector borne diseases) and third worst in three indicators (poverty, yield variability and presence of rural banks).

Mamit district also shows no variation in score position with weights. With both unequal and equal weight, Mamit district scored the worst among all district in two indicators (poverty and dependency on agriculture), scored second worst in two indicators (availability of medical personnel and infant mortality rate) and scored third worst in four indicators (livestock to rural household ratio, rainfed agriculture areas, average employment under MGNREGA and cases of vector borne diseases).

The vulnerability rank of the remaining five districts remains constant for both unequal and equal weight. Their respective standing out of all districts across all indicators are also constant for both equal and unequal weights. Siaha district rank 4th, followed by Serchhip district in rank 5th, Champhai district in rank 6th. Kolasib district is in rank 7th and Aizawl district being comparatively the least vulnerable district for this study is in rank 8th. The four districts from rank 4th to rank 7th are also placed in Medium vulnerability category. The least vulnerable district, Aizawl district was placed in low vulnerability category with unequal weights while it was placed in medium vulnerability category with equal weight.

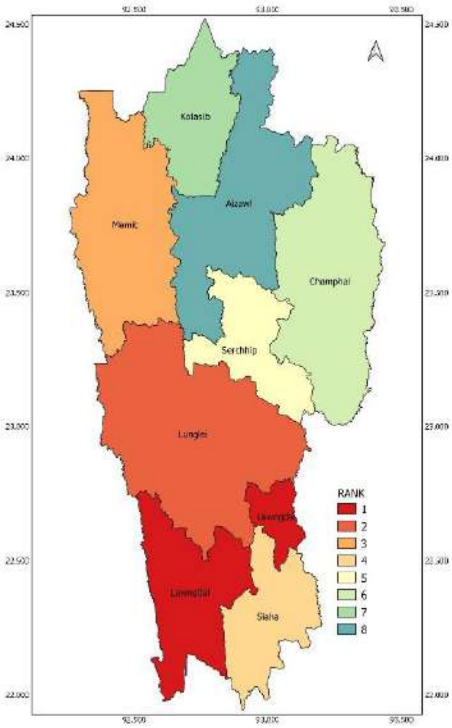


Figure 8a: Vulnerability Rank of different districts of Mizoram for unequal weight

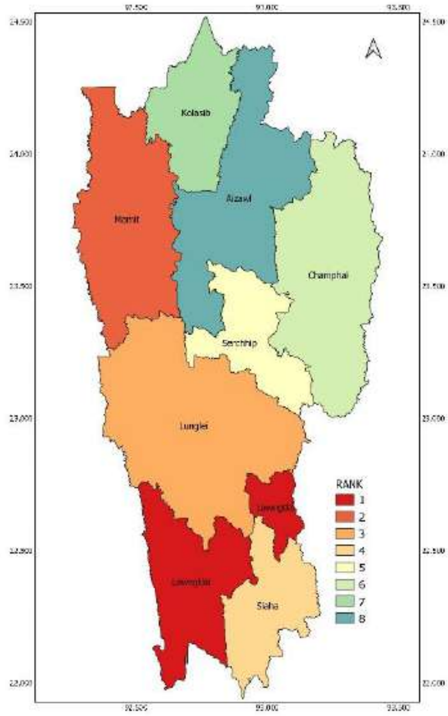


Figure 8b: Vulnerability Rank of different districts of Mizoram for equal weight

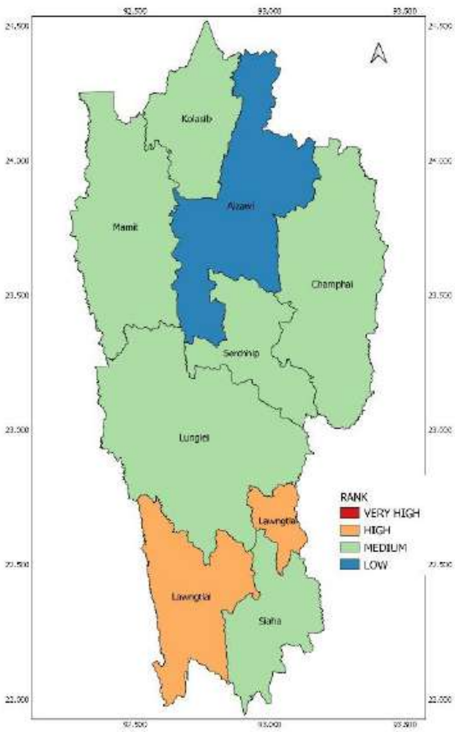


Figure 9a: Vulnerability Category of different districts of Mizoram for unequal weight

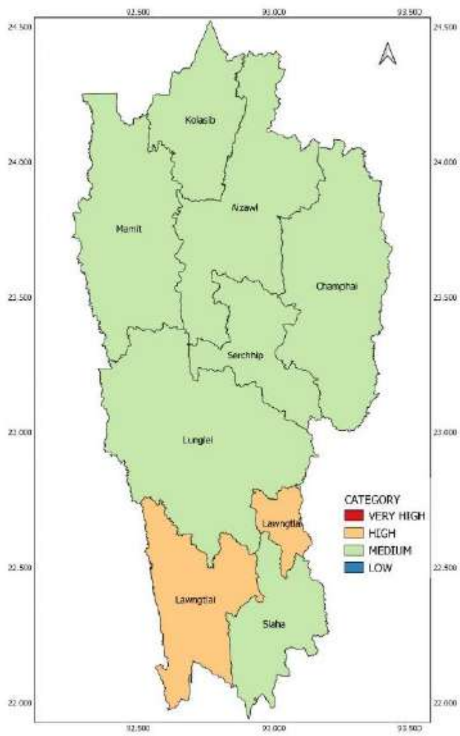


Figure 9b: Vulnerability Category of different districts of Mizoram for equal weight

3.12 Identification of drivers of vulnerability for adaptation planning

Most vulnerability studies are conducted as prerequisite of making policies to prevent further degradation of environmental assets. To develop efficient adaptation planning technique, identifying the main drivers behind vulnerability is crucial. Vulnerability assessment helps in selecting adaptation measures based on the assessment of the drivers of vulnerability.

Drivers of vulnerability are indicators used for vulnerability assessment which are expressed as sensitivity or lack of adaptive capacity. Their respective contributions to Composite Vulnerability Indices are quantified and represented as their magnitude.

For determining the drivers of vulnerability for the whole state of Mizoram, the weighted values across all districts were averaged for each indicator thereby resulting in every indicator having their own weighted values. The percentage score of the weighted value an indicator from the sum of weighted values of all indicators was then considered as the percent contribution of that indicator to the overall vulnerability (drivers of vulnerability); higher percent score indicates higher contribution to vulnerability.

The drivers of vulnerability for each district were also calculated separately by taking the percentage score of their respective weighted value in each indicator from the sum of their respective weighted values across all indicators. The processes for determining the drivers of vulnerability for the whole state of Mizoram and for different districts were done for both unequal and equal weights.

Figure 10a and 10b shows the drivers of vulnerability for the whole state of Mizoram for unequal and equal weights, calculated by averaging the weighted values of all districts combine. Here, the top contributors to vulnerability are less horticulture output to agriculture output, large percentage area under rainfed agriculture and high dependency of population to agriculture as main employment. These are the major drivers of vulnerability for the whole state of Mizoram combined for both unequal and equal weight. Figure 11a to 18b shows the drivers of vulnerability for eight (8) different districts of Mizoram separately with unequal and equal weight.

The frequency of presence of indicator (driver of vulnerability) in top (high percent score) five (5) of drivers of vulnerability determined for overall (all districts combine) and all districts separate. Indicators with high frequency are considered to be important among all the indicators considered in this study as they show disparity in their score across districts regardless of the weight assigned to them.

Table 10 and figure 19 shows the frequency of indicators in top 5 drivers of vulnerability across all districts and Mizoram combine. Among all the indicators (n=18) (drivers of vulnerability), less horticulture output to agriculture output (n=14), large percentage area under rainfed agriculture (n=14) and high dependency of population to agriculture as main employment (n=11) are having the highest frequency out of all the measuring unit considered for the calculation (n=18).

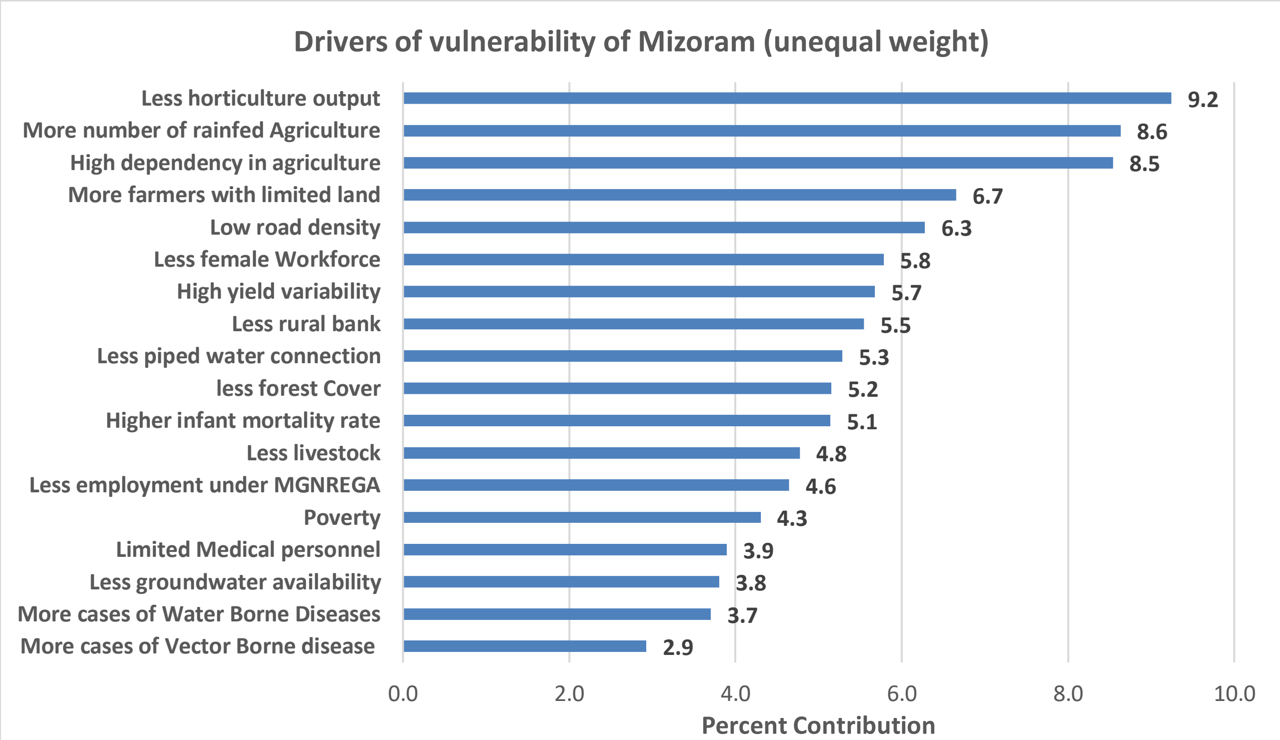


***Figure 10a**: Drivers of vulnerability and their percent contribution for Mizoram (all districts combined) with unequal weight.*

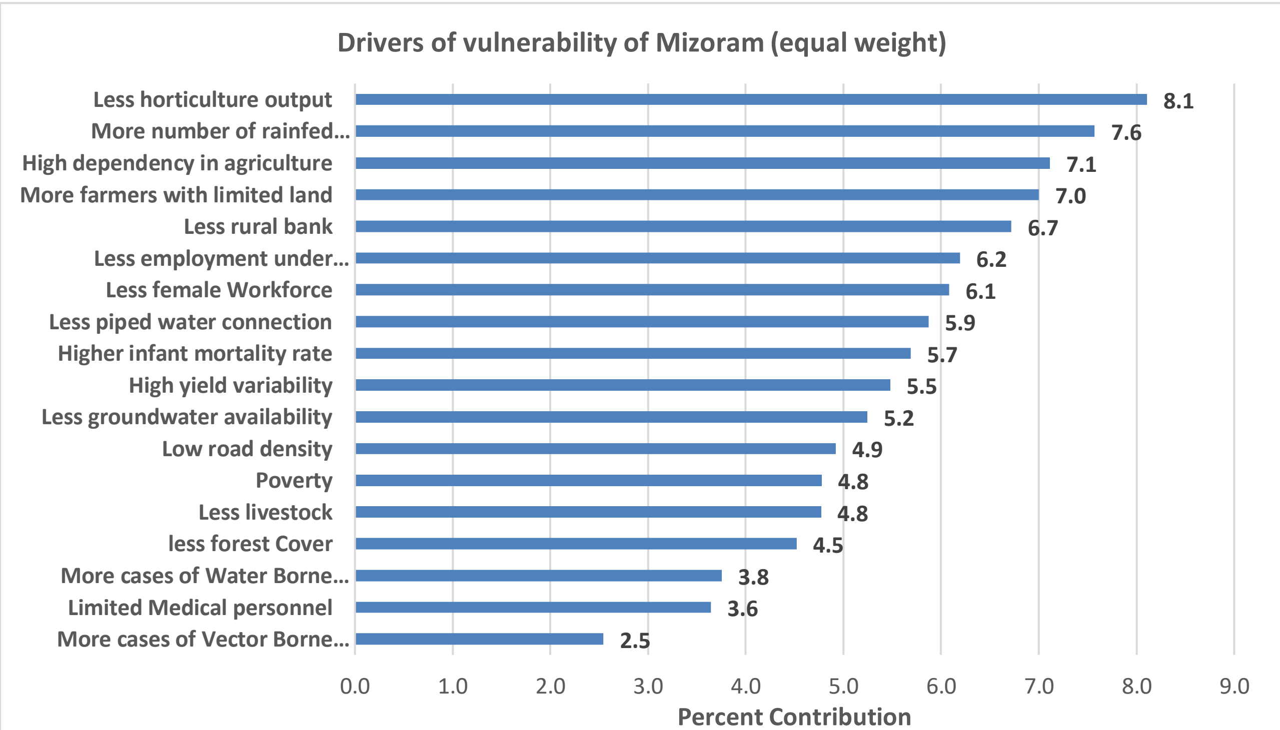


***Figure 10b**: Drivers of vulnerability and their percent contribution for Mizoram (all districts combined) with equal weight.*

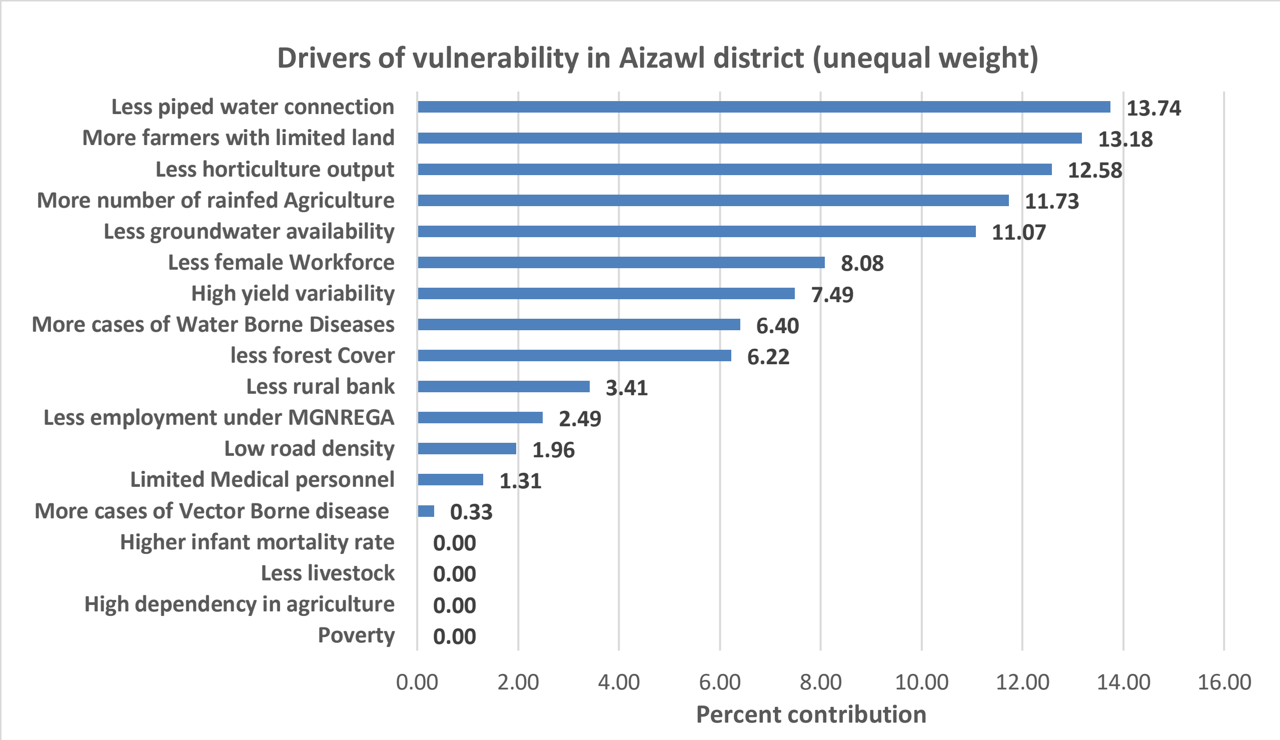


Figure 11a: Drivers of vulnerability and their percent contribution for Aizawl district with unequal weight.

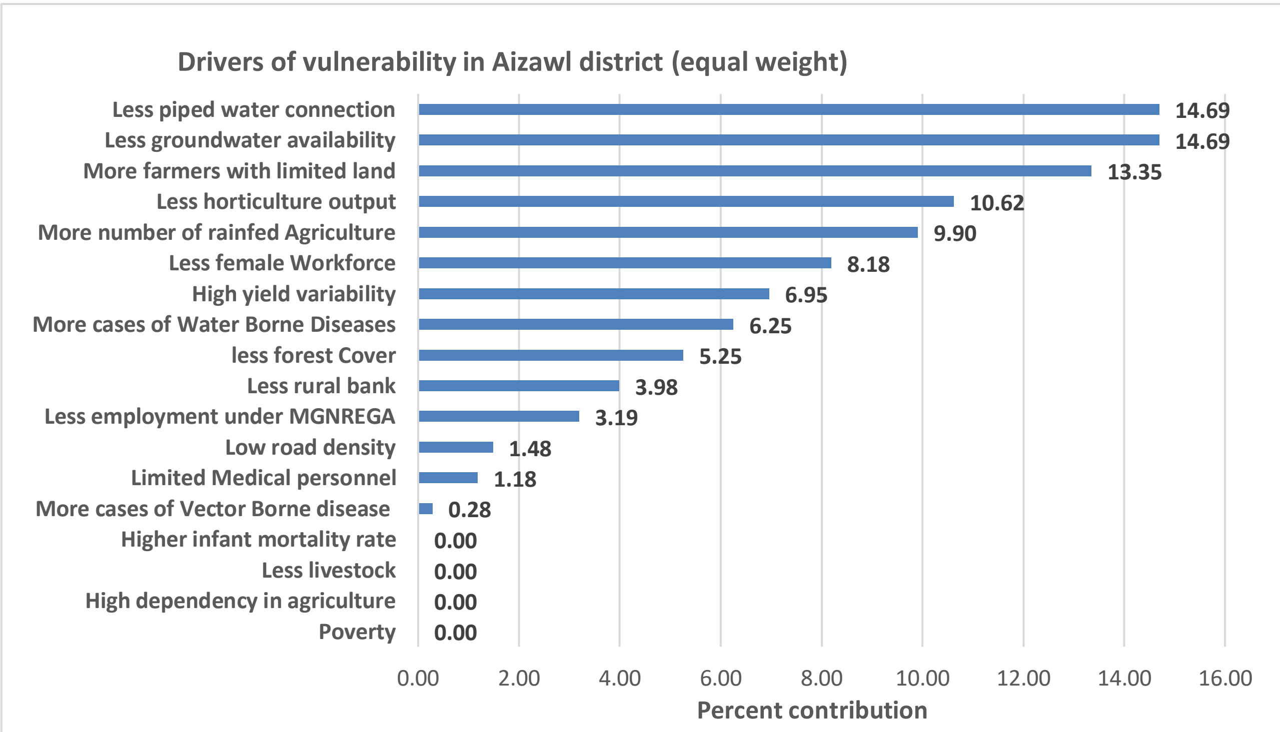


Figure 11b: Drivers of vulnerability and their percent contribution for Aizawl district with equal weight.

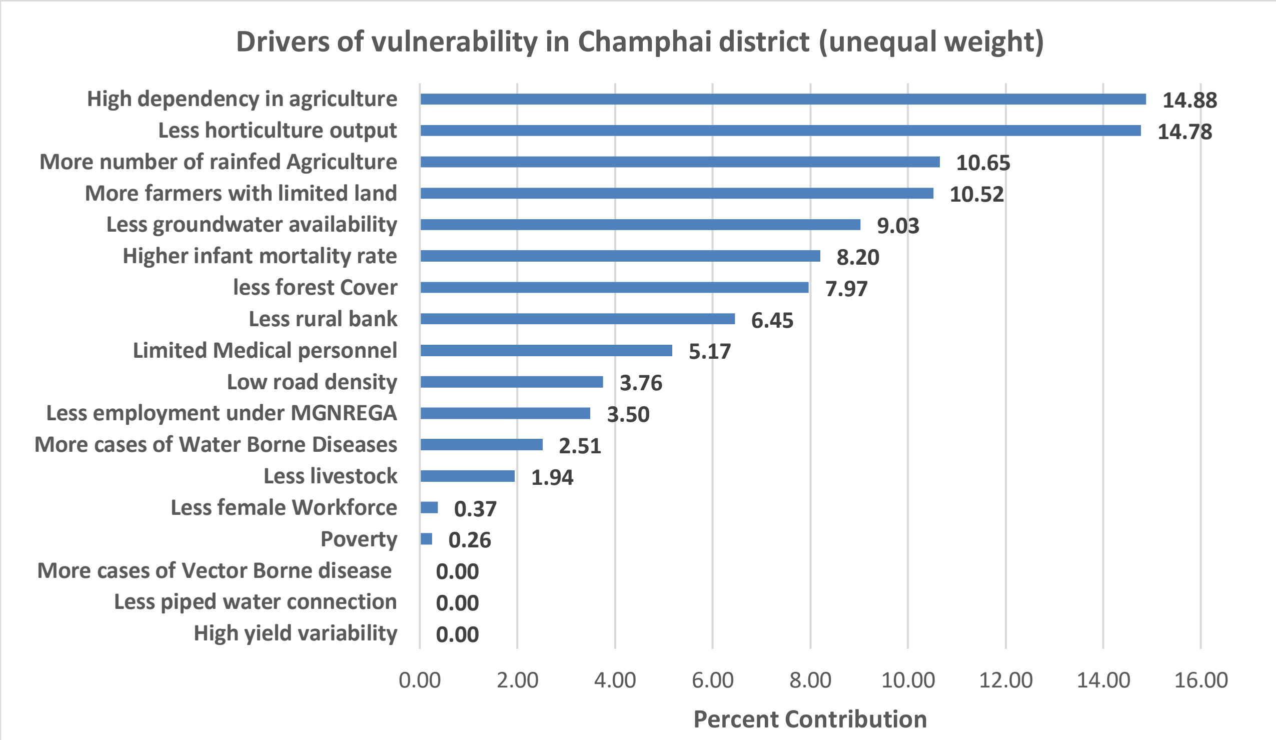


Figure 12a: Drivers of vulnerability and their percent contribution for Champhai district with unequal weight.

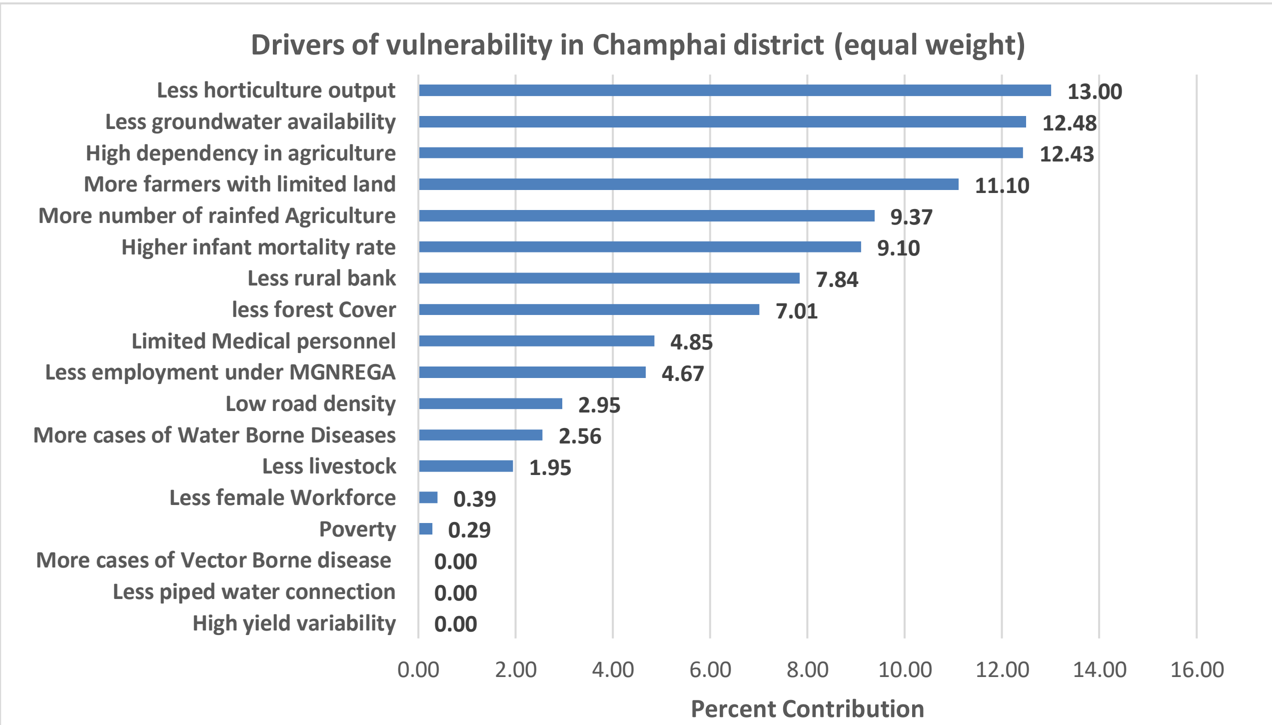


Figure 12b: Drivers of vulnerability and their percent contribution for Champhai district with equal weight.

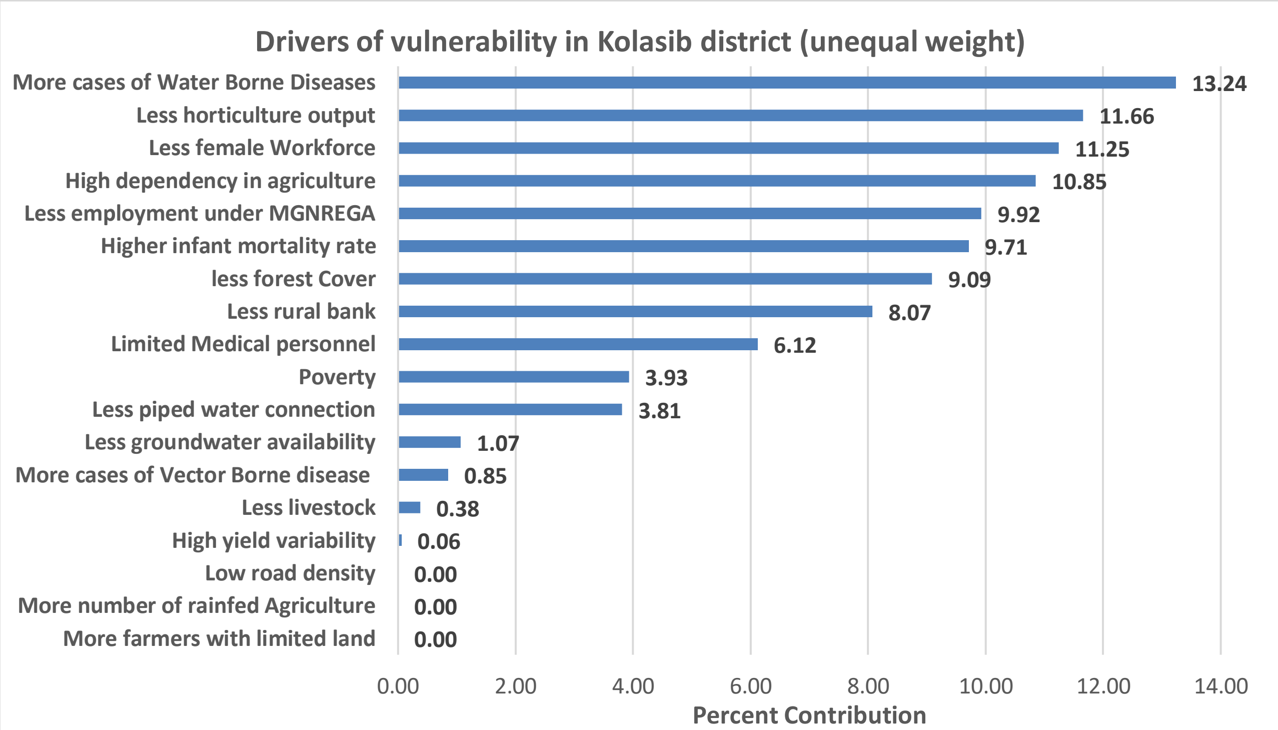


Figure 13a: Drivers of vulnerability and their percent contribution for Kolasib district with unequal weight.

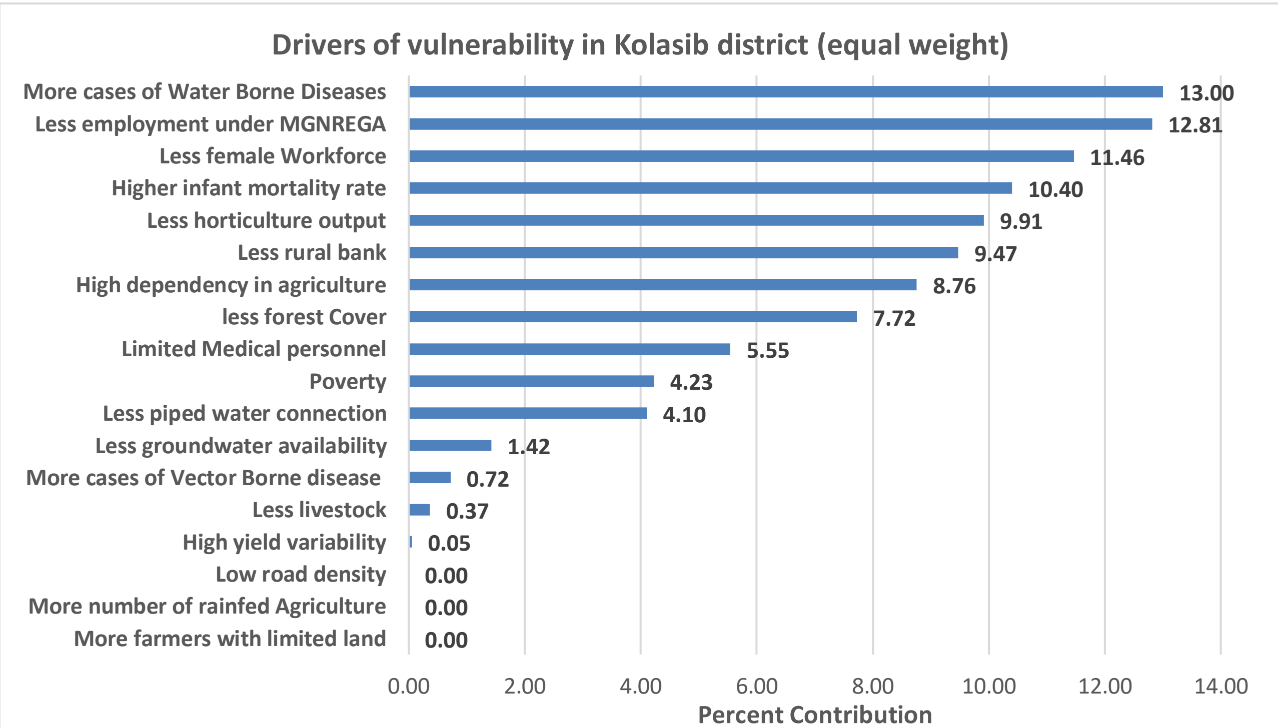


Figure 13b: Drivers of vulnerability and their percent contribution for Kolasib district with equal weight.

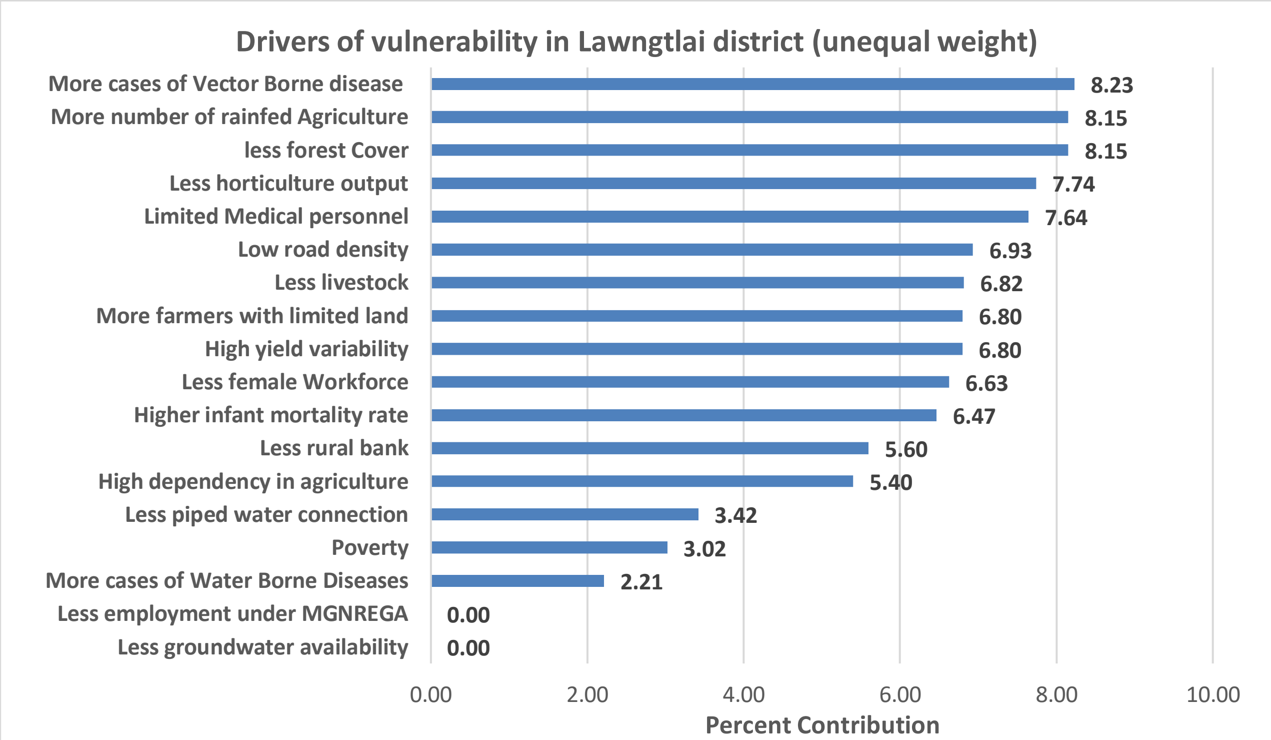


Figure 14a: Drivers of vulnerability and their percent contribution for Lawngtlai district with unequal weight.

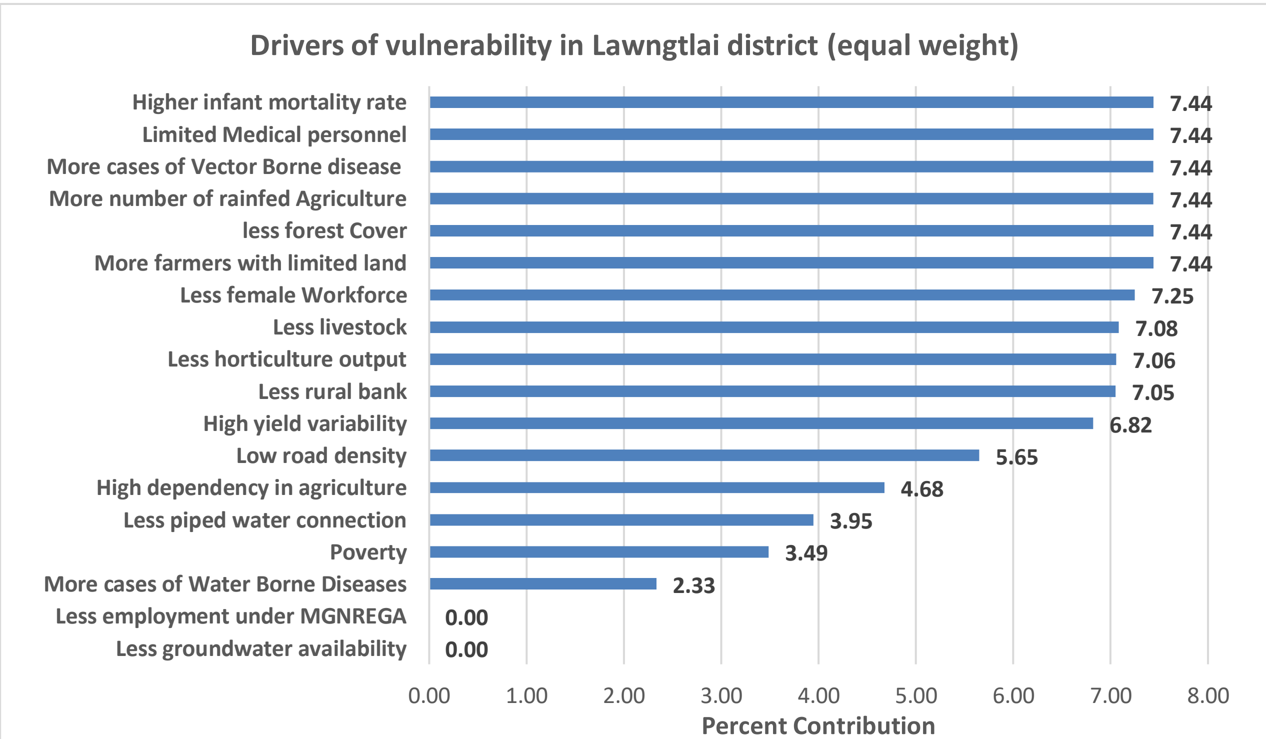


Figure 14b: Drivers of vulnerability and their percent contribution for Lawngtlai district with equal weight.

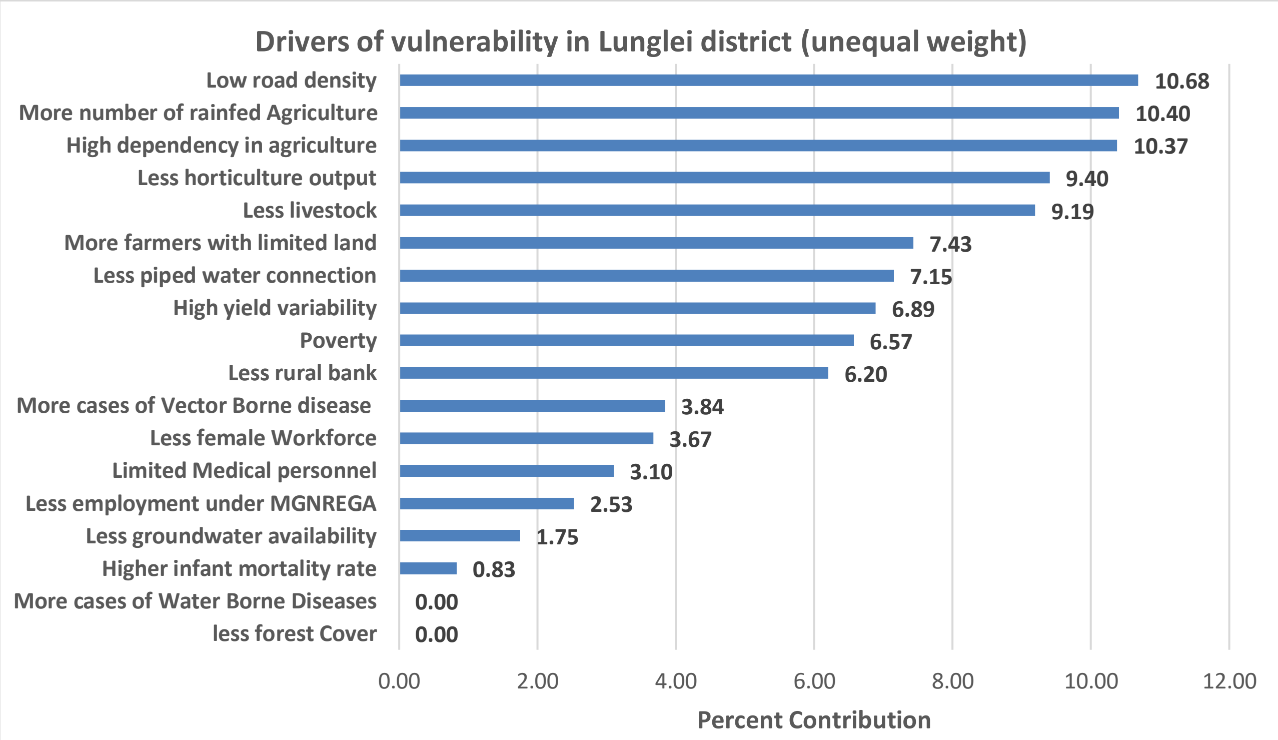


Figure 15a: Drivers of vulnerability and their percent contribution for Lunglei district with unequal weight.

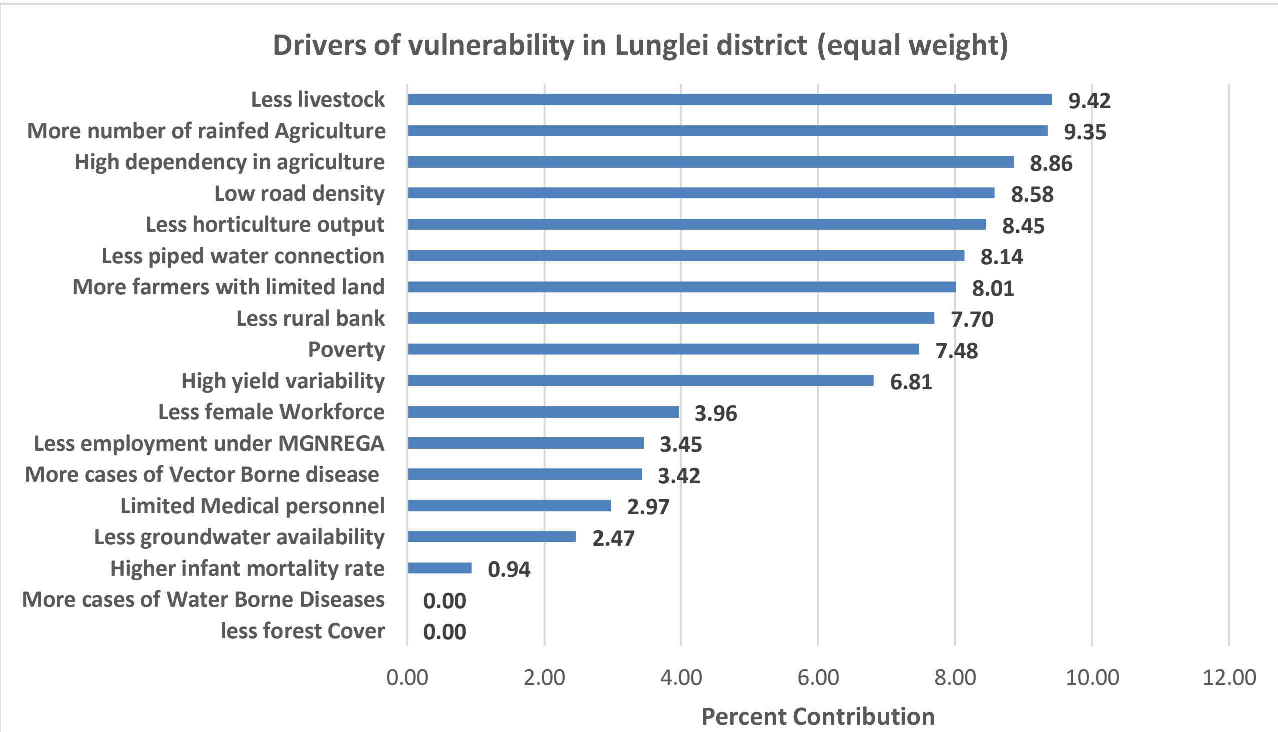


Figure 15b: Drivers of vulnerability and their percent contribution for Lunglei district with equal weight.

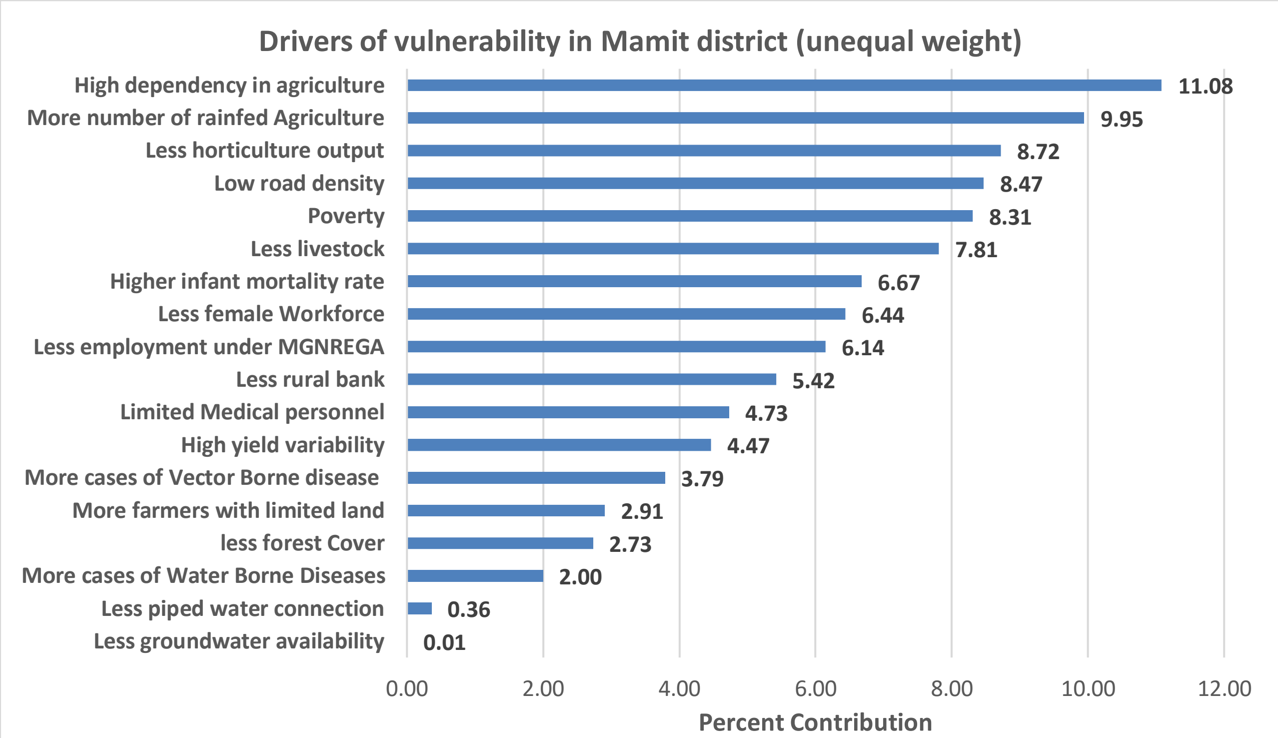


Figure 16a: Drivers of vulnerability and their percent contribution for Mamit district with unequal weight.

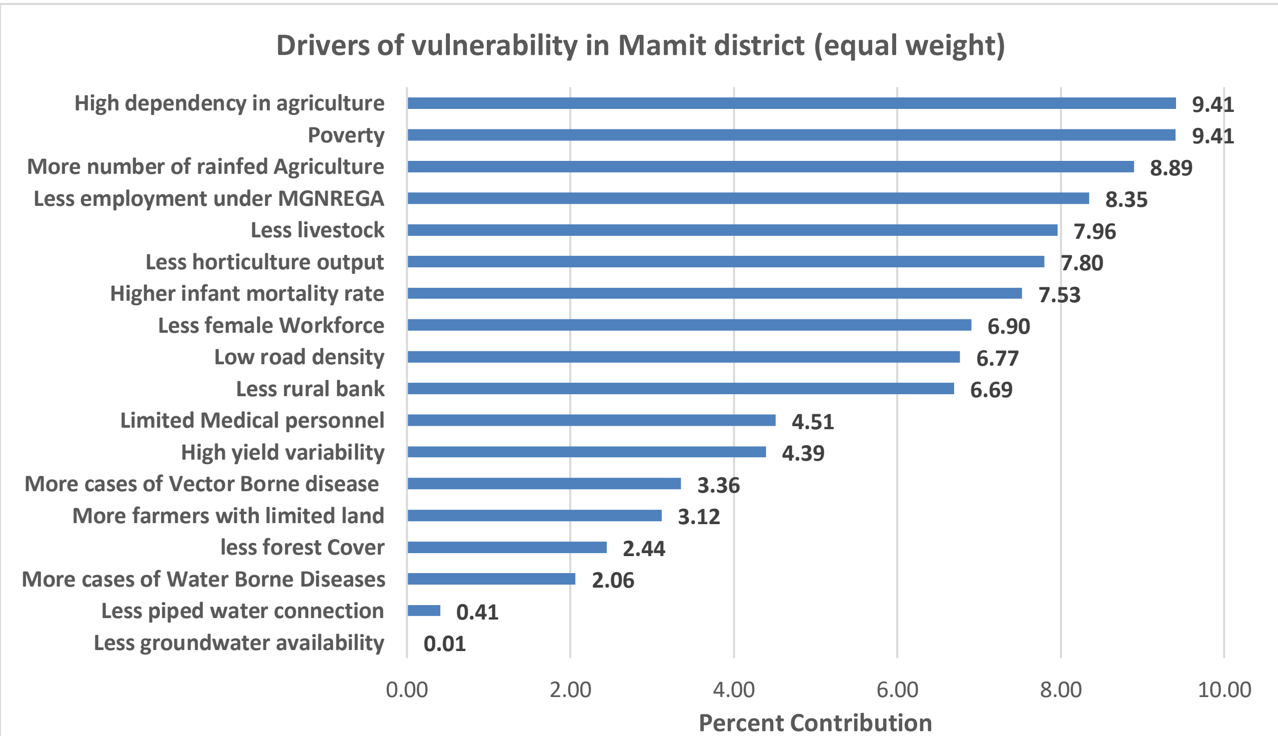


Figure 16b: Drivers of vulnerability and their percent contribution for Mamit district with equal weight.

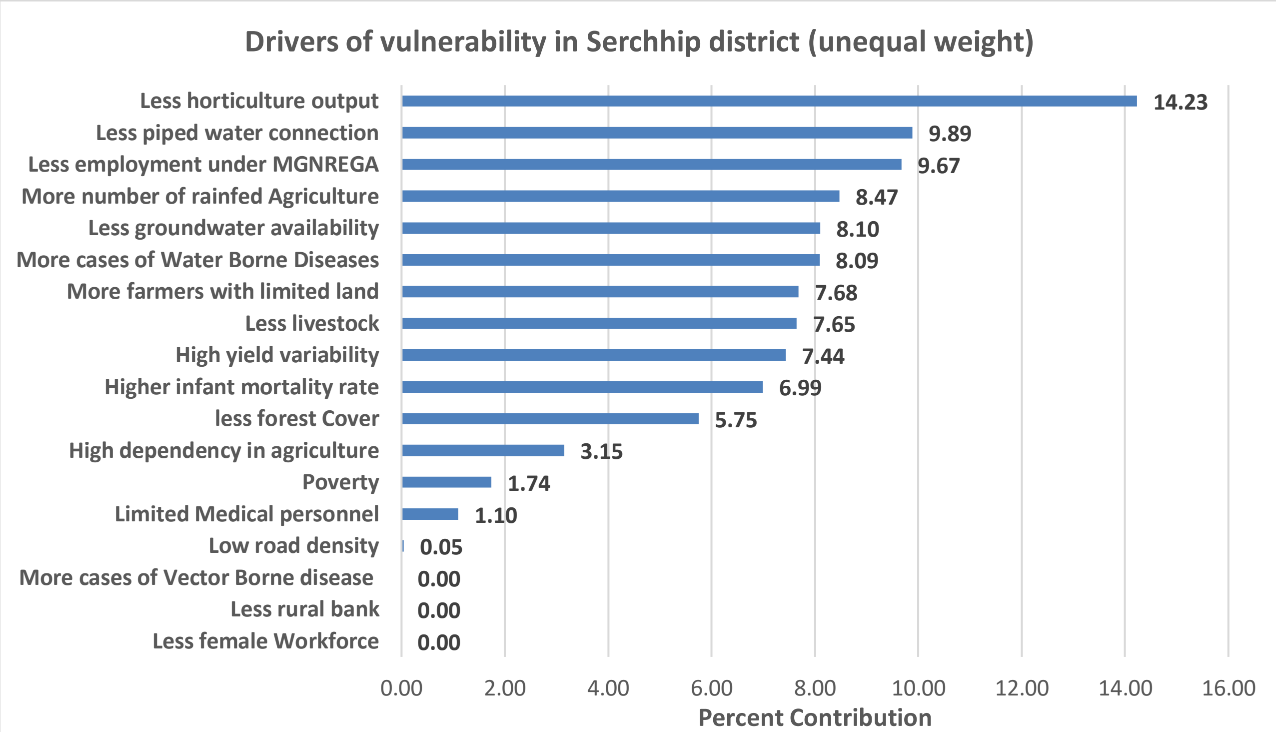


Figure 17a: Drivers of vulnerability and their percent contribution for Serchhip district with unequal weight.

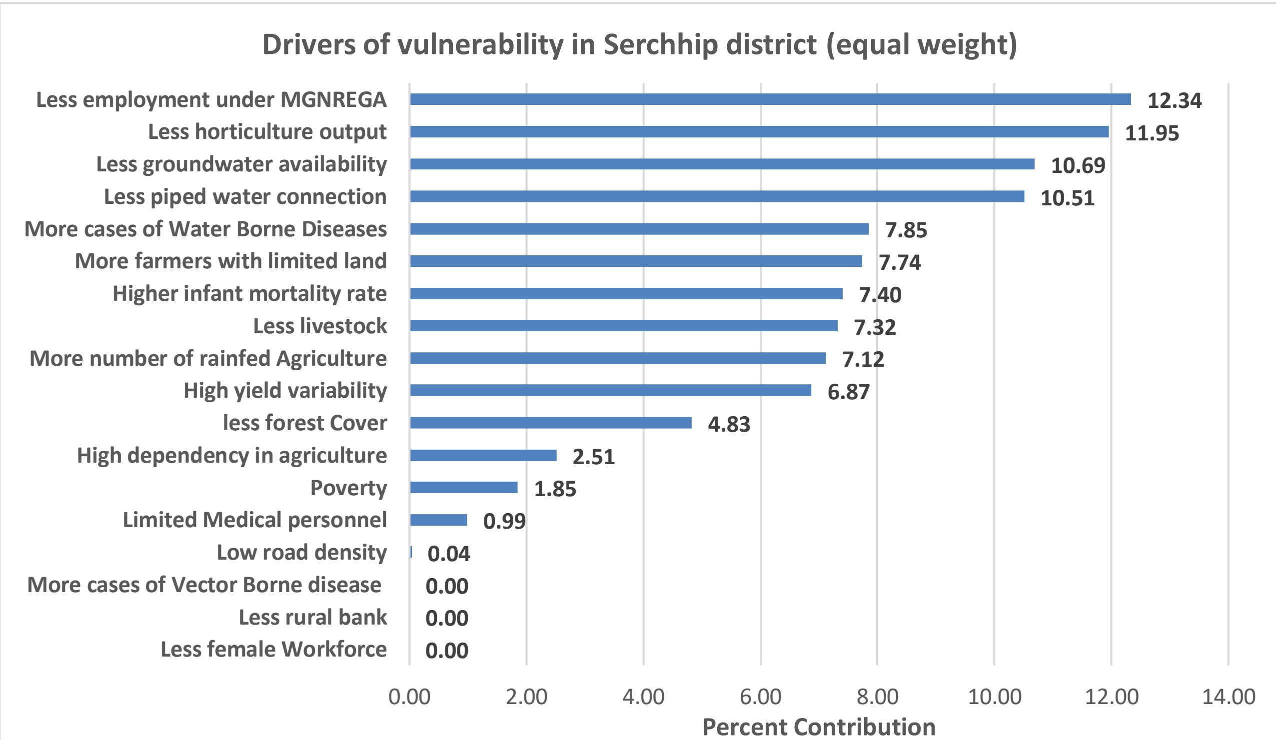


Figure 17b: Drivers of vulnerability and their percent contribution for Serchhip district with equal weight.

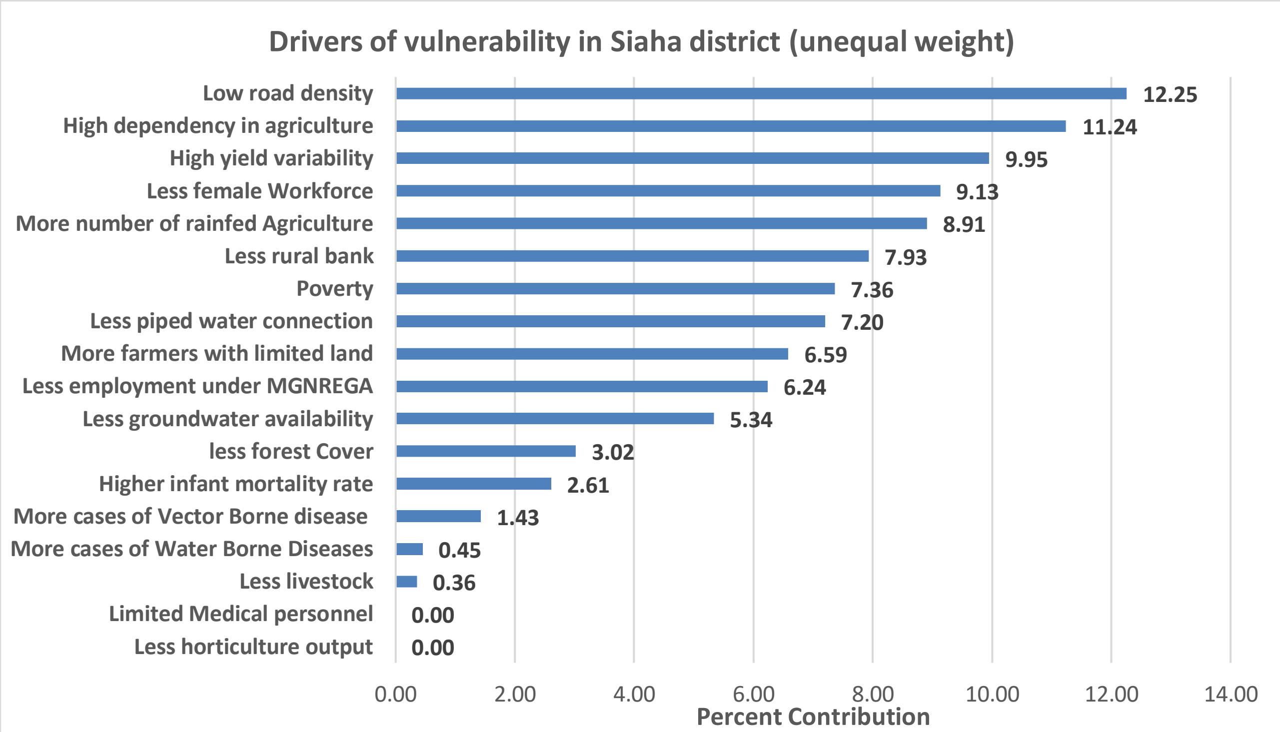


***Figure 18a**: Drivers of vulnerability and their percent contribution for Siaha district with unequal weight.*

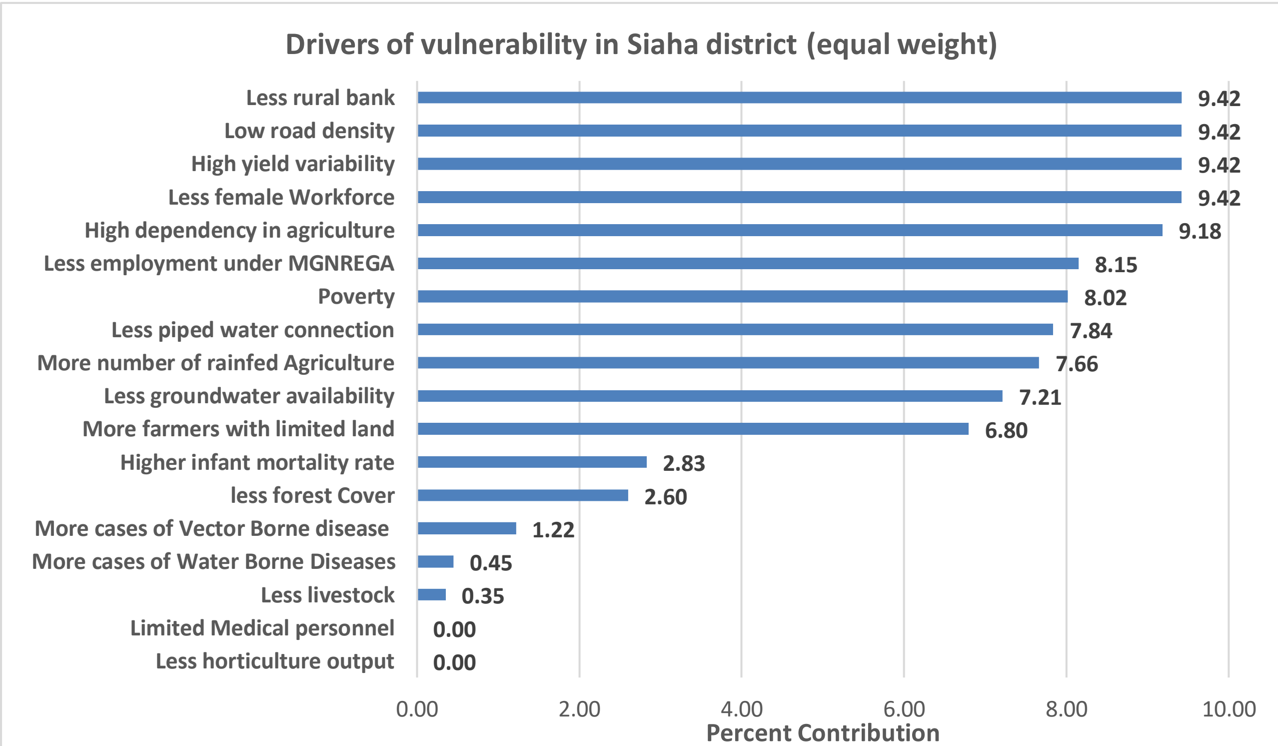


***Figure 18b**: Drivers of vulnerability and their percent contribution for Siaha district with equal weight.*

Table 10: Frequency of indicators in top 5 drivers of vulnerability across all districts and Mizoram combine.

Drivers of vulnerability (Indicators)	Unequal Weights	Equal weights	Total
Less horticulture output	8	6	14
More number of rainfed Agriculture	8	5	13
High dependency in agriculture	6	5	11
Low road density	5	4	9
More farmers with limited land	3	3	6
Less employment under MGNREGA	2	3	5
Less livestock	2	2	4
Less female Workforce	2	2	4
Less groundwater availability	1	3	4
Less piped water connection	2	2	4
Poverty	1	1	2
Higher infant mortality rate	0	2	2
More cases of Vector Borne disease	1	1	2
Limited Medical personnel	1	1	2
Less rural bank	0	2	2
less forest Cover	1	1	2
More cases of Water Borne Diseases	1	1	2
High yield variability	1	1	2

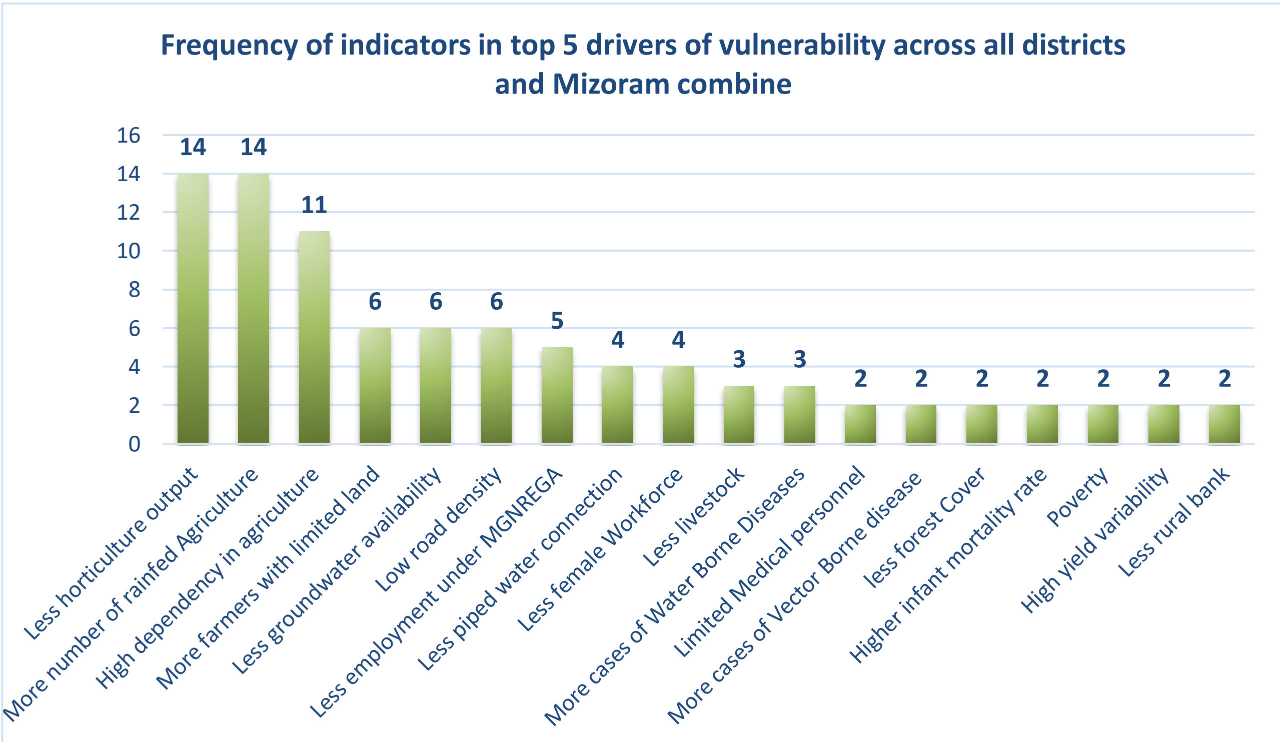


Figure 19: Frequency of indicators in top 5 drivers of vulnerability across all districts and Mizoram combine.

PART IV:
Conclusion

The assessment of vulnerability to climate change has been an important part of climate change research conducted around the globe. There has also been few studies previously done on climate change vulnerability assessment of Mizoram at district level for different sectors by the Mizoram State Climate Change Cell. These previous studies are taken as part of the learning process in which makeshift approach are usually taken due to constraints in technical and other resources. Whereas, the study in this report is conducted using robust methodology following the framework designed by Sharma et al. 2018 which was based on the risk assessment framework proposed by the Working Group II of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) published in 2014. Further, the study in this report was conducted specifically for the state of Mizoram in which apart from literatures, experts and stakeholders were consulted for the process of identifying specific indicators relevant to the state and for weighing of indicators which is a crucial part of the assessment process. Therefore, the result produce out of this assessment is believed to reflect the ground reality in the state.

The composite vulnerability indices determined for pre-existing eight districts of Mizoram based on eighteen sets of indicators for both unequal assigned weight and equal weight reveals that the values are highest for Lawngtlai district (0.783 and 0.7469) followed by Lunglei district (0.609 and 0.5906) Mamit district (0.606 and 0.5900) interchanging position with weights, then Siaha district (0.583 and 0.5879), Serchhip district (0.434 and 0.4503), Champhai district (0.432 and 0.4273), Kolasib district (0.417 and 0.4272) and lastly, Aizawl district (0.367 and 0.3782) being the least vulnerable district. These districts were assigned ranks based on these vulnerability indices calculated.

Vulnerability is a relative measure which indicates that the above ranking based on vulnerability indices are a comparative analysis between districts. Hence, it does not imply that districts having lower value of vulnerability indices are not outright vulnerable, they are comparatively less vulnerable than districts having high vulnerability index values.

A brief analysis on the drivers of vulnerability in general and for different districts suggested that the biophysical features such as horticulture output ratio to agriculture output and large area under rainfed agriculture in the states, including socio-economic features such as large number of farmers depending on agriculture as main employment are the dominant drivers of vulnerability.

While measuring the vulnerability using selected indicators, one should note that there can be other inherent characteristics that can be used as indicators to measure the vulnerability of the same study area. Therefore, the drivers of vulnerability mentioned above are not the only drivers of vulnerability for Mizoram nor it is homogeneous for all the districts. Districts may have specific problem or characteristics that needs to be addressed separately (Figure 11a to 18b). Therefore, vulnerability assessment do not end at this Tier 1 approach study, it is advisable that assessment of vulnerability should be repeated at finer resolution at block/village level/community level using primary data of location specific indicators.

Having said that, the result of this assessment provide an overview of the current scenario of Mizoram against probable impacts of climate change using carefully selected indicators and weights assigned by stakeholders from different background.

The vulnerability ranks and their drivers produced by this study can be used as baseline information for climate change adaptation planning at policy level for selecting priority areas and parameters that needs to be considered when resources for investment are limited.

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APPENDIX

1. Socio-economic and livelihood indicators data

1.1 *Below poverty line data of Mizoram (Directorate of Economics & Statistics, Govt. of Mizoram 2015-2016)*

Name of District	No. of Village Covered	APL Household	BPL household	Total No. of Household	% of BPL Families to the Total Household in the District
AIZAWL	178	77902	7475	85312	**8.76**
CHAMPHAI	106	26312	2715	29043	**9.35**
KOLASIB	52	16028	3401	19359	**17.50**
LAWNGTLAI	173	48427	13162	61593	**21.37**
LUNGLEI	186	26561	11437	37997	**30.10**
MAMIT	87	12977	7186	20163	**35.64**
SERCHHIP	48	12071	1770	13841	**12.79**
SIAHA	92	9172	4245	13416	**31.64**
TOTAL (MIZORAM)	**785**	**208211**	**45381**	**253473**	**18.31**

1.2 *District wise Mizoram data for percentage of population mainly employed in agriculture (Census of India 2011)*

Name of District	Total No. of population	Total number of cultivators	Total number of Agriculture Labourers	Total number of agriculture worker	% of agriculture worker from total pop
AIZAWL	4,00,309	39226	11434	50660	12.66
CHAMPHAI	1,25,745	38336	5823	44159	35.12
KOLASIB	83,955	17992	5921	23913	28.48
LAWNGTLAI	1,17,894	29189	3153	32342	27.43
LUNGLEI	1,61,428	45439	10662	56101	34.75
MAMIT	86,364	28669	2553	31222	36.15
SERCHHIP	56,574	8908	957	9865	17.44
SIAHA	64,937	21804	1284	23088	35.55
TOTAL (MIZORAM)	**10,97,206**	**229563**	**41787**	**271350**	**24.73**

1.3 *District wise Mizoram data livestock equivalency (20th Livestock Census, Govt. of India and Census of India 2011)*

Name of District	Total livestock equivalency	Total rural Population	Livestock equivalency per 1000 rural population
AIZAWL	22530.6	85555	263.35
CHAMPHAI	18247.8	77216	236.32
KOLASIB	9574.9	37077	258.24
LAWNGTLAI	8875	97064	91.43
LUNGLEI	7678.1	92676	82.85
MAMIT	7908.6	71465	110.66
SERCHHIP	5145.6	32918	156.32
SIAHA	8074	31464	256.61
TOTAL (MIZORAM)	**88034.6**	**525435**	**167.55**

Livestock equivalency table (http://www.mospi.gov.in/sites/default/files/publication_reports/Manual%20on%20Animal%20Husbandry%20Statistics.pdf)

Species	adults & old
Horses, Donkeys, mules	1
cattles	0.8
Bufalloes, camels	1.1
sheeps, goats	0.1
pigs	0.2
poultary and other small animals	None

1.4 *District wise Mizoram data on agriculture land holding sizes in ha (Statistical abstract of Mizoram 2017)*

Name of District	No of Marginal land holders	No of Small land holdings between 1 ha to 5 ha land	No of land holdings of all land sizes	% marginal + small farmers
AIZAWL	9861	5286	16329	92.76
CHAMPHAI	9629	8724	20200	90.86
KOLASIB	2183	1451	5925	61.33
LAWNGTLAI	8275	2931	11682	95.93
LUNGLEI	9083	5216	15754	90.76
MAMIT	4304	3294	10438	72.79
SERCHHIP	4130	2041	7432	83.03
SIAHA	2745	810	4120	86.29
TOTAL (MIZORAM)	**50210**	**29753**	**91880**	**87.03**

***1.5** District wise Mizoram data on female workforce (Census of India 2011)*

Name of districts	Main Workers			Marginal workers			Total Workforce			% Female workforce
	Total	Male	Female	Total	Male	Female	Total	Male	Female	
AIZAWL	151410	94442	56968	23226	10201	13025	174636	104643	69993	40.08
CHAMPHAI	53111	31518	21593	7231	2611	4620	60342	34129	26213	43.44
KOLASIB	29697	20013	9684	6975	2720	4255	36672	22733	13939	38.01
LAWNGTLAI	38082	25757	12325	7484	2760	4724	45566	28517	17049	37.42
LUNGLEI	62013	40961	21052	16279	5269	11010	78292	46230	32062	40.95
MAMIT	36185	23226	12959	3154	790	2364	39339	24016	15323	38.95
SERCHHIP	29838	17428	12410	2559	833	1726	32397	18261	14136	43.63
SIAHA	14694	9960	4734	4767	2251	2516	19461	12211	7250	37.25
TOTAL (MIZORAM)	415030	263305	151725	71675	27435	44240	486705	290740	195965	40.26

2. Biophysical indicators data

***2.1** District wise Mizoram data on forest cover (India State of Forest report, 2019)*

Name of districts	Forest area in sq km	Forest area in Ha	Rural population			Forest area in Ha per 1000 rural population
			Male	Female	Total	
AIZAWL	3078.91	307891	43780	41775	85555	359.87
CHAMPHAI	2487.79	248779	39110	38106	77216	322.19
KOLASIB	1152.55	115255	19097	17980	37077	310.85
LAWNGTLAI	2200.08	220008	49940	47124	97064	226.66
LUNGLEI	4022.17	402217	47577	45099	92676	434.00
MAMIT	2716.87	271687	37135	34330	71465	380.17
SERCHHIP	1161.65	116165	16643	16275	32918	352.89
SIAHA	1185.49	118549	15853	15611	31464	376.78
TOTAL (MIZORAM)	18005.51	1800551	269135	256300	525435	342.68

2.2 *District wise Mizoram data on horticulture and agriculture output (in Metric tonne) (Statistical abstract of Mizoram 2017). Here value and total production are relative value, so total production in metric tonne are considered for the data.*

Name of districts	Horticulture output									
	Orange	Banana	Grape	cabbage	passion fruit	Tomato	Birdeye chilli	chow chow	turmeric	ginger
AIZAWL	6615	37043	1268	14230	498	5470	2220	29220	2714	9322
CHAMPHAI	5260	9403	10903	4647	528	1360	1583	6270	2001	8218
KOLASIB	4307	8736	1050	4281	179	1050	967	8080	4181	9450
LAWNGTLAI	3508	6500	1370	10378	105	350	937	6190	2138	5923
LUNGLEI	3991	13308	777	4472	168	2458	1571	9680	2790	5944
MAMIT	4160	7512		4679	76	1010	1265	6540	8325	9396
SERCHHIP	9856	50707	1656	4452	301	630	1256	11240	3848	8769
SIAHA	3643	7837	974	2497	255	520	927	4710	2898	5721
TOTAL (MIZORAM)	**41340**	**141046**	**17998**	**49636**	**2110**	**12848**	**10726**	**81930**	**28895**	**62743**

Name of districts	Agriculture output						Total Horti	Total Agri	Horti/ Agri
	Paddy	maize	Pulse	Oilseeds	sugarcane	potato			
AIZAWL	6416	894	1243	420	15630		108600	24603	4.41
CHAMPHAI	14383	635	296	217	2730	141	50173	18402	2.73
KOLASIB	10961	1141	887	606	5065		42281	18660	2.27
LAWNGTLAI	9485	1685	278	214	2485	538	37399	14685	2.55
LUNGLEI	6339	917	446	181	3960	8	45159	11851	3.81
MAMIT	4826	1256	532	156	2240		42963	9010	4.77
SERCHHIP	7347	2000	1002	684	18026		92715	29059	3.19
SIAHA	1759	383	90	25	396		29982	2653	11.30
TOTAL (MIZORAM)	**61516**	**8911**	**4774**	**2503**	**50532**	**687**	**449272**	**128923**	**3.48**

2.3 *District wise Mizoram data on rainfed areas in Ha (Statistical abstract of Mizoram 2017).*

Name of District	Net irrigated area	Agriculture area operated by all size	% rainfed areas
AIZAWL	1824	15234.16	88.03
CHAMPHAI	2445	22273.59	89.02
KOLASIB	3048	11583.68	73.69
LAWNGTLAI	487	9670.96	94.96
LUNGLEI	817	15772.27	94.82
MAMIT	1078	17399.98	93.80
SERCHHIP	1256	8944.7	85.96
SIAHA	352	3910	91.00
TOTAL (MIZORAM)	**11307**	**104789.34**	**89.21**

2.4 *District wise Mizoram data yield variability from 2008-2009 to 2017-2018 (Area and production statistics, Ministry of Agriculture)*

Name of District	Mean yield of rice and maize	Standard Deviation	Coefficient of Variation (Variability of yield)
AIZAWL	1.42	0.30	21.25
CHAMPHAI	1.55	0.12	7.61
KOLASIB	1.47	0.11	7.73
LAWNGTLAI	1.56	0.53	34.04
LUNGLEI	1.76	0.50	28.46
MAMIT	1.44	0.30	21.06
SERCHHIP	1.31	0.48	36.43
SIAHA	1.36	0.32	23.65

2.5 *District wise Mizoram data on availability of groundwater in CUM (Public Health Engineering Department, Government of Mizoram 2018)*

Name of District	No. of population	No. of household	Total geographical area (TGA) (sq. km)	Annual extractable ground water resources	Available ground water resource wrt TGA
AIZAWL	400309	82524	3576	1398.71	0.39
CHAMPHAI	125745	25520	3185	1373.95	0.43
KOLASIB	83955	17270	1382	1782.90	1.29
LAWNGTLAI	117894	22984	2557	3581.37	1.40
LUNGLEI	161428	33058	4536	5153.85	1.14
MAMIT	86364	17731	3025	4234.27	1.40
SERCHHIP	56574	11144	1399	735.87	0.53
SIAHA	64937	12622	1421	891.76	0.63
TOTAL (MIZORAM)	**1097206**	**222853**	**21081**	**19152.68**	**0.91**

3. Institutional and infrastructure indicators data

3.1 *District wise Mizoram data on road density (in Kms) (Statistical abstract of Mizoram 2017)*

Name of District	Geographical area	National Highway	State Highway	District road	Village road	Town road	Total road length	Road density
AIZAWL	3576	353.00	164.00	132.60	474.65	63.37	1187.62	0.33
CHAMPHAI	3185	189.00		263.20	375.35	170.84	998.39	0.31
KOLASIB	1382	160.00	6.00	190.90	46.50	76.06	479.46	0.35
LAWNGTLAI	2557	137.82		152.50	234.30	76.40	601.02	0.24
LUNGLEI	4536	249.50		329.00	257.90	128.59	964.99	0.21
MAMIT	3025	174.62		355.50	128.15	70.64	728.91	0.24
SERCHHIP	1421	68.00		156.00	193.75	74.63	492.38	0.35
SIAHA	1399	82.38			152.55	44.40	279.33	0.20
TOTAL (MIZORAM)	**21081**	**1414.32**	**170**	**1579.7**	**1863.15**	**704.93**	**5732.1**	**0.27**

3.2 *District wise Mizoram data on rural banks (Head Office, Mizoram Rural Bank 2019)*

Name of District	No of Mizoram Rural Bank (MRB) rural branches	Total number of Rural population	No bank per 1000 rural population
AIZAWL	14	85555	0.16
CHAMPHAI	8	77216	0.10
KOLASIB	3	37077	0.08
LAWNGTLAI	4	97064	0.04
LUNGLEI	6	92676	0.06
MAMIT	6	71465	0.08
SERCHHIP	7	32918	0.21
SIAHA	1	31464	0.03
TOTAL (MIZORAM)	**49**	**525435**	**0.78**

3.3 *District wise Mizoram data on Average person-days employment generated per household under MGNREGA (http://nrega.nic.in)*

Name of Districts	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	Average persondays /household
AIZAWL	70.88	85.56	82.92	96.88	94.93	86.23
CHAMPHAI	65.75	93.20	78.54	94.72	93.53	85.14
KOLASIB	67.73	81.53	69.55	88.93	94.08	80.36
LAWNGTLAI	69.55	96.53	88.48	91.30	93.58	87.89
LUNGLEI	70.18	95.64	68.75	96.10	94.79	85.09
MAMIT	68.77	81.85	64.28	95.21	95.44	81.11
SERCHHIP	66.49	81.10	74.28	84.01	95.41	80.25
SIAHA	73.15	81.85	72.69	82.14	96.58	81.28
TOTAL (MIZORAM)	**69.06**	**87.15**	**74.94**	**91.16**	**94.79**	**83.42**

3.4 *District wise Mizoram data on Household piped water connection (Public Health Engineering Department, Government of Mizoram 2019)*

Name of District	No. of population	No. of household	Total household connection	% piped water connection
AIZAWL	4,00,309	82,524	3,728	4.52
CHAMPHAI	1,25,745	25,520	3,342	13.10
KOLASIB	83,955	17,270	1,794	10.39
LAWNGTLAI	1,17,894	22,984	1,963	8.54
LUNGLEI	1,61,428	33,058	1,879	5.68
MAMIT	86,364	17,731	2,256	12.72
SERCHHIP	56,574	11,144	645	5.79
SIAHA	64,937	12,622	752	5.96
TOTAL (MIZORAM)	**10,97,206**	**2,22,853**	**16,359**	**7.34**

4. Health indicators data

4.1 *District wise Mizoram data on Cases of vector borne diseases (VBD) (Health and Family Welfare Department, Government of Mizoram 2019)*

Name of Districts	Malaria	Dengue	Total	Total	1000 pop	VBD per 1000 pop
AIZAWL	151	101	252	400309	400.309	0.63
CHAMPHAI	6	13	19	125745	125.745	0.15
KOLASIB	119	10	129	83955	83.955	1.54
LAWNGTLAI	2974	2	2976	117894	117.894	25.24
LUNGLEI	1479	18	1497	161428	161.428	9.27
MAMIT	785	1	786	86364	86.364	9.10
SERCHHIP	9	1	10	64937	64.937	0.15
SIAHA	192	0	192	56574	56.574	3.39
TOTAL (MIZORAM)	**5715**	**146**	**5861**	**1097206**	**56.574**	**103.60**

4.2 *District wise Mizoram data on Cases of Water borne diseases (WBD) (Health and Family Welfare Department, Government of Mizoram 2019)*

Name of Districts	Avg combined cases of Acute Diarrhoea, Cholera (lab confirmed) and Viral Hepatitis A,C & E (2016 to 2019)	Total pop	1000 pop	WBD per 1000 pop
AIZAWL	6169.5	400309	400.309	15.41
CHAMPHAI	1236	125745	125.745	9.83
KOLASIB	2472.3	83955	83.955	29.45
LAWNGTLAI	1496.5	117894	117.894	12.69
LUNGLEI	811.75	161428	161.428	5.03
MAMIT	897	86364	86.364	10.39
SERCHHIP	1335.5	64937	64.937	20.57
SIAHA	350.5	56574	56.574	6.20

4.3 *District wise Mizoram data on Cases of Medical personnel (Health and Family Welfare Department, Government of Mizoram 2019)*

Name of Districts	No of medical persons (Doctors, nurses, paramedical personnel)	Total population	No of medical persons per 100 pop
AIZAWL	2028	400309	5.07
CHAMPHAI	520	125745	4.14
KOLASIB	333	83955	3.97
LAWNGTLAI	253	117894	2.15
LUNGLEI	697	161428	4.32
MAMIT	328	86364	3.80
SERCHHIP	329	64937	5.07
SIAHA	301	56574	5.32
TOTAL (MIZORAM)	**4789**	**1097206**	**4.36**

4.4 *District wise Mizoram data on Infant mortality rate (Health and Family Welfare Department, Government of Mizoram 2017-2018)*

Name of Districts	Number of infant death	Rate per 1000 birth
AIZAWL	152	17
CHAMPHAI	44	24
KOLASIB	29	25
LAWNGTLAI	48	27
LUNGLEI	45	18
MAMIT	30	25
SERCHHIP	17	23
SIAHA	24	20
MIZORAM (TOTAL)	389	22.36

About NMSHE

The **National Mission for Sustaining the Himalayan Ecosystem (NMSHE)** is one of the eight missions under India's National Action Plan on Climate Change. The Mission is being coordinated by the Department of Science and Technology, Government of India. The broad objectives of NMSHE include - understanding of the complex processes affecting the Himalayan Ecosystem and evolve suitable management and policy measures for sustaining and safeguarding the Himalayan ecosystem, creating and building capacities in different domains, networking of knowledge institutions engaged in research and development of a coherent data base on Himalayan ecosystem, detecting and decoupling natural and anthropogenic induced signals of global environmental changes in mountain ecosystems, studying traditional knowledge systems for community participation in adaptation, mitigation and coping mechanisms inclusive of farming and traditional health care systems and developing regional cooperation with neighbouring countries, to generate a strong data base through monitoring and analysis, to eventually create a knowledge base for policy interventions.

About Mizoram State Climate Change Cell

The **Mizoram State Climate Change Cell (SCCC)** was created on 25th November, 2014 with the financial support from Strategic Programme Large Initiatives Coordinated Actions Enabler (SPLICE) and Climate Change Programme (CCP) of Department of Science & Technology, Govt. of India through the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) of National Action Plan on Climate Change (NAPCC). There are three project staff along with two project investigators currently working under the cell. The Mizoram SCCC has been functioning under the aegis of Mizoram Science, Technology & Innovation Council (MISTIC), Directorate of Science Technology, Govt. of Mizoram. The Cell concentrates in implementation of its own project objectives whilst meeting the requirements of the mission objectives of the NMSHE under the National Action Plan on Climate Change (NAPCC), Government of India. Simultaneously, the Mizoram SCCC has been given the responsibility of a leading role by Government of Mizoram to implement the mission objectives of the Strategic Knowledge Mission (SKM) under the Mizoram State Action Plan on Climate Change (SAPCC).

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